YIELD AND STORABILITY OF SWEETPOTATO (*Ipomoea batatas* (L.) Lam) AS INFLUENCED BY CHICKEN MANURE AND INORGANIC FERTILIZER

By

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

JUNE, 2015

DECLARATION

I hereby declare that except for references to the works of other researchers which have been duly cited, this work is the result of my own original research and that this dissertation has neither in whole nor in part been presented for another degree elsewhere.

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ACKNOWLEDGEMENTS

I would like to express my thanks to God Almighty for providing all I needed to make this research work possible.

In writing this thesis, I faced numerous problems which I could not solve single-handedly, but with the help of my lecturers, I surmounted them. My gratitude goes to all the senior members who contributed in diverse ways towards the successful completion of this work.

I wish to express my sincere thanks to my thesis supervisor Prof (Mrs) Essie T. Blay, and my co-supervisors Prof. J.C. Norman and Prof. John Ofosu-Anim, for their guidance and invaluable suggestions.

I wish to express my sincere gratitude to Prof Harrison Kwame Dapaah, Principal of College of Agriculture Education of the University of Education, Winneba, Mampong-Ashanti campus, for his enormous support, encouragement and useful comments.

I thank Mr. William Asante Asiedu and other staff of the Department of Crop Science, University of Ghana for their technical assistance. The staff of the nutrition laboratory in the Noguchi Memorial Institute for Medical Research (MMIMR) of University of Ghana was helpful in laboratory analyses of sweetpotato tuber beta-carotene content. To them I am most grateful

I am also grateful to the Management of the University of Education, Winneba. College of Agriculture Education, Mampong–Ashanti Campus for the provision of land as well as chicken manure from the animal farm for this work. I also express my appreciation to Crop Research Institute and Soil Research Institute of CSIR all in Kumasi for the provision of planting material and for analyses of the soil and manure samples respectively.

Finally, the staff of physical laboratory in the chemistry Department of the Kwame Nkrumah University of Science and Technology in Kumasi was helpful in the laboratory analyses of sweetpotato tubers starch and sugar content.

DEDICATION

This research work is dedicated to God Almighty, my husband Mr. Joseph Essilfie and my children, Issac Nyarko, Josephine Essilfie and William Frempong.

ABSTRACT

Two field experiments were conducted at the Multipurpose Crop Nursery of the University of Education, Winneba, Mampong-Ashanti campus during the minor and major rainy seasons from September, 2011 to January, 2012 and April to August, 2012 respectively to verify the yield and storability of sweetpotato roots as influenced by chicken manure and inorganic fertilzer in the forest transitional agro-ecological zone of Ghana.. In both cropping seasons sweetpotato root tubers were stored for three (3) months after each harvest using three storage methods (Pit, Ash and Grass). The experimental design used for the field experiment was a 2 x 8 factorial arranged in randomized complete block design with four replicates in both studies. In the storability studies the experimental design used was a randomized complete block design with three replications. Sixteen (16) treatments were included in the field experiments. The factors under field study were two varieties of sweetpotato (i) Apomuden (Deep orange-fleshed colour with light orange skin), (ii) Okumkom (White-fleshed colour with light purple skin) and chicken manure and inorganic fertilizer (NPK) combination consisting of seven (7) organic manure and inorganic fertilizer rates and the control. In the storability studies the harvested tubers from the eight field treatments were sorted, cured and stored using the three storage methods (Grass, Ash and Pit). The results obtained revealed that the application of a combination of organic manure (chicken manure) and inorganic fertilizer for soil fertility enhancement in sweetpotato production is a better option than either organic or inorganic fertilizer applied alone. Apomuden grown on 15 – 30 – 30 kg/ha NPK + 5t/ha CM had the highest marketable and total tuber yield during the major cropping season, while Okumkom grown on 15-23-23 kg/ha NPK + 5t/ha CM and other amendments had the highest vegetative biomass (number of leaves per plant and vine fresh weight at harvest) in both seasons. Correlation analyses for both seasons showed that the vegetative growth was negatively correlated with tuber yield and market quality. However, tuber market quality was highly positively correlated with total yield of tuber. The vegetative characters were positively and significantly correlated with each other. The importance of using chicken manure and inorganic fertilizer either alone or preferably in combination as soil amendment to enhance tuber market quality at harvest, tuber nutritional composition with regard to beta-carotene, starch and sugar content over the control was clearly shown from both studies. The sweetpotato root tubers of both varieties with regard to beta- carotene, starch and sugar contents increased with manure application, especially, during the minor season. The results from both seasons clearly showed that for both varieties the pit method was the most effective storage method in terms of beta- carotene as well as starch and sugar contents over both ash and grass storage. Pit storage of Apomuden and Okumkom grown on amended and control plots resulted in improved beta-carotene, starch and sugar contents of root tuber and also stored better than ash and grass storage systems in both seasons. With regard to the cost benefit analysis Apomuden and Okumkom grown on 30-30-30 kg/ha NPK treatment dominated the other amended plots and the control in both growing seasons.

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LIST OF ABBREVIATIONS

FAO	Food and Agriculture Organization
CRI	Crop Research Institute
CSIR	Council for Scientific and Industrial Research,
SRI	Soil Research Institute
Kg	Kilogram
cm	centimeter
m	meter
g	gram
CM	Chicken manure
Ha	Hectare
T	Tonne
Ha^{-1}	Per hectare
Okum	Okumkom
Apm	Apomuden
LSD	Least significant difference
TGB	Total gross benefit
TVC	Total variable cost
MRR	marginal rate of return
NPK	Nitrogen, Phosphorus and Potassium
Δ	Change in cost incurred
HPLC	High performance liquid chromatography
OFSP	Orange fleshed sweetpotato
WFSP	White fleshed sweetpotato

CHAPTER ONE
1.0 INTRODUCTION

1.1 Background of Study

Sweetpotato (*Ipomoea batatas* (L.) Lam) is a dicotyledonous plant belonging to the family Convolvulaceae. It is an important tuber crop grown in the tropics, sub-tropics and warm temperate regions of the world. The crop has a short duration (3 – 4 months).

Sweetpotato is the world's seventh most important staple crop, grown in over 100 countries of the world, covering an estimated total area of 9.2 million hectare, with an annual global production around 125 million tonnes. Almost 95% of the total production is in developing countries. Being relatively resistant to pests and diseases and comparatively water-use efficient, sweetpotato grows well in regions of marginal agricultural production. The crop has the additional advantage that due to rapid soil coverage and good rooting characteristics, it helps to reduce soil erosion. Thus, sweetpotato is a particularly valuable crop for poorer farmers. This is reflected in the distribution of the crop. With an annual per capita production in Africa averaging nearly 9 kg per capita consumption often exceeds 100 kg within poorer communities (CIP 1996).

In many parts of Africa, including Ghana, the crop is grown for its staple properties. The root tuber is eaten boiled or as fried chips. It is also prepared into flour for various domestic uses and drinking juice can also be extracted from the root tuber (CRI, 2003). As a fast growing root crop that can be grown in all regions of the country, giving yields of 20 to 25 tonnes per hectare within four months, Sweetpotato has become an important food crop in Ghana. It is also gaining importance as an export crop in the Bawku East District of the Upper East Region. Farmers in the district export the crop to Burkina Faso, where good prices are obtained (CRI, 2003).

1.2 Problem Statement /Justification

The production of sweetpotato is particularly in the Northern and Central Regions of Ghana and as such local producers are not able to meet the demand for this crop in the country. Although the Crop Research Institute (CRI) in Kumasi had released improved varieties of sweetpotatoes with white, yellow and orange - flesh colours to farmers, it has been observed that the few Ghanaian farmers who engage in small scale potato cultivation in some selected areas in the country face a myriad of problems. The major problem is that there have not been extensive studies on the crop to equip farmers with adequate information on the agronomic practices. Rather work on testing adaptability and acceptability of these released varieties through farmer participatory research and dissemination of planting materials has been carried out (CRI- CSIR, 2006).

Despite its many benefits, sweetpotato is characterized by a low production, yield and tuber quality in the country. This can be attributed to among other factors, the low fertility of the soils on which the crop is grown. Sweetpotato responds to phosphorus and potassium application under most conditions though the response rate and hence optimum dose varies with the cultivar and soil types. Soil fertility depletion in smallholder farms is currently recognized as the fundamental biophysical cause of declining *per capita* food production in Africa. The inherent poor soil fertility of most soils in the tropics and subtropics constitute a major constraint in sustainable smallholder crop production in Sub-Saharan Africa (Myers *et. al.* 1994; Smailing *et al.*, 1997).

The use of both organic and mineral fertilizers is often limited and this has resulted in a gradual depletion of soil nutrients in sub- Saharan Africa (Smailing *et al.,* 1997). Increase in population which has resulted in land shortages has led to reduction in traditional methods of maintaining soil fertility. Technologies based on combinations of organic and inorganic sources of fertilizer would produce higher and more sustainable yields than either organic or inorganic fertilizer alone (Mukhtar *et al.,* 2010).

The soil in the production areas are characterized by low nitrogen, phosphorus and potassium levels (SRI-CSIR, 2003). Since there is increased focus on sweetpotato as source of energy and nutrients to meet the caloric and nutritional needs of the rapidly growing population in Ghana, there is therefore the need to improve the fertility of the soil through good management of potassium and phosphorus to achieve increase tuber yields.

Chemical fertilizers have been the conventional way supplying nutrients to the crop. However with the increasing cost of fertilizers following the removal of government subsidy on the commodity, farmers are looking for alternative but sustainable methods of cultivating the crop. Applying poultry manure in combination with inorganic fertilizers provides a favourable condition for both high and stable yields of various varieties of crops (Palm *et al.,* 1997).

In Ghana, not much work has been done on fertilizer regimes for optimum growth, yield and development of sweetpotato. There is therefore the need for intensive research work on nutrient supply to optimize the yield potential of the crop for commercial and industrial utilization. The identification and selection of appropriate combination and rates of inorganic and organic fertilizers will increase the production levels of sweetpotato in the country and offer the possibility of utilizing the tubers in production of composite flours thereby reducing the importationlevel of wheat flour and similar products for the food industry in Ghana.

The use of foods rich in vitamin A to combat vitamin A deficiencies is gaining importance in most parts of Africa. Increasing the consumption of the foods rich in vitamin A is considered one of the food-based strategies for addressing vitamin A deficiency in the communities (Smailing *et al.,* 1997).

There is the need to satisfy different sectors of the society and to provide the vital nutrients in the diet of those suffering from numerous ailments. There is therefore the need to provide an alternate (cheap) source of these elements. In view of these the inclusion of the orange fleshed cultivar which is important for vitamins and the white fleshed cultivar which is also important source of energy in the evaluation is appropriate in optimizing the soil nutrient supply for different sweetpotato types grown in the country to help combat malnutrition among the under resourced.

There are adaptable varieties that are suitable for the local climatic conditions and planting materials have been released to farmers by Crop Research Institute in the country. Additionally, high beta- carotene cultivars have significant role to play in the national crusade against Vitamin A deficiency (CRI, 2004).

Another serious constraint in large scale production and utilization of sweetpotato in Ghana is the short shelf life of the harvested tuber.The crop is highly perishable and as such requires good storage technique. Lack of suitable storage facilities among smallholder farmers continues to expose farmers to intermittent food shocks even after harvesting of the crop. Farmers rely on preservation methods derived from indigenous knowledge systems for storing the harvested sweetpotato tubers.Studies indicate that post harvest losses due to pest and diseases attack can account for as much as 40-60% of crop output (Amoah *et al.*, 2010). Important techniques of preserving crops derived from indigenous knowledge have rarely been subjected to scientific enquiry. This study is premised on the observation that local smallholder farmers in Ghana use most preservation methods informally but not much is known about their efficacy from a scientific perspective. This study will also examine the different sweetpotato storage techniques to compare their efficacies and comparative effects on tuber quality. Information gleaned from these studies may help to fine tune the indigenous technologies and popularize their use for improvement in sweetpotato production and preservation. This will stem the current trend of abandoning indigenous knowledge systems for more expensive and sometimes hazardous chemical- based methods.

The principal post harvest problems associated with sweetpotato storage are fungal rots, weevil damage and physiological changes (IITA, 1996). The only available storage methods for sweetpotatoes are by leaving the crop in the ground and harvesting it only when needed and trench storage (FAO, 1991). Eka (1998) reported that there is also dearth of information on nutrient changes during storage of most root and tuber crops in Nigeria. It is therefore important to optimize nutrient supply for high yield in the commonly cultivated sweetpotato types in Ghana and to carry out a systematic study of the effects of some storage methods on the stored sweetpotatoes in order to develop improved methods of storage of the crop. This work is therefore aimed at investigating the possible changes in quality and nutritional composition of sweetpotatoes during storage using different storage methods.

1.3Objective of the Study

The objective of the study was to determine the yield and storability of two sweetpotato cultivarsas influenced by chicken manure and inorganic fertilizer in the sweetpotato production forest transitional agro- ecological zone of Ghana.

1.3.1Specific Objectives

The specific objectives are to:

1. Compare the effectiveness of organic (chicken manure), inorganic fertilizers and integrated nutrient management for improvement of soil fertility on sweetpotato.
2. Determine the varietal response of sweetpotato root tubers to organic (chicken manure), inorganic fertilizers and integrated nutrient management.
3. Compare the effectiveness of pit, ash, and grass storage methods for sweetpotato root tubers in terms of: The rate of water loss in the root ubers, weight change, root tuber sprouting, the rate of rotting of root tubers and pest infestation of root tubers.
4. Assess the effect of soil amendments on the quality of sweetpotato
5. Assess the effect of storage methods (Ash, Grass and Pit) on the nutrient levels of sweetpotato root tubers.
6. Determine the financial implication of combined use of chicken manure and inorganic fertilizer on the yield of sweetpotato.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1Origin and Botany

Sweetpotato, which is unknown in the wild state, is suggested to originate from the region that extends from the south of Central America to the north – west of Latin America. (Hawkes, 1989). Its spread to Polynesia and New Zealand dates back to the pre – Columbian times. In the 16th century it reached many areas of Africa, Europe, India and Indonesia through the Portuguese navigators (Yens, 1976).

At present world production of the crop is in excess of 130 million tonnes per annum, but most of it is produced in Asia with China producing over 110 million (85%) tonnes per year. In Africa, sweetpotato is grown in abundance around upland areas in the East African Rift Valley, (Uganda, Burundi, Rwanda, Tanzania and Kenya) each country producing about 1% of the world's crop. The crop is now also widely grown as an important staple food in a number of African countries including Burundi, Rwanda, Uganda and Nigeria among others (Awojobi, 2004). It is also found in most African regions with large variations in relief (e.g. Cameroun, Guinea, Madagascar) or where the dry season is too marked for cassava growing as in the Sudano – Sahdian fringe or in North Africa. In all, sub-Saharan Africa produces only 6% of the world's sweetpotato crop (Tweneboah, 2000). Past and current production trends suggest that sweetpotato output in developing countries is increasing, for example in Africa it is estimated that it is presently growing at about five percent per year (CIP, 1996).

In Ghana, the production of sweetpotato is concentrated almost entirely in the Northern, Upper East and Upper West regions where it is sometimes included in traditional food crop rotations. The crop is also frequently cultivated in the northern part of the Volta region , Ada-Sege areas in Greater Accra region and Komenda –Peposo areas in the Central Region (Tweneboah, 2000).

Sweetpotato (*Ipomoea batatas* (L.) Lam), although naturally a perennial, is commonly grown and harvested within the same cropping season. It belongs to the family Convolvulaceae. It is grown particularly for its edible tubers produced by certain roots. It is propagated by stem cuttings and tubers.

Sweetpotato is a herbaceous plant, generally with trailing stems, only the extremity of which is erect. The stems are often called vines, but they are not true vines. The length of the stems varies between 0.5 and 5 m long depending on the variety and the growing conditions. Latex is present in all parts of the plant (Martin, 1985).

The leaves, measuring up to 15 cm long and pointed at the tip, are spirally arranged and have long petioles of 5 -30 cm. They are cordate, entire or lobed with a more or less pronounced leaf incision with a leaf area index (LAI) of 3-4, its growth decreasing when the LAI exceeds 4 (Bhagsari and Ashley, 1990).

The flowers are violet or white and are hermaphroditic but rarely self-fertile. The corolla is 2.5 - 5 cm long. Flowering and consequently seed production of sweetpotato varies with the variety and the environmental conditions. Flowering is maximal during short days (up to 12 hours of daylight) and stops when daylight lasts more than 13 hours. Natural pollination is done by insects. Cross-fertilization is the general rule as most varieties of sweetpotato are self-incompatible. At each node, cuttings may produce adventitious roots that can be divided into (i) young roots, (ii) fibrous roots, (iii) filiform tubers and (iv) good tubers. Depending on the activity of the primary cambium, the young roots will evolve into one of the three forms of root. In the case of seedlings, there is a fifth category of root, which is a tap-root that appears after germination. This tap-root is predominant in the tuberization process, giving rise to an enormous tuber (Janssens, 2001).

The tubers form where the roots curve downwards after growing horizontally. Their number and size as well as the colour of the skin and flesh are variable. Their weight usually varies between 0.2 and 3 kg and their number from two to five or more per plant. The number of tuberous roots is a major yield component.

Tuberization generally begins between the second and third month, depending on the variety and the agro-ecological conditions. The duration of vegetation, which can be as little as 4 months or as much as 12, depends on the variety and the climate.

The root system is extensive reaching its peak within four (4) weeks after planting (WAP) and secondary thickening starts at 8 WAP and is completed within 16 weeks (Lowe and Wilson, 1974). The root tuber which is the main harvested organ may have a white, yellow, orange, purple or brown skin surface and the flesh is white, yellow, orange, red or purple. It matures within 4 months after planting even though harvesting is delayed on higher elevations due to lower temperatures and radiation (Kimber, 1972).

The skin of the root tuber may be smooth or rough. It is sometimes grainy but only rarely scaly or veined, and may be marked by the points at which the rootlets emerged. The skin colour may change when the root tuber is cut and almost invariably do so when it is attacked by parasites. This turn greenish or dark brown as the tissues oxidise in contact with the air. The colours of the skin and of the storage parenchyma are good indicators of different cultivars in the fresh state, but may alter during cooking. Provided it is kept clean and in a favourable environment, the harvested root tuber will, after a few weeks, produce sprouts that can grow into a new plant. The sweetpotato is thus a perennial (Degras, 2003).

2.2Nutritive Value

The fresh tuber of Sweetpotato contains 60-70 % water, 15-25 % starch, 1-2% proteins and 1-2 % sugar. The tuber also contains significant amount of vitamins A, B1, B2 and C and minerals such as K, Na, P and Ca. The young leaves are also rich in protein, minerals and vitamins (Onwueme and Sinha., 1991). The crop is efficient in the production of carbohydrates, proteins, vitamins and cash income per unit area of land and time (Magagula *et al.*, 2010).

Varieties with yellow or orange flesh have a very high (up to 0.18 %) of beta-carotene and taste of sweetpotato where as the White –fleshed varieties have low contents of beta –carotene, a precursor to vitamin A (Messiaen, 1994).

2.3Varieties

The flesh colour of the root varies from various shades of white, cream, yellow to dark-orange depending upon the pigment present. In the orange-fleshed sweetpotato the major pigment present is carotenoids, especially β-carotene, while anthocyanin is present in purple-fleshed varieties. Several varieties of sweetpotato are cultivated in Ghana for food uses. Scientists of the Crop Research Institute (CRI) of the Council for Scientific and Industrial Research (CSIR) have developed a sweetpotato variety that has the potential of addressing the problem of Vitamin A deficiency in children.The new variety, locally called Sauti, which is said to have high levels of beta carotene, the substance that is synthesized to produce Vitamin A, is, therefore, a viable substitute for Vitamin A capsules administered to children to prevent them from the negative effects of Vitamin A deficiency which include poor eye sight. The new variety is one of the four improved varieties developed in 1998, after a 10-year research by the institute.

Other varieties released by the Institute were Faara, Okumkom, Ogyefo and Santom Pona (white-fleshed), sauti, high starch (yellow-fleshed), Apomuden and Otoo (orange- fleshed) (CRI-CSIR, 2006).

Varieties of Orange flesh sweetpotato (OFS) released in Ghana in 2005 have increased levels of beta-carotene and range from yellow- to orange-flesh colour. In previous studies in Ghana, consumers accepted and utilized sweetpotato leaves as food through modified and culturally-acceptable traditional recipes. Initial results of consumer preference tests in Ghana of incorporating OFS as an ingredient in local breads showed significant positive response and willingness to pay extra if available (Bonsi *et. al.* 2009).

A trial on an evaluation of five new sweetpotato varieties in University of Ghana, Legon shows that normally, sweetpotato varieties were accepted as staple food in Ghana in terms of flavour and colour. Variety 91/198 was most preferred, while variety 91/62 was the most preferred with regard to texture and taste. The overall acceptability showed that variety 91/198 was the most preferred and was also the one with the least sugar content. In fact, varieties 91/198 and 91/62 consistently emerged as the best two varieties, with most of their qualities preferred among the five studied. On the whole, the Injala White variety was the least accepted (Opare-Obisaw *et. al*. 2000).

2.4Growth Requirements

2 4.1 Climatic requirement

Sweetpotato thrives and does best in a warm climate, with plenty of sunshine and moderate showers evenly distributed throughout the growing season. The crop has a short growing season and so can avoid long dry seasons (Kapinga *et al*., 1995). Sweetpotatoes are widely grown from 40° N and 40° S and above 2500 m at the equator (Hahn and Hozyo 1984). Best growth for the crop is obtained at average temperature of 24°C. The crop is very adaptable, but the yield is higher under favourable conditions. Growth and production are better in hot, humid regions. The plant, however, requires a high humidity at the beginning of its growth only, once the tubers have formed, any excess moisture in the soil may cause rotting. Tuberization is favoured by short days (11 hours) and cool nights. Tuberization is inhibited if daylight lasts 14 hours or more (Degras, 2003).

Temperatures below 10° C may be inimical to sweetpotato plants. Growth begins at 15° C and is optimal between 21° and 28° C (Janssens, 2001). Leaf shading is a key determinant of soil temperature, relatively small increase in soil temperature can have a direct effect on tuber quality.

Bourke (1985a) reported of yields as high as 20 to 30 tonnes per hectare in 8 months at 1600-2000 m altitude, where temperatures are typically 16^{o} C to 18°C. According to Ngeve *et al.*, (1992), in the tropics, there is yield decline with increasing altitude. Goodbody and Humpfreys (1986) have also indicated a delay in maturity with increasing altitude.

According to Folquer (1974), flower and seed production are best at daily maxima and minima of 23-24°C and 13-19°C respectively. In Puerto Rico, flowering in glass houses did not occur above 27°C (Campbell *et al.,* 1963).

Kay (1973) has indicated a water requirement of at least 400 mm during the growing season stating that the crops tolerance of water deficit during tuber initiation at 50-60 days after planting. Sweetpotato is intolerant of water logging particularly during tuber initiation but the crop at times is tolerant to drought (Wilson, 1982; Hahn and Hozyo, 1984).

Maximum dry matter accumulation rates of 85-170 kg ha"1 d" reaching a leaf area index (LAI) of 3.24, were shown in a subtropical environment (latitude 29° S) (Lowe and Wilson, 1974a). Substantially higher values of 260 kg ha"1 d" at an LAI of 6.7 and a final tuber yield of 15t ha"1 were attained when the crop was trellised on wire mesh 1.2 m high. The authors however maintained that the growth rate and yield depends very much on genotype. On biomass partitioning, Austin *et al.,* (1970) and Huett, (1975) have indicated relative growth rates of tubers to be 0.4 to 0.6 g g'" wk for the first half of their growth period. Growth rate and partitioning between root tubers and vegetative organs are sensitive to plant structure and nutrition; translocation rate may increase during tuber growth (Hahn and Hozyo, 1984). There is an inverse relationship between mean tuber weight and number of tubers (Lowe and Wilson, 1975). Watanabe and Nakayama (1969) have reported of a large amount of fibrous root associated with increased top growth and reduced tuber growth, a condition associated with high temperature, low potassium or high nitrogen /potassium ratio.

Temperature both in the field and in storage has a large impact on tuber sugar content. High soil temperatures result in sugar ends or other sugar-related problems. Low temperatures result in cold-induced conversion of starch to sugars.

2.4.2 Soil Requirements

Sweetpotatoes are grown on a variety of soils, but well-drained light and medium textured soils with a pH range of 4.5-7.0 are more favourable for the plant (Woolfe, 1992; Ahn, 1993).

Sweetpotato can colonize marginal soils because it readily produces adventitious roots and has trailing vines,. Consequently, it is not very demanding as regards soil type. It needs a light, friable, fairly permeable loam, without an excess of nitrogen, which would otherwise stimulate development of the aerial parts at the expense of the root tubers (Raemaekers, 2001).

Sweetpotato shows good tolerance to aluminum-rich, phosphorus-poor acid soils. Growth is still possible at pH 4.0. It adjusts easily to highly organic soils. Conversely, compacted soils must be avoided. The crop will not tolerate continuous hydromorphic conditions for more than three days. Excess nitrogen and hydromorphic conditions promote the production of fibrous roots (Janseen, 2001).

Planting sweetpotato cuttings in heavy, waxy soils must be avoided as they are not conducive to high yields of potatoes. Sweetpotatoes grow best in a well-drained, loamy to sandy soil. Those grown in heavy clay soil may be smaller and misshapen. Sweetpotatoes are adapted to a wide range of textural classes of soil. According to Mcgraw (1999), the crop yields more and better on moist, well-drained light sandy loam or silty loam soils. He observed that rich, heavy soils produce high yields of low quality roots whilst extremely poor light sandy soils produce low yields of high quality tubers.

2.5 Propagation

Although sweetpotato can be cultivated by seed, conventionally and traditionally it is propagated using stem cutting fragments 20-30 cm long with 3-5 nodes. The planting materials are vines, sprouts and root cuttings and a hectare of land will require 400,000-1,250,000 vines depending on the cultivar (Du Plooy *et al.,* 1988).

Stems and lateral shoots can be used to supply cuttings. The age of the plant is an important factor in the recovery and survival of cuttings, especially in ecosystems where the length of the vegetative period is limited. Several factors influence the choice of plants from which to take cuttings assuming a shortage of planting materials does not mean that all plants have to be used. These include the degree of damage that may be caused to the crop if a nursery is not involved, the ease with which the cutting operation can be carried out, the plant's performance level and its health status. In most cases, only the upper parts of the plant are used. They are easier to access, since little or no rooting will have taken place, and they are generally considered to perform better. A study of two cultivars grown from August to February in Guadeloupe showed that cuttings taken from the middle part of the third stem gave better yields than cuttings taken from the top of the first two stems. The lower cutting from the first stem also did better than the upper one under these conditions. Nevertheless, when all responses are compared, upper cuttings are definitely the ones to use (Degras, 2003).

Propagation is done vegetatively, generally by stem cutting or by using a roottuber, a fragment of a tuber or a tuber sprout (sett), the latter having the same value as an ordinary cutting. (Propagation by seed is only done for breeding purposes).

Cuttings are only used in tropical countries where sweetpotato is grown all year round. They should be 20 - 40 cm in length, with 3 to 4 buds and should come from young tips or by the middle of stems. They should be taken at the right time of planting or stored in the shade until they are planted out. Cuttings taken at the base of the stem, where leaves have dropped off, do nott grow well and the corresponding yields will be low. Planting one hectare requires about 30,000 to 90,000 cuttings. Traditionally, the cuttings for a new crop are taken from the top halves of young plants. This practice reduces the risks of transmitting viruses and ensures a more vigorous growth of the cuttings. It does not, however, preclude the transmission of latent viruses, which are often present in the young tissues. Cuttings are planted at a spacing of 100 x 30 cm, with one cutting per hill. Virus-infected plants should be pulled out (Janssens, 2001).

2.6 Agronomic Practices

2.6.1 Weed Control

Weed control is important until the plants cover the row. Effective weed control is important during the early part of the growing season of the sweetpotato crop when the plants are getting established but before the vines have grown extensively. The soil is worked towards the row to widen the ridge. Cultivation should be continued until the vines meet in the middle, but after this no or less attention is paid except to pull out the large weeds by hand. The first intercultural operation 30 days after planting along with weeding and earthing-up improves the physical condition of the soil. The second inter-cultural operation and earthing-up should be done 45-60 days after planting. The cuttings take root very quickly and, after two months, the vegetation will have covered the ground. Maintenance operations are limited to weeding once or twice after planting and to protecting the mounds against erosion (Raemaekers, 2001).

Weeding can be carried out entirely manually or may be partially or fully mechanised. Under traditional manual cropping, the first weeding is often the only one. But provided it is done carefully it may be all that is needed if the plot has been cleared from primary or old secondary forest. Under such conditions the seed reserves of weeds in the soil are low, and the ability of sweetpotato to cover the soil rapidly limits weed development.

In the USA, sweetpotato cropping, combined with selected cultural practices, has been recommended for reducing infestations of *Cyperus rotundus* (Degras, 2003).

Weed control may also involve the use of herbicides. Application of herbicides has effect on tubers. Tubers exhibit various effects when sprayed with herbicides. Poor colour and flavour in potato chips will be experienced with the application of herbicides. Herbicides containing urea increase the sugar content of the tuber. Herbicides such as chloramben, Diphenamid and glyphosate cause decrease in the starch content of tubers, while others cause a restructuring of the starch granules, some herbicides lower the amount of amylase in the starch of the tuber while, some herbicides slow down the growth of plant roots, which is a factor in reducing the final crop yield.(Lisinska and Leszcvaski, 1989).

2.6.2 Pest and Diseases of Sweetpotato

Throughout its range, sweetpotato is prey to nearly 300 insect pests. It is also attacked by some 14 viruses and many different fungi. Yields are often lower in the tropics, suggesting that pests and diseases in general are also significant constraints in these environments (CIP, 1996).

Pests can attack the crop at any stage of its development - from the nursery to maturity in farmers' fields. Wet and warm conditions increase the likelihood of serious infestations. Harvested root tubers stored for processing at village level are also susceptible to pest attack. Exposing stored root tubers to the sun can sometimes treat or limit the pest damage. The feeding behaviour of some insects may look inconspicuous at the time but can lead to serious problems later due to the transmission of viruses (Degras, 2001).

Sweetpotato is prone to a number of pest and disease attack in the field, at harvest and during storage. In the field, the major pests are *Cylas formicarius (F*ab), a sweetpotato weevil, whose larvae feed on the tubers and Sweetpotato butterfly *(Acraea acerata)* which feed on the leaves (Purseglove, 1987; Capinera, 1998). According to them *Cylas puncticollis* (Sum) is yet another serious pest for susceptible varieties when planted on soils previously planted with infested crops with the attack being heaviest near the soil surface. According to Sowley (1999), weevil attack is most serious when drought persists for a long time, more especially in theminor season, but early planting and harvesting can greatly reduce this situation (Lema, 1992).

Milking increases cylas build up, but control of the weevil can be achieved using a solution of soap detergent (CRI, 2004). Major losses suffered by sweetpotato due to disease attack include; soft rot and ring rot caused by *Rhizopus stolonifer;* storage rot caused by *Erwinia* *chrysanthemi;* black rot caused by *Ceratocystis fimbriata;* surface rot by *Fusarium oxysporum;* dry rot by *Diapothe phaseolorum varbatatis;* charcoal rot by *Macrophomina phaseolina* and Java black rot by *Botryodiplodia theobromae* syn. *Lasiodiplodia theobromae* (Sowley, 1999). Early harvesting between 3-5 months after planting has generally been proven to maximize yield and reduce damage (Missah and Kissiedu, 1994).

The major disease of sweetpotato in Ghana is the Sweetpotato Virus Disease (SPVD) (CRI, 2004). Infected plants show stressed vegetative growth and development. Control measures include use of resistant varieties, use of healthy planting materials, practice of crop rotation and earthing up during weeding. The sweetpotato aphid is also reported to destroy the young leaves and vegetation.

After harvest, drying of rootstubers too slowly or during rainy weather can encourage attack by fungi or moulds (Degras, 2003).

2.7 Fertilization in Sweetpotato Production

2.7.1.1 Effect of Nitrogen

Bourke (1985b) reported that nitrogen is one of the most abundant elements in plants and animals, as it is a major component of proteins. The amount of nitrogen required by a crop is large compared with the natural nitrogen reserves in most soils, and so most crops respond positively to additional nitrogen, whether from animal manures or inorganic fertilisers such as urea. However, this pattern does not always hold for sweetpotato. In some studies, nitrogen application has been reported to reduce sweetpotato yields. More commonly, the pattern is for low rates of nitrogen to increase yield to some extent, but higher rates to cause a yield decline. The reason for this confusing response is that nitrogen supply has a strong influence on the distribution of dry matter within the plant, particularly affecting root growth relative to top growth. When nitrogen supply is high, plants tend to grow more tops relative to roots. In the case of sweetpotato, high nitrogen may cause luxuriant growth of the vines at the expense of root tuber yield. However, excessive N rates stimulate vine and root growth and delay tuber bulking and maturation (Bradbury and Holloway, 1988).

Cultivars vary greatly in the level of nitrogen required to maximise yield, and in their tendency to reduce yield at higher levels of nitrogen. In particular, negative responses to nitrogen are more common in cultivars developed in low-fertility areas where soil amendments are not traditionally used. One study reported that an application of 60 kg nitrogen/ha increased yields of three USA cultivars but decreased the yields of three African cultivars. In the soils of West Africa large responses to nitrogen are often obtained on soils which have been heavily cropped in the past, or those subject to heavy leaching. The response to nitrogen may be poor, however, if deficiencies of other nutrients such as potassium are overlooked and left untreated. Sweetpotato tends to respond better to composts of plant materials which contain high potassium relative to nitrogen, than to animal manures, which are lower in potassium. However, this depends on the balance of nutrients present in the soil (Hill and Bacon, 1984; Halavatau *et al.,* 1996)

A sweetpotato crop of 20 t/ha removes approximately 87 kg N/ha, if root tubers and vines are harvested. The optimum rate of fertilisation will depend on the amount of plant-available nitrogen in the soil, and on yield potential, which may be dictated by the available soil water and rainfall. Reported recommendations for application of nitrogen fertilisers to sweetpotato generally lie between 30 and 90 kg N/ha (De Geus, 1967). Over fertilization with nitrogen may lead to reduced yields, as it may encourage excessive vine growth at the expense of the root tubers.

Nitrogen deficiency is sometimes associated with waterlogging of the soil. Under anaerobic conditions, soil bacteria quickly convert soil nitrate into nitrogen gas (N_2), which is lost to the atmosphere. Improved drainage can be achieved by increasing the height of ridges or mounds, keeping the troughs between them clear of weeds, and providing adequate channels for excess water to leave the field. Sweetpotato is sensitive to waterlogging, and the crop tends to yield poorly if waterlogging occurs for even a short period, particularly in the early stages of crop growth. Therefore, good drainage is necessary regardless of nitrogen supply. Improved nitrogen nutrition of the crop also leads to higher protein concentrations in the root tubers, and this may be of considerable significance in communities which obtain much of their protein from crops (sweetpotato). Plants need nitrogen for growth, reproduction and photosynthesis. In most areas studied, nitrogen (N) was not as effective as other fertilizers (potassium or phosphorus) in increasing sweetpotato yield. Too much nitrogen could result in excessive vine growth, misshapen tubers with cracked skin and poor storage qualities (Mascianica *et al.*, 1985; Walker and Woodson, 1987).

Work done in Ghana revealed that when the soil nitrogen level is zero(0), increasing nitrogen fertilization is beneficial to yield, but that above 30 kg/ha nitrogen application was detrimental to yield increase (SRI-CSIR, 2003).

Nitrogen affects the number and weight of root tubers. In Ghana a trial conducted by SRI-CSIR on sweetpotato response to nutrient balances showed that when nitrogen levels are increased above zero, yield levels of sweetpotato increase, but when nitrogen levels are increased above the optimum level of 30 kg/ha to 60 or 90 kg/ha, the yield decreases, relative to the optimum rate of 30-30-30 (SRI-CSIR, 2003). Khush (1999) stated that historically, manure application rates have been based on crop nitrogen requirements, nitrogen content of manure, and N availability in the source. However, because animal manure causes soil phosphorus (P) to build up when manure is applied according to N needs, the current tendency is to base application rates on P content of manure and soil when P run off risk is high. Manure applications should consider both the P and N content and site-specific conditions. Utilization of compost, manure, fertilizer, and cover cropping has different effects on soil N movement, and soil quality and fertility, depending on how long each has been implemented. While insufficient soluble N can curtail potential yield, excessive soluble N can result in serious ground- and surface-water contamination. Intensive use of N fertilization has contributed to heavy N leaching into the environment (Socolow, 1999). Scientists have suggested improving crop plant utilization of N as one way of reducing groundwater nitrate contamination. Using non-fertilizer approaches to supply crops with less-soluble N could also help reduce N losses to the environment.

Nitrogen application also increases carotene content of sweetpotato root tuber (Degras, 2003). In a study conducted in Umudike in Nigeria on all trans-cis β-carotene content of selected sweetpotato varieties as influenced by different levels of nitrogen fertilizer application, revealed that there was a decline in the all-trans-cis-β-carotene content of sweetpotato varieties with the exception of CIP Tanzania above 80 kg N/ha. This trend established that the total β-carotene and all-trans-cis isomers of β-carotene yield are better at 40 to 80 kg N/ha. The β-carotene values from sweetpotato varieties common to Africa are however low (Ukom *et al.*, 2011).

The International sweetpotato Center (2007) noted that the β-carotene content of sweetpotato common to Africa ranged from 100 to 1,600 μ gRAE/100g, thus agreeing with the β-carotene values obtained in this work for most of the varieties. The implication of this result is that nitrogen fertilizer application for optimum β-carotene yield will depend on each variety and environmental variations (Villagaria, 1999). This may be the reason why TIS87/0087, (a white-fleshed, and improved elite variety) and Ex-Igbariam, (a local orange-fleshed variety) with high nitrogen response ability and high photosynthetic activity) yielded higher β-carotene and trans-cis β-carotene values than CIP Tanzania and TIS8164 varieties. CIP Tanzania was observed to have the least β-carotene concentration at 40-80 kg N/ha due probably to low nitrogen response and poor environmental adaptation (Okon, 2006).

2.7.1.2 Effect of Potassium

Sweetpotato like all other tuber crops has a high requirement of potassium fertilizer (Raemaekers, 2001). According to Foth (1978), K is required for efficient water utilization in the crop, increases its sugar content and tolerance to diseases.

Potassium contributes to early growth, water and nutrient use, protein production and improved resistance to disease. Increasing the rate of potassium fertilization results in a significant increase in tuber yield.It has been shown to be an important fertilizer for sweetpotatoes. In Ghana, potassium applications significantly improved sweetpotato yield. Applications were made at NPK ratios of 30-30-0, 30-30-30 and 30-30-60, with increased yields in tonnes/ha of 8.75, 12.3 and 14.4, respectively. The FAO document that outlined this study commented that potassium appeared to be the most important nutrient in the production of sweetpotato (SRI-CSIR, 2003).

Total root yield has been reported to increase with K supply but the magnitude however depends on the initial K level (Hammett *et al.,* 1984) indicating that K application at 120kg K_20/ha rate gave the highest yield. Nicholaides *et al.,* (1981) have shown that different K fertilizer levels produced no significant effect on both vine weight and vine length.

In a field study on K effect on yield, Zhi (1991) observed that total root yields were significant with increased K application. The treatment 120 kg K_2O/ha gave the highest yield of 21.4 t/ha while O kg K_2O/ha (control) gave the yield of 17.7 t/ha. Constantin *et al*., (1977) however established no significant difference in harvest index and dry matter among the levels of K fertilizers. According to him differences however exist among varieties. Villareal (1982) advocates for a far higher K level compared to N for maximum sweetpotato yield as increasing N rates tend to decrease root yield.

According to Hammett and Miller (1982), increased starch content decreased firmness of canned root and crude fibre content have been achieved through K application. Hammett and Miller (1982) found out that the carotene content, ascorbic acid levels and soluble carbohydrate levels of sweetpotato were not influenced by K application. K is significantly crucial in the plant energy status, translocation and storage of assimilates and maintenance of tissue water relations (Marschner, 1995).

Martin-Prevel (1989) and Perrenoud (1993) have indicated that K nutrition influences tuber quality, tuber size, specific gravity, susceptibility to black spot bruises, after cooking darkening, reducing sugar level, fry colour and storage quality. Perrenoud further submitted that for desired light colour potato chips, the glucose and fructose content of potato should not exceed 0.25%, which K effects or produces by its sugar reducing property.

Perrenoud (1990) has reported of K increasing the crop resistance to diseases by improving the plant's health and vigour. According to him, K increases the production of disease-inhibitory compounds such as phenols, phytoalexins and auxins around infected sites of resistant plants. Potassium fertilizers according to Perrenoud (1993), have also been found to decrease the incidence of such diseases as late blight.

Bergmann (1992) indicated that K promotes the thickening of cell wall and the growth of meristematic tissues thereby preventing penetration of the epidermis by parasites. Its deficiency according to Kiraly (1976), increases inorganic N accumulation and the break down of phenols that have fungicidal properties.

It is important to avoid excessive late-season applications of potash. Starch synthesis and specific gravity increase with increasing K concentration up to an optimum tuber concentration of 1.8 percent. However, at higher K concentrations, specific gravity decreases as root tubers begin to absorb more water due to the osmotic effects of increased tissue salt concentrations (Dahnke *et. al*. 1992).

2.7.1.3 Effect of Phosphorus

Phosphorus (P) as a major plant nutrient is generally essential for plant respiration, photosynthesis, cell division, energy storage and early crop maturity. Phosphorus is essential for energy transfer in plants and helps early growth and plant maturation, including flowering. Phosphorustends to increase starch synthesis, but in contrast with N it hastens rather than delays maturity. Phosphorus deficient potato plants typically produce tubers with lower specific gravity compared to those with adequate P nutrition. The P/N balance is also important and, to a degree, adequate P can help counter low specific gravity associated with high N levels. Like nitrogen, phosphorus increase the carotene content of tuberous roots during the yield increase period, and also affects the unit weight of roottubers (Degras, 2003).

Most studies have shown that phosphorus does not have a significant effect on increasing sweetpotato yield. For instance, the Philippine study commented that at all levels of N and K used, addition of P did not result in any significant increase in yield (Degras, 2003).

Researchers in Ghana showed that increasing the rate of phosphorus application does not increase sweetpotato yield (SRI-CSIR, 2003). A study by CRI (2003) on the effect of imbalanced fertilization on sweetpotato tuber yield and number in the Sudan Savanna Zone of Ghana showed that increasing rate of P does not increase yield.

Similar results were obtained by Jayawardenes (1985) when he conducted a study on the effect of inorganic P fertilizer and poultry manure on yield of sweetpotato. Application of inorganic P did not significantly affect yield and other characteristics of sweetpotato. Application of 10 t/ha of poultry manure (PM), however, significantly increased the number of marketable roots. A combination of 100 kg P_2 O >5/ha and 10 tonnes PM/ha recorded the highest yield compared to other treatments. Jayawardenes's findings also showed that marketable tuber yields were not also influenced by the percentage of P and PM applied. As part of Jayewardene's experiment the treatment 50 kg P_20_5/ha + 10 tonnes PM/ha treatment gave the lowest yield with no pronounced effect on vine growth and the number of tubers per plot. PM at 10 t/ha with zero P produced significant number of marketable tubers. PM at 30 t/ha gave significant root tuber yield in white sweetpotato (Grewel and Trehan, 1983).

2.7.2 Effect of Organic Fertilizers

2.7.2.1 Poultry Manure and its Effects on the Physical and Chemical Properties of the Soil

The physical and chemical composition of poultry manure is influenced by the bird type, number of birds per unit area, kind and amount of litter, time of use and management factors (Eno, (1962). The quality of PM is equally affected by climatic conditions during litter production, and storage after production. Overcash (1983) reported that average daily fresh manure produced by broilers and hens is 18 and 22 kg/1000 kg live weight per day respectively also affected by feed.

According to FAO (1984), fresh droppings of chicken contain about 70% moisture. Hileman (1967), reported that 1 tonne broiler litter could supply 6.38 kg Ca, 18.48 kg Mg, 1.01 kg Mn, 4.4 kg Fe, 0.18 kg B, 0.55 kg Zn and 0.015 kg Mo.

Poultry manure has been found to improve upon both the physical and chemical properties of the soil when applied appropriately. Physically, Hileman (1967), and Bonsu (1986), have reported that PM improves the physical condition of both light and heavy soils. Improved physical conditions enhance aeration, ease of seed bed preparation, seed germination,water holding capacity,soil microbial activity, water infiltration and structural stability of the soil.

Chemically Bandel *et al.,* (1972), has indicated that poultry manure helps to ameliorate and improve micro-nutrient deficiencies in most soils. In their study in the rain forest zones (Agboola *et al.,* (1972) have revealed that moderate poultry manure application slowed down humus decomposition by half compared to mineral fertilizer.

Poultry manure helps to correct Zn and Fe deficiencies in the soils and supplements NPK fertilizers in crop production (Miller *et al.*, 1970).

The release of ammonia from poultry litter when incorporated into the soil raised the pH of soil hence reducing soil acidity (Hileman, 1971). Agboola *et al.*, (1975), have reported of similar chemical properties, adding that the content of exchangeable Ca and Mg is increased and uptake of P improved, while reducing Fe, Al and Mn with the addition of PM to the soil.

Poultry litter incorporation also increased organic carbon and N to the depth of 15 and 30cm respectively (Kingery *et al.*, 1993). Addition of excess broiler manure to the soil according to Hileman (1970), however increases soil toxicity and renders it inefficient.

As a basal fertilizer, poultry manure is worked into the soil during land preparation, the depth depending on the soil type and climate. Deeper incorporation may be desired for light porous soils than heavy or wet soils. Muller-Samann and Kotschi(1994),suggested working the manure close to the surface rather than burying it deep. Owing to its caustic effect and heat generation, application of poultry manure shortly before cropping causes injury to crops (Bandel *et al.*, 1972). Incorporation with tillage also reduces N and P losses by volatilization and surface run-off (Moore *et al.*, 1995).

An incubation period of one month after application before planting allows for total nitrification to avoid the risk of ammonia toxicity (Siegel *et al.*, 1975). Rate of magnification and nitrification, varies depending on climate and soil. According to Hileman (1971), however, there is no need for any incubation period before planting of crops because of the rapid chemical changes in the soil following broiler litter incorporation.

In a field study conducted in the Middleveld agro-ecological zone at the Malkerns Research Station in Swaziland, the results showed that temperature at the soil surface was significantly higher than at lower depths and was negatively but not significantly correlated to some parameters: leaf area, leaf area index, specific leaf area ,net assimilation rate and crop growth. Sweetpotato yields declined with increased levels of chicken manure: 20 t/ha chicken manure yielded (20.6 t/ha); 40 t/ha chicken manure yielded (19.3 t/ha); and 60 t/ha chicken manure yielded (13.3 t/ha) (Magagula *et al*., 2010).

Guri (1986)stated that animal manure that is not well decomposed generates much heat in the soil. This heat can cause some soil microbes to become inactive and may also kill some young plants growing in the soil. It is therefore advisable after applying the manure on the land to leave it for at least two weeks to decompose well before planting. According to Leonard (1982), manure that is applied too far in advance may lose nitrogen by leaching. Fresh manure unlike decomposed manure should be applied a week or more in advance and should be ploughed in as early as possible.

According to Baffour (1984), fertility of the soil must be maintained by applying animal manure, compost, crop rotation, cover cropping, green manuring as well as proper land usage. Riceand Rice (1987) observed that the use of well rotted manure prior to planting, and a pre-planting application of complete fertilizer is generally beneficial and required for good plant growth and yield.

2.7.2.2 Effect of Poultry Manure on Growth and Yield of Sweetpotato

The nutrient composition of poultry manure varies with the type of bird, the feed ration, the proportion of litter to droppings, the manure handling system, and the type of litter. Except for nitrogen, the availability of most nutrients in poultry manures is fairly consistent. Nitrogen can occur in several forms, each of which can be lost when subjected to improper management or unfavourable environmental conditions. Nitrogen in poultry wastes comes from uric acid, ammonia salts, and organic (feacal) matter. The predominant form is uric acid, which readily transforms to ammonia (NH_3), a gaseous form of nitrogen that can evaporate if not mixed into the soil. When it is thoroughly mixed, the ammonia changes to ammonium (NH_4^+), which can be temporarily held on clay particles and organic matter. Thus, soil mixing can reduce nitrogen losses and increase the amount available to plants (Zublena *et al.*, 1996).

The value of poultry manure stems from the fact that it has been used successfully on a wide variety of crops either as a single plant nutrient source or in supplementation to commercial fertilizers (Hileman, 1972). Hileman was particularly emphatic on broiler litter which according to him returns huge proportion of plant food such as N, P, K and Mo to soil.

Nutrient studies conducted in 2009 at the north Mississippi research and extension center to grow, evaluate, and screen some sweetpotato cultivars showed that poultry litter can be utilized as a fertilizer source in sweetpotato production and that over-application of fertilizer can cause excessive vine growth and lower than expected yield. The excessive vine growth was most likely due to excessive N fertilizer from additional inorganic N fertilizer applied following a litter application. The best fertilizer system for conventional farming includes poultry litter plus supplemental P&K based on litter and soil test analyses. If growing for the organic market, a higher litter rate could be applied based on available K as long as total N content does not exceed soil test recommendations (Smith *et al*., 2009).

Asubonteng and Dennis (1995), in their study of poultry manure on rice revealed that poultry manure was as good as mineral fertilizer; however its impact on yields depended on the site and the state of the soil. In combination with N.P.K. (20.20.0), Boateng and Oppong (1995), observed that poultry manure gave the best yield of maize.

Baum *et al.,* (1983) observed that higher yield of maize was obtained with 10 t /ha of poultry manure than with adequate application of N and P fertilizers. Miller and Turk (1951) also observed that crops such as corn, cotton, tobacco and potato which were heavy users of N and P benefited a lot from poultry manure.

Studies on the effect of poultry manure with mineral fertilizer on crop yield have shown that poultry manure effectively complements inorganic fertilizers. Asubonteng and Dennis (1985), have shown that the combined effect of poultry manure and mineral fertilizer on crop yield was better than either of the two when applied on sole basis at all rates. Agboola *et al.,* (1975), have also reported that increasing P with mineral fertilizer and small amount of poultry manure increased yields, although mineral fertilizer alone on extremely acidic and humid sites had no effect on cowpea.

The combinations of poultry manure with mineral fertilizers are more often than not more effective than equivalents of manure nutrients alone or those of separately applied inorganic fertilizers (Buresh *et al.,* 1997); Palm *et al.,* (1997); and FAO, (1998)).

The combination of organic and inorganic fertilizer does not only improve crop yields, but also improves the physical status of the soil. Dennis *et al.,* (1993), have indicated that the combination is best for savanna soils.

2.8. Harvesting and Curing

Sweetpotato matures within 3-4 months after which the root tubers become infested with weevils. Maturity of the tubers is indicated by a slight yellowing or reddening of the leaves, depending on the variety. Roots should be harvested as soon as they mature and care taken so that tubers are not bruised during digging. Tubers should be handled with care to avoid skinning and bruising. At harvest the following precautions should be taken; a time when both the air and ground are dry should be selected, vine should be s removed with a sharp hoe, vine cutter or any implement that will do the work rapidly and well Harvest in the morning and allow the potatoes to lie out all day. Handle with great care, as they are easily bruised, and every injury lessens their keeping qualities (Geo *et al.*, 1925). Roots are susceptible to rotting especially after damage due to mechanical injury or insect infestation, as the wounds provide entry points for bacterial and fungal rots, and also increase water loss. Sweetpotatoes should be cured before storing to heal wounds and improve flavour. During the curing process starch is converted to sugar. Roots should be cured immediately after harvest at 29 ± 1 °C (84 ± 2 °F), 90 to 97% RH for 4 to 7 days (Kushman, 1975). During curing, ventilation is required to remove CO_2 and replenish O_2 because roots consume about 63 L metric ton^{-1} day^{-1} of O_2 and release equivalent amounts of CO_2. Curing heals wounds from harvest and handling, helping reduce moisture loss during storage and decrease the potential for microbial decay. In addition, curing facilitates synthesis of enzymes operative in flavour development during cooking (Wang *et al.*, 1998).

Where artificial curing may not be necessary the tubers need to be stored at 13 ^{o}C – 16 ^{0}C immediately after harvesting. However, if roots are to be cured they are allowed to cure for 4-5 days under ambient conditions and then stored in underground pits lined with dry materials (IITA, 1993). Sweetpotato is highly perishable once harvested unless processed. Piece meal harvesting of this crop limit land use for other crops. After harvest, sweetpotato roots can only be kept for a limited amount of time if not stored properly. Farmers sometimes like to store sweetpotato for a better market price, but damage due to sweetpotato weevil and root rot in stored roots may make storage counterproductive, resulting in a lost opportunity to take advantage of the expected better price a few months later (Degras, 2003).

2.9 Effect of storage method on quality and nutritional composition of sweetpotato root tubers

Despite nutritional importance of sweetpotato, the tubers have a short storage life, generally, less than four weeks in the tropics. Their skin is easily damaged during harvest and post-harvest handling leaving the crop highly perishable (IITA, 1996). Insect damage of the leaves and root tuber on the field, dehydration and rotting of the tubers, high moisture content leading to its high perishability, lack of storage skills which discourages production, sprouting and chilling injury during low temperature storage are some of the pre and post-harvest problems associated with sweetpotatoes cultivated in Nigeria (NSPRI, 2002). Cured sweetpotato can be stored for 4–7 months at 12.8–15.6°C and 85–90% relative humidity. Non-cured sweetpotatoes do not store well and have a much shorter shelf life.

Various traditional methods of sweetpotato storage such as heap storage, in-ground storage, platform and pit storage methods have been practiced in Nigeria and across African countries by farmers but the most common traditional method is the pit storage. Pit storage of sweetpotatoes has been reported in Indonesia, Zimbabwe, and Malawi by

Woolfe (1992) and in Nigeria by Awojobi (2004). Pit storage can generally be considered to be cheap for the rural communities since it requires minimum materials (Dandago and Gungula, 2011). A study undertaken to investigate the effect of traditional storage practices of small-scale organic farmers in rural KwaZulu–Natal on the quality of potatoes shows that leaving potatoes *in situ* as a method of storage maintains desirable sensory properties of potatoes by maintaining low sugar levels and higher starch content (Mutandwa and Tafara, 2007).

Soil based technique involves digging of pits at a certain level of inclination (sloped areas). This is done to facilitate the complete drainage of the pits which avoids accumulation of moisture which would in turn lead to rotting or germination of root tubers (Mutandwa and Tafara, 2007).

Tortoe *et al.,* (2010), in an experiment to determine microbial deterioration of sweetpotato root tubers stored in three different storage structures -traditional (cylindrical hole dug in the dry ground and lined on the floor and walls with 20 kg of dry grass.), pit, and clamp (consisted of a circular bed of dry grass, 20 cm thick, made on a 25 cm raised flat mound of earth, surrounded by a concrete wall 30 cm above ground level.) storage structures for a maximum of 28 days revealed that for the 7 days-cured sweetpotato root tubers, the bacteria population in the pit and clamp storage structures increased by 1.2-2.3 log cfu/g whereas for the 14 days-cured root tubers, the bacteria population was 0.1-1.0 log cfu/g within 28 days of storage. The fungal population in the 14 days-cured sweetpotato root tubers was higher than in the 7 days-cured sweetpotato root tubers by 0.6-1.6 log cfu/g for 28 days of storage. For both the 7 and 14 days-cured sweetpotato root tubers, the sweetpotato roo tuberts stored for 28 days in the three different storage structures had a higher microbial count compared to the sweetpotato root tubers stored for 14 days. The grass acted as an insulating material and ensured cool conditions in the pits (17^{o}C, RH95-100%).

Grass based technique involves the use of dry grass to create dry and cool conditions within the storage area. This avoids the development of fungal diseases that normally thrive under humid and warm conditions. Setiawati *et al.,* (1994) reported that storage of sweetpotato fresh root tubers in a room (with ordinary room temperature and air humidity) for one month caused 15% root tuber damage. However, root tuber damage is lower if the root tubers are covered with humid rice straw mulch, although the root tubers tend to sprout.

Similarly, in a study conducted in Zimbabwe to assess the effectiveness of using soil, ash and grass as means of preserving sweetpotato variety Mozambican White, the results indicate that if quality of the stored crop and weight variation of root tubers is considered, then use of soil banks is the most effective. However, weights of root tubers for ash and grass were not statistically different from the soil treatment but some root tubers were discoloured (Mutandwa and Tafara, 2007).

Ash based technique involves mixing ash powder with sweetpotatoes. The ash will act as an absorbent to moisture and has a repelling effect on pests. Ash has alkaline properties, which are not conducive to development of diseases (Mutandwa and Tafara, 2007).

Amoah *et al.,* (2011), investigated into the storage performance of sweetpotato root tubers in an evaporative cooling barn with three different pre-storage treatments - ash, brine and *Lantana camara* extract to evaluate their effects on tuber weight loss, shrinkage, weevil damage, sprouting and decay over 12 weeks duration. The control comprised root tubers with no pre-treatment. Weight loss increased linearly from the inception of storage whilst shrinkage became apparent only after 2 weeks and rose linearly. The root tubers were held against weevil damage until the 6th week. Sprouting was initiated after 4 weeks of storage. By the 12th week, the *Lantana camara* treatment yielded better results, recording overall root wholesomeness of 76%, followed by the control (56%), the ash treatment (50%) and the brine treatment (48%). The *Lantana camara* treatment also recorded the lowest weight loss of 28%, lowest shrinkage of 3.8%, lowest severity of decay and sustained less weevil damage at 47.5% compared with the other treatments. Sprouting was however, higher than the other treatments. The brine and ash treatments performed poorest with the performance indicators.

During storage, there are many changes that take place in the tissue micro structure of the sweetpotato root tubers. The physiological and compositional changes that take place include loss of moisture/water and modification of texture. During storage of sweetpotato root tubers, starch is degraded into sugars by the action of endogenous amylase, thereby affecting the micro structure of the sweetpotato root tubers. The extent of these amylase moderated microstructural changes depend on temperature and water content. These factors vary with storage time. High temperatures, in particular, are known to increase respiration leading to lignification of the sweetpotato cell walls during storage. Orange-fleshed sweetpotatoes {OFSP} (*Ipomoea batatas* (L.) Lam) contain high levelsof beta carotene, an important provitamin A carotenoid. Stored sweetpotato root tubers undergo many physiological changes that affect their beta carotene content and bioaccessibility as well as the tissue micro structure. In a study conducted in Uganda to investigate the changes in microstructure, beta carotene content and *in vitro* bioaccessibility of stored OFSP root tuber shows that storage of OFSP root tubers using methods that maintain low temperatures leads to higher retention of beta carotene (Tumuhimbise *et al*., 2010).

The post-harvest physiological processes that may affect storability include; respiration, evaporation of water from the product, sprouting, changes in chemical composition, diseases and damage by extreme temperatures. The relative importance of these processes differs with the storage environment. In a research conducted in Uganda and Mozambique to investigate into whether the substantial amount of vitamin A in orange sweetpotato is retained during drying and subsequent storage showed that, drying the sweetpotato did not greatly affect retention of vitamin A, but storage did. In fact, after four months of storage, up to 70-80% of the vitamin A in the sweetpotato can be lost (Bechoff, 2011).

Storage can be prolonged if root tubers are placed for a period of time, under conditions which promote the healing of wounds. The efficiency of wound healing may vary between varieties Initial studies of four Kenyan varieties undertaken at NRI have also indicated differences (Clark *et al.*, 1989).

Under tropical conditions high temperatures are likely to result in high rates of respiration. Increased rates of metabolic breakdown could result in increased levels of weight loss. The evaporation of water is directly related to atmospheric water vapour pressure deficit. Although the relative humidity in the tropics is frequently high, for uncovered root tubers during marketing it can be sufficiently low to allow rapid water loss through the skin surface. During marketing, the relative humidity to which root tubers are exposed can be low, whereas during long-term storage much higher humidities are likely. The main forms of deterioration will differ accordingly. The root tuber is primarily a starch storage organ, with some sugars (mainly sucrose, glucose and fructose) and low levels of protein. The main post-harvest physiological changes are associated with water loss, and carbohydrate (starch and sugar) metabolism. The extent of water loss is expected to depend on the properties of the periderm and the ability of the root tuber to heal wounds (Woolfe, 1992).

As the root tuber is a living organ, low levels of metabolism are necessary to maintain the integrityof the cells. However high rates of metabolism can be detrimental to quality, by changing the carbohydrate composition, or in the extreme case, by metabolizing so much starch that air spacesform, and the texture of the root tuber becomes spongy. Most work on the carbohydrate metabolism and respiration has been carried out on North American or Japanese cultivars under the temperature regimes used in refrigerated stores (typically 13-15°C) {Takahata *et al*., (1992) and Woolfe (1992)}. These have generally shown that sugar levels increase during storage (Woolfe 1992). However, the metabolic rate is temperature dependent, and the cultivars can vary significantly in their metabolic characteristics (Ahn *et al*., 1980).

During longer term storage, sprouting of the root tuber can cause loss. Sprouting can be controlled by sprout suppressants, but this is not economically feasible under most situations in East Africa. Initial observations at NRI have indicated that East African cultivars differ very markedly in their tendency to sprout during storage (Rees, unpublished results).

Under certain conditions, notably at low oxygen levels, a switch to anaerobic respiration, which involves the production of alcohol, and is detrimental to quality, can occur. For example, the sweetpotato crop is particularly sensitive to low oxygen conditions that occur during water logging. During storage in pits and clamps, oxygen levels can fall, and anaerobic respiration can occur. An understanding of the control of the switch to anaerobic respiration may enable the selection of varieties to minimise this problem (Tortoe *et. al*, 2010).

Root tubers are susceptible to rotting especially after damage due to mechanical injury or insect infestation. Trials conducted in Tanzania have shown clear indications of varietal differences in susceptibility to rots, but the basis of this difference has not been investigated (Chilosa *et al.*, 1995). More detailed studies have been carried out on North American germplasm {Clark *et al., (*1989) and Clark (1992)} where resistance to rotting has also been shown to exist within certain varieties. The root tuber possesses several mechanisms of resistance to invading pathogens, including the formation of physical barriers, as in the formation of wound periderm and hypersensitive cell death, and the production of chemicals toxic to invading pathogens such as phytoalexins, proteinase inhibitors and phenols. The relative importance of these mechanisms appears to vary depending on variety and pathogen.

Among the more commonly encountered microorganisms causing storage rots are: *Lasiodiplodia theobromae* (Java black rot); *Ceratocystis fimbriata* (black rot); *Erwinia chrysanthemi* (bacterial soft rot); *Fusarium oxysporum* (surface rot); *Fusarium solani* (root rot); *Macrophomina phaseolina* (charcoal rot); *Monilochaetes infuscans* (scurf); and *Rhizopus stolonifer* (soft rot)). Timing of infection varies with the organism, field harvest and storage conditions (Moyer, 1982).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Introduction

Two experiments were carried out at the Multipurpose Crop Nursery at the College of Agriculture Education, University of Education, Winneba, Mampong campus during the minor and major rainy seasons, 2011/12 and 2012 respectively. In both growing seasons sweetpotato root tubers were stored for three months after harvest using three storage methods (pit, ash and grass).

3.2Experimental Site and Climatic Conditions

3.2.1 Experimental Site

Two field experiments (minor and major rainy seasons) were conducted both at the Multipurpose Crop Nursery at the College of Agriculture Education, University of Education, Winneba, Mampong Campus from September, 2011 to January, 2012 and April to August, 2012 respectively.

Mampong - Ashanti (7° 8 N, 1° 24 W) is 457.5 m above sea level and is located in the forest transitional agro ecological zone. The soil type is the savanna ochrosol formed from the Voltaian sandstone of the Afram plains. Texturally, the soil is friable with a thin layer of organic matter and is deep and brown-sandy loam and well-drained. It however has a good water-holding capacity. The soil has been classified by FAO/UNESCO (1988) legend as Chronic Luvisol and locally as the Bediesi series with a pH range of 4.0-6.5 and is good for tuber, cereal, vegetable and legume crop production (Asiamah, 1988). The rainfall pattern of the Mampong-Ashanti is bimodal. The area receives major rainfall between March and July while the minor rainfall comes between August and October. The annual rainfall ranges between 1270 mm and 1534 mm with the monthly being 91.2 mm. The mean monthly temperature is between 25^{o} C and 32^{o} C (Ghana Meteorological Agency-Mampong Ashanti, 2002).

3.2.2Climatic Conditions at the Experimental Sites

Differences in climatic factors (rainfall, temperature and relative humidity) were observed between both cropping seasons (Tables 3.1; 3.2). The total monthly rainfall in the minor seasonwas 429.8 mm and it occurred from September, 2011 to January, 2012 with the peak in September and October. The mean monthly temperature of the area for the minor season ranged between 23°Cto 31.9°C with the highest daily of 33.7° C occurring in January, 2012. The mean monthly relative humidity ranged from 54 to 93.4% with the peak occurring between September and November. The bimodal rainfall pattern of Mampong-Ashanti gave the area two seasons, the major season occurred between March and July and the minor from September to November with one month drought spell in August (Ghana Meteorological Agency – Mampong Ashanti, 2011).

In the major rainy season (2012), during experiment 2, the total monthly rainfall was 1,042.3 mm and it occurred from April to August, 2012 with the peak in May and July. The mean monthly temperature of the site for the major season ranged between 22.5° C to 30.1° C, with the highest daily of 33.3° C occurring in April. The mean monthly relative humidity ranged from 67.4 to 93.4% with the peak occurring between April and June.

Similarly, the bimodal rainfall pattern of Mampong-Ashanti gave the area two seasons, the main season occurred between April and July for major season and the minor season from September to November with one month dry spell in August (Ghana Meteorological Agency – Mampong Ashanti, 2012).

3.3 Experimental Design and Treatments

In the field experiment, a 2 x 8 factorial arranged in randomized complete block design with four replicates made up of seven organic manure and fertilizer rates and the control (without any amendment) and two sweetpotato varieties (Okumkom and Apomuden) was assigned to each block..

3.3.1 Treatments

There were sixteen treatment combinations (Table 3.3a and 3.3b)

3.4 Organic manure preparation

The broiler chicken manure used for the research project for each season was four months old (20.0% moisture content) and was obtained from the poultry farm of the College of Agriculture, University of Education, Winneba - Mampong campus and heaped under shade for one month to dry and decompose before use. Sub-samples of the dried manure were taken for nutrient analysis. The decomposed and dried chicken manure was applied and worked into the soil two weeks before planting of vines.

Table 3.1: Climatic Data for 2011 Minor Rainy Season for Experiment One (1)

Month	Total Rainfall (mm)	Mean Relative Humidity (%)		MeanTemperature (° C)	
		06.00 h	15.00 h	Min.	Max.
September,2011	155.6	98	73	22.3	29.4
October	188.1	97	67	22.3	30.9
November	38.0	96	54	28.0	32.7
December	0.0	92	41	22.2	32.9
January, 2012	48.1	84	35	20.8	33.7

Source: Ghana Meteorological Agency– Mampong Ashanti.

Table 3.2: Climatic Data for 2012 Major Rainy Season for Experiment Two (2)

Month	Total Rainfall (mm)	Mean Relative Humidity (%)		Mean Temperature (° C)	
		06.00 h	15.00 h	Min.	Max.
April	119.3	96	61	23.0	33.3
May	270.8	96	63	23.0	31.4
June	379.8	97	71	22.6	29.5
July	178.6	96	71	21.9	28.2
August	93.8	96	71	21.9	28.2

Source: Ghana Meteorological Agency – Mampong -Ashanti

Table 3.3a: Details of fertilization Treatments

Treatment	Fertilization Treatments
T1	Okumkom + 15-30-30 kg/haNPK+ 5t/ha CM
T2	Okumkom + 15-23 23kg/ha NPK + 5t/ha CM
T3	Okumkom + 15-15- 15kg/haNPK + 5t/ha CM
T4	Okumkom + 30-60-60kg/haNPK + 5t/ha CM (Recommended)
T5	Okumkom + 30-45-45kg/haNPK
T6	Okumkom + 30-30-30kg/haNPK
T7	Okumkom + 10t/ha CM
T8	Okumkom + no fertilizer (Control)
T9	Apomuden +15-30-30 kg/haNPK+ 5t/ha CM
T10	Apomuden + 15-23 23 kg/ha NPK + 5t/ha CM
T11	Apomuden +15-15- 15kg/haNPK + 5t/ha CM
T12	Apomuden +30-60-60 kg/haNPK + 5t/ha CM (Recommended)
T13	Apomuden +30-45-45 kg/ha NPK
T14	Apomuden + 30-30-30 kg/haNPK
T15	Apomuden + 10t/ha CM
T16	Apomuden + no fertilizer (Control)

Table 3.3b: Treatment combinations

Treatments	Inorganic Fertilizer (IF) (NPK 15-15-15)	Triple Super Phosphate (TSP)	Muriate of Potash (MOP)	Chicken Manure (CM)
T_1	100kg/ha	65kg/ha	24kg/ha	5t/ha
T_2	100kg/ha	32.5kg/ha	12kg/ha	5t/ha
T_3	100kg/ha	-	-	5t/ha
T_4	200kg/ha	130kg/ha	48kg/ha	-
T_5	200kg/ha	65kg/ha	24kg/ha	-
T_6	200kg/ha	-	-	--
T_7	-	-	-	10t/ha
T_8	-	-	-	-
T_9	100kg/ha	65kg/ha	24kg/ha	5t/ha
T_{10}	100kg/ha	32.5kg/ha	12kg/ha	5t/ha
T_{11}	100kg/ha	-	-	5t/ha
T_{12}	200kg/ha	130kg/ha	48kg/ha	-
T_{13}	200kg/ha	65kg/ha	24kg/ha	-
T_{14}	200kg/ha	-	-	-
T_{15}	-	-	-	10t/ha-
T_{16}	-	-	-	-

3.5 Soil and Manure Sampling

After lining and pegging the experimental area was demarcated into plots and prior to planting, soil and chicken manure were mixed thoroughly. Samples of the mixture of soil and manure and no-manure soil (control) were randomly taken from Ap horizon at the uniform depth of 0-20 cm from the Multipurpose Crop Nurseryat the College of Agriculture Education, University of Education, Winneba, Mampong Campus.

3.6 Soil Physical and Chemical Analyses

Soil samples and soil plus chicken manure from the site were bulked, air-dried and sub-samples were taken for analysis at the CSIR-Soil Research Institute, Fumesua near Kumasi. The characteristics analyzed for included; Bulk density, soil texture, Soil pH, Organic matter, Total Nitrogen, Exchangeable Calcium, Magnesium, Potassium, Sodium and Effective Cation Exchange Capacity, and Bray N0.2 Extractable Phosphorus and Potassium.

The soil after air-drying was homogenized by passing it through 5 mm sieve. Soil texture was determined by the Hydrometer method. Soil pH was measured on 1:1 (soil: distilled water) and 1:2 (soil: 0.01m $CaCl_2$) mixtures and measured on a pH meter (Pracitronic pH meter) manufactured by Veb Pracitron in Dresden, Germany. The soil pH was taken for manure plus soil mixtures and the control plots. Soil organic matter was determined by the wet combustion method (Walkey and Black, 1934). Percentage total nitrogen was determined by the micro Kjeldahl-technique ((AOAC, 1975). The available phosphorus was extracted by the Bray method and determined colorimetrically (Bray and Kurtz 1945). Potassium was determined by flame emission photometry (IITA, 1979). The exchangeable cations calcium, magnesium, potassium and sodium were determined as recommended by

IITA (1979) using EDTA Titration after extraction with 0.1N Ammonium Acetate at pH 7. Effective Cation Exchange Capacity (ECEC) was calculated as the sum of the exchangeable bases and exchangeable acidity (IITA, 1979).

3.7 Land Preparation and Fertilization

Land clearing was immediately followed by ploughing and harrowing as there were no stumps. The major weed at site was *Cyperus* spp and it was also controlled with 41%g Glyphosate (Weedout) at the rate of 2.0 1/ha. The 3.0 m long x 4.0 m wide plots were laid with four ridges per plot each measuring about 0.4m high. The ridges were manually constructed with a hoe.

Chicken manure was applied and worked into the soil two weeks before planting of vines. This was done to ensure complete decomposition of organic manure and to allow for total nitrification to avoid the risk of ammonia toxicity. The NPK (15:15:15), Triple super phosphate (TSP), and Muriate of potash (MoP) were applied two weeks after planting of vines. This was applied 5 cm deep and 5 cm away from the vines. The inorganic fertilizers were applied at this period because it will help the sweetpotato vines to get a good start as plants can get access to nutrient early. Both inorganic (NPK, TSP, MoP) and organic (Chicken manure) were applied at appropriate rates as per treatments.

3.8 Planting Materials and Planting

The sweetpotato varieties used for the experiments were '*Okumkom'* (a 120 – day maturing improved variety) and '*Apomuden'* (also a 120 – day maturing improved variety) developed by the Crop Research Institute of the Council for Scientific and Industrial Research (CSIR-

CRI), Kumasi. The tuber skin colour of '*Okumkom'* is light purple while the tuber flesh is white and it has a yield capacity of over 19 t/ha. The tuber skin colour of '*Apomuden'* is light orange while the tuber flesh is reddish (deep) orange and it has a yield capacity of over 29 t/ha.

Vine cuttings of length 0.3 m from topmost apical sections and other actively growing sections were used for planting. All open leaves were detached from mature vines, each of which was cut to 30 cm in length. The removal of leaves was done to reduce transpiration and ensure good vine establishment. Two-thirds of each vine (with 4-5 nodes) was buried into the soil (about 15-20 cm deep) at an angle leaving one-third above the soil at one vine per hill/stand at a spacing of 1.0 m x 0.3 m. Each experimental plot contained four (4) rows with eleven (11) plants within each row. There were eighteen (18) plants within the harvest area (two central rows per plot). Planting of vines for the minor rainy season was done on the 20th September, 2011 and that of the major rainy season, was on the 19 May, 2012. Vines for the major rainy season experiment were obtained from a multiplication nursery raised during the dry season in the Multipurpose Crop Nursery, at the College of Agriculture Education, University of Education,Winneba- Mampong campus. Each experimental plot measured 4.0 m x 3.0 m with 1.0 m between plot and 2.0 m between blocks. The total field size for each season was 64.0 m x 18.0 m (1152 m^2).

3.9 Agronomic Practices

Weeds were controlled in both field experiments at 3 -4 weeks after planting of vines using cutlass and hand hoeing method before close of the canopy and to reduce competition with crops. Subsequent weed control was by hand pulling and reshaping of ridges.

During the minor rainy season field experiment, intermittent drought spell necessitated supplementary irrigation from mid- October 2011 to harvesting in January, 2012.

The NPK (15:15:15), Triple super phosphate (TSP), and Muriate of potash (MoP) were applied two (2) weeks after planting of vines. Both inorganic (NPK, TSP, MoP) and organic (Chicken manure) were applied at appropriate rates as per treatments.

Incidence of pests and diseases was periodically monitored by visits to experimental sites to check for such pests as sweetpotato weevil *(Cylas* spp*)* and sweetpotato butterfly (*Acraea aceratd*) and diseases such as Sweetpotato Virus Disease (SPVD). Pests and diseases were controlled by spraying sweetpotato plants with Polythrine 10 insecticide at the rate of 350 ml per 15 litre Knapsack sprayer tank. This was done three times before harvesting for both seasons.

3.10 Data Collection

3.10.1 Vegetative Data

The percentage crop establishment was measured at 4 weeks after planting (WAP). This was achieved by counting the number of plants that sprouted and the percentage crop establishment subsequently estimated.

The vegetative data taken were leaf number, number of branches, plant height, vine length, vine diameter/girth, leaf chlorophyll content, vine fresh weight per plant, root fresh weight per plant, dry matter accumulation and vine fresh weight at harvest. Five non-border plants from each treatment plot were randomly sampled for leaf number, number of branches, plant height, vine length, vine diameter. However, three plants were randomly sampled for leaf chlorophyll content, vine and root fresh weight per plant and dry matter accumulation data was collected at two weeks interval beginning from 4 weeks after planting (WAP). For vine fresh weight at harvest, however, all eighteen plants from the two central rows for each treatment plot were sampled.

The number of leaves per plant, number of branches, plant height, vine length and vine diameter/girth were measured at 2 weeks interval from 4 WAP to 12 WAP. The leaf chlorophyll content was measured at four weeks interval from 4 WAP to 16 WAP using a Fieldscout CM 100 chlorophyll meter, Spectrum Technologies Inc.

Plants were also destructively sampled and weighed for vine fresh weight accumulation at 2 weeks interval from 4 WAP to 12 WAP using an electronic weighing scale. Mean values per treatment were then estimated. After destructive sampling for vine and root fresh weight gain, 200 g samples per plot were oven-dried at 72°C for 72 hours to remove all moisture. Dried samples were then weighed using an electronic weighing scale and the mean dry matter gain per treatment was subsequently estimated using the sample vine dry weight, the sample vine fresh weight and the total fresh vine weight. This can be expressed mathematically as follows:

$$\text{Fresh vine weight} = \frac{(Xg)\ X\ (Yg)}{200g\ of\ fresh\ vine\ weight}$$

Where: X (g) = total fresh vine weight

Y(g) = 200 g of fresh vine weight

Vine dry weight $= \frac{(Xg)\ X\ (Yg)}{200g\ of\ vine\ dry\ weight}$

Where: X (g) = vine dry weight

Y (g) = 200 g of vine dry weight

The fresh vines of all the plants from the two central rows were sampled and the root tubers were harvested and weighed using a weighing scale and the weight of root tubers at harvest estimated in tonnes per hectare.

3.10.2 Yield and Yield Component Data

The number of marketable and unmarketable root tubers per plot, root tuber length, weight per root tuber and total root tuber /yield was estimated from the two central rows. The marketable and unmarketable root tubers diameters were classified as tuber diameter less than (<) 3 cm -unmarketable and the tuber diameter greater than (>) 3 cm - marketable. Diameters were measured from the middle portion of the tuber using vernier calipers.

The dry matter of root tuber (DM) was estimated from a sub sample of 200 g taken from the tubers harvested from the two central rows. The 200 g sub samples were oven-dried for 48 hours at 80°C and the dry matter weight estimated using an electronic scale.

3.10.3 Market Quality of Tuber

The main parameters considered under market quality attributes of harvested tubers included tuber cracks, tuber rot, sprouts in tubers, tuber split, misshapen root tubers and weevil infestation. The tubers harvested from the eighteen plants of each plot were sorted into five categories using the recommended scale below CRI (2003) under the Roots and Tubers Improvement Programme (RTIP). None…(1) means 1% of the root tuber had symptoms of Cylas infestation, slight ….(2) means 25% of the root tubers had symptoms of Cylas infestation,Moderate ....(3) means 50 % of the root tubers had symptoms of Cylas infestation,Severe..........(4) means 75 % of the root tubers had symptoms of Cylas infestation and Very Severe ……(5) means almost 100 % of the root tubers had symptoms of Cylas infestation

Each attribute was scored by relating the number of affected tubers to the total number of tubers per treatment plot.

Rating Scale

i. None 1

ii. Slight............2

iii. Moderate 3

iv. Severe..........4

v. Very Severe 5

3.10.4 Estimation of Harvest Index and Commercial Harvest Index

At harvest, the plants from the two central rows of each treatment plot were harvested and separated into tubers and vegetative parts and their separate weights taken for estimation of the harvest and commercial indexes. The harvest index was estimated as the ratio of the total root tuber yield to the sum of the root tuber yield and vegetative biomass. Commercial harvest index was also estimated as the ratio of the weight of the marketable root tubers obtained earlier to the total root tuber yield (CRI, 2003).

3.11 Sensory Evaluation

3.11.1 Preparation of Tubers for Sensory evaluation and Analysis

The fresh sweetpotato tubers after harvest were washed and cooked separately based on the treatment at a temperature of 100^0 C for 30 minutes. They were boiled with 8.0 g of iodated salt dissolved in 1000 ml of water. The cooked tubers were cut into cubes of size 2 cm x 2 cm x 2 cm, coded randomly and served to panelists for evaluation.

Six panelists consisting of three males and three females, aged between 25 and 43 years old who had been selected and trained were used in the sensory evaluation. Cooked samples of sweetpotato tubers for the two varieties were evaluated for their colour (surface and inner flesh), flavour, taste, texture, palatability and overall acceptability. A 5- point (Appendix 21) category scale was used for scoring and the results were subjected to statistical analysis.

3.12. Storage of Sweetpotato Root Tubers

Sweetpotato root tubers used for the storage experiment were obtained from the field experiments during both growing seasons. The root tubers were harvested at four months from the day of planting. After harvest, sweetpotato root tubers of 200-250 g were sorted to remove physically, and pest or disease damaged tubers. The sorted root tubers were cured naturally in the sun for three days by spreading them on the ground (25-30 ^{0}C, RH 80-95%).The sweetpotatoes from each treatment were divided into three portions. For each storage condition or method (pit, ash and grass) the root tubers were divided into sixteen treatments, each containing seven tubers. The experimental design used was randomized complete block design where the two varieties and fertilization constituted the treatments and were each replicated three times. A simple random sampling technique was used to select tubers from each treatment and replicate. The random sampling approach was to ensure that the parameters under observation are taken from representative universe of units from each replicate and treatment.

3.12.1 Storage Methods

The various storage methods were set up as follows:

3.12.1.1 Pit Storage Method

Storage in pit (50x 50x 50 cm) with alternate layers of grass and finally covered with soil. Pit store was constructed (under a shade to prevent rain water from entering the storage pit) by digging circular pit of 0.5 m diameter at the top, 0.5 m depth and 0.5 m wide at the base. The size of the pit was chosen to suit local climatic conditions and is modification of traditional pits. Pit was lined with dry plantain leaves before the sweetpotato tubers were stored in them. Layers of tubers as per treatment were separated with about 1.0 kg dry spear grass

(*Imperata cylindrica*). The sweetpotatoes tubers were finally covered with dry spear grass before covering them with approximately 2.0 kg of soil. The grass acted as an insulating material and ensured cool condition in the pit (17^{O} C, RH 95-100%).

3.12.1.2 Ash Storage Method

Storage in wood ash packed in a basket (50x 50x 70 cm) and tubers alternated with layers of grass and finally covered with grass. A basket measuring 0.5 m at the base, 0.5 m high and 0.7 m wide at the top was lined with dry plantain leaves before tubers were stored in them. Tubers as per treatment were thoroughly coated with wood ash by mixing them with two (2) kg of wood ash and tubers were then alternated with 1.0 kg of dry spear grass The ash acted as an absorbent to moisture and has a repelling effect on pests. Wood ash has alkaline properties, which are not conducive to development of diseases.

3.12.1.3 Grass Storage Method

Tubers were stored in grass packed in a basket (50 x 50 x70 cm) with tubers alternating with layers of grass and finally covered with a grass. A basket measuring 0.5 m at the base, 0.5 m high and 0.7m wide at the top was lined with plantain leaves before tubers were placed in them. Layers of tubers as per treatment were separated with about 1.0 kg dry spear grass (*Imperata cylindrica*). The sweetpotatoes were then finally covered with dry spear grass at the top.

In each basket and pit 112 tubers were placed and subjected to the experimental conditions. These quantities of tubers were obtained from the field experiments after harvest. After setting up the potato under the various storage methods it was monitored for three months and data was collected every two weeks on.

Weight loss in sweetpotato (as a % of the total weight stored), Sprouting of sweetpotatoes (%), Spoilage of sweetpotatoes (%), tuber shrinkage, pests and disease infested tubers were the data collected. The freshly harvested sweetpotatoroot tubers were also analyzed for their nutrient composition and the following data were collected: Sugar, Starch (predominant carbohydrate in sweetpotatoes) and beta carotenoid.

At the expiration of the storage period the stored samples were carefully sorted and observations recorded. Samples from each treatment were thereafter also analyzed for sugar, starch, and Beta- carotenoid.

3.13 Procedure for Beta – Carotenoid Analysis

3.13.1 Sample collection

A total of forty eight (48) fresh sweetpotato root tubers comprising 24 orange- flesh sweetpotatoes (OF) and 24 white-flesh sweetpotatoes with pink skin (WF) were obtained from the field experiments after harvest.

3.13.2 Sample preparation

Three sweetpotato root tubers were randomly selected from each treatment at harvest. The freshly harvested sweetpotato samples (from each variety and treatment) were washed with clean water, packaged in aluminum foil, labeled and stored at -4°C. The samples were shredded later with a plastic grater and made to pass through a 0.2 mm mesh, packaged in well labeled test tubes and stored at - 30°C for subsequent β- carotene analysis using HPLC. Precautionary measures such as exclusion of oxygen, and protection from light were taken to prevent carotenoids losses. Similar sweetpotato sample preparation was carried out after three months storage of tubers from each of the storage method for β- carotene analysis using HPLC.

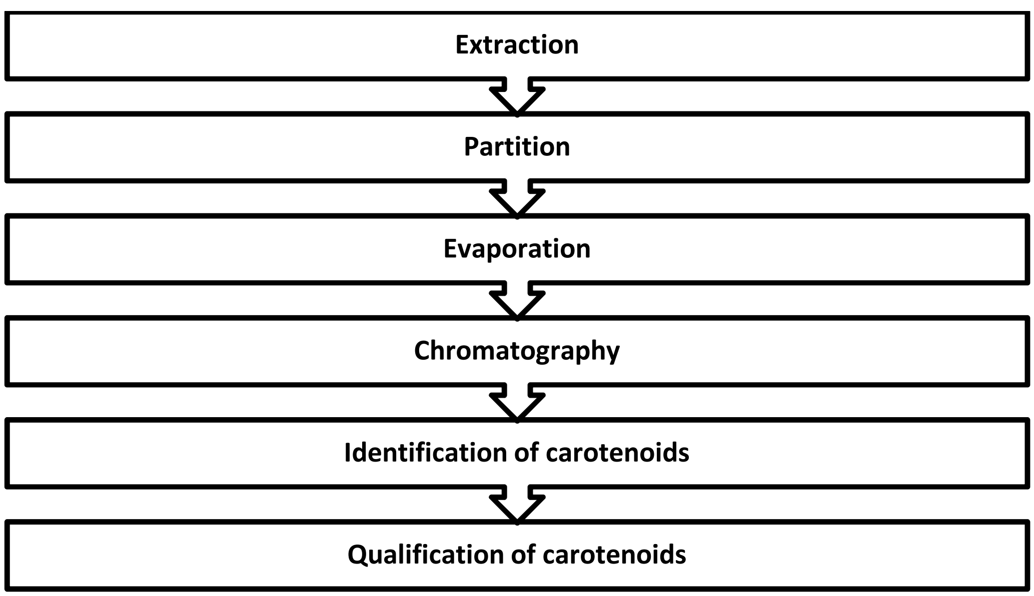
3.13.3 Chemicals and standard reagents used

All chemicals and beta-carotene standard were obtained from nutrition laboratory of the Noguchi Memorial Institute for Medical Research (MMIMR) of the University of Ghana, Legon-Accra, with the beta-carotenoid analysis also carried out in the same nutrition laboratory. The water used for analytical work was double-distilled.

3.14 Carotenoids Analysis

The steps involved in the carotenoids analysis according to method described by Rodriguez-Amaya (1999a) are outlined in the following chart below:

Flow diagram of carotenoids content determination



3.14.1 Carotenoid Extraction

The -4° C frozen and thawed samples were used for the beta-carotene analysis using HPLC. Small amount (about 1.0 g) of the prepared sample was weighed using an electronic balance (Sartorius, Analytic $AC210_s$) into a mortar.Carotenoids were extracted by grinding about 1.0 g of each sample in a mortar using pestle for five (5) minutes with about 1/3 of the measured cold acetone (20 ml) was poured into the mortar containing the sample. The residue was filtered in Butcher funnel equipped with filter paper (Whatman # 2 filter paper, Maidstone, England). The residue was returned to the mortar and the extraction was repeated using 20 ml of cold acetone until the residue was nearly colourless. Precautionary measures such as exclusion of oxygen, protection from light and avoiding temperatures above 40 ^{o} C were taken to prevent carotenoid losses during extraction and analysis.

3.14.2 Partition

Since the acetone used during the extraction is water-soluble, and also has damaging effect on HPLC system, it was washed away as described by Rodriguez- Amaya (1999). The total extract was gently and carefully transferred to a separating funnel (250 m) containing 20 ml of petroleum spirit. Two distinct phases (lower and upper) were formed during the washing. The water used for washing was allowed to flow along the wall of the separating funnel. The lower acetone-aqueous phase was carefully discarded. Washing procedure continued for five more times with 200 mls of distilled water at each time until the lower phase appeared extremely clear, indicating complete removal of acetone from the extract. The final washing was done carefully. The lower phase was gently and completely discarded as much as possible without losing the upper phase (extract). The upper phase (petroleum-extract) was collected over about 5.0 g anhydrous sodium sulphate (dry agent), to absorb residual water in the extract. The separating funnel was rinsed thoroughly with petroleum spirit into a 50ml eppendorf tube containing the extract. The final volume of the extract in the tube was noted and recorded.

3.14.3 Evaporation of solvent

The petroleum spirit used during the partition was evaporated from the extract because of its damaging effect on the HPLC equipment. Under normal circumstance, the whole volume of the extract was supposed to be evaporated, but due to insufficiency of the nitrogen gas, 2mls of the total volume of the extract was evaporated on rotary evaporator with nitrogen gas to dryness. The evaporated extracts were used for the spectrophotometric analysis and injection in the HPLC.

3.14.4 Chromatography

A rapid reversed-phase HPLC was used for the analysis of the carotenoids. The HPLC system consisted of pressure pump (model: shimadzu LC-64), injector port, stationary column, detector (model: shimadzu SPD-6AV) and recorder (model: shimadzu C-R6A chromatopac). A mixture of acetonitrile/dichloromethane/methanol in the ratio 7:2:1 v/v/v was used as the blank. The absorbance of the standard carotenoids was determined spectrophotometrically at a wavelength of 450 mm. The HPLC system was calibrated using the blank (mobile phase) and was washed thoroughly using the mobile phase (a mixture of acetonitrile/dichloromethane/methanol) in the ratio (7:2:1 v/v/v) for ten (10) minutes Immediately before injection, the dried extracts in the test tubes were dissolved in a mixture of methanol/dichloromethane (50%:50% v/v) and vortexed.. About 20 µl of the redissolved extract was injected into the HPLC using a syringe. The extract was pumped at a rate of 1.5 ml/minute from the injector into the stationary column, where separation of the carotenoids took place according to their polarity. The absorbance of the carotenoids was determined at a wavelength of 450 mm. The results were recorded and printed by recorder as spectra. The standard carotenoids and the extracts were injected separately in equal volumes into the HPLC.

3.14.6 Identification of carotenoids

The different varieties of sweetpotatoes contained different arrays of carotenoids such as lutein, β- carotene, lycopene etc. The identification of the carotenoids from the extract was based on the elution (retention) time between the standard carotenoids and extracts.

3.14.7 Quantification of Carotenoids

Carotenoids, as other analytes in solution obey Beer-Lambert law which states that, absorbance of carotenoids is directly proportional to the concentration.

The concentrations of the carotenoids in the extracts were calculated by comparing the concentration and area under the peak of the standard carotenoids with the area under the peak of the carotenoid in the extract. The calculations are shown in (Appendix 22)**.**

3.15 Starch and Sugar Analyses

Three sweetpotato root tubers were randomly selected from each treatment at harvest. The freshly harvested sweetpotato samples from (each treatment) were washed with clean water, packaged in aluminum foil, labeled and stored at -4°C for starch and sugar analysis using

Abbe Refractometer, model, 98-440, Novex-Holland. Additionally, fresh sweetpotato root tubers were randomly selected after three months storage from each of the storage method for similar analysis.

The samples were shredded later with a plastic grater and made to pass through a 0.2 mm mesh. 10.0 g of each sample was placed in a cheese cloth and a few drops of the sap squeeze out and slowly onto the lens of the Refractometer and closed with the cover. The eye piece was immediately focused to clearly see the graduation. The sugar content of each sample (in Brix) was quickly recorded. This was repeated for the other treatments by using new cheese cloth.

For the determination of starch, the refractive indices obtained from the samples were compared to standard scale to obtain accurate values, thus the percentage mass of the starch was read from a chart corresponding to the value of refractive index. Precautionary measures such as cleaning of lens with soft damp cloth after every reading and allowing sap to rest on the lens for at least 30 seconds before taking a reading were taken.

3.16 Estimation of Partial Budget

Partial budget analyses for both Apomuden and Okumkom varieties of sweetpotato grown in the minor and major seasons using chicken manure and inorganic fertilizer combination consisting of seven (7) organic manure and inorganic fertilizer rates and the control were estimated. The adjusted yield, total gross benefit, variable cost (fertilizer, application and transportation costs), total variable cost (TVC), net benefit (NB) and marginal rate of return were also estimated. These can be expressed mathemathically as follows:

1. Adjusted yield(t/ha) = 85 % x yield obtained
2. Total Gross Benefit = Adjusted yield x farm gate price
3. Total variable cost= fertilizer cost + application cost + transportation cost
4. Net benefit = Total gross benefit – Total variable cost
5. Marginal rate of return (MRR) (%) = $\frac{\Delta \text{ net benefit}}{\Delta \text{ total variable cost}} \times 100$

3.17 Statistical Analyses

The data collected were analyzed using Analysis of Variance (ANOVA) The data obtained were analyzed using the GenStat Release 9.2 (PC/Windows XP) statistical package, Copyright 2007, Lawes Agricultural Trust (Rothamsted Experimental Station) and the Least Significant Difference (LSD) was used to separate the means at 5 % level of probability.

CHAPTER FOUR

4.0 RESULTS

4.1Organic Manure, Soil and Soil Plus Manure Analysis

4.1.1 Manure Characteristics

Table 4.1 shows nutrient contents of 4-month old chicken manure from a deep litter system which was used for Experiments 1 and 2. The organic carbon, organic matter, available phosphorus and exchangeable Aluminium were relatively high although available potassium and the exchangeable cations especially calcium and magnesium were low for Experiment 1 site. The acidity level of the chicken manure for experiment 1 site is (6.81) being almost neutral but slightly alkaline (8.28) for Experiment 2 site. The wide difference that existed between the chicken manure used for the two experiments is attributed to differences in climatic conditions during litter production and storage after production and the time of use of the organic manure.

4.1.2 Changes in Soil Nutrients Levels Due to Treatments

Initial effects of manure application on some soil physical and chemical properties at the 2011 experimental site are shown in Table 4.2. Both the untreated soil (no- manure) and manure supplemented soils fell within the sandy loam textural range 10t/ha chicken manure supplemented soil gave higher levels of organic matter, exchangeable Ca, Mg and effective cation exchange capacity than the other manured soil and control. Both the untreated soil and manured soil gave an acidic pH (5.44 and 5.77); however, 10t/ha chicken manure supplemented soil gave a slightly acidic pH (6.45).

Table 4.3 shows the effect of manure application on soil chemical properties at 16 weeks after planting. Organic carbon, total nitrogen, organic matter, available phosphorus and potassium decreased while the soil pH and bulk density for all treatments increased.

Table 4.1: Chemical Properties of Chicken Manure used for the Minor and Major Growing Seasons (2011) and 2012) Respectively

Property	Value	
	Chicken Manure (Experiment 1- 2011)	**Chicken Manure (Experiment 2-2012)**
Organic carbon (%)	4.36	13.42
Total nitrogen (%)	0.46	2.35
Organic matter (%)	7.52	23.14
Available P (ppm)	319.69	439.29
Available K (ppm)	828.91	74.40
PH (1:1 H_2O)	6.81	8.28
Total Exchangeable Bases (TEB)	37.59	0.05
Exchangeable Aluminium (Al^+H)	0.08	29.99
Effective Cation Exchange Capacity (E.C.E.C) Me/100g	37.67	29.99
Bases saturation (%)	99.70	99.83
Exchangeable Cations		
Ca^{2+} (mg/100g)	20.03	11.48
Mg^{2+}(mg/100g)	14.95	7.48
K^+ (mg/100g)	2.05	7.88
Na^+ (mg/100g)	0.56	3.10

Table 4.2: Physical and Chemical Properties of Soil and Soil Plus Manure Ap Horizon at 0-20 cm Depth Two Weeks after Planting (2 WAP) for Experiment 1- (2011)

Property	Value			
	Untreated Soil (Control)	Inorganic Fertilizer + Soil	10t/Ha Chicken Manure + Soil	5t/Ha Chicken Manure + Inorganic Fertilizer +Soil
Sand (%)	66.49	68.78	66.86	65.93
Silt (%)	27.51	27.22	25.14	26.07
Clay (%)	6.00	4.00	8.00	8.00
Organic carbon (%)	1.06	1.07	1.26	1.14
Total nitrogen (%)	0.13	0.14	0.17	0.15
Organic matter (%)	1.83	1.84	2.17	1.97
pH (1:1 H_2O)	5.44	5.44	6.45	5.77
Available P (ppm)	38.02	1018.78	334.04	436.10
Available K (ppm)	73.65	503.78	113.83	177.44
Bulk density (g/cm^3)	1.49	1.51	1.67	1.51
Exchangeable cations				
Ca^{2+} (mg/100g)	2.49	2.97	12.80	6.14
$Mg^{2+(}$mg/100g)	2.94	2.94	6.74	2.14
K^+ (mg/100g)	0.35	1.34	0.48	0.67
Na^+ (mg/100g)	0.13	0.13	0.17	0.18
Total Exchangeable bases	5.91	7.38	20.19	9.13
Effective Cation Exchange Capacity (E.C.E.C) Me/100g	7.11	8.13	20.34	9.58
Exchangeable Aluminium (Al^+H)	0.75	0.15	0.15	0.45

Bases Saturation (%)	89.40	90.70	99.26	95.30

Table 4.3: Physical and Chemical Properties of Soil and Soil Plus Manure Ap Horizon at 0-20 cm Depth Sixteen Weeks after Planting (16 WAP) for Experiment 1 (2011)

Property	Value			
	Untreated Soil (Control)	Inorganic Fertilizer + Soil	10t/Ha Chicken Manure + Soil	5t/Ha Chicken Manure + Inorganic Fertilizer +Soil
Sand (%)	67.34	68.55	67.00	66.50
Silt (%)	27.00	27.15	26.20	27.00
Clay (%)	5.66	4.30	6.80	6.50
Organic carbon (%)	0.98	0.71	0.84	0.74
Total nitrogen (%)	0.07	0.02	0.11	0.13
Organic matter (%)	1.69	1.22	1.45	1.28
pH (1:1 H_2O)	5.69	5.61	6.60	5.88
Available P (ppm)	33.48	11.56	13.47	11.08
Available P (ppm)	100.43	130.56	93.74	113.82
Bulk density (g/cm^3)	1.48	1.50	1.58	1.52
Exchangeable cations				
Ca^{2+} (mg/100g)	4.14	4.01	3.47	4.27
Mg^{2+}(mg/100g)	0.93	1.87	1.34	1.34
K^+ (mg/100g)	0.38	0.45	0.34	0.41
Na^+ (mg/100g)	0.13	0.12	0.14	0.21
Total exch. bases	5.58	6.45	5.29	6.23
Effective cation Exchange Capacity (E.C.E.C) Me/100g	6.18	7.25	5.89	6.64
Exchangeable Aluminium (Al^+H)	0.60	0.80	0.60	0.50
Bases saturation (%)	90.30	89.00	89.80	92.47

4.1.3 Changes in Soil Nutrient Levels Due to Treatment for Experiment 2 During the Major Growing Season in 2012

Soil nutrient analysis at depth 0-20 cm at both sites was carried out and the results are presented in Tables 4.5, 4.6. The soil and manure supplemented soil for both initial and final analyses fell within the sandy loam textural range. The soil analyses for both initial and final showed that pH was neutral for the top soil. The soil supplemented with inorganic fertilizer was acidic at the initial manure application but slightly acidic at 16 weeks after planting. The other manure treated soils were slightly acidic at both initial and final soil nutrient analyses. Organic matter content was low to moderate and the total nitrogen levels were moderate at two to 16 weeks after planting. Exchangeable calcium and magnesium levels were low to moderate at the initial soil nutrient analysis. However, exchangeable calcium levels were moderate at 16 weeks after planting.

4.2 Growth Performance of Two Sweetpotato Varieties as Influenced by Chicken Manure and Inorganic Fertilizer

4.2.1 Percentage Crop Establishment

The percentage crop establishment as influenced by chicken manure and inorganic fertilizer is presented in Table 4.7. During the minor season (2011), there was a significant difference between Apomuden and Okumkom in percentage crop establishment (Appendix 1). Apomuden grown on the control plot had the highest percentage crop establishment (78.8 %) and differed significantly from 15-30-30 kg/ha NPK+5t/ha CM plot which recorded the lowest mean (59.2%) at 4 WAP. However, Okumkom grown on 30-30-30 kg/ha NPK plot had the highest percentage crop establishment (70.9 %) followed by 15-30-30 kg/ha

NPK+5t/ha CM plot with the lowest recorded by 30-45-45 kg/ha NPK plot (59.8 %) at 4 WAP.

Table 4.4: Guide to interpretation of soil analytical data

Nutrient	**Rank/Grade**
Phosphorus, P (ppm), (Bray 1)	
< 10	Low
10-20	Moderate
>20	High
Potassium, K (pmm)	
< 50	Low
50-100	Moderate
> 100	High
Calcium, Ca (ppm) / Meg = 0.25 Ca	
< 5.0	Low
5.0-10.0	Moderate
> 10.0	High
ECEC (cmol (+) /kg)	
< 10	Low
10-20	Moderate
> 20	High
Soil pH (Distilled Water Method)	
< 5.0	Very Acidic
5.1 – 5.5	Acidic
5.6 – 6.0	Moderately Acidic
6.0 – 6.5	Slightly Acidic
6.5 – 7.0	Neutral
7.0 – 7.5	Slightly Alkaline
7.6 – 8.5	Alkaline
> 8.5	Very Alkaline
Organic Matter (%)	
< 1.5	Low
1.6 – 3.0	Moderate
3.0	High
Nitrogen (%)	
< 0.1	Low
0.1-0.2	Moderate
>0.2	High
Exchangeable Potassium (cmol (+)/kg)	
< 0.2	Low
0.2-0.4	Moderate
>0.4	High

(SRI, 2007)

Table 4.5: Physical and Chemical Properties of Soil and Soil Plus Manure Ap Horizon at 0-20 cm Depth Two Weeks after Planting for Experiment 2 – (2012)

Property	Value			
	Untreated Soil (Control)	**Inorganic Fertilizer + Soil**	**10t/ha Chicken Manure + Soil**	**5t/ha Chicken Manure + Inorganic Fertilizer +Soil**
Sand (%)	75.80	59.90	70.80	66.90
Silt (%)	15.20	31.30	22.00	26.60
Clay (%)	9.00	8.80	7.20	6.50
Organic carbon (%)	1.21	1.00	0.92	1.07
Total nitrogen (%)	0.13	0.21	0.32	0.16
Organic matter (%)	2.09	1.72	1.59	1.85
pH (1:1 H_2O)	6.73	5.42	6.19	6.02
Available P (ppm)	153.87	439.29	285.42	692.82
Available K(ppm)	43.96	74.40	71.01	87.92
Bulk density (g/cm^3)	1.51	1.49	1.49	1.49
Exchangeable cations				
Ca(mg/100g)	5.34	3.47	4.54	5.07
Mg	2.67	2.67	0.80	0.53
K	0.50	0.66	0.62	0.80
Na	0.17	0.22	0.21	0.25
Total Exchangeable bases	8.68	7.02	6.17	6.65
Effective cation Exchange Capacity (E.C.E.C) Me/100g	8.78	7.82	6.27	7.45
Exchangeable Aluminium (Al^+H)	8.68	7.02	6.17	6.65
Bases saturation (%)	98.86	89.77	98.41	89.26

Table 4.6: Physical and Chemical Properties of Soil and Soil Plus Manure Ap Horizon at 0-20 cm Depth Sixteen Weeks after Planting for Experiment 2 – (2012)

Property	**Value**			
	Untreated Soil (Control)	**Inorganic Fertilizer + Soil**	**10t/ha Chicken Manure + Soil**	**5t/ha Chicken Manure + Inorganic Fertilizer +Soil**
Sand (%)	74.64	59.80	72.54	67.58
Silt (%)	15.36	32.20	21.46	26.46
Clay (%)	10.00	8.00	6.00	6.00
Organic carbon (%)	0.57	1.11	0.47	0.68
Total nitrogen (%)	0.05	0.10	0.04	0.06
Organic matter (%)	0.98	1.91	0.81	1.17
pH (1:1 H_2O)	6.72	6.45	6.49	6.33
Available P (ppm)	76.40	59.86	71.00	55.10
Available K (ppm)	115.68	97.58	133.12	126.05
Bulk density (g/cm^3)	1.47	1.44	1.44	1.44
Exchange cations				
Ca^{2+} (mg/100g)	4.54	6.70	5.34	5.61
Mg^{2+}(mg/100g)	5.67	0.80	0.53	0.53
K^+ (mg/100g)	0.30	0.25	0.34	0.32
Na^+ (mg/100g)	0.11	0.08	0.14	0.12
Total Exch. bases	10.62	7.83	6.35	6.58
Effective cation Exchange Capacity (E.C.E.C) Me/100g	11.75	10.54	6.41	6.68
Exch. Al. (Al^+H)	0.10	0.10	0.10	0.10
Bases saturation (%)	99.19	89.05	98.44	98.50

In the major season (2012), chicken manure and inorganic fertilizer applied either singly or in combination did not significantly influence crop establishment for the two cultivars. In both seasonsOkumkom grown on amended plots during the major season produced substantially higher percentage crop establishment than in the minor season. Crop establishment ranged from (53.5- 85.5%) in both seasons (Table 4.7).

Table 4.7: Percentage crop establishment during 2011 minor season and 2012 major season

	Percentage Crop Establishment (%) (minor season)			Percentage Crop Establishment (%) (major season)		
Variety	Apomud	Okumk.	Mean	Apomud	Okumk	Mean
Fertilizer Rates						
No fertilizer (Control)	78.8	69.2	74.0	80.6	72.6	76.6
10t/ha CM	66.1	60.6	63.3	53.5	75.5	64.5
30-30-30 kg/ha NPK	72.9	70.9	71.9	53.5	61.1	57.3
15-15-15 kg/ha NPK + 5t/ha CM	75.2	63.7	69.5	73.9	63.2	68.6
30-45-45 kg/ha NPK	71.3	59.8	65.5	85.5	61.1	73.3
15-23-23 kg/ha NPK + 5t/ha CM	71.3	68.7	70.0	76.1	69.6	72.8
30-60-60 kg/ha NPK	66.9	64.5	65.7	75.0	71.5	73.3
15-30-30 kg/ha NPK + 5t/ha CM	59.2	70.6	64.9	63.5	75.5	69.5
Mean	70.2	66.0		70.2	68.8	
LSD (P =0.05) ; Variety	7.7			NS		
Fertilizer	15.4			NS		
Variety x Fertilizer	21.8			NS		

4.2.2 Number of Leaves per Plant

The result on number of leaves per plant as influenced by chicken manure and inorganic fertilizer is presented in Figure 4.1. During the minor season (2011), Okumkom under amendment and control differed significantly from Apomuden in number of leavesper plant for the enrire growing period. Apomden grown on amended plots did not differ significantly in number of leaves per plant from the control from 4 to 10 WAP. Apomuden grown on 15-15-15 kg/ha NPK + 5t/ha CM plot differed significantly from other amended and the control plots at 12 WAP. The least (160) number of leaves per plant was recorded by 10t/ha CM at 12 WAP. Okumkom grown on amended plots did not differ significantly in number of leaves per plant from the control from 4 to 10 WAP.The highest (542) number of leaves was recorded by Okumkom grown on 15-30-30 kg/ha NPK+ 5t/ha CM and differed significantly from other amended and the control plots at 12 WAP. The least (400) number of leavesper plant was recorded by 10t/ha CM at 12 WAP (Fig. 4.1).

In the major season (2012), Okumkom under amendment differed significantly from Apomuden in number of leavesper plant for the enrire growing period. Apomden grown on amended and the control plots did not differ significantly in number of leaves per plant from 4 to 10 WAP. Apomuden grown on 10t/ha CM differed significantly in number of leaves per plant ffrom other amended and the control plots at 12 WAP. The least was recorded by 30-30-30 kg/ha NPK at 12 WAP.Okimkom grown on amended and the control plots did not differ significantly in number of leaves per plant from 4 to 10 WAP. The highest (463) number of leaves per plant was recorded by Okumkom grown on 30-45-45 kg/ha NPK and differed significantly from other amended and the control plots at 12 WAP. The least (409) number of leaves per plant was recorded by 15-23-23 kg/ha NPK + 5t/ha CM at 12 WAP.

Generally, Apomuden and Okumkom grown on 10t/ha CM produced the lowest number of leaves per plant in the minor season than in the major season at 12 WAP (Fig. 4.1).

4.2.3 Number of Branches

The result on number of branches as influenced by chicken manure and inorganic fertilizer is presented in Figure 4. 2. During the minor season (2011), Apomuden grown on amended plots did not differ significantly in number of branches per plant from the control from 4 to 8 WAP. Apomuden grown on 30-45-45 kg/ha NPK differed significantly in number of branches per plant from other amended and the control plots from 10 to 12 WAP. Apomuden grown on 10t/ha CM had the lowest (9.0) number of branches at 12 WAP. Okumkom grown on amended plots did not differ significantly in number of branches per plant from the control from 4 to 8 WAP. Okumkom grown on 15-30-30 kg/ha NPK + 5t/ha CM had significantly higher (42.0) number of branches per plant at 10WAP. Application of 30-45-45 kg/ha NPK to Okumkom which had the highest number of branches per plant (50.0) differed significantly from othe amended and the control plots at 12 WAP. . The lowest (26.0) number of branches per plant was recorded by 10t/haCM at 12 WAP (Fig 4.2).

In the major season (2012), Okumkom grown on amended and the control plot had significantly higher number of vine branches than Apomuden. Apomuden grown on amended plots did not differ significantly in number of branches per plant from the control from 4 to 12 WAP. Okumkom grown on amended plot did not differ significantly in number of branches per plant from the control from 4 to 8 WAP. Okumkom grown on 15-30-30 kg/ha NPK+ 5 t/ha CM differed significantly from other amended plots and the control from 10 tol 12 WAP. The control plot had the least number of branches from at 12 WAP (Fig 4.2).

4.2.4 Vine Diameter

The results of vine diameter as influenced by chicken manure and inorganic fertilizer are presented in Fig. 4.3. During the minor season (2011), Apomuden grown on amended plots did not show any significant difference from the control from 4 to 10 WAP. . Application of 15-30-30 kg/ha NPK + 5t/ha CM to Apomuden had the highest vine diameter (1.14 cm) and differed significantly from other amended and the control plots at 12 WAP. The lowest (0.62 cm) was recorded by 10t/ha CM plot at 12 WAP (Fig 4.3). Okumkom grown on amended plots gave substantially high vine diameter than the control plot over the period except 10t/ha CM which had the lowest mean (0.89) at 12 WAP. 30 -45-45 kg/ha NPK plot had the highest vine diameter from 8 to 12 WAP.

In the major season (2012), application of amended and unamended plots to Apomuden and Okumkom did not show significant difference between the treatments over the period. In both seasons Apomuden grown on chicken manure in combination with inorganic fertilizer (15-15-15 kg/ha NPK + 5t/ha CM and 15-30-30 kg/ha NPK+5t/ha CM) produced the highest vine diameter at 12 WAP.Okumkom grown on inorganic fertilizer alone (30-45-45 kg/ha NPK and 30-30-30 kg/ha NPK) in 2011 and 2012 growing seasons respectively had the highest vine diameter at 12 WAP. However, the two sweetpotato varieties (Apomuden and Okumkom) grown on amended and unamended plots during the major season in 2012 produced substantially higher vine diameter than when grown on the same treatments during the minor season (Fig 4.3).

4.2.5 Vine Length

Vine length as influenced by chicken manure and inorganic fertilizer is presented in figure 4. 4. In 2011, during the minor season application of amendment to Apomuden did not differ significantly from the control in vine length from 4 to 6 WAP. However,application of 10t/ha CM to Apomuden recorded the lowest vine length among the amended treatments over the period except at 10 WAP. Apllication of 15-23-23 kg/ha NPK + 5t/ha CM. to Apomuden which had the highest (104.5 cm) vine length differed significantly from other amended and the control plots at 8 WAP. Apomuden grown onamended plots did not differ significantly from the control in vine length from 10 to 12 WAP. Okumkom grown on amended plots did not differ significantly from the control plot in vine length over the entire period (Fig 4.4).

In the major season (2012), application of amendment to Apomuden did not differ significantly from the control in vine length at 4 WAP. Apomuden grown on15-23- 23kg/ha NPK+ 5 t/ha CM plot differed significantly from the other amended and the control plots at 6 WAP and from 10t/haCM which had the highest vine length (147.2 cm) at 8 WAP. Apomuden grown on 15-30- 30kg/ha NPK+ 5 t/ha CM plot had the highest vine length (164.8 cm) and differed significantly from the other amended and the control plots at 12 WAP. The 30-30-30 kg/ha NPK treated plant recorded the lowest vine length at 12 WAP.Application of amendment to Okumkom did not differ significantly from the control in vine length from 4 to 10 WAP. Okumkom grown on 30-30-30 kg/ha NPK plot had the highest vine length (183.5 cm) and differed significantly from the other amended and the control plots at 12 WAP. The lowest (130.1 cm) vine length was recorded by the control at

12 WAP. In both seasons Okumkom grown on amended plots produced substantially higher vine length over Apomuden on the same treatments at 12 WAP (Fig. 4.4).

4.2.6 Chlorophyll Content of Leaves

The chlorophyll content of leaves as influenced by chicken manure and inorganic fertilizer is presented in Figure 4.5. During the 2011 minor season, application of amendment to Apomuden did not differ significantly from the control in chlorophyll content of leaves from 4 to 12 WAP.Apomuden under 15-23-23 kg/ha NPK + 5t//haCM which had the highest (721 spad) chlorophyll content of leaves differed significantly from the other amended plots and the control at 16 WAP. The lowest (615 spad) was recorded by 15 30-30 kg/ha NPK + 5t//haCM at 16 WAP There was however, a substantial reduction of chlorophyll content of leaves at 16 WAP in all the treatments(Fig.4.5). Application of amendment to Okumkom did not differ significantly from the control in chlorophyll content of leaves from 4 to 16 WAP. The Apomuden variety showed significant difference response of leaf chlorophyll content to the different amendments from Okumkom (Fig.4.5).

In the major season (2012), application of amendment to Apomuden did not differ significantly from the control in chlorophyll content of leaves at 4 WAP Apomuden grown on 30-45-45 kg/ha NPK differed significantlyin chlorophyll content of leaves from the other amended and the control plots at 8 WAP and from 10t/ha CM at 10 WAP. Apomuden grown on 15-23-23 kg/ha NPK+ 5t/ha CM plot had the highest chlorophyll content of leaves (639.0 spad) and differed significantly from the other amended and the control plots at 16 WAP.

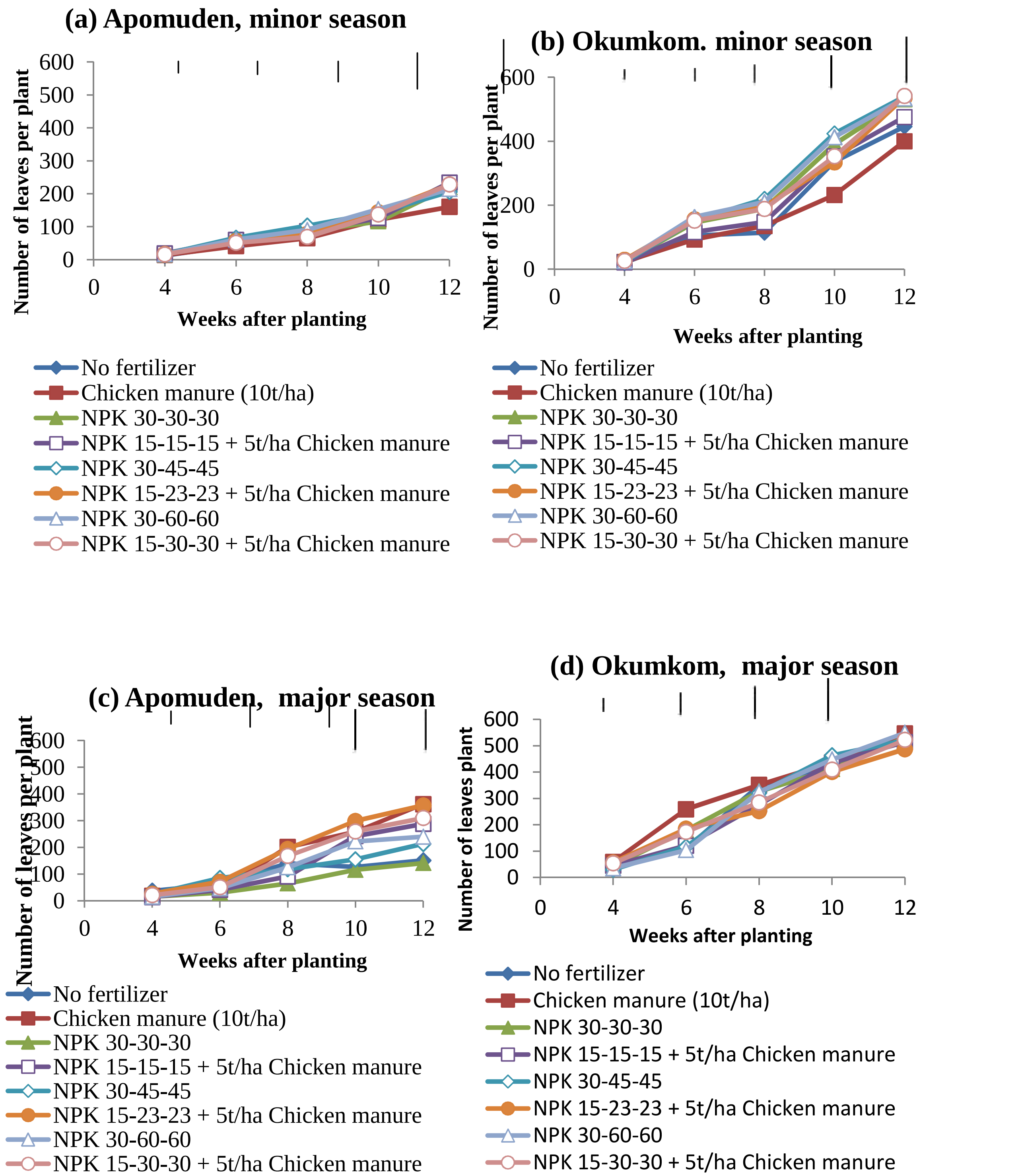


Fig. 4.1 Leaf numbers for 2011 minor season and 2012 major season

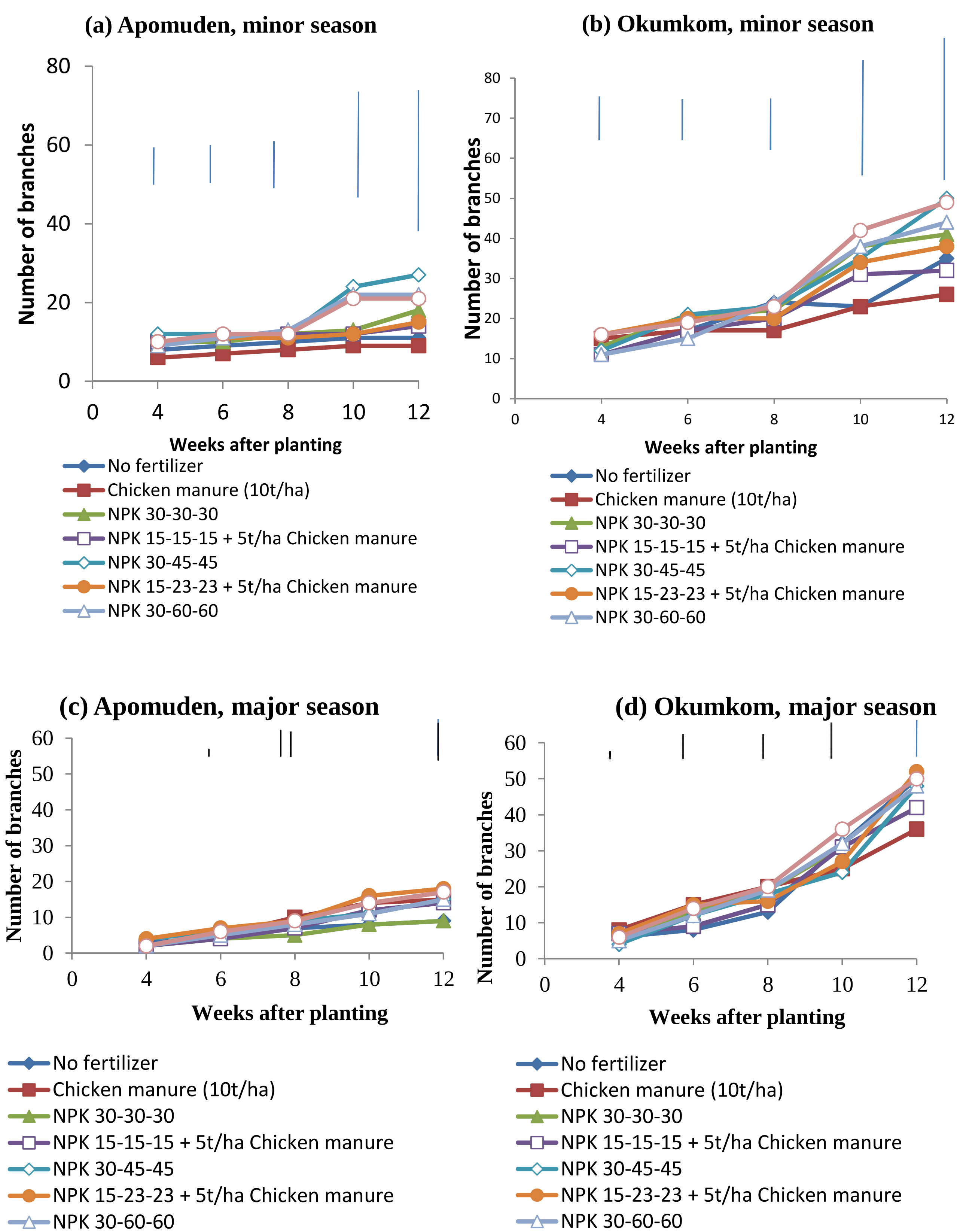


Fig. 4.2 Number of branches during 2011 minor season and 2012 major season

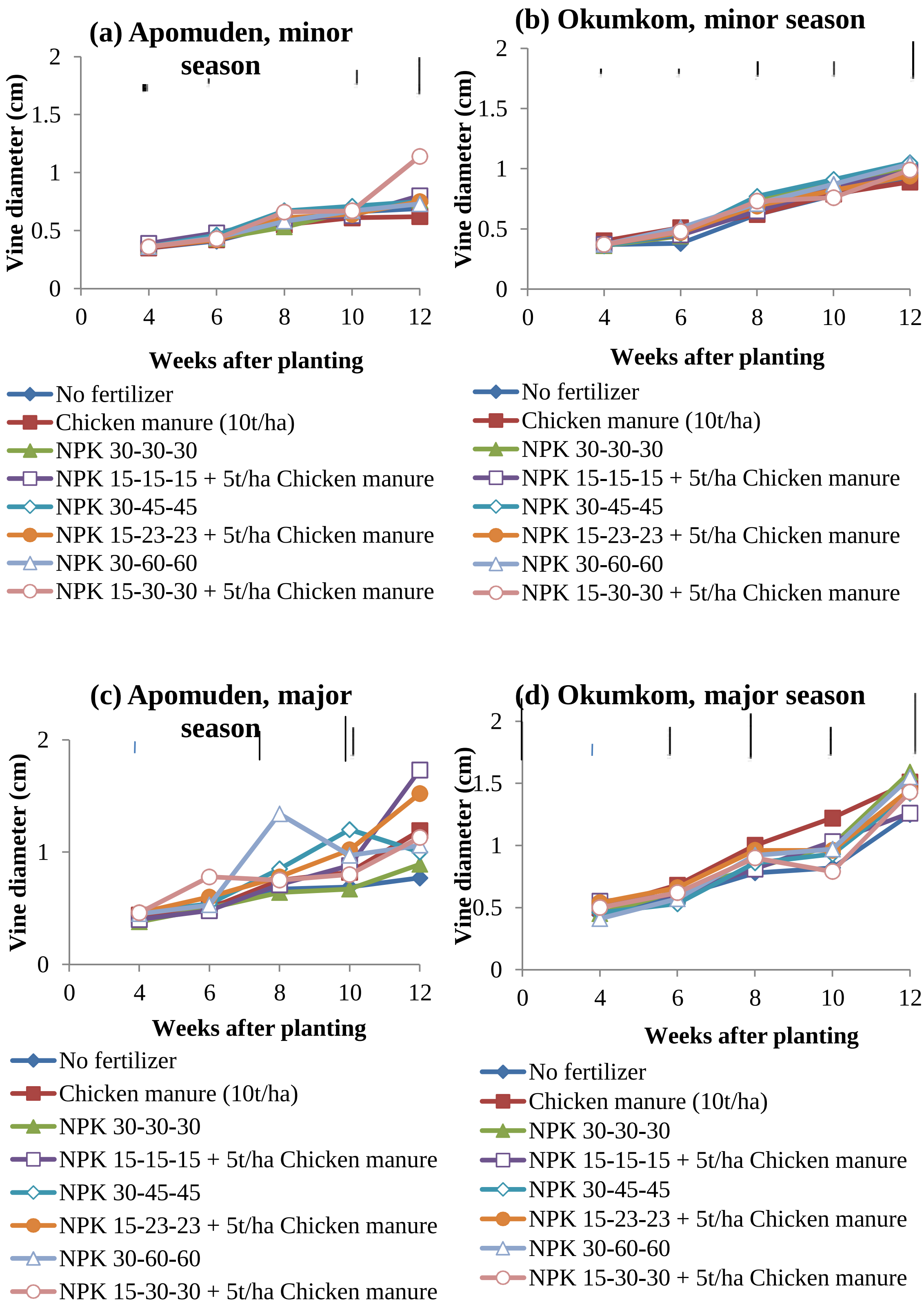


Fig. 4.3 Vine diameter during 2011 minor season and 2012 major season

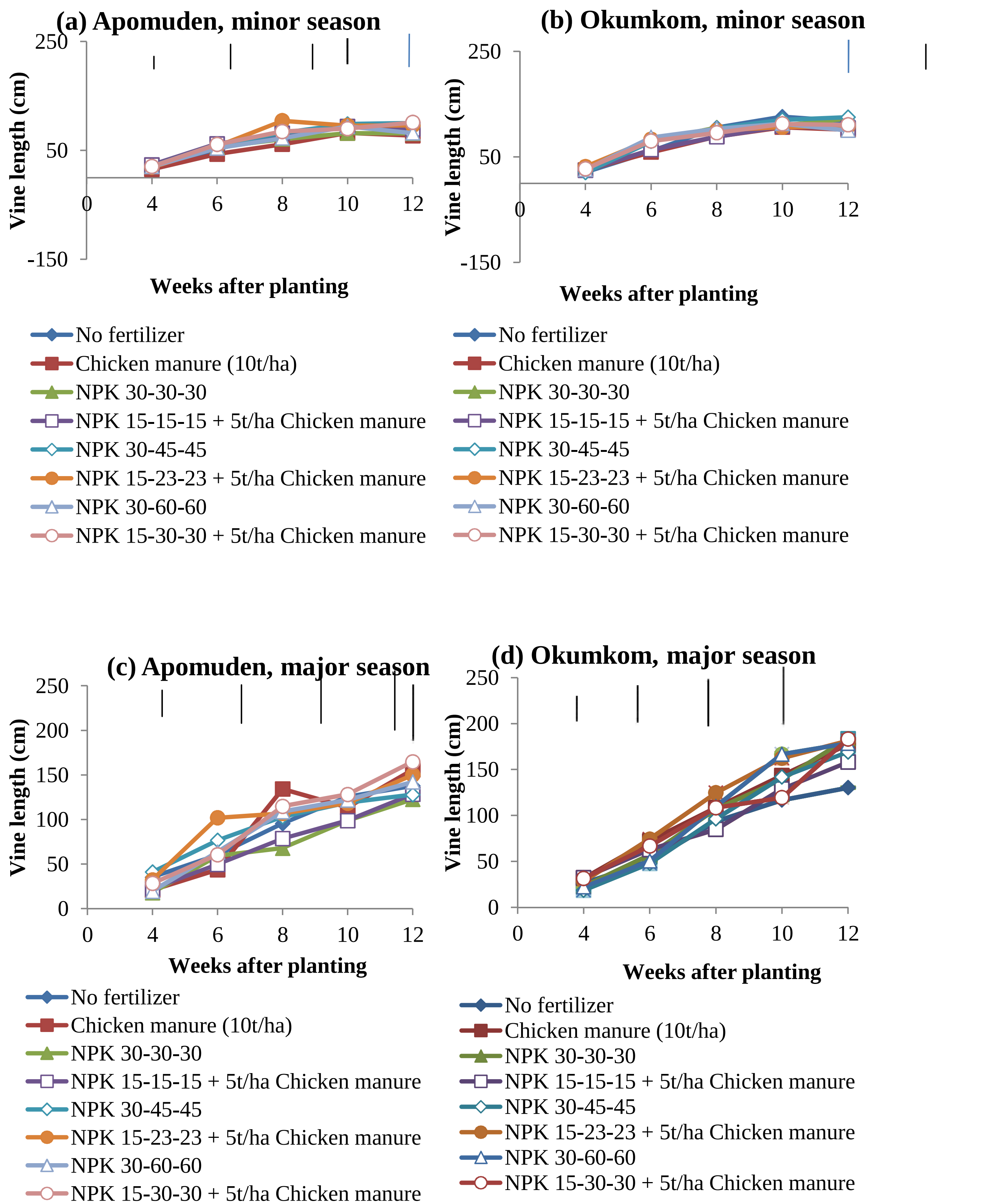


Fig. 4.4 Vine length during 2011 minor season and 2012 major season

The least (426.0 spad) chlorophyll content of leaves was recorded by 30-30-30kg/ha NPK at 16 WAP (Fig.4.5). Application of amendment to Okumkom did not differ significantly from the control in chlorophyll content of leaves at 4 WAP. Okumkom under amendment differed significantly from the control from 8 to 12 WAP. However, Okumkom grown on amended and the control plots did not differ significantly in chlorophyll content of leaves at 16 WAP. There was a substantial reduction in chlorophyll content of leaves for all treatments at 16 WAP (Fig.4.5).

In both seasons Apomuden grown on 15-23-23 kg/ha NPK+5t/ha CM plot had the highest chlorophyll content of leaves at 16 WAP. For both varieties leaf chlorophyll content was higher during the minor season (2011) than during the major season (2012) for all treatments (Fig .4.5).

4.2.7 Root Fresh Weight per plant

The results of root fresh weight per plant as influenced by chicken manure and inorganic fertilizer are presented in Figure 4.6. During the minor season (2011), Apomuden grown on amended plots did not differ significantly from the control in root fresh weight per plant from 4 to 10 WAP. Application of 15-15 kg/ha NPK+5t/ha CM to Apomuden differed significantly from the other amended and the control plots in root fresh weight per plant at 12 WAP. The lowest (364 g) was recorded by 30-45-45 kg/ha NPK plot. Okumkom grown on amended plots did not differ significantly from the control in root fresh weight per plant from 4 to 8 WAP. Application of 15-23-23 kg/ha NPK+5t/ha CM differed significantly from other amended plots and the controlin root fresh weight per plant from 10 to 12 WAP. Okumkom under 15-23-23 kg/ha NPK+5t/ha CM had the highest (479 g) root fresh weight per plantat 12 WAP. The lowest root fresh weight per plant (205 g) was recorded by 10t/ha CM at 12WAP (Fig 4.6).

In the major season (2012), Apomuden grown on amended plots did not differ significantly from the control in root fresh weight per plant from 4 to 6 WAP.

Application of 30-60-60 kg/ha NPK Apomuden differed significantly from other amended and the control plotsin root fresh weight per plant from 8 to 10 WAP.At 12 WAP, application of 15-15-15 kg/ha NPK+5t/ha CM to Apomuden which had the highest root fresh weight per plant (1093 g) differed significantly from the other amended and the control plots at 12 WAP. The lowest (123 g) was recorded by the control at 12 WAP (Fig. 4.6).

In both seasons application of 15-15-15 kg/ha NPK+5t/ha CM to Apomuden had the highest root fresh weight per plant at 12 WAP. However, Apomuden treated with 15-15-15 kg/ha NPK+5t/ha CM during the major season in 2012 had substantially higher root fresh weight per plant thanduring the minor season at 12 WAP. Similarly, application of 15-23-23kg/ha NPK+5t/ha CM to Okumkom had the highest root fresh weight per plant at 12 WAP in both seasons with the root fresh weight per plant during the major season (2012) being substantially higher than during the minor season (Fig. 4.6).

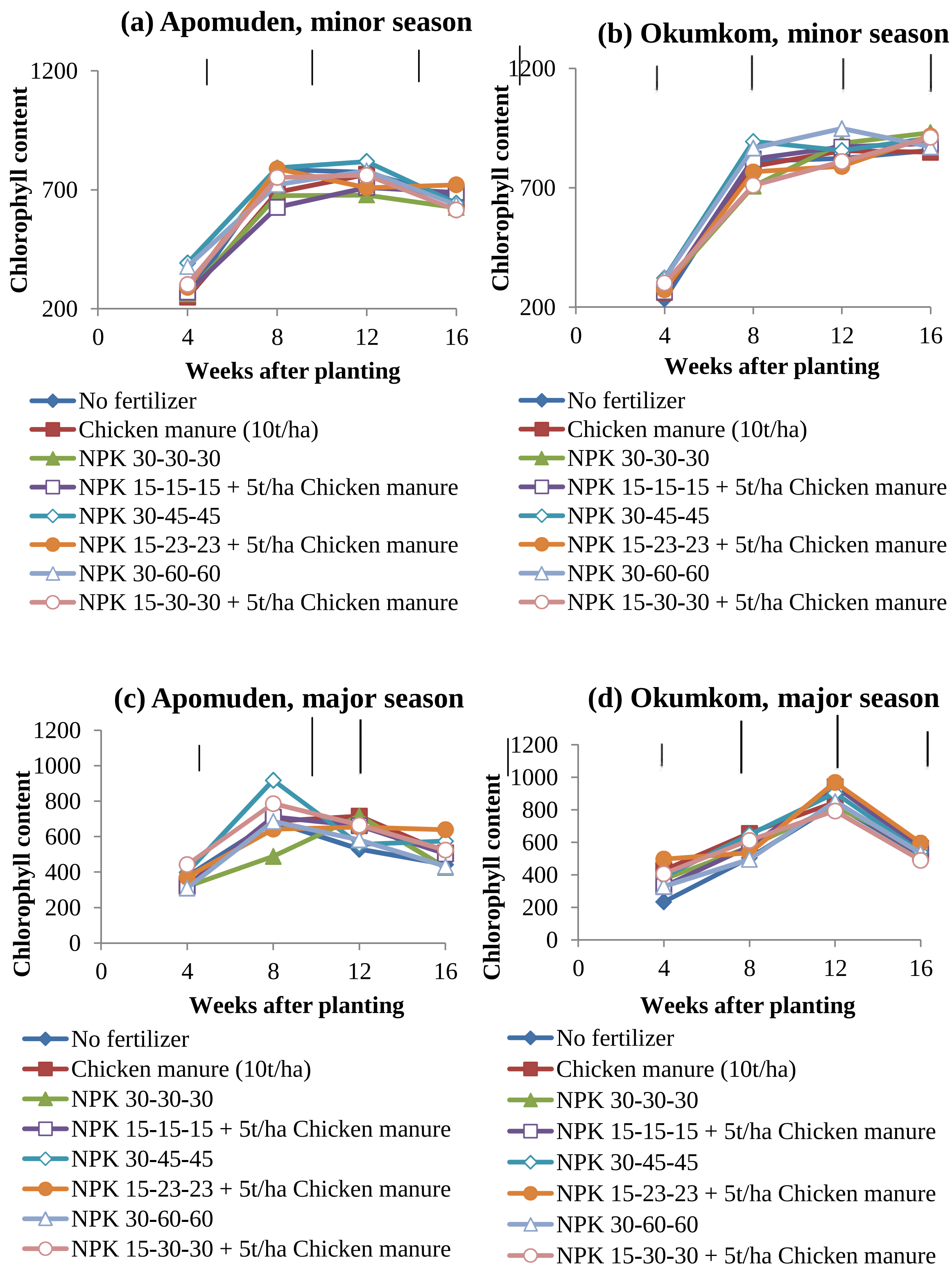


Fig. 4.5 Chlorophyll content of leaves during 2011 minor season and 2012 major season

4.2.8 Root Dry Weight Per Plant

The result on root dry weight per plant as influenced by chicken manure and inorganic fertilizer is presented in Figure 4. 7. In 2011 during the minor season, application of amendment to Apomuden did not differ significantly in root dry weight per plant from the control from 4 to 6 WAP. Application of 30-30-30 kg/ha NPK to Apomuden differed significantly in root dry weight per plant from other amended and the control plots from 8 to 10 WAP and from 10t/ha CM at 12 WAP. The lowest (139.8 g) root dry weight per plant was recorded by 30-45-45 kg/ha NPK, at 12 WAP (Fig 4.7).

Application of amendment to Okumkom did not differ significantly in root dry weight per plant from the control from 4 to 6 WAP. Okumkom grown on 15-15-15 kg/ha NPK+5t/ha CM plot differed significantly in root dry weight per plant from the other amended and the control plots from 8 to 10 WAP and from 15-30-30 kg/ha NPK+5t/ha CM plot with the highest (239.8 g) root dry weight per plant at 12 WAP. The lowest (126.2 g) was recorded by 10t/ha CM at 12WAP (Fig. 4.7). In the major season (2012), Apomuden grown on amended plot did not differ significantly in root dry weight per plant from the control at 4 WAP.

Apomuden grown on 30-30-30 kg/ha NPK, differed significantly in root dry weight per plant from other amended and the control plots from 6 to 10WAP and from 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP. The least (60.0 g) root dry weight per plant was recorded by 15-23-23 kg/ha NPK+5t/ha CM and the control plots at 12 WAP (Fig. 4.7). Okumkom grown on amended plot did not differ significantly in root dry weight per plant from the control from 4 to 8 WAP.

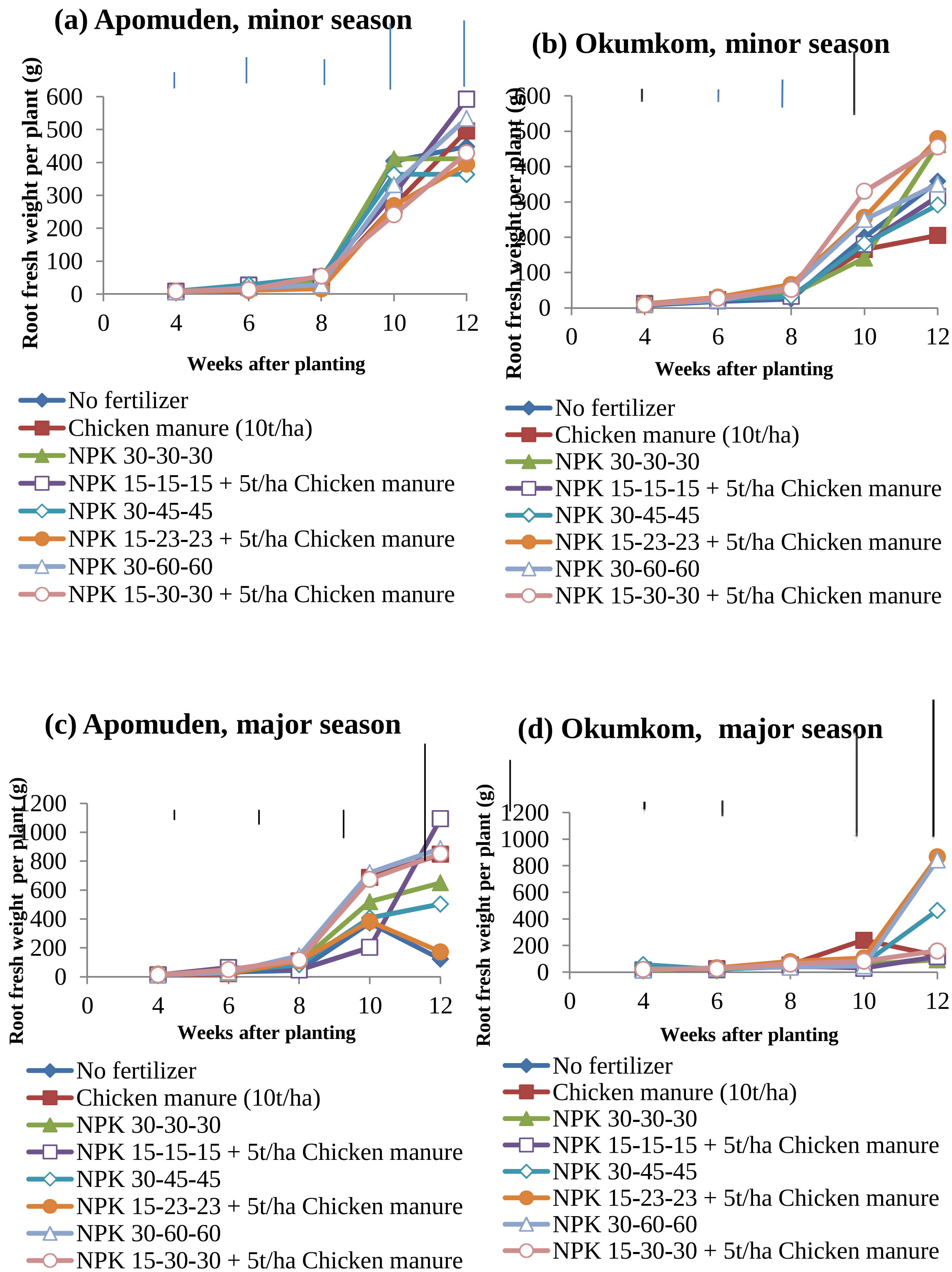


Fig. 4.6 Root fresh weight per plant during 2011 minor season and 2012 major season

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest

(388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest

(388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

Okumkom under15-23-23 kg/ha NPK+5t/ha CM differed significantly in root dry weight per plant from other amended and the control plots from 10 to 12 WAP with the highest (388.0 g) root dry weight per plant recorded at 12 WAP. The lowest root dry weight per plant (43.0 g) was recorded by 15-15-15 kg/ha NPK+5t/ha CM at 12 WAP (Fig. 4.7).

4.2.9 Vine Fresh Weight per Plant

The vine fresh weight per plant as influenced by chicken manure and inorganic fertilizer is presented in Fgure 4. 8. During the minor season (2011), Apmuden grown on amended plots did not differ significantly from the control in vine fresh weight per plant from 4 to 10 WAP. Application of 15-15-15 kg/ha NPK+5t/ha CM to Apomuden differd significantly in vine fresh weight per plant from other amended and the control plots at 12 WAP. The lowest (544 g) vine fresh weight per plant was recorded by 30-30-30kg/ha NPK. There was substantial decrease in vinefresh weight per plant between treatments at 12 WAP (Fig. 4.8). Okumkom grown on amended plots did not differ significantly from the control in vine fresh weight per plant from 4 to 8 WAP.Application of 30-30-30kg/ha NPK to Okumkom differed significantly in vine fresh weight per plant from other amended and the control plots from 10 to 12 WAP. The lowest (1371 g) vine fresh weight per plant was recorded by the control at 12 WAP. In the major season (2012), Apomuden grown on amended plots did not differ significantly in vine fresh weight per plant from the control from 4 to 6 WAP. Application of 30-60-60 kg/ha NPK to Apomuden differed significantly in vine fresh weight per plant from other amended and the control plot at 8WAP and from 15-15-15 kg/ha NPK+5t/ha CM plot differed significantly in vine fresh weight per plant from 10 to 12 WAP. The lowest was recorded by the control at 12 WAP (Fig 4.8).

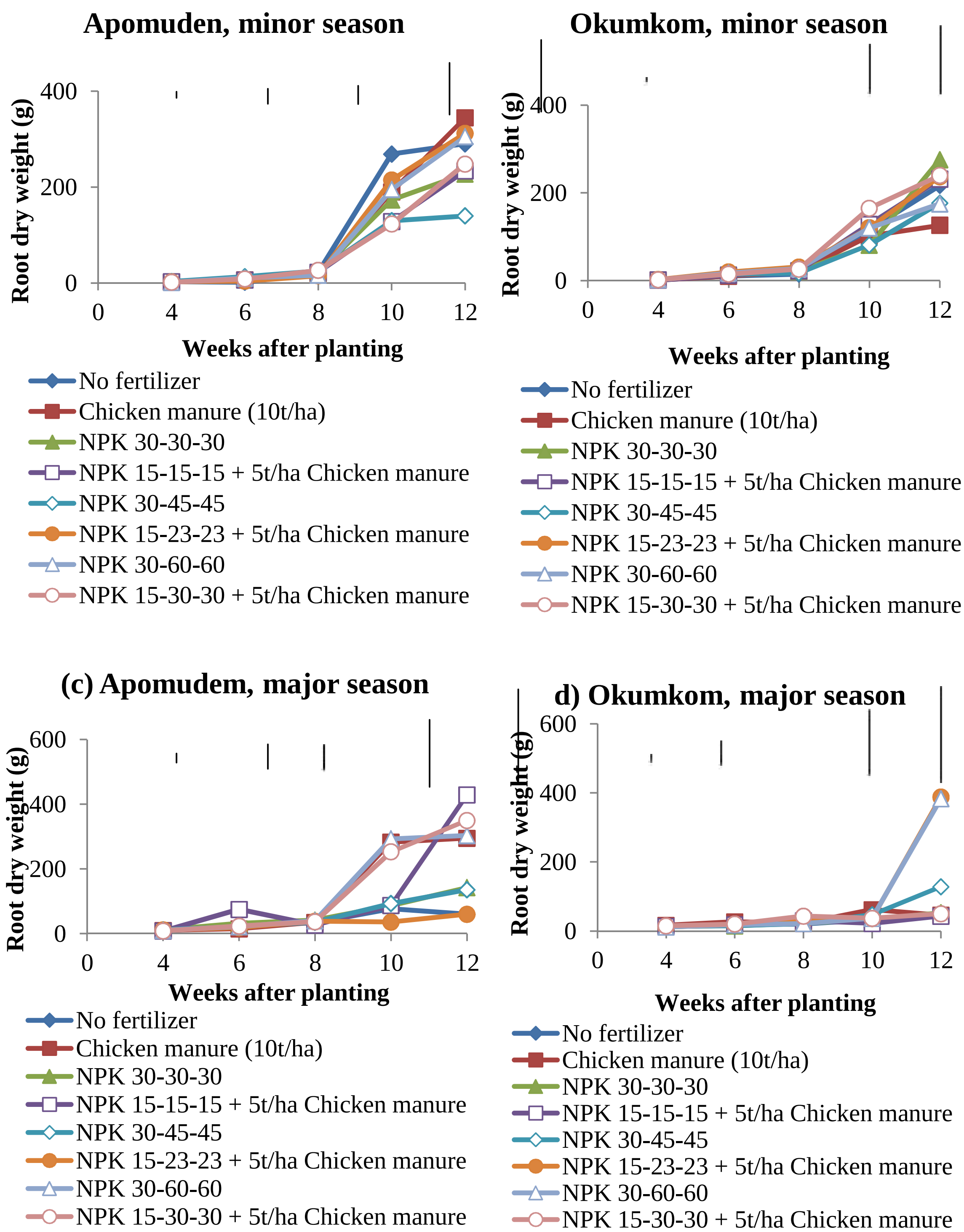


Fig. 4.7 Root dry weight per plant during 2011 minor season and 2012 major season

Okumkom grown on amended plots did not differ significantly from the control in vine fresh weight per plant from 4 to 6 WAP.Application of 15-23-23 kg/ha NPK + 5t/ha CM to Okumkom differed significantly in vine fresh weight per plant from other amended and the control plot at 8WAP. The 15-30-30 kg/ha NPK+5t/ha CM had the highest vine fresh weight per plant and differed significantly from other amended and the control plots from 10 to 12 WAP. The lowest was recorded by 15-15-15 kg/ha NPK + 5t/ha CM at 12 WAP.

4.2.10 Vine Dry Weight Per Plant

The vine dry weight per plant as influenced by chicken manure and inorganic fertilizer is presented in Figure 4. 9. During the minor season (2011), Apmuden grown on amended plots did not differ significantly from the control in vine dry weight per plant from 4 to 8 WAP. Application of 30-45-45 kg/ha NPK to Apomuden differed significantly in vine dry weight per plant from other amended and the control plots at 10 WAP. The lowest vine dry weight per plant was recorded by 10t/ha CM at 10 WAP. However, application of 10t/haCM to Apomuden had significantly higher (294 g) vine dry weight per plant than other amended and the control plotsat 12 WAP. The lowest (132 g) was recorded by 30-30-30 kg/ha NPK at 12 WAP (Fig. 4.8). Okumkom grown on amended plots did not differ significantly from the control in vine fresh weight per plant from 4 to 6 WAP. Application of 30-30-30kg/ha NPK to Okumkom differed significantly in vine dry weight per plant from other amended plots from 8 to 10 WAP. The 15-15-15 kg/ha NPK + 5t/haCM to Okumkom had the highest (1305 g) vine dry weight per plant and differedsignificantly in vine dry weight per plant from other amended plots at 12 WAP. The lowest (351 g) vine dry weight per plant was recorded by 15-30-30 kg/haNPK +5t/haCM at 12 WAP (Fig. 4.8).

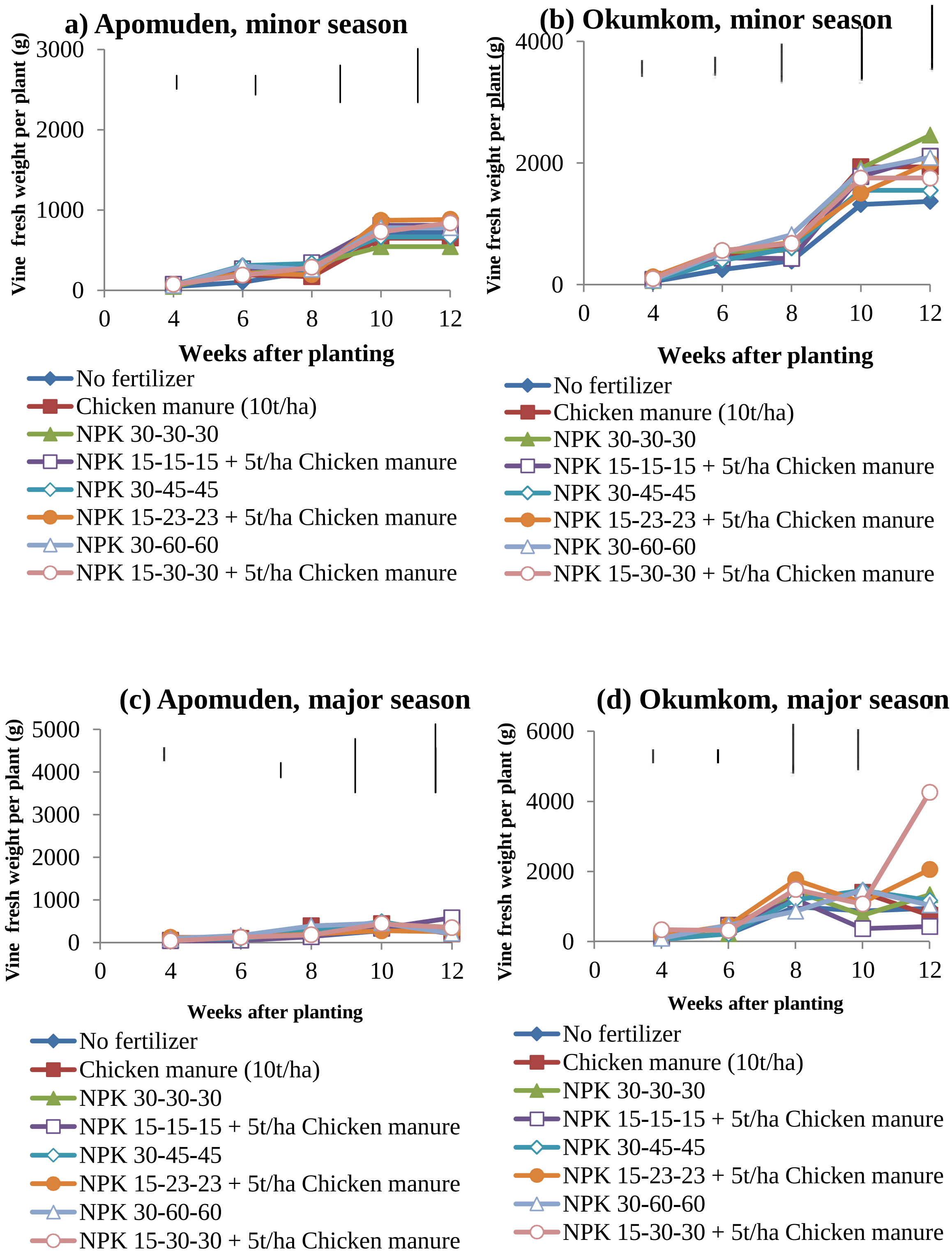


Fig. 4.8 Vine fresh weight per plant during 2011 minor season and 2012 major season

In the major season (2012), Apmuden grown on amended plots did not differ significantly from the control in vine dry weight per plant from 4 to 6WAP. Apomuden grown on the 10t/haCM plot differed significantly in vine dry weight per plant from other amended and the control plots at 8 WAP and from 30-45-45 kg/ha NPK at 10 WAP. The 15-15-15 kg/ha NPK + 5t/haCM to Apomuden differed significantly in vine dry weight per plant from other amended and the control plots at 12WAP. The lowest was recorded by 10t/haCM at 12 WAP (Fig. 4.8).

Okumkom grown on amended plots did not differ significantly from the control in vine fresh weight per plant at 4 WAP. Application of 30-45-45kg/ha NPK to Okumkom differed significantly in vine dry weight per plant from other amended plots at 6 WAP and from 15-23-23 kg/ha NPK + 5t/haCM to Okumkom from 8 to 10 WAP. Application of 15-23-23 kg/ha NPK + 5t/haCM to Okumkom had the highest vine dry weight per plant (798.0 g) and differed significantly in vine dry weight per plant from other amended and the control plots at 12 WAP. The lowest vine dry weight per plant (112.0 g) was recorded by 15-15-15 kg/ha NPK +5t/haCM at 12 WAP (Fig. 4.8). In both Apomuden and Okumkom grown on amended and unamended treatments in the major season (2012) had substantially higher vine dry weight per plant than in the minor season at 12 WAP.

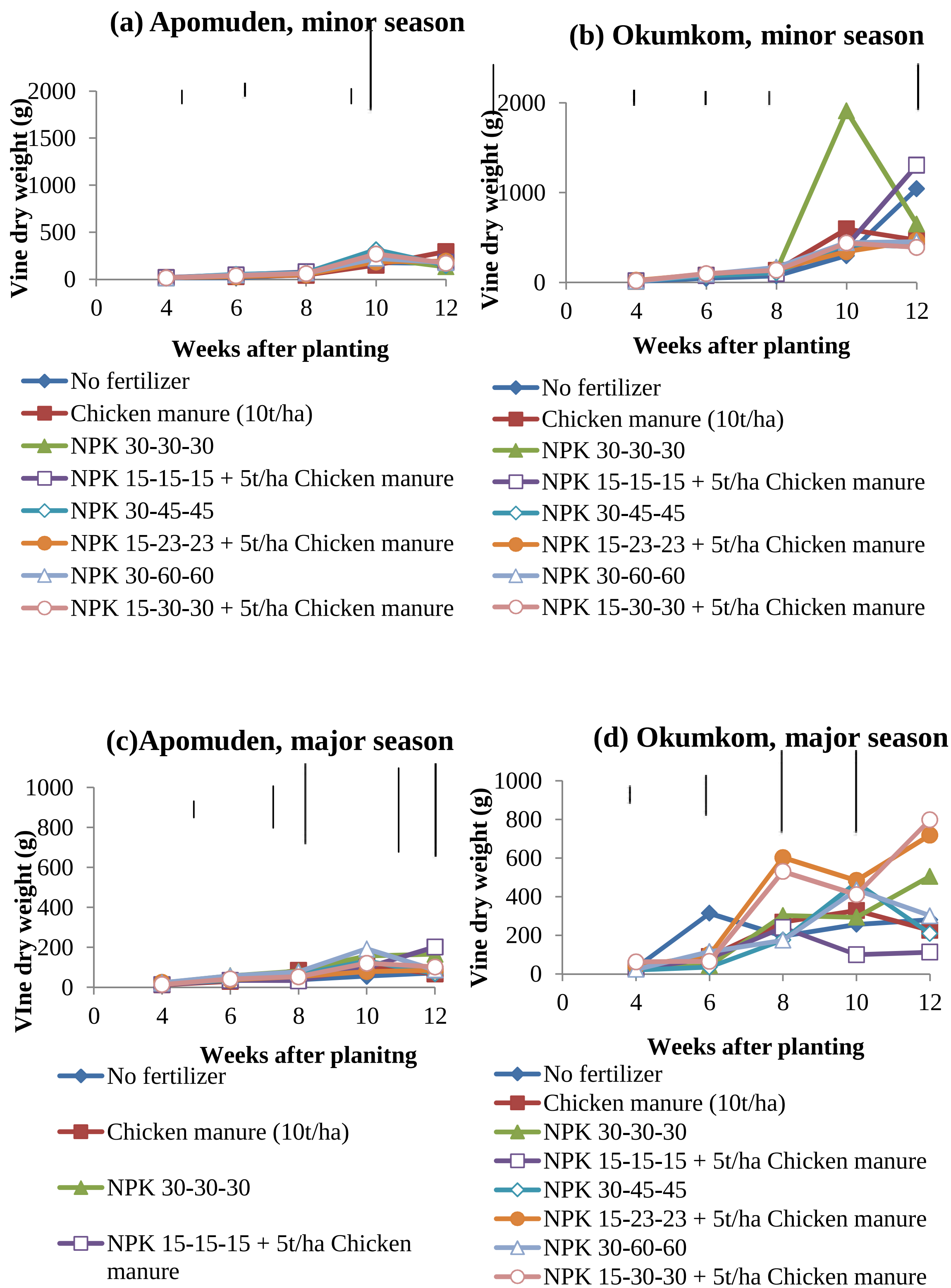


Fig. 4.9 **Vine dry weight per plant during 2011 minor season and 2012 major season**

4.2.11 Days To 50 % Flowering

Table 4.8 shows the days to 50 % flowering of Apomuden variety of sweetpotato as influenced by chicken manure and inorganic fertilizer. Apomuden grown on 30-45-45 kg/ha NPK plot during the minor season in 2011 was the earliest to flower (57.0 days). However, 30-60-60 kg/ha NPK, 15-30-30 kg/ha NPK + 5t/ha CM and the control plots had the same days to 50 % flowering. Similarly, 30-30-30 kg/ha NPK and 15-23-23 kg/ha NPK + 5t/ha CM plots had the same days to 50 % flowering during the minor season. In the major season (2012), application of 15-15-15 kg/ha NPK + 5t/ha CM to Apomuden produced the earliest flowering (53.0 days). Application of 15-15-15 kg/ha NPK + 5t/ha CM to Apomuden shortened days to 50 % flowering by 15 days compared to the control. Apomuden cultivar showed non- significant difference in days to 50 % flowering in response to fertilization in both seasons (Table 4.8).

Table 4.8: Days to 50% flowering during 2011 minor season and 2012 major season

Variety	Days to 50 % flowering (minor season) Apomuden	Days to 50% flowering (major season) Apomuden
Fertilizer Rates		
No fertilizer (Control)	62.0	68.0
10t/ha CM	63.0	59.0
30-30-30kg/ha NPK	59.0	62.0
15-15-15 kg/ha NPK + 5t/ha CM	58.0	53.0
30-45-45kg/ha NPK	57.0	62.0
15-23-23kg/ha NPK + 5t/ha CM	59.0	65.0
30-60-60kg/ha NPK	62.0	56.0
15-30-30 kg/ha NPK + 5t/ha CM	62.0	60.0
LSD (P = 0.05)	NS	NS

4.2.12 Vine Fresh Weight at Harvest

Table 4.9 shows vine fresh weight at harvest as influenced by chicken manure and inorganic fertilizer. During the minor season (2011), application of 15-23-23 kg/ha NPK + 5t/ha CM to Apomuden recorded the highest vine fresh weight at harvest (27.0 t/ha) with the lowest recorded by 30-30-30 kg/ha NPK plot (18.0 t/ha). There was no significant difference between amended and control plots in vine fresh weight at harvest. However, Okumkom grown on 30-60-60 kg/ha NPK plot had the highest vine fresh weight at harvest.and the lowest recorded by 30-30-30kg/ha NPK plot (Table 4.9).

In the major season (2012), application of 15-15-15 kg/ha NPK+5t/ha CM to Apomuden recorded the highest vine fresh weight at harvest followed by 15-30-30 kg/ha NPK +5t/ha CM plot (6.83 t/ha) with the lowest recorded by the control. There was however, no significant difference between amended and unamended plots in vine fresh weight at harvest .Similarly, application of 15-23-23 kg/ha NPK+5t/ha CM to Okumkom recorded the highest vine fresh weight at harvest with the lowest recorded by 15-15-15 kg/ha NPK+5t/ha CM plot followed by the control. However, there was no significant difference between amended and unamended plots in vine fresh weight at harvest (Table 4.9).

Table 4.9: Vine fresh weight at harvest during 2011 minor season and 2012 major season

Variety	Vine fresh weight at harvest (t/ha) (minor season)			Vine fresh weight at harvest (t/ha) (major season)		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer Rates						
No fertilizer	22.2	54.0	38.1	3.47	8.20	5.83
10t/ha CM	19.0	64.5	41.7	4.60	16.00	10.30
30-30-30 kg/ha NPK	18.0	57.2	37.6	3.83	8.87	6.35
15-15-15 kg/ha CM + 5t/ha CM	20.0	59.0	39.5	6.92	6.30	6.61
30-45-45kg/ha NPK	26.5	58.5	42.5	3.70	14.07	8.88
15-23-23 kg/ha NPK + 5t/ha CM	27.0	63.5	45.2	4.80	20.23	12.52
30-60-60 kg/ha NPK	24.7	67.7	46.2	4.30	12.60	8.45
15-30-30 kg/ha NPK + 5t/ha CM	20.7	60.0	40.4	6.83	11.40	9.12
Mean	22.3	60.6		4.81	12.21	
LSD (P =0.05) Variety	6.1				3.23	
Fertilizer	NS				NS	
Variety x Fertilizer	NS				NS	

4.3 Yield Performance of Two Varieties of Sweetpotato

4.3.1 Number of Marketable and Unmarketable Root Tubers per Plot

Table 4.10 shows number of marketable and unmarketable root tubers per plot as influenced by chicken manure and inorganic fertilizer. During the minor season (2011), there was a significant difference between Apomuden and Okumkom in marketable root tuber number per plot (Appendix 2). Apomuden grown on 15-15-15 kg/ha NPK + 5t/ha CM and 30-45-45 kg/ha NPK plots had the highest marketable root tuber numbe rper plot

(22.0) with the lowest recorded by 10t/ha CM plot (14.0). Application of 15-23-23 kg/ha NPK+ 5t/ha CM and the control to Okumkom had the highest number of marketable root tubers per plot and 15-15-15 kg/ha NPK + 5t/ha CM plot recorded the lowest mean (9.0) (Table 4.10). Generally, Apomuden grown on 15-15-15 kg/ha NPK + 5t/ha CM, 10t/ha CM, 30-30-30 kg/ha NPKand 30-45-45 kg/ha NPK plots had significantly higher marketable root tuber number per plot than Okumkom grown on the same treatmenst. Apomuden and Okumkom grown on15-23-23 kg/ha NPK+ 5t/ha CM plot had the same marketable root tuber number per plot (Table 4.10).

In the major season (2012), there was a significant difference between Apomuden and Okumkom in marketable root tuber number per plot (Appendix 3). Apomuden grown on 15-30-30 kg/ha NPK + 5 t/ha CM plot had the highest number of marketable root tuber per plot (49.0) and 30-45-45kg/ha NPK plot had the lowest mean (28.0). Okumkom grown on 15-23-23 kg/ha NPK + 5 t/ha CM plot had the highest marketable root tuber number per plot (35.0) and the control had the lowest mean (15.0) (Table 4.10).

In both seasons Okumkom grown on 15-23-23 kg/ha NPK + 5 t/ha CM plot had the highest marketable root tuber number per plot. Generally, both sweetpotato varieties grown on amended and unamended plots during the major season in 2012 had higher marketable root tuber numbers than yields obtained during the minor season in 2011. There was no significant difference between variety x fertilizer interaction in marketable root tuber number per plot (Table 4.10).

In the case of unmarketable number of root tuber per plot, there was a significant difference between Apomuden and Okumkom in unmarketable root tuber number per plot (Appendix 4). Application of 30-30-30 kg/ha NPK to Apomuden had the highest mean

(20.0) with the lowest recorded by 10t/ha CM plot (11.0) during the minor season in 2011. Application of 30-45-45 kg/ha NPK to Okumkom produced the highest unmarketable root tuber number per plot (9.0) compared to the other treatments which recorded the same mean (6.0) except 15-23-23 kg/ha NPK + 5t/ha CM and control plots (Table 4.10).In the major season (2012), there were significant differences between Okumkom and Apomuden except for treatments 10t/ha CM and the control in unmarketable root tuber number per plot (Appendix 5). Apomuden grown on 15-30-30 kg/ha NPK+5t/ha CM plot had the highest unmarketable root tuber number per plot (40.0) and differed significantly from the control, 15-23-23 kg/ha NPK+5t/ha CM and 30-45-45 kg/ha NPK plots (Table 4.10). Okumkom grown on 15-23-23 kg/ha NPK+5t/ha CM plot had the highest unmarketable root tuber number per plot (61.0) and differed significantly from all the treatments except 30-60-60 kg/ha NPK and 15-30-30 kg/ha NPK + 5t/ha CM. Okumkom grown on amended plots except 10t/ha CM, 30-30-30 kg/ha NPK and 15-15-15 kg/ha NPK+5t/ha CM plots and the control had significantly higher unmarketable root tuber number per plot than Apomuden. In both seasons Okumkom grown on 15-15-15 kg/ha NPK +5t/ha CM plot had the lowest unmarketable root tuber number per plot.

Generally, both Apomuden and Okumkom grown on amended and the control plots during the major season had substantially higher unmarketable root tuber number per plot than the mean obtained during the minor season (Table 4.10).

Table 4.10.: Number of marketable and unmarketable tubers during 2011 minor season and 2012 major season

	Number of marketable root tubers per plot (No.) (minor season)			Number of marketableroot tubers per plot (No.) (major season)			Number of unmarketable root tubers per plot (No.). (minor season)			Number of unmarketable root tubers per plot (major season)		
Variety	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apom.	Okum.	Mean	Apomud.	Okum.	Mean
Fertilizer Rates												
No fertilizer	18.0	19.0	18.0	34.0	15.0	25.0	17.0	7.0	12.0	24.0	20.0	22.0
Chicken manure (10t/ha)	14.0	10.0	12.0	31.0	20.0	25.0	11.0	6.0	8.0	35.0	22.0	29.0
NPK 30-30-30	21.0	14.0	17.0	34.0	26.0	30.0	20.0	6.0	13.0	24.0	31.0	28.0
NPK 15-15-15 + 5t/ha Chicken manure	22.0	9.0	16.0	37.0	20.0	28.0	16.0	6.0	11.0	24.0	19.0	22.0
NPK 30-45-45	22.0	16.0	19.0	28.0	25.0	27.0	14.0	9.0	11.0	16.0	32.0	24.0
NPK 15-23-23 + 5t/ha Chicken manure	19.0	19.0	19.0	36.0	35.0	36.0	12.0	8.0	10.0	17.0	61.0	39.0
NPK 30-60-60	19.0	16.0	18.0	35.0	33.0	34.0	16.0	6.0	11.0	35.0	48.0	41.0
NPK 15-30-30 + 5t/ha Chicken manure	15.0	17.0	16.0	49.0	21.0	35.0	13.0	6.0	10.0	40.0	47.0	44.0
Mean	19.0	15.0		35.0	25.0		15	7.0		27.0	35.0	
LSD(P =0.05) Variety	3.60			7.38			2.82			7.86		
Fertilizer	NS			NS			NS			15.72		
Variety x Fertilizer	NS			NS			NS			22.23		

4.3.2 Marketable and Unmarketable Tuber Weight Per Plot

The effect of chicken manure and inorganic fertilizer on marketable and unmarketable tuber weight per plot of two sweetpotato varieties is presented in Table 4.11.During the minor season (2011), there was a significant difference between Apomuden from Okumkom in marketable tuber weight per plot except the control plot (Appendix 6). Apomuden grown on amended plots except 15-23-23 kg/ha NPK-5t/ha CM differed significantly from Okumkom grown on the same treatments in marketable tuber weight per plot. Apomuden grown on 30-45-45 kg/ha NPK plot had the highest marketable tuber weight per plot (3.75 kg). The lowest marketable tuber weight was recorded by 10t/ha CM plot (2.13 kg). Okumkom grown on the control plot had the highest marketable tuber weight per plot (3.05 kg) and the least was recorded by 15-15-15 kg/ha NPK+ 5t/ha CM treatments. There was no significant difference between amended and the control treatmentst in marketable tuber weight per plot (Table 4.11).

In the major season (2012), there was a significant difference between Apomuden from Okumkom in marketable tuber weight per plot (Appendix 7). Apomuden grown on amended treatments differed significantly from the control treatment in marketable tuber weight per plot.Apomuden grown on 15-30-30 kg/ha NPK +5t/ha CM plot had the highest marketable tuber weight per plot (12.13 kg) with the least recorded by the control plot (2.80kg). Okumkom grown on 15-23-23kg/ha NPK+5t/ha CM plot had the highest marketable tuber weight per plot (7.00 kg) followed by 30-60-60kg/ha NPK plot both of which differed significantly from the control plot with the lowest mean(1.93 kg). Application of 15-15-15kg/ha NPK + 5t/ha CM and 15-30-30kg/haNPK + 5tlha CM to Apomuden differed significantly in variety x fertilizer interaction from Okumkom in marketable tuber weight per plot. Generally, Apomuden and Okumkom grown on amended plots during the major season had higher marketable tuber weight per plot than mean values obtained during the minor season (Table 4.11).

In the case of unmarketable tuber weight, during the minor season (2011), there was a significant difference between Apomuden and Okumkom in unmarketable tuber weight per plot (Appendix 8). Apomuden grown on amended plots except 10tlha CM and 30-45-45 kg/ha NPK and the control plots differed significantly from Okumkom in unmarketable tuber weight per plot Apomuden grown on 30-30-30 kg/ha NPK plot had the highest unmarketable tuber weight per plot (0.55 kg) followed by 30-60-60 kg/ha NPK plot (0.44 kg) with the lowest recorded by 10t/ha CM (0.23 kg) (Table 4.11). Okumkom grown on 30-45-45 kg/ha NPK plot had the highest unmarketable tuber weight per plot (0.31 kg) and the lowest recorded by 15-30-30 kg/ha NPK + 5t/ha CM in unmarketable tuber weight per plot (0.13 kg). Application of 15-15-15 kg/ha NPK + 5t/ha CM to Okumkom had the same unmarketable tuber weight per plot with the control (0.18 kg). There was no significant difference between amended plots and the control in unmarketable tuber weight per plot (Table 4.11).

In the major season (2012), there was a significant difference between Okumkom and Apomuden in unmarketable tuber weight per plot except 10t/haCM, 30-30-30 kg/ha NPK and the control plots (Appendix 9). Apomuden grown on 30-60-60 kg/ha NPK plot had the highest unmarketable tuber weight per plot (0.67 kg) which differed significantly from 15-23-23 kg/ha NPK +5t/ha CM plot with the lowest mean value (0.13 kg). Significant difference occurred between Okumkom grown on 15-23-23 kg/ha NPK +5t/ha CM plot from 15-15-15 kg/ha NPK +5t/ha CM and the control plots in unmarketable tuber weight per plot. Apomuden and Okumkom grown on 30-30-30 kg/ha NPK and the control plots had the same unmarketable tuber weight per plot (0.33 kg) and (0.27 kg) respectively (Table 4.11). Generally, Okumkom grown on amended and unamended plots during the major season produced substantially higher unmarketable tuber weight per plot than mean obtained during the minor season (Table 4.11).

4.3.3 Total Tuber Yield

Effect of chicken manure and inorganic fertilizer on total tuber yield of two sweetpotato varieties is presented in Table 4.12. During the minor season (2011), A significant difference occurred between Apomuden grown on the different amendments except 15-23-23 kg/haNPK + 5t/ha CM 15-30-30 kg/haNPK +5t/ha CM and the control from Okumkom in total tuber yield Apomuden grown on 30-30-30 kg/haNPK plot had the highest total tuber yield (41.00 t/ha) with the lowest recorded by 15-30-30kg/haNPK + 5t/ha CM (28. 00 t/ha). There was no significant difference between the amended and the control plots (Table 4.12).

In the major season (2012), there was no significant difference in variety x fertilizer interaction between treatments in total tuber yield. Generally, Apomuden and Okumkom grown on amended and unamended plots during the major growing season produced substantially higher total tuber yield than during the minor growing season (Table 4.12).

Table 4.11.: Marketable and Unmarketable tuber weight per plot during 2011 minor season and 2012 major season

Variety	Weight of marketable tubers per plot (kg) (minor season)			Weight of marketable tubers per plot (kg) (major season)			Weight of Unmarketable tubers per plot (kg) (minor season)			Weight of Unmarketable tubersper plot (kg) (major season)		
	Apomud	Okumk.	Mean	Apomud	Okumk	Mean	Apomud	Okumk	Mean	Apomd	Okumk	Mean
Fertilizer Rates												
No fertilizer	2.98	3.05	3.01	2.80	1.93	2.37	0.37	0.18	0.27	0.27	0.27	0.27
10t/ha CM	2.13	1.65	1.89	6.47	3.93	5.20	0.23	0.20	0.22	0.50	0.30	0.40
30-30-30 kg/haNPK	3.18	1.95	2.56	7.03	3.83	5.43	0.55	0.22	0.38	0.33	0.33	0.33
15-15-15 kg/haNPK + 5t/ha CM	3.33	1.53	2.43	8.73	2.90	5.82	0.31	0.18	0.25	0.37	0.27	0.32
30-45-45 kg/haNPK	3.75	2.80	3.28	5.80	4.23	5.02	0.30	0.31	0.30	0.23	0.73	0.48
15-23-23 kg/haNPK + 5t/ha CM	3.30	3.00	3.15	7.23	7.00	7.12	0.32	0.22	0.27	0.13	1.73	0.93
30-60-60 kg/haNPK	3.43	2.68	3.05	6.97	6.23	6.60	0.44	0.16	0.30	0.67	1.23	0.95
15-30-30 kg/haNPK+ 5t/ha CM	3.15	2.63	2.89	12.23	3.23	7.73	0.26	0.13	0.20	0.57	1.13	0.85
Mean	3.15	2.41		7.16	4.16		0.35	0.20		0.38	0.75	
LSD (P =0.05); Variety	0.46			1.33			0.07			0.32		
Fertlizer	NS			2.67			NS			0.46		
Variety x Fertilizer	NS			3.78			NS			0.66		

Table 4.12: Total Tuber Yield During 2011 Minor Season and 2012 Major Season

	Total tuber yield (t/ha) (minor season)			Total tuber yield (t/ha) (major season)		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean
Fertilizer Rates						
No fertilizer	35.0	26.0	30.0	59.0	38.0	49.0
10t/ha CM	25.0	16.0	20.0	64.0	52.0	58.0
30-30-30 kg/haNPK	41.0	20.0	30.0	61.0	66.0	63.0
15-15-15kg/haNPK + 5t/ha CM	38.0	15.0	26.0	65.0	49.0	57.0
30-45-45 kg/haNPK	36.0	25.0	30.0	45.0	62.0	53.0
15-23-23 kg/haNPK + 5t/ha CM	31.0	27.0	30.0	58.0	85.0	72.0
30-60-60 kg/haNPK	34.0	22.0	28.0	70.0	93.0	82.0
15-30-30 kg/haNPK + 5t/ha CM	28.0	23.0	26.0	86.0	89.3	88.0
Mean	33.0	22.0		64.0	67.0	
LSD (P =0.05); Variety	5.18			NS		
Fertilizer	NS			NS		
Variety x Fertilizer	NS			NS		

4.3.4 Marketable Tuber Diameter

The results of the marketable tuber diameter as influenced by chicken manure and inorganic fertilizer and variety are presented in Table 4.13. For the minor growing season (2011), the diameter of marketable tubers was not significantly affected either by variety or the application of fertilizer. However, there was a general trend towards an increase in marketable tuber diameter in Okumkon grown on amendments except 10t/ha CM, 30-60-60 kg/ha NPK and 15-30-30g/ha NPK + 5t/ha CM and the control (Table 4.13).

In the major season (2012), there was a significant difference between Apomuden grown on amendments except 15-23-23 kg/haNPK + 5t/ha CM and the control from Okumkom in marketable tuber diameter. Apomuden grown on 15-30-30kg/haNPK +5t/ha CM plot had the highest marketable tuber diameter (8.64cm) with the lowest recorded by the control (6.31cm). No significant difference was observed between amended and unamended plots in marketable tuber diameter (Table 4.13).

In both seasons Apomuden grown on 15-30-30kg/haNPK+5t/ha CM plot had the highest marketable tuber diameter. Similarly, both Apomuden and Okumkom grown on 15-15-15kg/haNPK+5t/ha CM plot had the lowest marketable tuber diameter during the minor and major growing seasons respectively. Generally, Apomuden and Okumkom grown on amended and unamended plots produced substantially higher marketable tuber diameter during the major season than in the minor season (Table 4.13).

Table 4.13: Marketable and UnmarketableTuber Diameter During 2011 Minor SeasonAnd 2012 Major Season

Variety	Marketable Tuber Diameter (cm) (minor season)			Marketable Tuber Diameter(cm) (major season)			Unmarketable tuber Diameter (cm) (minor season)			Marketable tuber Diameter (cm) (major season)		
	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomud	Okumk	Mean	Apomd	Okumk	Mean
Fertilizer Rates												
No fertilizer	4.60	5.32	4.96	6.31	5.40	5.85	2.15	2.06	2.11	2.42	2.52	2.45
10t/ha CM	4.66	4.46	4.56	6.75	6.72	6.73	2.03	2.19	2.11	2.55	2.50	2.53
30-30-30 kg/haNPK	4.68	4.93	4.80	7.37	6.33	6.85	2.09	2.37	2.23	2.43	2.44	2.43
15-15-15 kg/haNPK + 5t/ha CM	4.56	5.24	4.90	7.14	5.38	6.26	1.93	2.24	2.08	2.49	2.52	2.50
30-45-45 kg/haNPK	5.11	5.65	5.38	6.39	5.99	6.19	2.03	2.24	2.13	2.26	2.55	2.41
15-23-23 kg/haNPK + 5t/ha CM	4.83	5.25	5.04	6.46	7.01	6.73	2.19	2.13	2.16	2.71	2.56	2.63
30-60-60 kg/haNPK	5.02	5.00	5.01	7.01	6.17	6.59	2.19	2.08	2.13	2.63	2.55	2.59
15-30-30 kg/haNPK + 5t/ha CM	5.14	5.11	5.13	8.64	5.65	7.15	2.02	2.19	2.07	2.65	2.61	2.50
Mean	4.82	5.12		7.01	6.08		2.08	2.18		2.52	2.53	
LSD (P =0.05)Variety	NS			0.64				0.10		NS		
Fertilizer	NS			NS				NS		NS		
Variety x Fertilize	NS			NS				NS		NS		

4.3.5 Unmarketable Tuber Diameter

The results of the unmarketable tuber diameter as influenced by chicken manure and inorganic fertilizer and variety are presented in Table 4.13. During the minor season (2011), there was a significant difference between Okumkomgrown on amendments except 15-23-23 kg/ha NPK + 5t/ha CM and 30-60-60 kg/ha NPK and the control from Apomuden inunmarketable tuber diameter. Application of 15-23-23kg/ha NPK + 5t/ha CM and 30-60-60kg/ha NPK to Apomuden had the highest and the same unmarketable tuber diameter. The lowest was recorded byApomuden under 15-15-15kg/ha NPK+5t/ha CM inunmarketable tuber diameter. Application of 10t/ha CM and 30-45-45kg/ha NPK to Apomuden had the same mean (2.03 cm) (Table 4.14).Okumkom grown ongrown on 30-30-30 kg/ha NPK had the highest unmarketable tuber diameter (2.37 cm) with the lowest recorded by the control (2.06 cm). Application of 15-15-15 kg/ha NPK + 5t/ha CM and 30-45-45 kg/ha NPK to Okumkom had the same mean (2.24 cm). Similarly, Okumkom grown on 10t/ha CM and 15-30-30 kg/ha NPK + 5t/ha CM plots also had the same mean in unmarketable tuber diameter. No significant difference was observed in variety x fertilizer interaction in unmarketable tuber diameter (Table 4.13).

In the major season (2012), the diameter of unmarketable tuber was not significantly affected either by variety or the application of fertilizer. However, there was a general trend towards an increase in unmarketable tuber diameter with Okumkon grown on amendments except 10t/ha CM, 15-23-23 kg/ha NPK, 30-60-600 kg/ha NPK and 15-30-30 kg/ha NPK + 5t/ha CM and the control.No significant difference was observed in variety x fertilizer interaction in unmarketable tuber diameter (Table 4.13).

In both seasons Apomuden grown on 15-23-23 kg/ha NPK+5t/ha CM plot had the highest unmarketable tuber diameter. Similarly, Apomuden and Okumkom grown on amended and unamended plots during the major season produced substantially higher unmarketable tuber diameter than in the minor season (Table 4 .13).

4.3.6 Average Tuber Weight

Table 4.14 shows the average tuber weight as influenced by chicken manure and inorganic fertilizers. During the minor season (2011), there was a significant difference between Apomuden from Okumkom in average tuber weight (Appendix 10). Apomuden grown on 30-45-45 kg/ha NPK + 5t/haCM plot had the highest average weight per tuber (0.30 kg) and 15-15-15kg/ha NPK + 5t/ha CM plot had the lowest weight per tuber (0.15kg). Application of 15-15-15 kg/ha NPK+ 5t/ha CM to Okumkom had the highest weight per tuber (0.23 kg).and the lowest recorded by 10t/haCM, 30-30-30 kg/ha NPK, 30-60-60 kg/ha NPK and 15-30-30 kg/ha NPK+ 5t/ha CM plots in average weight per tuber (0.16 kg). Amended plots did not differ significantly from the control plot in average weight per tuber. However, there was a general trend towards an increase in average weight per tuber with Apomuden grown on amendments except 15-15-15 kg/ha NPK+ 5t/ha CM and the control (Table 4.14).

In the major season (2012), there was a significant difference between Apomuden from Okumkom in average tuber weight (Appendix 11).Apomuden grown on 15-30-30 kg/ha NPK+5t/ha CM plot had the highest average tuber weight (0.53 kg) with the lowest recorded by the control (0.28 kg). Okumkom grown on 15-23-23 kg/ha NPK+5t/ha CM plot had the highest average tuber weight (0.30 kg) with the lowest recorded by 15-15-15 kg/ha NPK+5t/ha CM and the control (0.19 kg). No significant difference occurred between amended and unamended plots in average tuber weight (Table 4.14).

Generally, Apomuden grown on amended and the control plots during the majorseason produced substantially higher average tuber weight than Apomuden grown on the same treatments during the minor season. Okumkom grown on amended plots except NPK 15-15-15+5t/ha CM treatment during the major season produced substantially higher average tuber weight than Okumkom grown on the same treatments during the minor season (Table 4.14).

4.3.7 Average Tuber Length

Table 4.14 shows average tuber length as influenced by chicken manure and inorganic fertilizers.During the minor season (2011), there was a significant difference between Apomuden from Okumkom in average tuber length (Appendix 12). Application of 15-30-30 kg/ha NPK+5t/ha CM to Apomuden had the highest average tuber length (17.88 cm) and 30-60-60kg/ha NPK plot recorded the lowest average tuber length (13.80 cm). Okumkom grown on 10t/ha CM plot had the highest average tuber length (14.0 cm) and the control recorded the lowest average tuber length (10.77 cm). There was no significant difference between amended plots and the control in average tuber length (Table 4.14).

In the major season (2012), there was a significant difference between Apomuden from Okumkom except Apomuden under 15-23-23 kg/ha NPK +5t/ha CM in average tuber length.

Table 4.14: Average Tuber Weight and Tuber Length During 2011 Minor SeasonAnd 2012 Major Season

	Average tuber weight (kg) (minor season)			Average tuber weight (kg) (major season)			Average tuber Length (cm) (minor season)			Average tuber Length (cm) (major season)		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomud	Okumk	Mean	Apomd	Okumk	Mean
Fertilizer Rates												
No fertilizer	0.22	0.21	0.21	0.28	0.19	0.23	16.67	10.77	13.72	20.74	17.17	18.95
10t/ha CM	0.22	0.16	0.19	0.36	0.23	0.29	15.82	14.00	14.91	19.43	17.57	18.50
30-30-30kg/haNPK	0.22	0.16	0.19	0.37	0.24	0.31	14.52	11.95	13.24	19.87	17.33	18.60
15-15-15kg/haNPK + 5t/ha CM	0.15	0.23	0.19	0.35	0.19	0.27	15.00	12.12	13.56	22.29	16.83	19.56
30-45-45 kg/haNPK	0.30	0.17	0.23	0.36	0.26	0.31	16.17	11.15	13.66	20.79	18.40	19.59
15-23-23 kg/haNPK + 5t/ha CM	0.24	0.18	0.21	0.31	0.30	0.30	14.30	12.02	13.16	19.38	20.03	19.71
30-60-60 kg/haNPK	0.23	0.16	0.20	0.43	0.23	0.33	13.80	12.40	13.10	21.59	20.26	20.92
15-30-30 kg/haNPK + 5t/ha CM	0.26	0.16	0.21	0.53	0.21	0.37	17.88	11.32	14.60	24.50	17.40	20.95
Mean	0.23	0.18		0.37	0.23		15.52	11.97		21.07	18.12	
LSD (P =0..05)Variety	0.04			0.06			1.48			1.05		
Fertilizer	NS			NS			NS			NS		
Variety x Fertilizer	NS			NS			NS			2.97		

Apomuden grown on 15-30-30 kg/haNPK+5t/ha CM plot had the highest average tuber length (24.50 cm) and the lowest (19.38 cm) average tuber length recorded by 15-23-23 kg/ha NPK+5t/ha CM plot. Okumkom grown on 30-60-60 kg/haNPplot had the highest (20.26 cm) average tuber length and the least (16.83 cm) average tuber length recorded by15-15-15 kg/ha NPK+5t/ha CM plot.There was no significant difference between amended and the control plots in average tuber length (Table 4.14).

In both seasons Apomuden grown on 15-30-30 kg/ha NPK+5t/ha CM plot had the highest average tuber length. Generally, Apomuden grown on amendedplots except 15-23-23 kg/ha NPK+5t/ha CM plot during the major season and the control produced substantially higher average tuber length than Okumkom grown on the same treatments in both seasons. Similarly, Apomuden and Okumkom grown on amended and unamended plots recorded substantially higher average tuber length during the major seasonthan during the minor season (Table 4.14).

4.3.8 Tuber Dry matter accumulation at harvest

Table 4.15 shows tuber dry matter accumulation at harvest as influenced by chicken manure and inorganic fertilizers. During the minor season (2011), there was no significant difference between variety x fertilizer interaction in tuber dry matter accumulation at harvest However, there was a general trend towards greater increase in tuber dry matter accumulation at harvest with Okumkon grown on amendments except 30-60-60 kg/ha NPK and the control than in Apomuden (Table 4.15).

In the major season (2012), there was a significant difference between amendments and the control in tuber dry matter accumulation at harvest. There was however, no significant difference in variety x fertilizer interaction in tuber dry matter accumulation at harvest. Generally, application of chicken manure plus inorganic fertilizer to Apomuden during the major season produced substantially higher tuber dry matter accumulation at harvest than during the minor season with 15-30-30 kg/ha NPK + 5t/haCM plot producing the highest mean (3.08 kg) (Table 4.15).

4.3.9 Harvest Index and Commercial Harvest Index

The harvest index and commercial harvest index as influenced by chicken manure and inorganic fertilizer are presented in Table 4.16. During the minor season (2011), there was a significant difference between Apomuden from Okumkom in harvest index. Application of 30-30-30 kg/haNPK and 15-15-15 kg/ha NPK + 5t/ha CM to Apomuden produced the highest and the same Harvest index (0.66) with 10t/ha CM recording the lowest mean (0.55). On the other hand Okumkom grown on the control plot produced the highest harvest index (0.41) and the lowest recorded by treatment 10t/ha CM (0.21). There was no significant difference between amendments and the control in harvest index (Table 4.16).

In the major season (2012), there was a significant difference between Apomuden from Okumkom in harvest index. Application of 30-45-45 kg/ha NPK to Apomuden produced the highest Harvest index (0.65) and the lowest was recorded by the control plot (0.52). However, 30-30-30 kg/ha NPK, 30-60-60 kg/ha NPK and 15-30-30 kg/ha NPK+5t/ha CM plots had the same mean (0.64).

Table 4.15: Tuber Dry Matter Accumulation at Harvest during 2011 Minor Season and 2012 Major Season

Variety	Tuber dry matter accumulation at Harvest (kg) (minor season)			Tuber dry matter accumulation at Harvest (kg) (major season)		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer						
No fertilizer	1.24	1.43	1.34	0.55	0.71	0.63
10t/haCM	0.74	0.76	0.75	1.71	1.12	1.41
30-30-30 kg/haNPK	1.11	0.72	0.91	1.28	1.57	1.43
15-15-15 kg/haNPK + 5t/ha CM	1.10	0.72	0.91	1.80	0.86	1.33
30-45-45 kg/haNPK	1.21	4.81	3.01	1.83	1.32	1.57
15-23-23 kg/haNPK + 5t/ha CM	1.21	1.36	1.29	1.92	2.63	2.27
30-60-60 kg/haNPK	1.11	1.07	1.09	1.53	1.97	1.75
15-30-30 kg/haNPK + 5t/ha CM	1.09	1.17	1.13	3.08	1.51	2.29
Mean	1.10	1.51		1.71	1.46	
LSD (P =0.05); Variety	NS			NS		
Fertilizer	NS			0.85		
Variety x Fertilizer	NS			NS		

Okumkom grown on 15-23-23 kg/ha NPK+5t/ha CM plot had the highest harvest index with the lowest recorded by 10t/ha CM plot followed by the control plot. There was no significant difference between amendmends and the control in harvest index. In both seasons application of 10t/ha CM to Okumkom produced the same and the lowest Harvest index (0.21) (Table 4.16).

In the case of commercial harvest index, during the minor season (2011), there was no significant difference between Okumkom from Apomuden in commercial harvest index.

However, there was a general trend towards an increase in commercial harvest index with Okumkon grown on amendments except 10t/ha CM and 30-45-45 kg/ha NPK plots and the control compared with Apomuden There was no significant difference in variety x fertilizer interactionin commercial harvest index (Table 4.16).

In the major season (2012), there was a significant difference between Apomuden and Okumkom in commercial harvest index. Application of 15-23-23 kg/ha NPK+5t/ha CM to Apomuden produced the highest commercial harvest index (0.97) and the least (0.86) was recorded by the control. Okumkom grown on 30-30-30 kg/ha NPK and 15-15-15kg/ha NPK+5t/ha CM plots had the same and the highest commercial harvest index (0.91) and the least (0.73) was recorded by 15-30-30kg/ha NPK +5t/ha CM plot.There was no significant difference between amendments and the control in commercial harvest index (Table 4.16). Generally, Apomuden grown on amended and the control plots during the major season produced substantially higher commercial harvest index than during the minor season. However, Okumkom grown on amended plots except 10t/ha CM, 30-30-30 kg/ha NPK plot and the control produced substantially higher commercial harvest index during the minor season than during the major season. Okumkom grown on 15-15-15 kg/ha NPK + 5t/ha CM plot had the same mean (0.91) in both seasons (Table 4.16).

Table 4.16: Harvest Index and Commercial Harvest Index As Influenced By Chicken Manure And Inorganic Fertilizer During 2011 Minor Season And 2012 Major Season

Variety	Harvest index (minor season)		Mean	Harvest index (major season)		Mean	Commercial harvest index (minor season)		Mean	Commercial harvest index (major season)		Mean
	Apomud.	Okumk.		Apomud	Okumk		Apomud	Okumk		Apomd	Okumk	
Fertilizer Rates												
No fertilizer	0.60	0.41	0.50	0.52	0.23	0.37	0.85	0.94	0.90	0.86	0.87	0.87
10t/ha CM	0.55	0.21	0.38	0.61	0.21	0.41	0.88	0.87	0.87	0.93	0.88	0.90
30-30-30 kg/haNPK	0.66	0.27	0.46	0.64	0.30	0.47	0.84	0.89	0.86	0.95	0.91	0.93
15-15-15 kg/haNPK + 5t/ha CM	0.66	0.22	0.44	0.57	0.36	0.47	0.90	0.91	0.91	0.95	0.91	0.93
30-45-45 kg/haNPK	0.61	0.33	0.47	0.65	0.24	0.44	0.93	0.89	0.91	0.95	0.85	0.90
15-23-23 kg/haNPK + 5t/ha CM	0.57	0.35	0.46	0.58	0.41	0.50	0.89	0.93	0.91	0.97	0.80	0.88
30-60-60 kg/haNPK	0.58	0.27	0.42	0.64	0.34	0.49	0.85	0.92	0.89	0.91	0.84	0.88
15-30-30 kg/haNPK + 5t/ha CM	0.61	0.33	0.47	0.64	0.30	0.47	0.92	0.94	0.93	0.95	0.73	0.84
Mean	0.61	0.30		0.61	0.30		0.88	0.91		0.93	0.85	
LSD (P =0.05); Variety	0.044			0.078			NS			0.039		
Fertilizer	NS			NS			NS			NS		
Variety x Fertilizer	NS			NS			NS			NS		

4.4 Marketable Quality of Tubers (Percentage Tuber Crack, Tuber Rot, Deformed Tuber, Forked Tuber, Pests Infested Tuber, Tuber Sprout) As Influenced By Chicken Manure And Inorganic Fertilizer On Two Sweetpotato Varieties (Okumkom And Apomuden)

4.4.1 Percentage Cracked Tubers

Percentage cracked tubers produced in the different treatments are shown in Table 4.17. In the minor season (2011), there was no significant difference between Apomuden and Okumkom in percentage cracked tubers. However, there was a general trend towards an increase in percentage cracked tubers with Okumkon grown on amendments except 15-15-15 kg/ha NPK + 5t/ha CM, 30-60-60 kg/ha NPK and 15-30-30 kg/ha NPK + 5t/ha CM and the control than Apomuden. There was no significant difference between the amended and the control plots in percentage cracked tuber (Table 4.17).

In the major season (2012), the difference between Apomuden and Okumkom was not significant in percentage cracked tubers although there was a general trend towards an increase in percentage cracked tubers with Okumkon grown on amendments except30-30-30 kg/ha NPK, 30-45-45kg/ha NPK 15-23-23 kg/ha NPK + 5t/ha CM, 30-60-60 kg/ha NPK and 15-30-30 kg/ha NPK + 5t/ha CM and the control than Apomuden. There was no significant difference between the amended and the control plots in percentage cracked tuber (Table 4.17).

Apomuden and Okumkom grown on amended plots except 15-15-15 kg/aNPK+5t/ha CM and 30-45-45 kg/ha NPK plots respectively and the control produced substantially higher percentage cracked tubers during the major season than during the minor season (Table 4.17).

Table 4.17: Percentage Cracked and RottenTubers During 2011 Minor Season And 2012 Major Season

	Percentage Cracked tubers (%) (minor season)			Percentage Cracked tubers (%) (major season)			Percentage Rotten Tubers (%) (minor season)			Percentage Rotten Tubers (%) (major season)		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomud	Okumk	Mean	Apomd	Okumk	Mean
Fertilizer Rates												
No fertilizer	0.0	7.5	3.8	8.66	11.05	9.86	0.0	0.0	0.0	2.11	0.0	1.06
10t/ha CM	4.4	8.1	6.3	13.55	13.59	13.57	6.3	0.0	3.2	0.0	0.0	0.0
30-30-30kg/ha NPK	2.8	3.0	2.9	14.70	12.04	13.37	6.7	6.2	6.4	2.17	0.0	1.08
15-15-15 kg/ha NPK + 5t/ha CM	9.7	8.9	9.3	7.51	11.42	9.47	0.0	3.9	1.9	0.0	0.0	0.0
30-45-45 kg/ha NPK	5.8	9.7	7.7	12.44	6.44	9.44	2.1	4.1	3.1	0.0	0.0	0.0
15-23-23 kg/ha NPK + 5t/ha CM	5.1	5.3	5.2	11.39	7.64	9.52	3.6	3.7	3.7	0.0	0.0	0.0
30-60-60 kg/ha NPK	7.1	2.3	4.7	12.59	9.80	11.19	2.1	3.9	3.0	2.04	0.0	1.02
15-30-30 kg/ha NPK + 5t/ha CM	3.2	0.0	1.6	16.78	11.76	14.27	0.0	0.0	0.0	0.0	0.0	0.0
Mean	12.20	10.47		4.8	5.6		2.6	2.7		0.79	0.00	
LSD (P =0.05); Variety		NS			NS			NS			NS	
Fertilizer		NS			NS			NS			NS	
Variety x Fertilizer		NS			NS			NS			NS	

4.4.2 Percentage Rotten Tubers

Percentage of rotten tubers produced in the different treatments is presented in (Table 4.17).In the minor season (2011), there was no significant difference between Apomuden and Okumkom in percentage cracked tubers. There was no significant difference between the amended and the control plots in percentage cracked tuber (Table 4.17).

In the major season (2012), the difference between Apomuden and Okumkom was not significant although there was a general trend towards increasing percentage cracked tubers in Apomuden grown on amendments and the control than Okumkom. There was no significant difference between the amended and the control plots in percentage cracked tuber (Table 4.17).

4.4.3 Percentage Forked Tubers

Percentage of forked and deformed tubers produced in the different treatments is presented in Table 4.18. In the minor season (2011), there was a significant difference between Apomuden from Okumkom in percentage forked tubers. Apomuden grown on 30-45-45 kg/ha NPK plot had the highest percentage forked tubers (19.2 %) followed by 15-23-23kg/ha NPK + 5t/ha CM plot (19.0 %) with the lowest recorded by 10t/ha CM (14.4 %). Application of 15-15-15 kg/ha NPK+ 5 t/ha CM to Okumkom had the highest percentage forked tubers (28.8 %) and the lowest recorded by the control plot (18.6 %). There was no significant difference between the amended and the control plots in percentage forked tubers (Table 4.18).

In the major season (2012), there was a significant difference between Apomuden and

Okumkom in percentage forked tubers. Apomuden grown on 15-23-23 kg/ha NPK+5t/ha CM plot had the highest (6.47%) percentage forked tubers followed by 15-30-30 kg/ha NPK+5t/ha CM and 15-15-15 kg/haNPK +5t/ha CM plots with zero (0.0) forked tubers recorded by the other amended and the control plots. Okumkom grown on 15-15-15kg/ha NPK+5t/ha CM plot had the highest (13.7 %) percent forked tubers followed by the control plot (13.46%) with the lowest (2.84%) percentage forked tubers recorded by 15-30-30kg/ha NPK+ 5t/ha CM treatment. There was no significant difference between the amended and the control plots in percentage forked tubers.There was no significant difference between the amended and the control plots in percentage forked tubers (Table 4.18).

Apomuden grown on 10t/ha CM plot had the lowest percentage forked tubers in both seasons. Similarly, Apomuden and Okumkom grown on both amended and the control plots during the minor season recorded substantially higher percentage forked tubers than during the major season (Table 4.18).

Table 4.18: Percentage Forked and Deformed Tubers During 2011 Minor Season And 2012Major Season

Variety	Percentage Forked tubers (%) (minor season)			Percentage Forked tubers (%) (major season)			Percentage Deformed tubers (%)(minor season)			Percentage Deformed tubers (%)(major season)		
	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomud	Okumk	Mean	Apomd	Okumk	Mean
Fertilizer Rates												
No fertilizer	17.5	18.6	18.1	0.0	13.46	6.73	17.2	18.3	17.7	17.78	19.05	18.42
10t/ha CM	14.4	21.4	17.9	0.0	2.99	1.50	17.0	17.5	17.2	17.41	18.82	18.17
30-30-30kg/ha NPK	14.7	23.0	18.8	0.0	7.73	3.86	12.0	14.5	13.3	12.66	14.53	13.60
15-15-15 kg/ha NPK + 5t/ha CM	18.7	28.8	23.8	2.30	13.69	8.00	14.8	15.2	15.0	15.30	17.07	16.19
30-45-45 kg/ha NPK	19.2	20.4	19.8	0.0	8.49	4.25	19.2	16.3	17.7	19.19	19.57	19.38
15-23-23 kg/ha NPK + 5t/ha CM	19.0	23.3	21.1	6.47	8.30	7.38	15.6	12.0	13.8	16.06	15.34	15.70
30-60-60 kg/ha NPK	15.9	26.7	21.3	0.0	4.43	2.21	14.0	14.8	14.4	15.16	23.34	19.25
15-30-30 kg/ha NPK + 5t/ha CM	17.0	23.3	20.2	3.03	2.84	2.94	17.0	11.9	14.5	18.72	16.77	17.75
Mean	17.0	23.2		12.48	7.48		15.9	15.1		16.54	18.08	
LSD (P =0.05); Variety	3.74			2.95			NS			NS		
Fertilizer	NS			NS			NS			NS		
Variety x Fertilizer	NS			NS			NS			NS		

4.4.4 Percentage Deformed Tubers

The result of percentage deformed tubers produced in the different treatment is presented in (Table 4.18). In the minor season (2011), there was no significant difference between Apomuden and Okumkom in percentage deformed tubers. There was no significant difference between the amended and the control plots in percentage deformed tuber (Table 4.18).

In the major season (2012), the difference between Apomuden and Okumkom was not significant in percentage deformed tubers. There was no significant difference between the amended and the control plots in percentage deformed tuber (Table 4.18). Okumkom grown on amended and unamended plots during the major season produced substantially higher percentage deformed tubers than during the minor season (Table 4.18).

4.4.5 Percentage Pest Infested Tubers

The results of percentage pests infested tubers produced in the different treatment is presented in (Table 4.19).In the minor season (2011), there was a significant difference between Apomuden from Okumkom in percentage pest infestedtubers.Apomuden grown on 15-23-23 kg/ha NPK + 5t/ha CM plot had the highest (37.4%) percentage pess infested tubers by followed by 30-45-45 kg/ha NPK and the lowest (20.1%)percentage pess infested tubers recorded by 15-30-30kg/ha NPK + 5t/ha CM plot. The level of pest infestation was however very severe (5) in Apomuden (Table 4.19). Okumkom grown on 15-23-23kg/ha NPK + 5t/ha CM plot had the highest (17.4%) percentage pest infested tubers followed by 30-45-45 kg/ha NPK plot with the lowest 9.7%) percentage pest infested tubers recorded by 10t/ha CM plot. The level of infestation was however slight (2) (Table 4.19). There was no ignificant difference between amendments and the control in percentage pest infested tubers.

In the major season (2012), there was a significant difference between Apomuden from Okumkom in percentage pest infestedtubers.Apomuden grown on 15-30-30 kg/ha NPK+5t/ha CM plot had the highest (25.6%) percentage pest infested tubers and the lowest (14.3%) recorded by 10t/ha CM plot. The level of infestation was severe (4) (Table 4.19). Okumkom grown on 15-15-15 kg/ha NPK+5t/ha CM plot had the highest (15.2%) percentage pest infested tubers and the lowest (5.0%) recorded by the control. The level of infestation was however slight (2) (Table 4.19). There was no significant difference in variety x fertilizer percentage peat infeated tubers. Apomuden grown on amended and the control plots produced substantially higherpercentage pest infested tubers than Okumkomin both seasons. Okumkom grown on 10t/ha CM plot had the lowest percentage pest infested tubers in both seasons. Generally, the level of pest infestation of Apomuden and Okumkom grown on amended and control plots during the minor season was more severe than during the major season (Table 4.19).

Table 4.19: Percentage Pest Infested Tubers during 2011 Minor Season and 2012 Major Season

Variety	Percentage Pest infested tubers (%) (minor season)			Percentage Pest infested tubers (%) (major season)		
	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean
Fertilizer Rates						
No fertilizer	28.8	11.2	20.0	18.2	5.0	11.6
10t/ha CM	24.1	9.7	16.9	14.3	5.3	9.8
30-30-30 kg/ha NPK	29.6	16.0	22.8	14.7	6.1	10.4
15-15-15 kg/ha NPK + 5t/ha CM	28.3	14.4	21.3	23.8	15.2	19.5
30-45-45 kg/ha NPK	30.1	16.9	23.5	21.4	5.8	13.6
15-23-23 kg/ha NPK + 5t/ha CM	37.4	17.4	27.4	24.9	9.2	17.0
30-60-60 kg/ha NPK	27.4	15.7	21.6	21.6	9.6	15.6
15-30-30 kg/ha NPK + 5t/ha CM	20.1	12.1	16.1	25.6	11.5	18.5
Mean	28.2	14.2		20.6	8.5	
LSD (P=0.05); Variety	5.94			5.22		
Fertilizer	NS			NS		
Variety x Fertilizer	NS			NS		

4.4.7 Percentage Sprouted Tuber at Harvest

The percentage sprouted tuber at harvest produced in the different treatments is presented in (Table 4.20). In the minor season (2011), there was no significant difference between Apomuden and Okumkom in percentage sprouted tubers. There was no significant difference in variety x fertilizer interaction in percentage sprouted tuber (Table 4.20).

In the major season (2012), there was no significant difference between Apomuden and Okumkom in percentage sprouted tubers. There was no significant differene in variety x fertilizer interaction in percentage sprouted tuber (Table 4.20).

Table 4.20: Percentage Sprouted Tubers at Harvest During 2011 Minor Season And 2012 Major Season

Variety	Percentage sprouted tubers (%) (minor season)			Percentage sptoutedtubers (%) (major season)		
	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean
Fertilizer Rates						
No fertilizer	4.53	0.00	2.27	0.0	0.0	0.0
10t/ha CM	4.39	0.00	2.19	0.0	0.0	0.0
30-30-30kg/ha NPK	0.00	3.41	1.70	0.0	0.0	0.0
15-15-15 kg/ha NPK + 5t/ha CM	0.00	0.00	0.00	6.46	0.0	3.23
30-45-45 kg/ha NPK	2.91	3.74	3.33	2.63	0.0	1.32
15-23-23 kg/ha NPK + 5t/ha CM	2.55	0.00	1.27	3.95	0.0	1.98
30-60-60 kg/ha NPK	0.00	0.00	0.00	0.0	1.78	0.89
15-30-30 kg/ha NPK + 5t/ha CM	0.00	0.00	0.00	2.14	0.0	1.07
Mean	1.80	0.89		1.90	0.22	
LSD (P =0.05); Variety	NS			NS		
Fertilizer	NS			NS		
Variety x Fertilizer	NS			NS		

4.5 Sensory Characteristics of Cooked Tubers of Two Sweetpotato Varieties (Apomuden and Okumkom) During the Minor season, (2011) and Major season, (2012)

Table 4.21 shows sensory characteristics of cooked tubers of two varieties of sweetpotato as influenced by chicken manure and inorganic fertilizer. In the minor season (2011), there was a significant difference between Apomuden and Okumkom in terms of taste, texture, colour, palatability and overall acceptability at harvest and after cooking. Application of 30-45-45 kg/ha NPK to Okumkom had higher (4.83) preference rating in terms of taste than Apomuden grown on all the other amended and the control tubers (Table 4.21a).

Okumkom grown on 30-45-45 kg/ha NPK plot had the highest (4.17) preference with regard to colour and the least (2.50) preference recorded by 30-30+30 kg/ha NPK. In terms of texture, Okumkom grown on 15-15-15 kg/ha NPK + 5t/ha CM, 30-45-45 kg/ha NPK and 15-23-23 kg/ha NPK+5t/ha CM plots produced similar and the highest (3.33) preference compared to Apomuden. Okumkom grown on 15-23-23 kg/ha NPK+ 5t/ha CM plot had the highest (4.17) preference and the lowest was recorded by the control (2.67) with regard to flavour (Table 4. 21b). In terms of palatability Okumkom differed significantly from Apomuden with 30-45-45 kg/ha NPK treatment recording the highest preference under the amended plot except 15-23-23 kg/ha NPK+ 5t/ha CM and the control. Overall acceptability showed that Okumkom grown on 30-45-45 kg/ha NPK was the most preferred.Apomuden grown on 15-30-30 kg/ha NPK+ 5t/ha CM was the least accepted during the minor season. There was no significant difference between amendment and the comtrol tubers in terms of taste, texture, colour and flavour at harvest and after cooking (Tables 4.21a and 4.21b).

In the major season (2012), there was a significant difference between Apomuden and Okumkom in terms of taste, texture, colour, palatability andOverall acceptabilityat harvest and after cooking.The overall acceptability showed that Apomuden grown on amendment except 30-30-30 kg/ha NPK and 30-45-45 kg/ha NPK and the control differed significantly from Okumkom with Apomuden grown on 15-15-15 kg/ha NPK+ 5t/haCM recording the highest preference.Okumkom under 15-30-30 kg/ha NPK +5t/ha CM emerged as the overall best acceptable tuber in terms of taste than Apomuden. Okumkom grown on amendment except 15-23-23 kg/ha NPK+5t/haCM and 15-30-30 kg/ha NPK+ 5t/ha CM and the control differed significantlyfrom Apomuden with regards to texture at harvest.

Table 4.21a: Sensory Characteristics of Cooked Apomuden and Okumkom Tubers at Harvest During The 2011 Minor Season

	Taste			Texture			Colour		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomud	Okumk	Mean
Fertilizer Rates									
No fertilizer	3.50	3.67	3.58	1.50	3.00	2.25	4.67	2.83	3.75
10t/ha CM	2.83	4.00	3.42	2.17	2.16	2.16	3.67	3.00	3.33
30-30-30 NPK	3.83	3.50	3.67	2.50	2.83	2.66	4.00	2.50	3.25
15-15-15 kg/ha NPK+ 5t/ha CM	3.33	3.67	3.50	2.00	3.33	2.66	3.33	3.33	3.33
30-45-45 kg/ha NPK	3.50	4.83	4.17	1.83	3.33	2.58	4.16	4.17	4.16
15-23-23 kg/ha NPK + 5t/ha CM	3.83	2.50	3.17	1.66	3.33	2.50	4.66	3.16	3.91
30-60-60 kg/ha NPK	3.00	4.17	3.58	2.33	3.00	2.66	3.66	3.33	3.50
15-30-30 kg/ha NPK + 5t/ha CM	2.67	3.50	3.08	2.33	3.16	2.75	2.16	3.83	3.00
Mean	3.31	3.73		2.04	3.02		3.79	3.27	
LSD (P =0.05); Variety	0.40			0.27			0.39		
Fertilizer	NS			NS			NS		
Variety x Fertilizer	1.13			0.77			1.12		

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Table 4.21b: Sensory Characteristics of Cooked Apomuden And Okumkom Tubers at Harvest During The 2011 Minor Season

	Flavour			Palatability			Overall acceptability		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomud	Okumk	Mean
Fertilizer Rates									
No fertilizer	3.83	2.67	3.25	3.17	3.66	3.41	16.7	15.9	16.3
10t/ha CM	2.66	3.67	3.16	2.83	4.00	3.41	14.2	16.9	10.5
30-30-30 kg/haNPK	3.83	2.83	3.33	3.16	3.83	3.50	17.3	15.4	16.3
15-15-15 kg/haNPK + 5t/ha CM	3.16	3.33	3.25	3.50	4.16	3.83	15.3	17.8	16.5
30-45-45 kg/haNPK	3.16	3.83	3.50	3.16	4.66	3.91	15.9	20.8	18.3
15-23-23 kg/haNPK + 5t/ha CM	4.00	4.17	4.08	2.83	2.66	2.75	17.0	15.9	16.5
30-60-60 kg/haNPK	4.00	3.33	3.66	2.50	4.00	3.25	15.5	17.8	16.7
15-30-30 kg/haNPK + 5t/ha CM	2.66	3.33	3.00	2.83	3.16	3.0	12.7	17.0	14.9
Mean	3.41	3.39		3.00	3.77		15.6	17.2	
LSD (P= 0.05); Variety	NS			0.36			0.30		
Fertilizer	NS			0.73			0.60		
Variety x Fertilizer	1.08			NS			NS		

Apomuden and Okumkom grown on 15-23-23 kg/ha NPK+5t/ha CM emergedas most of its qualities preferred (colour, flavour and palatability).There was no significant difference between tubers under amendment and the comtrol in terms of taste, texture, colour and flavor (Tables 4. 21c and 4.21d). Apomuden grown on 15-30-30 kg/ha NPK+ 5t/ha CM was the least accepted in both seasons (Tables 4.21b and 4.21d).

4.6. Storability Studies

4.6.1 Percentage Pest Infested Tubers of Sweetpotato During the 2011 Minor and 2012 Major Seasons After 12 weeks of Storage in Ash, Grass or Pit

4.6.1.1 Percentage Pest Infested Tubers In Ash Storage

Table.4.22a shows the percentage pests infested tubers of two varieties of sweetpotato as influenced by chicken manure, inorganic fertilizer and storage in Ash. In the minor season (2011), tubers obtained from Apomuden and Okumkom grown on amended plots and the control recorded zero pest infested tubers for the first 6 weeks in ash storage except in 30-30-30 kg/ha NPK treatment which recorded (22.2%). Apomuden treated with 15-15-15 kg/ha NPK+5t/ha CM had the highest percentage pest infested tubers (49.3%) in ash storage while Okumkom under the same treatment had no pest infested tubers at 10 and 12 weeks after storage in ash (Table. 4.22a).

In the major season (2012), both Apomuden and Okumkom tubers produced under amended or unamended treatments and storage in Ash had zero mean value pests infested tubers for the first 2 weeks in ash storage.

Table 4.21c: Sensory Characteristics of Cooked Apomuden And Okumkom Tubers at Harvest During the 2012Major Season

	Taste			Texture			Colour		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomud	Okumk	Mean
Fertilizer Rates									
No fertilizer	3.71	3.57	3.64	2.14	3.13	2.64	4.43	3.00	3.72
10t/ha CM	4.00	1.29	2.65	2.29	3.57	2.93	4.14	3.43	3.79
30-30-30 kg/ha NPK	2.57	3.71	3.14	2.86	2.29	2.58	3.57	3.43	3.50
15-15-15 kg/ha NPK + 5t/ha CM	4.57	3.86	4.22	2.00	3.29	2.65	4.29	2.57	3.33
30-45-45 kg/ha NPK	3.53	3.00	3.27	2.00	3.14	2.57	4.14	4.00	4.43
15-23-23 kg/ha NPK + 5t/ha CM	4.71	3.86	4.29	1.57	1.71	1.64	4.29	3.71	4.00
30-60-60 kg/ha NPK	3.00	4.00	3.50	1.86	2.71	2.29	3.86	2.57	3.22
15-30-30 kg/ha NPK + 5t/ha CM	2.86	4.29	3.58	2.71	1.57	2.14	3.29	3.57	3.43
Mean	3.63	3.44		2.17	2.68		4.08	3.29	
LSD (P =0.05); Variety		0.40			0.27			0.39	
Fertilizer		NS			NS			NS	
Variety x Fertilizer		1.13			0.77			1.12	

Table 4.21d: Sensory Characteristics of Cooked Apomuden and Okumkom Tubers at HarvestDuringthe 2012 Major Season

	Flavour			Palatability			Overall acceptability		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomud	Okumk	Mean
Fertilizer Rates									
No fertilizer	3.29	3.14	3.22	4.14	3.57	3.86	17.6	16.4	17.0
10t/ha CM	3.86	3.29	3.58	3.29	3.43	3.36	17.6	15.0	8.3
30-30-30 kg/haNPK	3.00	2.86	2.93	2.57	3.86	3.22	14.7	16.2	15.5
15-15-15 kg/haNPK + 5t/ha CM	4.00	3.43	3.72	4.71	3.86	4.29	19.6	17.1	18.3
30-45-45 kg/haNPK	3.43	3.71	3.57	3.43	3.00	3.22	16.4	16.8	16.6
15-23-23 kg/haNPK + 5t/ha CM	4.14	3.29	3.72	4.71	4.14	4.43	19.4	16.7	18.0
30-60-60 kg/haNPK	4.14	3.00	3.57	3.43	3.71	3.57	16.3	16.0	16.2
15-30-30 kg/haNPK + 5t/haCM	3.00	3.57	3.29	2.71	4.57	3.64	14.6	14.1	14.3
Mean	3.60	3.29		3.62	3.76		17.0	16.0	
LSD (P =0.05); Variety	NS			0.36			0.30		
Fertilizer	NS			1.12			1.27		
Variety x Fertilizer	1.08			NS			0.85		

However, application of 10t/ha CM, 15-15-15 kg/ha NPK+5t/ha CM or 15-30-30 kg/ha NPK+5t/ha CM to Apomuden and storage in Ash had the highest percentage pest infested tubers at the first 8 WAS with the lowest recorded by unamended tubers (Table. 4.22b). Okumkom treated with 15-23-23kg/ha NPK +5t/ha CM and 15-30-30 kg/haNPK+5t/ha CM and storage in Ash produced the highest percentage pest infested tubers (52.2%) with the lowest recorded by 10t/ha CM and the control tubers. However, 30-30-30 kg/ha NPK and 30-45-45 kg/ha NPK and the control tubers of Apomuden and Okumkom stored in Ash recorded the same percentage pests infested tubers at 8 WAS (Table 4.22b).

Apomuden produced on 15-23-23 kg/ha NPK +5t/ha CM and stored in Ash had the highest percentage pest infested tubers while the lowest was recorded by 30-60-60 kg/ha NPK treated tubers at 12 WAS. However, Okumkom grown on 10t/ha CM and 30-30-30 kg/ha NPK plots had the highest percentage pest infested tubers at 12 WAS in Ash storage. Tubers of Okumkom grown on the other fertilizer treatments except 15-15-15kg/ha NPK +5t/ha CM had the same mean (52.2%) percentage pest infested tubers at 12 WAS in Ash storage (Table. 4.22b). A significant difference occurred in variety x fertilizer interaction in percentage pest infested tubers in Ash storage 12 WAS in both seasons (Tables. 4.22a and 4.22b).

Table 4.22a: Percentage Pest Infested Tubers in Ash Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.4	0.0	11.2	40.5	22.4	31.5	40.4	22.3	31.4
T 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.4	11.2	32.3	32.4	32.4	32.3	32.4	32.3
T 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.2	11.1	0.0	32.4	16.2	0.0	32.5	16.2	0.0	32.3	16.1
T 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.2	0.0	16.1	49.3	0.0	24.6	49.3	0.0	24.6
T 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.4	0.0	11.2	40.4	32.3	36.3	40.4	32.2	36.3
T 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.4	0.0	11.2	32.3	32.4	32.3	32.3	32.2	32.3
T 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.5	32.4	36.4	40.6	49.3	44.9	40.6	49.2	44.9
T 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.4	22.4	27.4	32.3	32.4	32.4	32.4	32.4	32.4
Mean	0.0	0.0		0.0	0.0		0.0	2.7		21.5	13.7		33.4	29.2		33.4	29.1	
LSD (P = 0.05); Variety =	0.0			0.0			0.2			0.5			0.5			0.6		
Fertilizer =	0.0			0.0			0.4			1.1			1.1			1.3		
Variety x Fertilizer =	0.0			0.0			0.6			1.5			1.5			1.9		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/ha CM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Table 4.22b: Percentage Pest Infested Tubers in Ash Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	0.0	20.7	10.3	20.7	20.7	20.7	20.7	20.7	20.7	37.7	45.0	41.3	52.2	60.0	56.1
T 2	0.0	0.0	0.0	0.0	0.0	0.0	37.7	0.0	18.8	45.0	20.7	32.8	45.0	60.0	52.5	60.0	69.2	64.6
T 3	0.0	0.0	0.0	0.0	0.0	0.0	20.7	0.0	10.3	30.0	30.0	30.0	30.0	60.0	45.0	45.0	69.2	57.1
T 4	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	45.0	30.0	37.5	45.0	52.2	48.6	45.0	60.0	52.5
T 5	0.0	0.0	0.0	30.0	0.0	15.0	30.0	0.0	15.0	37.7	37.7	37.7	37.7	37.7	37.7	45.0	52.2	48.6
T 6	0.0	0.0	0.0	0.0	30.0	15.0	0.0	30.0	15.0	45.0	52.2	48.6	69.2	52.2	60.7	69.2	52.2	60.7
T 7	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	30.0	37.7	33.8	30.0	52.2	41.1	30.0	52.2	41.1
T 8	0.0	0.0	0.0	30.0	20.7	25.3	30.0	45.0	37.5	45.0	52.2	48.6	45.0	52.2	48.6	45.0	52.2	48.6
Mean	0.0	0.0		12.6	8.9		22.5	11.9		37.3	35.1		42.4	51.4		48.9	58.4	
LSD (P = 0.05); Variety =	0.0			0.38			0.48			0.59			0.60			0.59		
Fertilizer =	0.0			0.77			0.96			1.17			1.20			1.17		
Variety x Fertilizer =	0.0			0.09			0.36			1.66			1.70			1.60		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

4.6.1.2 Percentage Pest Infested Tubers in Grass Storage

The results of percentage pests infested tubers of two varieties of sweetpotato as influenced by chicken manure and inorganic fertilizers and storage in Grass are presented in Table 4. 23**.** In the minor season (2011), Apomuden grown on 15-30-30 kg/ha NPK+ 5t/ha CM had the highest percentage pest infested tubers (32.4%) for the first 4 weeks in Grass storage followed by 15-15-15kg/ha NPK+5t/ha CM treatrment (22.4%) with zero pest infestation recorded by 30-45-45 kg/ha NPK. There were significant differences in variety x fertilizer interaction in percentage pests infested tubers under grass storage and for amended and unamended plots (Table 4.23a). There was no significant difference between Apomuden and Okumkom stored in grass in percentage pest infestion at 12 WAS.There was a significantdifference in variety x fertilizer interaction in percentage pests infested tubers at 12 WAS in grass storage (Table 4. 23a).

In the major season (2012), application of amended and unamended treatments to Apomuden and Okumkom and storage in grass for the first 2 weeks recorded zero values for pest infestation in the tubers (Table. 4.23b). Application of 10t/ha CM, 30-30-30 kg/ha NPK and 30-45-45 kg/ha NPK to Apomuden produced the highest percentage pest infested tubers (20.7%) for the first 6 WAS in grass storage with other amended and unamended tubers recording zero values pest infestation for the same period. However, 15-15-15kg/ha NPK +5t/ha CM treated tubers recorded the highest percentage pest infested tubers followed by 15-23-23 kg/ha NPK +5t/ha CM, 15-30-30kg/ha NPK+5t/ha CM and tubers from unamended treatment with the lowest recorded by tubers produced on the other amendment treatments for the first 6 WAS in grass storage (Table. 4.23b). Similarly, Apomuden treated with 15-23-23 kg/ha NPK +5t/ha CM had the highest percentage pest infested tubers (60.0%) with the lowest recorded by 30-45-45 kg/ha NPK (20.7%) at 12 WAS in grass storage. However, tubers of Okumkom from all amended treatments had the highest and the same percentage pest infested tubers (69.2%) except 15-23-23kg/ha NPK +5t/ha CM and 15-30-30kg/ha NPK +5t/ha CM treated tubers which recorded the lowest (52.2%) at 12 WAS in grass storage. There was significant difference in variety x fertilizer interaction in percentage pests infested tubers at 12 WAS in grass storage (Table. 4.23b).

4.6.1.3 Percentage Pest Infested Tubers in Pit Storage During the Minor and Major Seasons

The percentage pest infested tubers of two varieties of sweetpotato under chicken manure and inorganic fertilizers or storage in pit is presented in Table. 4.24**.** In the minor season (2011), Apomuden raised on the control plot produced the highest (22.4%) percent pest infested tubers followed by 30-45-45 kg/ha NPK and 30-60-60 kg/ha NPK (22.3%) which differed significantly from other amended tubers in percentage pest infested tubers for the first 4 WAS in pit storage (Table 4.24a). In the case of Okumkom tubers raised on unamended plot had the highest pest infested tubers (32.5%) and differed significantly from tubers from all the amended plots for the first 4 weeks in pit storage. Application of 15-30-30 kg/ha NPK +5t/ha CM or 15-23-23kg/ha NPK+5tlha CM to Apomuden differed significantly from other amended and the control raised tubers for the first 8 WAS in pti storage . However, Okumkom raised on control plot had the highest pest infested tubers (40.59%) and differed significantly from the amended plots raised tubers for the first 8 WAS in pit (Table 4.24a).

Table 4.23a: Percentage Pest Infested Tubers In Grass Storage During The 2011Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	0.0	0.0	10.3	22.4	22.4	22.4	22.4	22.3	22.3	32.3	40.4	36.4	32.4	40.5	36.5
T 2	0.0	0.0	0.0	0.0	0.0	0.0	32.4	0.0	16.2	32.4	0.0	16.2	32.4	22.5	27.4	32.2	22.4	27.3
T 3	0.0	0.0	0.0	0.0	0.0	0.0	22.4	22.4	22.4	32.5	22.3	27.4	32.4	49.2	40.8	32.4	49.3	40.9
T 4	0.0	0.0	0.0	22.4	0.0	10.3	22.4	0.0	11.2	32.5	22.3	27.4	40.4	32.4	36.4	40.5	32.4	36.4
T 5	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0	32.4	22.2	27.3	32.3	32.4	32.4	32.3	32.3	32.3
T 6	0.0	0.0	0.0	0.0	0.0	15.0	22.4	0.0	11.2	32.3	32.4	32.3	40.4	32.3	36.4	40.5	32.4	36.5
T 7	0.0	0.0	0.0	0.0	0.0	10.3	22.3	22.4	22.3	22.3	32.3	27.3	40.4	49.2	44.8	40.5	49.3	44.9
T 8	32.5	0.0	16.2	32.4	0.0	25.3	32.4	22.3	27.4	32.4	22.4	27.4	32.3	22.4	27.3	32.4	22.3	27.3
Mean	4.0	0.0		6.8	0.0		22.1	11.2		29.9	22.0		35.4	35.1		35.4	35.1	
LSD (P = 0.05); Variety =	0.10			0.20			0.40			0.60			NS			NS		
Fertilizer =	0.30			0.40			0.90			1.30			1.20			1.60		
Variety x Fertilizer =	0.50			0.60			1.30			1.90			1.80			2.30		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Table 4.23b: Percentage Pest Infested Tubers In Grass Storage During The 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.7	10.3	37.7	52.2	44.9	37.7	60.0	48.8	45.0	60.0	52.5
T 2	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	37.7	69.2	53.4	37.7	69.2	53.4	52.2	69.2	60.7
T 3	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	30.0	60.0	45.0	30.0	69.2	49.6	37.7	69.2	53.4
T 4	0.0	0.0	0.0	0.0	45.0	22.5	0.0	45.0	22.5	37.7	60.0	48.8	37.7	69.2	53.4	37.7	69.2	53.4
T 5	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	20.7	60.0	40.3	20.7	60.0	40.3	20.7	69.2	44.9
T 6	0.0	0.0	0.0	0.0	20.7	10.3	0.0	20.7	10.3	52.2	52.2	52.2	52.2	52.2	52.2	60.0	52.2	56.1
T 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	60.0	45.0	37.7	69.2	53.4	37.7	69.2	53.4
T 8	0.0	0.0	0.0	0.0	20.7	10.3	0.0	20.7	10.3	37.7	52.2	44.9	37.7	52.2	44.9	52.2	52.2	52.2
Mean	0.0	0.0		7.7	10.8		7.7	13.3		35.4	58.2		36.4	62.6		42.9	63.8	
LSD (P = 0.05); Variety =	0.0			0.37			0.40			0.60			0.59			0.60		
Fertilizer =	0.0			0.71			0.80			1.21			1.17			1.21		
Variety x Fertilizer =	0.0			1.05			1.13			1.72			1.66			1.72		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Apomuden grown on 15-30-30 kg/ha NPK + 5t/ha CM had the highest percentage pest infested tubers (49.3%) and differed significantly from the control treatment raised tubers at 12 WAS. Similarly, Apomuden raised on amended plots gave higher percentage pest infested tubers than Okumkom at 12 WAS in pit storage (Table. 4.24a).

In the major season (2012), application of 10t/ha CM 15-15-15 kg/ha NPK+5t/ha CM to Apomuden differed significantly from tubers from all the other amended and the control tubers in pest infested tubers for the first 4 WAS (Table 4.24b). Okumkom raised on 15-15-15 kg/ha NPK+5t/ha CM or 15-30-30 kg/ha NPK+5t/ha CM had the highest percentage pest infested tubers (45.0%) and differed significantly from the other amended and the control tubers in pest infested tubers at the first 4 WAS in pit (Table. 4.12b). At 6 weeks after pit storage, application of the treatments namely 10t/ha CM, 15-15-15 kg/ha NPK+5t/ha CM and 15-23-23 kg/ha NPK+5t/ha CM to Apomuden had the same mean percent infestation as which was the highest percentage pest infested tubers (52.2%) with the least recorded by control raised tubers. Amended tubers of Apomuden differed significantly from control tubers in percentage pest infested tubers at 6 WAS. However, application of 15-15-15kg/ha NPK+5t/ha CM or 30-45-45kg/ha NPK to Okumkom produced the highest percentage pest infested tubers at the first 6 WAS in pit storage with zero values pest infestation recorded by 10t/ha CM and 15-23-23kg/ha NPK+5t/ha CM treated tubers. Application of 15-30-30kg/ha NPK+5t/ha CM to both Apomuden and Okumkom resulted in the same percentage pests infested tubers at 6 WAS under pit storage (Table. 4.24b).Application of 15-23-23 kg/ha NPK+5t/ha CM to Apomuden produced the highest percentage pest infested tubers (69.2%) with the lowest recorded by 30-60-60 kg/ha NPK, 15-30-30 kg/ha NPK+5t/ha CM and control raised tubers at 12 WAS in pit storage. However, 30-45-45 kg/ha NPK raised tubers of Okumkom recorded the highest percentage pest infested tubers (69.2%) followed by 15-15-15kg/ha NPK+5t/ha CM treated tubers (60.0%) with zero values infestation recorded by 10t/ha CM and 15-23-23 kg/ha NPK+5t/ha CM treated tubers at 12 WAS in pit storage. There was significant difference in variety x fertilizer interaction in percentage pest infested tubers at 12 WAS in pit storage (Table. 4.24b). Generally, Apomuden and Okumkom grown on amended and control plots in the major season (2012) and stored under the three storage conditions (Ash, Grass and Pit) had substantially higher percentage pest infested tubers at 12 WAS than plants grown during the minor season in 2011 for both varieties and stored under similar conditions. In both seasons, Okumkom treated with 10t/ha CM and stored in pit had the lowest percentage pest infested tubers at 12 WAS. Generally, Apomuden grown under soil amendment and stored in pit had the highest percentage pest infested tubers followed by ash storage with the leastpercent infestation recorded by grass storage at 12 WAS in both seasons (Tables. 4.24a and 4.24b).

4.6.2.1 Percentage Shrinkage in Tubers Stored in Ash During The Minor And Major Seasons

Table 4.25 shows percentage shrinkage in tubers of two sweetpotato varieties stored for 12 weeks in Ash. In the minor season (2011), Apomuden treated with 10t/ha CM had the highest percentage shrinkage in tubers (32.5%) followed by the control and 30-30-30 kg/ha NPK tubers (32.4%) for the first 4 weeks in ash storage with the least recorded by 15-23-23 kg/ha NPK+ 5t/ha CM and 30-60-60 kg/ha NPK treated tubers with zero value percent shrinkage (Table 4.25a).

Table 4.24a: Percentage Pest Infested Tubers in Pit Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	22.4	32.5	27.4	32.5	32.4	32.4	32.4	40.5	36.5	32.4	40.4	36.4	32.4	40.5	36.4
T 2	0.0	0.0	0.0	0.0	0.0	0.0	32.5	0.0	16.1	32.3	0.0	16.1	32.3	22.4	27.3	32.4	22.3	27.3
T 3	0.0	0.0	0.0	0.0	0.0	0.0	21.9	0.0	10.9	22.4	22.6	22.5	22.4	32.5	27.5	22.4	32.5	27.4
T 4	0.0	0.0	0.0	0.0	0.0	0.0	22.4	22.2	22.3	32.3	32.4	32.4	57.4	32.3	44.8	57.4	32.4	44.9
T 5	0.0	0.0	0.0	22.3	22.4	22.3	32.4	22.2	27.3	32.4	32.4	32.4	40.5	32.3	36.4	40.4	32.2	36.3
T 6	0.0	0.0	0.0	0.0	0.0	0.0	22.4	22.3	22.3	40.4	22.4	31.4	40.5	40.5	40.5	40.4	40.5	40.4
T 7	22.5	0.0	11.2	22.3	22.5	22.4	22.3	22.3	22.3	32.4	32.4	32.4	40.4	32.5	36.4	40.5	32.3	36.4
T 8	0.0	0.0	0.0	0.0	0.0	0.0	32.3	22.5	27.4	40.4	22.4	31.4	49.3	32.4	40.8	49.3	32.4	40.8
Mean	2.8	0.0		8.3	9.6		27.3	18.0		33.1	25.6		39.4	33.2		39.4	33.1	
LSD (P =0.05); Variety =	0.09			0.30			0.60			0.60			0.50			0.50		
Fertilizer =	0.18			0.70			1.30			1.30			1.00			1.10		
Variety x Fertilizer =	0.25			1.00			1.90			1.90			1.40			1.60		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Table 4.24b: Percentage Pest Infested Tubers in Pit Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	30.0	20.7	25.3	30.0	20.7	25.3	37.7	45.0	41.3	37.7	45.0	41.3	45.0	45.0	45.0	45.0	45.0	45.0
T 2	45.0	0.0	22.5	52.2	0.0	26.1	52.2	0.0	26.1	52.2	0.0	26.1	52.2	0.0	26.1	52.2	0.0	26.1
T 3	30.0	0.0	15.0	37.7	0.0	18.8	45.0	37.7	41.3	45.0	37.7	41.3	60.0	45.0	52.5	60.0	45.0	52.5
T 4	45.0	20.7	32.8	52.2	45.0	48.6	52.2	60.0	56.1	52.2	60.0	56.1	52.1	60.0	56.0	52.1	60.0	56.0
T 5	37.7	30.0	33.8	37.7	37.7	37.7	45.0	60.0	52.5	45.0	60.0	52.5	52.2	69.2	60.7	52.2	69.2	60.7
T 6	30.0	0.0	15.0	30.0	0.0	15.0	52.2	0.0	26.1	52.2	0.0	26.1	69.2	0.0	34.6	69.2	0.0	34.6
T 7	37.7	30.0	33.8	45.0	30.0	37.5	45.0	37.7	41.3	45.0	37.7	41.3	45.0	52.2	48.6	45.0	52.2	48.6
T 8	37.7	37.0	37.3	37.7	45.0	41.3	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Mean	36.6	17.3		40.3	22.3		46.7	35.6		46.7	35.6		52.6	39.5		52.6	39.5	
LSD (P =0.05); Variety =	0.52			0.54			0.48			0.48			0.56			0.56		
Fertilizer =	1.05			1.09			0.96			0.96			1.12			1.12		
Variety x Fertilizer =	1.49			1.54			1.36			1.36			1.59			1.59		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/ha CM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Okumkom on control plot gave the highest percentage shrinkage in tubers (49.3%) in ash storage and the least recorded by 30-30-30 kg/ha NPK treated tubers for the first 4 weeks in ash storage. In the case of Apomuden under 30-60-60 kg/ha NPK treated tubers recorded had the highest percentage shrinkage (49.3%) while the least was recorded by 15-30-30 kg/ha NPK +5t/ha CM tubers at 12 weeks storage in ash. However, at 12 WAS the control raised tubers of Okumkom had the highest percentage shrinkage was tubers (67.3%) and the least.shrinkage recorded by 15-15-15 kg/ha NPK +5t/ha CM (49.1%). There was a significant difference in variety x fertilizer interaction in percentage shrinkage tuber in ash storage at 12 WAS (Table.4.25a).

In the major season (2012), 30-30-30 kg/ha NPK and the control raised tubers of Apomuden gave the highest percentage shrinkage in tubers (30.0%) at the first 4 weeks in ash storage with the least recorded by all other amended plots (20.7%) except 15-15-15 kg/ha NPK+5t/ha CM and 15-23-23 kg/ha NPK +5t/ha CM tubers which recorded zero values percent tuber shrinkage (Table 4.25b). At 8 weeks in ash storage, Apomuden raised on amended plots had the highest and the same percentage shrinkage in tubers (30.0%) except 15-15-15 kg/ha NPK +5t/ha CM and the control which recorded the same and the least percent shrinkage (20.7%). Similarly, Okumkom raised on 15-15-15 kg/ha NPK+5t/ha CM and 15-30-30 kg/ha NPK+5t/ha CM treatments had the highest percentage tuber shrinkage at the first 8 weeks in ash storage with the least recorded bytubers from all the other amended treatments except 30-45-45 kg/ha NPK and the control plots which recorded zero value tuber shrinkage. Application of 10t/ha CM, 15-15-15 kg/ha NPK+5t/ha CM and 15-30-30 kg/ha NPK+5t/ha CM to Apomuden showed the highest percentage shrinkage in tubers (45.0%) at 12 weeks in ash storage with the lowest recorded by 30-60-60 kg/ha NPK and 30-30-30 kg/ha NPK plots (30.0%). Similarly, application of 10t/ha CM to Okumkom produced the highest percentage shrinkage in tubers (69.3%) followed by 15-15-15 kg/ha NPK+5t/ha CM and the control raised tubers with (60.0%) shrinkage ant the lowest recorded by 30-45-45 kg/ha NPK raised tubers (37.7%) at 12 weeks in ash storage. Application of 30-45-45 kg/ha NPK to Apomuden and Okumkom produced the same and lowest percentage tuber shrinkage at 12 weeks in ash storage (37.7%). There was significant difference in variety x fertilizer interaction in percentage tuber shrinkage at 12 weeks in ash storage (Table 4.25b).

4.6.2.2 Percentage Shrinkage Tubers in Grass storage

Table 4.26 shows percentage shrinkage in tubers of two sweetpotato varieties as influenced by chicken manure and inorganic fertilizersa nd storage for 12 weeks in grass. In the minor season (2011), Apomuden raised on15-30-30 kg/ha NPK +5t/ha had the highest percentage shrinkage in tuber (32.5%) and differed from other amended tubers except 30-60-60 kg/ha NPK and the control tubers for the first 4 weeks in grass storage (Table 4.26a). Okumkom raised on 30-45-45 kg/haNPK had the highest percentage shrinkage of tubers (47.2%) and differed significantly from all the amended and the control treated tubers for the first 4 weeks in grass storage. At 12 WAS Apomuden raised on 30-60-60kg/ha NPK had the highest percentage shrinkage in tubers (49.3%) with the lowest recorded by 30-30-30kg/ha NPK plot (32.4%) in grass storage. Okumkom raised on 10t/ha CM had the highest percentage shrinkage in tubers (57.4%) and differed significantly from other amended tubers except 30 60-60 kg/ha NPK and the control tubers in percentage shrinkage at 12 WAS.

Table 4.25a: Percentage Shrinkage Tubers in Ash Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	32.2	40.4	36.3	32.4	49.3	40.8	40.4	57.3	48.8	40.4	67.3	53.9	40.5	67.3	53.9	40.4	67.3	53.9
T 2	22.4	32.3	27.3	32.5	40.4	36.4	32.2	57.3	44.8	32.5	57.4	44.9	32.2	57.5	44.8	32.4	57.3	44.8
T 3	22.4	0.0	11.2	32.4	0.0	16.2	32.2	40.6	36.4	40.3	57.3	48.8	40.4	57.3	48.9	40.4	57.3	48.9
T 4	0.0	32.4	16.2	0.0	40.5	20.2	32.4	49.3	40.8	32.3	49.2	40.7	32.3	49.3	40.8	32.2	49.1	40.7
T 5	0.0	0.0	0.0	22.4	22.4	22.4	22.2	32.5	27.3	32.3	40.4	36.4	41.5	49.3	45.4	40.4	49.3	44.9
T 6	0.0	0.0	0.0	0.0	22.4	11.2	22.2	49.2	35.7	22.4	40.5	31.5	32.2	57.3	44.7	32.2	57.4	44.8
T 7	0.0	0.0	0.0	0.0	22.4	11.2	22.2	32.4	27.3	40.5	40.4	40.4	49.1	57.4	53.2	49.3	57.4	53.3
T 8	0.0	22.3	11.1	0.0	40.6	20.3	0.0	40.4	20.2	22.3	49.2	35.7	22.2	49.4	35.8	22.4	49.2	35.8
Mean	9.6	15.9		14.9	29.7		25.5	44.9		32.9	50.2		36.3	55.6		36.2	55.6	
LSD (P = 0.05); Variety =	0.40			0.40			0.40			0.50			0.50			0.70		
Fertilizer =	0.80			0.80			0.90			1.10			1.10			1.40		
Variety x Fertilizer =	1.20			1.20			1.30			1.50			1.60			2.00		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Table 4.25b: Percentage Shrinkage Tubers in Ash Storage During ihe 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	30.0	0.0	15.0	30.0	0.0	15.0	37.7	20.7	29.2	37.7	60.0	48.8	37.7	60.0	48.8
T 2	0.0	0.0	0.0	20.7	0.0	10.3	30.0	0.0	15.0	30.0	20.7	25.3	45.0	69.2	57.1	45.0	69.3	57.1
T 3	0.0	0.0	0.0	30.0	0.0	15.0	30.0	20.7	25.3	30.0	20.7	25.3	30.0	52.2	41.1	30.0	52.2	41.1
T 4	0.0	0.0	0.0	0.0	0.0	0.0	20.4	20.7	20.6	20.7	30.0	25.3	45.0	60.0	52.5	45.0	60.0	52.5
T 5	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	30.0	0.0	15.0	37.7	37.7	37.7	37.7	37.7	37.7
T 6	0.0	0.0	0.0	0.0	20.7	10.3	30.0	20.7	25.3	30.0	20.7	25.3	37.7	52.2	45.0	37.7	52.3	45.0
T 7	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	30.0	20.7	25.3	30.0	52.2	41.1	30.0	52.2	41.1
T 8	0.0	0.0	0.0	20.7	30.0	25.3	20.7	30.0	25.3	30.0	30.0	30.0	45.0	52.2	48.6	45.0	52.2	48.6
Mean	0.0	0.0		17.8	6.3		25.3	11.5		29.8	20.4		38.5	54.4		38.5	544	
LSD (P = 0.05); Variety =	0.0			0.42			0.56			0.56			0.59			0.60		
Fertilizer =	0.0			0.85			1.13			1.13			1.18			1.21		
Variety x Fertilizer =	0.0			1.20			1.59			1.59			1.68			1.71		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/ha CM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Apomuden and Okumkom raised on amended and the control plots differed significantly in variety x fertilizer interaction in percentage tuber shrinkage at 12 weeks in grass storage (Table 4.26a).

In the major season (2012), Apomuden raised on 30-60-60 kg/ha NPK differed significantly from the other amended and the control plots in percentage tuber shrinkage during the first 4 weeks (Table 4.26b). Okumkom raised on 15-23-23kg/ha NPK + 5t/ha CM, 15- 30-30 kg/ha NPK +5t/ha CM and the control plots had the highest (20.7%) and the same percentage shrinkage in tuber in tuber and differed significantly from the other amended tubers at 6 weeks in grass storage.. Apomuden raised on 30-60-60kg/ha NPK had the highest percentage tuber shrinkage (37.7%) with the least recorded by 30-30-30kg/ha NPK, 30-45-45 kg/ha NPK and 15-30-30 kg/ha NPK +5t/ha CM treated tubers (20.7%). However, unamended tubers of Okumkom had the highest percentage tuber shrinkage (30.0%) with the least recorded by 15-23-23kg/ha NPK +5t/ha CM and 15-30-30kg/ha NPK+5t/ha CM and 15-30-30kg/ha NPK+5t/ha CM raised tubers at 6 weeks in grass storage. All other amended treated tubers however recorded zero values for tuber shrinkage at the same period (Table.4.26b). Application of 15-23-23 kg/ha NPK +5t/ha CM to Apomuden produced the highest percentage in tuber shrinkage (52.2%) followed by 15-30-30 kg/ha NPK +5t/ha CM tuber (45.0%) at 12 weeks in grass storage with the least recorded by 30-30-30 kg/ha NPK raised tubers (30.0%). Similarly, at 12 weeks in grass storage application of 10t/ha CM, 30-30-30 kg/haNPK and 30-60-60 kg/ha NPK to Okumkom recorded the highest percentage in tuber shrinkage (69.0%) followed by 15-15-15 kg/ha NPK+5t/ha CM raised tuber with the lowest recorded by 15-23-23 kg/ha NPK+ 5t/ha raised tubers (52.2%). Apomuden and Okumkom raised on amended and the control plots differed significantly in variety x fertilizer interaction for percentage tuber shrinkage at 12 weeks in grass storage (Table 4.26b). Generally, Okumkom raised on amended and the control plots produced higher percentage tuber shrinkage than Apomuden at 12 WAS in grass storage in both seasons. Similarly, in both seasons application of 10t/ha CM to Okumkom had the highest percentage in tuber shrinkage at 12 weeks in grass storage. However, application of 30-30-30 kg/ha NPK to Apomuden showed the lowest percentage in tuber shrinkage at 12 weeks in grass storage for both seasons (Tables 4.26a and 4.26b).

4.6.2.3 Percentage Shrinkage in Tubers In Pit Storage

Table 4.27 shows percentage shrinkage tubers of two sweetpotato varieties as influenced by chicken manure and inorganic fertilizers and storage for 12 weeks in pit. In the minor season (2011), Apomuden tubers raised on30-45-45 kg/ha NPK differed significantly from all the amended tubers except 10t/ha CM and 30-30-30kg/ha NPK in percentage shrinkage in tubers (32.5%) for the first 4 weeks in pit storage (Table 4.27a). Okumkom raised on control plot had the highest percentage shrinkage in tubers (40.5%) and differed significantly from amended tubers in percentage shrinkage in tuber for the first 4 weeks in pit storage. Apomuden raised on 30-30-30 kg/ha NPK and 30-45-45 kg/ha NPK which had the highest and the same percentage shrinkage tubers (49.3%) differed significantly from the control in percentage shrinkage in tuber at 12 weeks in pit storage. Okumkom raised on 30-60-60 kg/haNPK differed significantly from all the other amended and control tubers at 12 weeks in pit storage. There was significant difference in variety x fertilizer in percentage shrinkage in tuber (Table 4.27a). In the major season (2012), Apomuden raised on 30-45-45 kg/ha NPK and 30-60-60 kg/ha NPK plots.

Table 4.26a: Percentage Shrinkage in Tubers under Grass Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	22.4	11.2	32.3	32.4	32.3	32.3	40.6	36.4	40.5	40.4	40.4	40.4	49.2	44.8	40.4	49.4	44.9
T 2	0.0	32.5	16.2	22.3	32.2	27.2	22.3	40.6	31.4	40.4	40.4	40.4	40.4	57.3	48.8	40.5	57.4	49.0
T 3	0.0	22.4	11.2	0.0	42.5	21.2	32.3	49.2	40.8	32.4	49.6	41.0	32.3	49.2	40.8	32.4	49.3	40.8
T 4	0.0	22.3	11.1	22.3	40.5	31.4	32.33	40.5	36.4	40.5	57.3	48.9	40.5	57.3	48.9	40.5	57.3	48.9
T 5	0.0	0.0	0.0	22.4	47.2	34.8	32.3	49.3	40.8	32.2	32.4	32.3	40.3	32.2	36.3	40.4	32.4	36.4
T 6	0.0	0.0	0.0	22.5	0.0	11.2	22.3	32.2	27.2	40.6	32.4	36.5	40.4	49.4	44.9	40.5	49.2	44.9
T 7	22.4	22.2	22.3	32.4	40.6	36.5	32.4	49.2	40.8	40.5	49.3	44.9	49.4	57.5	53.4	49.3	57.3	53.3
T 8	0.0	22.4	11.2	32.5	32.3	32.4	32.3	32.5	32.4	40.4	40.4	36.4	40.4	40.5	40.5	40.4	40.6	40.5
Mean	2.8	18.0		23.3	33.5		29.8	41.7		37.4	42.8		40.5	49.1		40.5	49.1	
LSD (P =0.05); Variety =	0.30			0.90			0.60			0.50			0.70			0.70		
Fertilizer =	0.70			1.90			0.30			1.10			1.40			1.40		
Variety x Fertilizer =	1.00			2.70			1.80			1.60			2.00			2.00		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/ha CM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Table 4.26b: Percentage Shrinkage in Tubers under Grass Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	20.7	0.0	10.3	30.0	20.7	25.3	30.0	30.0	30.0	37.7	30.0	33.8	37.7	60.0	48.8	37.7	60.0	48.8
T 2	20.7	0.0	10.3	30.0	0.0	15.0	30.0	0.0	15.0	37.7	0.0	18.8	37.7	69.2	53.4	37.7	69.3	53.5
T 3	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	23.8	0.0	11.9	30.0	69.2	49.6	30.0	69.3	49.6
T 4	20.7	0.0	10.3	30.0	0.0	15.0	30.0	0.0	15.0	37.7	20.7	29.2	37.7	69.2	53.4	37.7	69.2	53.5
T 5	20.7	0.0	10.3	20.7	0.0	10.3	20.7	0.0	10.3	20.7	20.7	20.7	37.7	60.0	48.8	37.7	60.0	48.8
T 6	20.7	0.0	10.3	30.0	20.7	25.3	30.0	20.7	25.3	37.7	37.7	37.7	52.2	52.2	52.2	52.2	52.2	52.2
T 7	30.0	0.0	15.0	37.7	0.0	18.8	37.7	0.0	18.8	37.7	30.0	33.8	37.7	69.2	53.5	37.8	69.3	53.5
T 8	20.7	0.0	10.3	20.7	20.7	20.7	20.7	20.7	20.7	30.0	30.0	30.0	45.0	60.0	52.5	45.0	60.0	52.5
Mean	19.2	0.0		27.4	7.7		27.5	8.93		32.9	21.1		39.5	63.6		39.5	63.6	
LSD (P = 0.05); Variety =	0.38			0.47			0.42			0.94			0.60			0.60		
Fertilizer =	0.76			0.94			1.84			1.88			1.21			1.20		
Variety x Fertilizer =	1.08			1.33			1.19			2.67			1.71			1.70		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/ha CM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

This had the highest and the same percentage shrinkage in tuber (30.0%) differed significantly from the other amended and the control tubers for the first 4 weeks in pit storage (Table 4.27b). Okumkom raised on 30-60-60 kg/ha NPK differed significantly from other amended and the control tubers in percentage tuber shrinkage for the first 4 weeks in pit storage. Application of 30-45-45 kg/ha NPK to Apomuden tubers differed significantly from other amended and unamended Apomuden tubers in percentage shrinkage at 12 weeks in pit storage. Similarly, Okumkom raised on 30-60-60 kg/ha NPK differed significantly from other amended and unamended tubers in percentage tuber shrinkage at 12 weeks in pit storage with 15-23-23 kg/ha NPK+5t/ha CM treated tubers recording no mean value for the same period. There was a significant difference in variety x fertilizer interaction for percentage tuber shrinkage at 12 WAS in pit (Table.4.27b).

Generally, Apomuden and Okumkom raised on amended and unamended plots during the minor season and stored in pit or grass had higher percentage tuber shrinkage than tubers stored under the same conditions in the major season after 12 weeks in storage (Tables 4.26 and 4.27). However, application of 30-60-60 kg/ha NPK to Apomuden during the minor season and storage in ash and grass produced higher and same percentage tuber shrinkage (49.3 %) at 12 weeks in storage (Tables 4.4.25a and 4.26a). Apomuden raised on amended and unamended plots and stored in grass and ash had higher percentage shrinkage than in pit storage. In the major season, Application of 30-30-30 kg/ha NPK to Apomuden and storage in pit, ash or grass recorded the lowest percentage tubers shrinkage at 12 weeks in storage. However, application of 10t/ha CM to Okumkom during the major season and storage in grass and ash had higher percentage tuber shrinkage and same percent shrinkage in tuber (69.3%) at 12 weeks in storage (Tables .4.25. 4.26 and 4.27).

Table 4.27a: Percentage Shrinkage Tubers in Pit Storage During the 2011Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	32.4	0.0	16.2	32.4	40.5	36.5	32.3	40.5	36.4	32.3	40.5	36.4	40.5	57.3	48.9	40.4	57.3	48.9
T 2	22.3	0.0	11.1	32.4	22.5	27.4	32.3	22.3	27.3	32.4	22.4	27.4	49.3	40.4	44.9	49.2	40.6	44.9
T 3	32.4	0.0	16.2	32.3	21.9	27.1	32.4	22.4	27.4	32.2	22.4	27.3	49.1	57.5	53.3	49.3	57.3	53.3
T 4	0.0	0.0	0.0	22.4	0.0	11.2	22.2	0.0	11.1	22.4	0.0	11.2	49.2	40.5	44.9	49.2	40.5	44.8
T 5	22.4	0.0	11.2	32.5	22.4	27.4	32.4	32.4	32.4	32.4	32.4	32.4	49.4	49.2	49.3	49.3	49.3	49.3
T 6	22.3	0.0	11.1	22.3	0.0	11.1	22.3	0.0	11.1	22.3	22.3	22.3	32.3	32.2	32.3	32.4	32.4	32.4
T 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.4	67.4	44.9	22.3	67.4	44.9
T 8	22.3	0.0	11.1	22.4	0.0	11.2	0.0	22.4	11.2	22.4	32.4	27.4	22.4	40.6	31.5	22.3	40.6	31.4
Mean	19.2	0.0		24.6	13.4		24.5	14.7		24.5	21.5		39.3	48.1		39.3	48.2	
LSD (P = 0.05); Variety =	0.40			0.40			0.50			0.60			0.40			0.70		
Fertilizer =	0.80			0.90			1.10			1.20			1.90			1.40		
Variety x Fertilizer =	1.10			1.30			1.60			1.70			1.30			2.00		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/ha CM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Table 4.27b: Percentage Shrinkage Tubers in Pit Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	0.0	20.7	10.3	20.7	20.7	20.7	20.7	30.0	25.3	20.7	37.7	29.2	20.7	45.0	32.8
T 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.7	20.7	20.7	20.7	20.7	20.7	30.0	20.7	25.3
T 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.7	10.3	20.7	20.7	20.7
T 4	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	30.0	20.7	25.3	37.7	20.7	29.2	37.7	20.7	29.2
T 5	0.0	0.0	0.0	30.0	20.7	25.3	30.0	20.7	25.3	37.7	20.7	29.2	45.0	30.0	37.5	45.0	30.0	37.5
T 6	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	20.7	0.0	10.3	30.0	0.0	15.0	30.0	0.0	15.0
T 7	0.0	20.7	10.3	30.0	30.0	30.0	30.0	37.7	33.8	30.0	45.0	37.5	30.0	60.0	45.0	30.0	60.0	45.0
T 8	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	20.7	20.7	20.7	20.7	30.0	25.3	23.8	30.0	26.9
Mean	0.0	2.5		15.2	8.9		17.8	9.9		22.5	19.7		25.6	27.4		29.7	28.4	
LSD (P = 0.05); Variety =	0.14			0.41			0.44			0.55			0.51			0.96		
Fertilizer =	0.28			0.83			0.88			1.10			1.03			1.93		
Variety x Fertilizer =	0.39			1.18			1.24			1.58			1.46			2.73		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/ha CM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

4.6.3.0 Percentage Rotten Tubers of Sweetpotato in Ash, Grass and Pit Storage during the Minor and the Major Seasons

4.6.3.1 Percentage Rotten TubersIn Ash Storage

Table 4.28 shows percentage shrinkage tubers of two sweetpotato varieties as influenced by chicken manure and inorganic fertilizers and stored in ash for 12 weeks. In the minor season (2011), Apomuden and Okumkom raised on amended and unamended plots and stored in ash recorded zero values percent rotten tubers for the first 2 weeks in storage. Application of 30-30-30 kg/ha NPK to Apomuden which had the highest percentage rotten tubers (49.3%) differed significantly from other amended and unamended plots for the first 6 weeks in ash storage. However, application of 30-45-45 kg/ha NPK, 15-23-23 kg/ha NPK, +5t/ha CM and 30-60-60 kg/ha NPK, treatments to Okumkom produced the highest percentage rotten tubers (32.4%) while the the control recorded zero values percent rotten tubers at 6 weeks in ash storage (Table 4.28a).

Application of 30-45-45 kg/ha NPK to Apomuden which had the highest percentage rotten tubers (67.5%) differed significantly from other amended and unamended Apomuden tubers at 12 weeks in ash storage. Similarly Okumkom under 30-45-45 kg/ha NPK had the highest percentage rotten tubers (49.4%) while the least was recorded by 15-30-30 kg/ha NPK+5t/ha CM treated tubers (22.3%) in percentage rotten tubers at 12 weeks in ash storage (Table 4.28a).

In the major season (2012), application of 30-60-60 kg/ha NPK to Apomuden had the highest percentage rotten tubers (37.7%) for the first 4 weeks in ash storage with no mean values percent trotten tubers recorded by 10t/ha CM, 30-30-30 kg/ha NPK and 30-45-45 kg/ha NPK treated tubers (Table 4 28b). However, application of 15-23-23 kg/ha NPK+5t/ha CM and 15-30-30 kg/ha NPK+5t/ha CM to Okumkom tubers recorded the highest percentage rotten tubers (20.7%) for the first 4 weeks in storage with other amended and control treated tubers recording zero values rotten tubers during the same period in ash storage. Application of 30-60-60 kg/ha NPK to Apomuden produced the highest percentage rotten tubers (69.2%) with the lowest recorded by 15-23-23 kg/ha NPK +5t/ha CM treated tubers (20.8%) for the first 8 weeks in ash storage. A significant difference in percentage rotten tubers was observed between amended and unamended Apomuden tubers at 8 weeks in ash storage. Application of 15-23-23 kg/ha NPK +5t/ha CM and 15-30-30 kg/ha NPK+ 5t/ha CM to Okumkom showed the highest percentage rotten tubers (37.7%) followed by 30-30-30 kg/ha NPK, 30-45-45 kg/ha NPK and unamended treated tubers which had the same percent rotten tubers (20.7%) at 8 weeks in ash storage. The other amended tubers of Okumkom recorded zero values percent rotten tubers for the same period in ash storage (Table. 4.28b).

Application of inorganic fertilizers and organic manure either alone or in combination except 15-23-23 kg/ha NPK +5t/ha CM and 10t/ha CM and the unamended tubers of Apomuden recorded the highest percentage rotten tubers (90.0%) with the least recorded by 15-23-23 kg/ha NPK +5t/ha CM treated tubers (52.2%) at 12 weeks in ash storage. Similarly, application of organic manure and inorganic fertilizers either alone or in combination except 15-15-15 kg/ha NPK +5t/ha CM and the unamended tubers of Okumkom had the highest percentage rotten tubers (90.0%) with the least recorded by 30-45-45 kg/ha NPK and 30-60-60 kg/ha NPK treated tubers (52.2%) at 12 weeks in ash storage (Table 4. 28b).

Table 4.28a: Percentage RottenTubers in Ash Storage Duing the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	22.3	0.0	11.1	32.3	0.0	16.1	32.2	22.3	27.3	40.6	22.3	31.5	40.7	22.4	31.6
T 2	0.0	0.0	0.0	32.3	0.0	16.1	32.5	22.3	27.4	32.3	22.3	27.3	32.4	32.3	32.4	32.1	32.2	32.2
T 3	0.0	0.0	0.0	32.2	0.0	16.1	49.3	22.4	35.8	49.2	22.3	35.8	49.3	40.4	44.9	49.1	40.4	44.8
T 4	0.0	0.0	0.0	32.2	22.2	27.2	32.3	22.3	27.3	49.1	22.4	35.7	57.5	22.2	39.9	57.3	22.5	39.9
T 5	0.0	0.0	0.0	0.0	22.4	11.2	22.3	32.4	27.4	40.3	32.3	36.3	67.5	49.3	58.4	67.5	49.4	58.4
T 6	0.0	0.0	0.0	40.5	0.0	20.2	22.3	32.4	27.4	22.3	32.4	27.3	22.2	40.5	31.3	22.3	40.6	31.4
T 7	0.0	0.0	0.0	22.3	0.0	11.1	32.3	32.4	32.4	40.6	32.3	36.4	40.4	49.3	44.8	40.5	49.3	44.9
T 8	0.0	0.0	0.0	0.0	22.4	11.2	40.6	22.3	31.4	49.2	22.4	35.8	49.1	22.3	35.7	49.1	22.3	35.7
Mean	0.0	0.0		22.7	8.3		33.0	23.3		39.4	26.1		44.9	34.8		44.8	34.9	
LSD (P =0.05); Variety =	0.0			0.30			0.40			0.40			0.40			0.40		
Fertilizer =	0.0			0.60			0.80			0.90			0.90			0.80		
Variety x Fertilizer =	0.0			1.90			1.20			1.30			1.30			1.10		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Table 4.28b: Percentage RottenTubers in Ash Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	30.0	0.0	15.0	37.7	0.0	18.8	52.2	20.7	36.4	90.0	69.2	79.6	90.0	90.0	90.0
T 2	0.0	0.0	0.0	0.0	0.0	0.0	20.7	0.0	10.3	37.7	0.0	18.8	69.2	69.2	69.2	69.3	90.0	79.6
T 3	0.0	0.0	0.0	0.0	0.0	0.0	20.7	20.7	20.7	37.7	20.7	29.2	52.2	60.0	56.1	90.0	60.0	75.0
T 4	0.0	0.0	0.0	20.7	0.0	10.3	45.0	0.0	22.5	45.0	0.0	22.5	90.0	60.0	75.0	90.0	59.6	74.8
T 5	0.0	0.0	0.0	0.0	0.0	0.0	45.0	0.0	22.5	45.0	20.7	32.8	69.2	45.0	57.1	90.0	52.2	71.1
T 6	0.0	0.0	0.0	20.7	20.7	20.7	20.7	37.7	29.2	20.8	37.7	29.2	45.0	90.0	67.5	52.2	90.0	71.1
T 7	0.0	0.0	0.0	37.7	0.0	18.8	60.0	0.0	30.0	69.2	0.0	34.6	90.0	52.2	71.1	90.0	52.2	71.1
T 8	0.0	0.0	0.0	20.7	20.7	20.7	45.0	30.0	37.8	45.0	37.7	41.3	90.0	90.0	90.0	90.0	90.0	90.0
Mean	0.0	0.0		16.2	5.1		36.8	11.0		44.0	17.2		74.4	66.9		82.6	73.0	
LSD (P = 0.05); Variety =	0.0			0.39			0.50			0.51			0.47			0.52		
Fertilizer =	0.0			0.78			1.01			1.02			0.94			1.04		
Variety x Fertilizer =	0.0			1.10			1.43			1.45			1.34			1.47		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

4.6.3.2 Percentage Rotten Tubers in Grass Storage

Table 4.29 shows percentage rotten tubers of two sweetpotato varieties as influenced by chicken manure and inorganic fertilizer and stored in grass for 12 weeks. In the minor season (2011), Apomuden under control had the highest percentage (22.5%) rotten tubers while all the amended tubers except 15-23-23 kg/ha NPK+5t/ha CM recorded no mean valuespercent rotten tubers for the first 4 weeks in grass storage. Okumkom under amended plots except 15-30-30 kg/ha NPK+ 5t/ha CM recorded the highest percentage rotten tubers (40.6%) while the unamended tubers recorded zero values for rotten tubers during the first 4 weeks in grass storage (Table 4.29a). Similarly, 15-23-23 kg/ha NPK+5t/ha CM and 30-60-60 kg/ha NPK treated tubers of Apomuden which had the highest percentage rotten tubers (40.5%) differed significantly from other amended and the control tubers with zero values for rotten tubers recorded by 30-45-45 kg/ha NPK and 30-60-60 kg/ha NPK tubers during the first 8 weeks in grass storage (Table 4.29a).

Apomuden under 15-30-30 kg/ha NPK+5t/ha CM had the highest percentage rotten tubers (49.7%) with the least recorded by the control (32.4%) at 12 weeks in grass storage. Similarly, application of 15-30-30 kg/ha NPK+5t/ha CM to Okumkom produced the highest percentage rotten tubers (40.6%) followed by 15-23-23kg/ha NPK+5t/ha CM (40.4%) and differed significantly from other amended and control tubers at 12 weeks in grass storage. However, 30-45-45 kg/ha NPK tubers of Okumkom recorded zero values rotten tubersat 12 weeks in grass storage (Table 4.29a).

In the major season (2012), application of 30-45-45 kg/ha NPK and 30-60-60 kg/ha NPK to Apomuden produced the highest percentage rotten tubers (52.2%) and differed significantly from the other amended and unamended tubers with the lowest recorded by

15-15-15 kg/ha NPK +5t/ha CM tubers for the first 6 weeks in grass storage (Table 4.29b). In the case of Okumkom, application of 15-30-30 kg/ha NPK +5t/ha CM and unamended tubers showed the highest percentage rotten tubers (30.0%) for the first 6 weeks in grass storage. Zero srotten tuber wasr ecorded by the other amended plots for the same period. Tubers produced from application of30-45-45 kg/ha NPK to Apomuden had the highest percentage rotten tubers (69.2%) and differed significantly from the other amended and the control tubers for the first 8 weeks in grass storage with the lowest recorded by 15-23-23kg/ha NPK+5t/ha CM treated tubers (37.7%). Similarly, application of 15-23-23kg/haNPK +5t/ha CM to Okumkom recorded the highest percentage rotten tubers (37.7%) and differed significantly from the other amended and control tubers for the first 8 weeks in grass storage. Application of amended and unamended treatments to both Apomuden and Okumkom produced the same mean percentage rotten tubers at 10 and 12 weeks in grass storage (Table.4.29b).

4.6.3.3 Percentage Rotten Tubers in Pit Storage

Table4.30 shows percentage rotten tubers of two sweetpotato varieties as influenced by chicken manure and inorganic fertilizer and storage in pit for 12 weeks. In the minor season (2011), Apomuden grown on 30-45-45 kg/ha NPK treatment gave the highest (49.3%) percentage rotten tubers and differed significantly from the other amended and unamended tubers at 12 weeks in pit storage and the least (22.3%) was recorded by 15-15-15 kg/ha NPK + 5t/ha CM tubers for the same period.

Table 4.29a: Percentage RottenTubers in Grass Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	22.5	0.0	11.2	22.3	22.3	22.3	32.4	22.4	27.4	32.3	22.4	27.3	32.4	22.2	27.3
T 2	0.0	0.0	0.0	0.0	0.0	0.0	22.0	22.5	22.2	32.5	22.4	27.4	40.4	22.4	31.4	40.5	22.3	31.4
T 3	0.0	0.0	0.0	22.4	0.0	11.2	22.4	22.3	22.3	32.4	22.4	27.4	32.4	22.2	27.3	32.5	22.7	27.6
T 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.4	11.2	32.4	22.4	27.4	32.4	22.3	27.4	32.5	21.9	27.2
T 5	0.0	0.0	0.0	22.4	0.0	11.2	22.4	0.0	11.2	22.3	0.0	11.1	49.2	0.0	24.6	49.3	0.0	24.6
T 6	0.0	0.0	0.0	22.3	0.0	11.1	22.6	40.5	31.5	32.4	40.5	36.4	40.6	40.4	40.5	40.7	40.4	40.5
T 7	0.0	0.0	0.0	22.4	0.0	11.2	32.3	0.0	16.1	32.4	0.0	16.2	40.5	22.2	31.3	40.5	22.3	31.4
T 8	0.0	0.0	0.0	0.0	40.6	20.3	22.4	40.5	31.4	32.4	40.5	36.5	49.2	40.5	44.9	49.7	40.6	45.1
Mean	0.0	0.0		14.0	5.0		20.8	21.3		31.2	21.3		39.6	24.0		39.7	24.0	
LSD (P = 0.05); Variety =	0.0			0.30			0.40			0.50			0.50			0.60		
Fertilizer =	0.0			0.60			0.90			1.10			1.10			1.30		
Variety x Fertilizer =	0.0			0.90			1.30			1.50			1.60			1.80		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Table 4.29b: Percentage RottenTubers in Grass Storage Duirng the2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	37.7	30.0	33.8	37.7	30.0	33.8	45.0	30.0	37.5	90.0	90.0	90.0	90.0	90.0	90.0
T 2	0.0	0.0	0.0	37.7	0.0	18.8	37.7	0.0	18.8	52.2	20.7	36.4	90.0	90.0	90.0	90.0	90.0	90.0
T 3	0.0	0.0	0.0	37.7	0.0	18.8	45.0	0.0	22.5	52.2	20.7	36.4	90.0	90.0	90.0	90.0	90.0	90.0
T 4	0.0	0.0	0.0	20.7	0.0	10.3	45.0	0.0	22.5	52.2	20.7	36.4	90.0	90.0	90.0	90.0	90.0	90.0
T 5	0.0	0.0	0.0	52.2	0.0	26.1	69.2	20.7	45.0	69.2	30.0	49.6	90.0	90.0	90.0	90.0	90.0	90.0
T 6	0.0	0.0	0.0	30.0	0.0	15.0	30.0	0.0	15.0	37.7	37.7	37.7	90.0	90.0	90.0	90.0	90.0	90.0
T 7	0.0	0.0	0.0	52.2	0.0	26.1	52.3	0.0	26.1	52.4	20.7	36.5	90.0	90.0	90.0	90.0	90.0	90.0
T 8	30.0	0.0	15.0	37.7	30.0	33.8	45.0	30.0	37.5	52.2	37.7	44.9	90.0	90.0	90.0	90.0	90.0	90.0
Mean	3.7	0.0		38.2	7.5		45.2	10.0		51.6	27.3		90.0	90.0		90.0	90.0	
LSD (P = 0.05); Variety =		0.14			0.48			0.49			0.59			0.60			0.60	
Fertilizer =		0.29			0.96			0.99			1.18			1.21			1.21	
Variety x Fertilizer =		0.41			1.35			1.41			1.67			1.75			1.72	

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Application of 15-30-30 kg/ha NPK + 5t/ha CM to Okumkom had the highest percentage rotten tubers (90.3%) and differed significantly from other amended and unamended treatments with the least (22.3%) recorded by the controlat 12 weeks in pit storage (Table 4.30a).

In the major season (2012), application of 30-45-45kg/ha NPK to Apomuden produced the highest (45.0%) percentage rotten tubers and differed significantly from the other amended and unamended tubers for the first 6 weeks in pit storage (Table 4.30b). However, 10t/ha CM and 15-23-23kg/haNPK +5t/ha CM treated tubers recorded zero values for percent rotten tubersduring the same period and in storage condition. Application of 15-15-15 kg/ha NPK +5t/ha CM to Okumkom showed the highest percentage rotten tubers (52.0%) and differed significantly from other amended tubers and the control for the first 6 weeks in pit storage. 10t/ha CM treated tubers however recorded zero values for percent rotten tubers for the same period and storage condition. Application of 30-45-45 kg/haNPK to Apomuden produced the highest (52.4%) percentage rotten tubers followed by 15-15-15 kg/haNPK+5t/ha CM treatment (52.2%) and the lowest (20.7%) was recorded by 15-23-23kg/ha NPK+5t/ha CM treatment at 12 weeks in pit storage. There was a significant difference between amended and the control tubers of Apomuden in percentage rotten tubers at 12 weeks in pit storage. 30-60-60 kg/ha NPK under Okumkom had the highest percentage rotten tubers (90.0%) and differed significant from the other amended tubers and the control at 12 weeks in pit storage with the lowest (30.0 %) recorded by 10t/ha CM and 15-23-23kg/ha NPK+5t/ha CM tubers. There was a significant difference in variety x fertilizer interaction in percentage rotten tubers at 12 weeks in pit storage (Table 4.30b). In both seasons Apomuden and Okumkom grown on amended and unamended plots and stored in grass during the major season had substantially higher percentage rotten tubers followed by ash storage with the least recorded by pit storage at 12 weeks in storage. Generally, Apomuden and Okumkom grown on amended and the control plots and stored in pit, ash and grass during the major season produced higher percentage rotten tubers compared to the minor season (Tables 4. 30a and 4.30b).

4.6.4.0 Percentage Tuber Sprouting of Sweetpotato under Ash, Grass or Pit Storage During the Minor and The Major Seasons

4.6.4.1 Percentage Tuber Sprouting in Ash storage

Table 4.31 shows the percentage tuber sprout of two varieties of sweetpotato as influenced by chicken manure and inorganic fertilizer and storage in ash for 12 weeks. In the minor season (2011), Apomuden grown on the control plot and stored in ash which had the highest (40.3%) percentage sprouted tuber differed significantly from the amended treatments for the first 4 weeks in ash storage (Table 4.31a). Okumkom under 10t/ha CM treatment had the highest (22.4%) percentage sprouted tuber while the other amended and unamended tubers recorded zero values for sprouted tubers during the first 4 weeks in ash storage. Similarly, Apomuden grown on unamended plot had the highest percentage sprouted tubers (67.4%) with no mean values sprouted tuber recorded by 30-60-60 kg/haNPK at 12 weeks in ash storage.

Table 4.30a: Percentage RottenTubers in Pit Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	22.4	11.2	0.0	22.5	11.2	40.5	22.5	31.5	40.5	22.3	31.4	40.6	22.5	31.5	40.5	22.3	31.4
T 2	22.3	0.0	11.1	32.5	22.4	27.4	32.4	40.6	36.5	40.5	40.5	40.5	40.5	4.5	40.5	40.5	40.5	40.5
T 3	22.5	0.0	11.2	22.4	22.4	22.4	40.5	32.5	36.5	40.6	40.65	40.6	40.5	40.5	40.5	40.5	40.6	40.5
T 4	22.4	22.5	22.4	22.3	22.5	22.4	22.4	32.3	27.4	22.3	32.4	27.3	22.5	32.4	27.4	22.3	32.5	27.4
T 5	0.0	22.5	11.2	32.5	32.5	32.5	49.2	32.5	40.9	49.3	40.5	44.9	49.2	40.6	44.9	49.3	40.3	44.8
T 6	0.0	0.0	0.0	32.3	22.4	27.3	32.5	22.6	27.5	32.3	32.5	32.4	40.5	32.5	36.5	40.7	32.5	36.6
T 7	32.4	0.0	16.2	32.5	32.5	32.5	32.6	40.7	36.6	32.5	40.6	36.5	40.5	57.5	49.0	40.6	57.5	49.1
T 8	22.3	67.4	44.9	22.4	67.4	44.9	32.4	67.4	49.9	40.5	67.4	54.0	40.5	90.3	65.4	40.5	90.3	65.4
Mean	15.2	16.8		27.6	30.6		35.3	36.4		37.3	39.6		39.3	44.6		39.4	44.6	
LSD (P =0.05); Variety =	0.40			0.30			0.50			0.60			0.50			0.60		
Fertilizer =	0.80			0.70			1.00			1.20			1.10			1.20		
Variety x Fertilizer =	1.10			1.10			1.40			1.70			1.60			1.70		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/ha NPK

T 4 - 15-15-15 kg/ha NPK + 5t/ha CM

T5 - 30-45-45 kg/ha NPK

T6 - 15-23-23 kg/ha NPK +5t/haCM

T7 - 30-60-60 kg/ha NPK

T8 - 15-30-30 kg/ha NPK + 5t/ha CM

Table 4.30b: Percentage RottenTubers in Pit Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	20.7	0.0	10.3	30.0	30.0	30.0	30.0	45.0	37.5	45.0	45.0	45.0	45.0	45.0	45.0
T 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	30.0	30.0	30.0
T 3	0.0	0.0	0.0	0.0	0.0	0.0	20.7	37.7	29.2	20.7	37.5	29.1	31.0	37.7	34.3	37.8	45.0	41.4
T 4	0.0	0.0	0.0	20.7	30.0	25.3	37.7	52.2	45.0	45.0	52.3	48.6	52.2	52.4	52.3	52.2	52.6	52.4
T 5	0.0	20.7	10.3	37.7	20.7	29.2	45.0	37.7	41.3	45.0	45.0	45.0	52.2	45.0	48.6	52.4	45.0	48.7
T 6	0.0	20.7	10.3	0.0	20.7	10.3	0.0	20.7	10.3	20.7	20.8	20.7	20.7	20.8	20.7	20.7	30.0	25.3
T 7	0.0	0.0	0.0	30.0	0.0	15.0	30.0	30.0	30.0	37.8	45.0	41.4	37.8	45.0	41.4	37.8	90.0	63.9
T 8	20.7	0.0	10.3	31.0	0.0	15.5	31.0	37.7	34.3	31.0	37.7	34.3	31.0	37.8	34.4	37.4	45.0	41.2
Mean	2.5	5.1		17.5	8.9		24.3	30.7		31.3	35.4		36.3	35.4		39.1	47.8	
LSD (P =0.05); Variety =	0.21			0.36			0.49			0.50			0.53			0.56		
Fertilizer =	0.42			0.73			0.99			1.00			1.06			1.12		
Variety x Fertilizer =	0.60			1.04			1.41			1.41			1.50			1.59		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

Okumkom under 10t/ha CM treatment had the highest percentage sprouted tuber (32.3%) while the other amended and unamended plots recorded no values sprouted tuber at 12 week in ash storage. There was a significant difference in variety x fertilizer in percentage sprouted tuber at 12 weeks in ash storage (Table 4.31a).

In the major season (2012), application of 10t/ha CM to Apomuden had the highest (45.0%) percentage sprouted tubers with 30-30-30kg/haNPK and the control recorded no values sprouted tuber at the first 6 weeks in ash storage (Table 4.31b). Application of 30-60-60kg/haNPK to Okumkom had the highest (37.7%) percentage sprouted tubers with the least (20.7%) recorded by 10t/ha CM and 15-30-30kg/haNPK+5t/ha CM tubers at the first 6 weeks in ash storage. Application of 10t/ha CM and 15-30-30kg/haNPK+5t/ha CM to Apomuden had the highest (45.0%) percentage sprouted tubers with the least (20.7%) recorded by 30-45-45 kg/haNPK and 15-15-15kg/haNPK +5t/ha CM tubers at 12 weeks in ash storage. However, 30-30-30 kg/haNPK and the control tubers recorded zero values percent sprouted tuber (0.0) at 12 weeks of ash storage. Application of 30-60-60kg/haNPK to Okumkom had the highest (60.0%) percentage sprouted tuber with the least (20.7%) recorded by 10t/ha CM and 15-30-30kg/haNPK+5t/ha CM tubers at 12 weeks of ash storage. However, 30-30-30kg/haNPK, 15-15-15kg/haNPK +5t/ha CM and the control tubers recorded the same percentager sprouted tubers (37.7%) at 12 weeks in ash storage. There was a significant difference in variety x fertilizer interaction in percentage sprouted tubers at 12 weeks in ash storage (Table. 4.31b).

Table 4.31a: Percentage Sprouted Tubers in Ash Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	22.4	0.0	11.2	40.3	0.0	20.1	67.4	0.0	33.7	67.4	0.0	33.7	67.4	0.0	33.7	67.4	0.0	33.7
T 2	0.0	22.4	11.2	22.4	22.4	22.4	22.3	32.3	27.3	22.4	32.4	27.4	22.4	32.3	27.3	22.3	32.3	27.3
T 3	0.0	0.0	0.0	0.0	0.0	0.0	22.3	0.0	11.1	32.4	0.0	16.2	32.4	0.0	16.2	32.3	0.0	16.1
T 4	0.0	0.0	0.0	22.3	0.0	11.1	32.4	0.0	16.2	32.4	0.0	16.2	32.5	0.0	16.2	32.4	0.0	16.2
T 5	0.0	0.0	0.0	32.4	0.0	16.2	49.1	0.0	24.5	49.4	0.0	24.7	49.3	0.0	24.6	49.2	0.0	24.6
T 6	22.4	0.0	11.2	22.4	0.0	11.2	32.4	0.0	16.2	32.2	0.0	16.1	32.4	0.0	16.2	32.5	0.0	16.2
T 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 8	0.0	0.0	0.0	22.5	0.0	11.2	32.3	0.0	16.1	32.4	0.0	16.2	32.2	0.0	16.1	32.2	0.0	16.1
Mean	5.6	2.8		20.3	2.8		32.3	4.0		33.6	4.0		33.6	4.0		33.5	4.0	
LSD (P = 0.05); Variety =	0.20			0.30			0.40			0.40			0.50			0.60		
Fertilizer =	0.50			0.70			0.90			0.80			1.10			1.20		
Variety x Fertilizer =	1.70			1.00			1.30			1.10			1.60			1.70		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

Table 4.31b: Percentage Sprouted Tubers in Ash Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	0.0	20.7	10.3	0.0	30.0	15.0	0.0	37.7	18.8	0.0	37.7	18.8	0.0	37.7	18.8
T 2	0.0	0.0	0.0	37.7	0.0	18.8	45.0	20.7	32.8	45.0	20.7	32.8	45.0	20.7	32.8	45.0	20.7	32.8
T 3	0.0	0.0	0.0	0.0	20.7	10.3	0.0	30.0	15.0	0.0	37.7	18.8	0.0	37.7	18.8	0.0	37.7	18.8
T 4	0.0	0.0	0.0	0.0	0.0	0.0	20.7	30.0	25.3	20.7	37.7	29.2	20.7	37.7	29.2	20.7	37.7	29.2
T 5	0.0	0.0	0.0	0.0	20.7	10.3	20.7	26.3	23.5	20.7	26.4	23.5	20.7	26.5	23.6	20.7	26.5	23.6
T 6	0.0	0.0	0.0	0.0	20.7	10.3	30.0	30.0	30.0	37.7	30.0	33.8	37.7	30.0	33.8	37.7	30.0	33.8
T 7	0.0	0.0	0.0	20.7	37.7	29.2	20.7	37.7	29.2	20.7	60.0	40.3	20.8	60.0	40.4	20.8	60.0	40.4
T 8	0.0	0.0	0.0	20.7	0.0	10.3	26.3	20.7	23.5	45.0	20.7	32.8	45.0	20.7	32.8	45.0	20.7	32.8
Mean	0.0	0.0		9.8	15.0		20.4	28.1		23.7	33.8		23.7	33.9		23.7	33.9	
LSD (P = 0.05); Variety =	0.0			0.36			1.54			1.54			0.54			1.54		
Fertilizer =	0.0			0.73			3.08			1.00			1.07			3.08		
Variety x Fertilizer =	0.0			1.03			4.36			1.41			4.35			4.35		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

4.6.4.2 Percentage Sprouted Tuber in Grass storage

Table 4.32 shows the percentage sprouted tuber of two varieties of sweetpotato as influenced by chicken manure and inorganic fertilizer and stored in grass for 12 weeks. In the minor season (2011), Apomuden grown on 30-45-45 kg/haNPK treatment which had the highest (40.4%) percentage sprouted tuber differed significantly from the other amended and unamended tubers with the least (22.3%) recorded by 15-23-23kg/haNPK +5t/ha CM and 15-30-30 kg/haNPK +5t/ha CM treatments at the first 6 weeks in grass storage (Table 4.32a). However, amended and the control tubers of Okumkom recorded zero values percent sprouted tuber for the same storage period. Application of 30-45-45 kg/haNPK to Apomuden had the highest (40.4%) percentage sprouted tuber at 12 weeks in grass storage and differed significantly from the other amended and unamended tubers with the lowest (22.3%) recorded by 15-23-23 kg/haNPK +5t/ha CM and 15-30-30kg/haNPK +5t/ha CM tubers. Similarly, Okumkom under 15-23-23kg/haNPK +5t/ha CM treatment had the highest percentage sprouted tuber (32.3%) followed by 15-30-30 kg/haNPK +5t/ha CM (22.5%). The other amended and unamended tubers recorded zero values for sprouted tubers at 12 weeks in grass storage. There was a significant difference in variety x fertilizer interaction in percentage sprouted tuber at 12 weeks in ash storage (Table 4.32a).

In the major season (2012), application of 15-23-23kg/haNPK +5t/ha CM to Apomuden had the highest (37.7%) percentage sprouted tuber followed by 30-60-60 kg/haNPK treated tubers at the first 8 weeks in grass storage. However, the other amended and the control tubers record zero values for sprouted tuber at the first 8 weeks in grass storage (Table 4.32b). Application of 10t/ha CM and 15-23-23kg/haNPK +5t/ha CM to Okumkom had the highest percentage sprouted tubers (37.7%) followed by 30-30-30kg/haNPK (30.0%) treated tubers with the least recorded by 15-30-30kg/haNPK +5t/ha CMtubers at the first 8 weeks in grass storage. The other amended and unamended tubers recorded no values at the first 8 weeks in grass storage. However, application of 15-23-23kg/haNPK +5t/ha CM to Apomuden produced the highest percentage sprouted tubers (37.8%) with the least recorded by 30-60-60 kg/haNPK tubers at 12 weeks in grass storage. The other amended and unamended treated tubers recorded zero values sprouted tubers at the same period in grass storage. Application of 15-23-23kg/haNPK +5t/ha CM to Okumkom however, had the highest percentage sprouted tubers (37.8%) with the least (20.7%) recorded by 15 -30-30kg/haNPK +5t/ha CM treated tubers at 12 weeks in grass storage. Apomuden and Okumkom under 15-23-23kg/haNPK +5t/ha CM had similar (37.8%) sprouted tubers at 12 weeks in grass storage (Table 4.32b).

Table 4.32a: Percentage Sprouted Tubers in Grass Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	32.4	0.0	16.2	32.4	0.0	16.2	32.2	0.0	16.1	32.3	0.0	16.1	32.4	0.0	16.2
T 2	0.0	0.0	0.0	32.4	0.0	16.2	32.5	0.0	16.2	32.5	0.0	16.2	32.3	0.0	16.1	32.3	0.0	16.1
T 3	22.4	0.0	11.2	32.3	0.0	16.1	32.4	0.0	16.2	32.4	0.0	16.2	32.4	0.0	16.2	32.4	0.0	16.2
T 4	22.3	0.0	11.1	32.3	0.0	16.1	32.3	0.0	16.1	32.4	0.0	16.2	32.5	0.0	16.2	32.3	0.0	16.1
T 5	22.4	0.0	11.2	32.4	0.0	16.2	40.4	0.0	20.2	40.5	0.0	20.2	40.4	0.0	20.2	40.4	0.0	20.2
T 6	22.3	0.0	11.1	22.4	0.0	11.2	22.3	0.0	11.1	22.2	32.4	27.3	22.4	32.3	27.3	22.3	32.3	27.3
T 7	22.4	0.0	11.2	32.4	0.0	16.2	32.3	0.0	16.1	32.4	0.0	16.2	32.4	0.0	16.2	32.2	0.0	16.1
T 8	0.0	0.0	0.0	22.4	0.0	11.2	22.3	0.0	11.1	22.3	22.3	22.3	22.3	22.4	22.3	22.3	22.5	22.4
Mean	14.0	0.0		29.9	0.0		30.8	0.0		30.8	6.85		30.9	6.8		30.8	6.8	
LSD (P = 0.05); Variety =	0.30			0.40			0.40			0.50			0.40			0.60		
Fertilizer =	0.60			0.90			0.90			1.00			0.90			1.20		
Variety x Fertilizer =	0.90			1.30			1.20			1.50			1.40			1.80		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

Table 4.32b: Percentage Sprouted Tubers in Grass Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 2	0.0	0.0	0.0	0.0	20.7	10.3	0.0	37.7	18.8	0.0	37.7	18.8	0.0	37.7	18.8	0.0	37.7	18.8
T 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	15.0	0.0	30.0	15.0	0.0	30.0	15.0	0.0	30.0	15.0
T 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 6	0.0	0.0	0.0	20.7	30.0	25.3	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.8	37.8	37.8
T 7	0.0	0.0	0.0	20.7	0.0	10.3	20.7	0.0	10.3	20.7	0.0	10.3	20.7	0.0	10.3	20.8	0.0	10.4
T 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.7	10.3	0.0	20.7	10.3	0.0	20.7	10.3	0.0	20.7	10.3
Mean				5.1	6.3		7.3	15.7		7.3	15.7		7.3	15.7		7.3	15.7	
LSD (P = 0.05); Variety =		0.0			0.29			1.54			0.34			0.34			0.34	
Fertilizer =		0.0			0.58			3.08			0.68			0.68			0.68	
Variety x Fertilizer =		0.0			1.83			4.36			0.96			0.96			0.96	

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

4.6.4.3 Percentage Sprouted Tuber in Pit storage

Table 4.33 shows the percentage sprouted tuber of two varieties of sweetpotato grown under chicken manure, inorganic fertilizer or various combinationsof the two and storeds in pit for 12 weeks. In the minor season (2011), Apomuden grown on control plot and stored in pit had the highest (32.4%) percentage sprouted tuber and no mean value recorded by 30-60-60 kg/haNPK treatment for the first 4 weeks in pit storage.Okumkom grown on 15-30-30kg/haNPK +5t/ha CM treatment which had the highest percentage sprouted tuber (22.5%) differed significantly from the other amended tubers which recorded zero values for the first 4 weeks in pit storage (Table 4.33a) . Application of 15-15-15 kg/haNPK +5t/ha CM to Apomuden produced the highest (57.4%) percentage sprouted tuber and differed significantly from the other amended tubers with the least recorded by the control tubers (32.2%) for the first 8 weeks in pit storage.

At 12 weeks, Apomuden under 15-15-15kg/haNPK +5t/ha CM and 30-30-30 kg/haNPK treatments which had the highest and the same (57.4%) percentage sprouted tuber differed significantly from the other amended and control tubers in pit storage. Okumkom grown on 30-60-60 kg/haNPK treatment, had the highest (49.3%) percentage sprouted tuber and the least recorded by 10t/ha CM and 30-45-45 kg/haNPK treated tubers at 12 weeks in pit storage. There was a significant difference in variety x fertilizer in percentage sprouted tuber at 12 weeks in pit storage (Table 4.33a).

In the major season (2012), application of 15-23-23kg/haNPK +5t/ha CM to Apomuden had the highest (52.2%) percentage sprouted tubers and 30-60-60kg/haNPK and 15-15-15kg/haNPK +5t/ha CM tubers recorded zero sprouted tuber at the first 4 weeks in pit storage. Application of 30-30-30 kg/haNPK to Okumkom which had the highest (52.2%)

percentage sprouted tuber differed significantly from other amended and the control tubers at 4 weeks in pit storage (Table 4.33b). Application of 10t/ha CM and 30-30-30 kg/haNPK to Apomuden which had the highest and the same (69.2%) percentage sprouted tubers differed significantly from the control which recorded the least mean (37.7%) at first 8 weeks in pit storage. Similarly, 30-30-30kg/haNPK, 15-23-23kg/haNPK+5t/ha CM and 15-30-30kg/haNPK +5t/ha CM tubers of Okumkom had the highest and the same (69.2%) percentage sprouted tuberswith the least (20.7%) recorded by 30-60-60 kg/haNPK tubers at 8 weeks in pit storage A significant difference was observed between Okumkom under amended except 10t/ha CM and 30-45-45kg/haNPK tubers and the control in percentage sprouted tubers at the first 8 weeks in pit storage. At 12 weeks application of 30-30-30 kg/haNPK to Apomuden and Okumkom had the same (69.3%) percentage sprouted tubers in pit storage. There was a significant difference in variety x fertilizer in percentage sprouted tubers at 12 weeks in pit storage (Table 4.33b). Apomuden and Okumkom under amended and control plots and stored in pit produced relatively higher percentage sprouted tubers during the major season than in the minor season at 12 weeks of store (Tables 4.33a and 4.33b).

Apomuden and Okumkom under amended and control plots and stored in pit produced higher percentage sprouted tubers compared to ash or grass storage at 12 weeks of store. Application of 10t/ha CM to Okumkom and storage in grass or pit during the minor season recorded zero values sprouted tubers at 12 weeks in storage (Tables 4. 32a and 4.33a).

Table 4.33a: Percentage Sprouted Tubers in Pit Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	22.4	22.4	22.4	32.4	22.3	27.3	32.2	32.2	32.2	32.2	32.3	32.3	32.3	32.5	32.4	32.4	32.2	32.3
T 2	0.0	0.0	0.0	22.4	0.0	11.2	32.4	0.0	16.2	32.4	0.0	16.2	32.5	0.0	16.2	32.4	0.0	16.2
T 3	22.2	0.0	11.1	32.3	0.0	16.1	40.5	22.3	31.4	49.3	22.3	35.8	57.3	32.4	44.9	57.4	32.4	44.9
T 4	22.4	0.0	11.2	22.2	0.0	11.1	40.4	22.4	31.4	57.4	22.3	39.8	57.3	32.4	44.8	57.4	32.4	44.9
T 5	22.2	0.0	11.1	22.3	0.0	11.1	40.5	0.0	20.2	40.4	0.0	20.2	40.5	0.0	20.2	40.4	0.0	20.2
T 6	22.4	0.0	11.2	22.6	0.0	11.3	32.2	22.4	27.3	32.4	22.3	27.3	40.4	32.2	36.3	40.4	32.4	36.4
T 7	0.0	0.0	0.0	0.0	0.0	0.0	40.5	22.3	31.4	40.4	22.3	31.3	49.3	49.2	49.2	49.2	49.3	49.2
T 8	0.0	0.0	0.0	32.3	22.5	27.4	32.2	32.55	32.4	40.5	40.5	40.5	49.2	40.5	44.8	49.2	40.2	44.7
Mean	13.9	2.8		23.3	5.6		36.4	19.3		40.6	20.2		44.9	27.4		44.8	27.4	
LSD (P = 0.05); Variety =	0.30			0.50			0.50			0.50			0.50			0.60		
Fertilizer =	0.80			1.10			1.10			1.10			1.00			1.30		
Variety x Fertilizer =	1.20			1.60			1.50			1.50			1.50			1.80		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

Table 4.33b Percentage Sprouted Tubers in Pit Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	0.0	0.0	0.0	20.7	30.0	25.3	30.0	37.7	33.8	37.7	45.0	41.3	37.7	45.0	41.3	37.8	45.0	41.4
T 2	0.0	30.0	15.0	37.7	45.0	41.3	45.0	45.0	45.0	69.2	52.2	60.7	69.2	60.0	64.6	69.3	60.0	64.6
T 3	20.7	0.0	10.3	20.7	52.2	36.4	69.2	52.2	60.7	69.2	69.2	69.2	69.3	69.3	69.3	69.3	69.3	69.3
T 4	0.0	20.7	10.3	0.0	37.7	18.8	30.0	45.0	37.5	45.0	45.0	45.0	52.2	45.0	48.6	52.2	45.0	48.6
T 5	30.0	20.7	25.3	37.7	26.3	32.0	30.0	52.2	41.1	45.0	52.2	48.6	45.0	52.3	48.6	45.0	52.3	48.6
T 6	0.0	20.7	10.3	52.2	45.0	48.6	52.2	69.2	60.7	52.2	69.2	60.7	52.2	69.2	60.7	52.2	69.2	60.7
T 7	0.0	20.7	10.3	0.0	20.7	10.3	30.0	20.7	25.3	45.0	20.7	32.8	60.0	20.8	40.4	60.0	20.8	40.4
T 8	0.0	30.0	15.0	20.7	45.0	32.8	37.7	45.0	41.3	52.2	69.2	60.7	52.2	69.2	60.7	52.3	69.3	60.8
Mean	6.3	17.8		23.7	37.7		40.5	45.9		51.9	52.8		54.7	53.8		54.8	53.8	
LSD (P = 0.05); Variety =	0.42			1.54			0.60			0.56			0.60			0.60		
Fertilizer =	0.84			3.08			1.20			1.13			1.21			1.22		
Variety x Fertilizer =	1.19			4.35			1.69			1.59			1.71			1.72		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

4.6.5.0 Percentage Weight Loss of Sweetpotato Tubers in Ash, Grass or Pit StorageDuring the Minor and The Major Seasons

4.6.5.1 Percentage Weight Loss of Tubers in Ash Storage

Table 4.34 shows the percentage weight loss of two varieties of sweetpotato as influenced by chicken manure and inorganic fertilizer and storage in ash for 12 weeks. In the minor seasom (2011), there was a significant difference between Apomuden from Okumkom in percentage weight loss in tubers..Application of 15-15-15kg/haNPK +5t/ha CM to Apomuden produced the highest percentage weight loss in tubers followed by 10t/ha CM tubers with the lowest recorded by 30-45-45kg/haNPK at the first 4 weeks in ash storage (Table 4. 34a). A significant difference was observed between amended and unamended tubers in percentage weight loss in tubers in ash storage at the first 4 weeks in storage. Similarly, Okumkom grown on 15-15-15kg/haNPK +5t/ha CM plot and stored in ash had the highest percentage weight loss in tubers and differed significantly from 15-30-30kg/haNPK+5t/ha CM tubers which recorded the lowest mean at the first 4 weeks in ash storage (Table 4.34a).

At eight weeks in ash storage, 30-60-60kg/haNPK on Apomuden produced the highest (68.7%) percentage weight loss in tubers with the lowest recorded by 30-45-45kg/haNPK tubers followed by unamended tubers (49.5%). Application of 15-15-15kg/haNPK +5t/ha CM to Okumkom had the highest (73.6%) percentage weight loss in tubers and differed significantly from 10t/ha CM tubers which had the lowest mean (42.4%) at the first 8 weeks in ash storage. There was a significant difference between Apomuden from Okumkom in percentage weight loss in tubers at 12 weeks in ash storage (Appendix 18). Application of 30-30-30kg/haNPK and 15-30-30kg/haNPK+5t/ha CM to Apomuden which recorded the highest percentage weight loss in tubers at 12 weeks in ash storage differed significantly from the other amended and unamended treatments with the lowest weight loss recorded by unamended tubers. Okumkom under 15-15-15kg/haNPK +5t/ha CM differed significantly from unamended tubers in percentage weight loss at 12 weeks in ash storage. There was a significant difference in variety x fertilizer interaction in percentage tuber weight loss at 12 weeks in ash storage (Table 4.34a).

In the major season (2012), Apomuden under controland stored in ash which had the highest (41.52%) percentage weight loss in tubers differed significantly from amended tubers at the first 4 weeks in ash storage. Application of 15-23-23kg/haNPK +5t/ha CM to Okumkom produced the highest (28.46%) percentage tuber weight lossand differed significantly from other amended and unamended tubers which recorded the lowest mean(10.78%) at the first 4 weeks in ash storage (Table 4 34b).

Similarly, application of 30-60-60kg/haNPK to Apomuden which had the highest percentage weight loss in tubers (70.25%) differed significantly from the other amended and unamended tubers at the first 8 weeks in ash storage with the least (37.49%) weight loss recorded by 15-23-23kg/haNPK+5t/ha CM tubers. Okumkom under 15-23-23kg/haNPK+5t/ha CM differed significantly from the other amended and unamended tubers and had the highest (52.36%) percentage tuber weight loss at the first 8 weeks in ash storage with the least (16.36%) recorded by 30-60-60kg/haNPK tubers. At 12 weeks 30-60-60 kg/haNPK grown on Apomuden had the highest (76.22%) percentage tuber weight loss and differed significantly from the other amended and unamended tubers with the least tuber weight loss recorded by 15-23-23kg/haNPK +5t/ha CM tubers in ash storage. Okumkom grown on 15-23-23 kg/haNPK +5t/ha CM had the highest percentage weight loss in tubers (58.54%) at 12 weeks in ash storage. followed by 30-45-45kg/haNPK (57.19%) tubers with the least tuber weight loss recorded by 30-60-60kg/haNPK fertilized tubers There was a significant difference in variety x fertilizer interaction in percentage tuber weight loss at 12 weeks in ash storage (Table 4.34b).

Table 4.34a: Percentage Weight loss of Tubers in Ash Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	23.6	13.5	18.6	31.4	24.6	28.0	39.6	40.6	40.1	49.5	50.4	50.0	64.6	60.3	62.4	69.4	65.1	67.3
T 2	26.8	24.8	25.8	38.5	29.7	34.1	54.2	34.4	44.3	66.6	42.4	54.5	78.4	59.4	68.9	81.2	65.1	73.2
T 3	26.2	22.5	24.3	38.4	23.7	31.0	51.4	33.4	42.4	63.6	49.3	56.5	90.3	59.6	74.9	92.1	65.4	78.8
T 4	29.4	23.7	26.6	39.4	57.6	48.5	55.3	71.6	63.4	64.6	73.6	69.1	75.4	73.7	74.5	80.3	78.3	79.3
T 5	23.5	22.6	23.1	30.5	31.3	30.9	36.5	41.6	39.0	48.4	65.6	57.0	73.3	70.5	71.9	79.2	75.2	77.2
T 6	24.4	22.7	23.5	36.3	27.6	31.9	45.3	36.4	40.9	57.5	52.6	55.0	82.4	58.5	70.4	85.1	64.3	74.7
T 7	24.4	21.5	22.9	34.6	30.3	32.4	54.6	36.5	45.5	68.7	47.4	58.1	85.6	59.5	72.5	87.3	65.3	76.3
T 8	23.3	11.6	17.5	30.6	22.7	26.7	41.5	40.4	41.0	61.6	51.6	56.6	90.3	66.7	78.5	92.1	70.4	80.8
Mean	25.2	20.4		34.9	30.9		47.3	41.9		60.1	54.1		80.0	63.5		83.3	68.6	
LSD (P = 0.05); Variety =	0.38			0.40			0.44			0.41			0.41			0.78		
Fertilizer =	0.77			1.80			0.89			0.83			0.83			1.57		
Variety x Fertilizer =	1.20			1.13			1.26			1.18			1.18			2.22		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

Table 4.34b: Percentage Weight loss of Tubers in Ash Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	11.51	6.24	8.8	41.52	10.78	26.15	43.26	18.83	31.05	49.34	24.61	36.98	66.37	45.38	55.88	66.27	45.35	55.81
T 2	11.51	12.21	11.8	14.69	19.62	17.15	24.60	19.62	22.11	40.34	25.30	32.82	53.64	37.63	45.64	53.64	37.47	45.55
T 3	16.27	12.35	14.3	34.61	18.24	26.43	41.67	21.46	31.56	47.37	25.43	36.40	62.38	30.31	46.35	62.35	30.28	46.32
T 4	5.24	9.30	7.2	31.65	15.60	23.62	31.58	18.41	25.00	55.48	28.34	41.91	58.49	37.75	48.12	58.42	37.55	47.99
T 5	18.41	14.33	16.3	30.62	14.33	22.47	33.24	17.32	25.28	49.60	21.32	35.46	60.62	57.35	58.99	60.49	57.19	58.84
T 6	13.32	13.81	13.5	34.42	28.46	31.44	35.25	32.50	33.88	37.49	52.36	44.92	43.26	58.58	50.92	43.26	58.54	50.90
T 7	5.6	11.23	8.4	30.49	11.27	20.88	35.55	14.55	25.05	70.25	16.36	43.30	76.22	26.49	51.36	76.22	26.46	51.34
T 8	14.8	12.77	13.8	30.62	24.68	27.65	31.33	24.58	27.95	51.48	36.26	43.87	58.22	53.71	55.96	58.18	53.68	55.93
Mean	12.0	11.5		31.08	17.87		34.56	20.91		50.17	28.75		59.90	43.40		59.86	43.31	
LSD (P =0.05); Variety =	0.53			0.62			0.59			0.56			0.58			0.67		
Fertilizer =	1.07			1.24			1.18			1.13			1.17			1.34		
Variety x Fertilizer =	1.52			1.75			1.66			1.61			1.66			1.90		

T 1 - No fertilizer
T 2 - 10t/ha CM
T3 - 30-30-30 kg/haNPK
T 4 - 15-15-15 kg/haNPK + 5t/ha CM
T5 - 30-45-45kg/haNPK
T6 - 15-23-23kg/haNPK +5t/haCM
T7 - 30-60-60kg/haNPK
T8 - 15-30-30kg/haNPK + 5t/ha CM

4.6.5.2 Percentage Tuber Weight Loss in Grass storage

Table 4.35shows the percentage weight loss of two varieties of sweetpotato as influenced by chicken manure and inorganic fertilizer and storage in grass for 12 weeks.In the minor season (2011), application of 30-30-30kg/haNPK to Apomuden and stored in grass had the highest (41.5%) percentageweight loss in tuberswith the lowest recorded by 10t/ha CM tubers at the first 4 weeks in grass storage (Table 4.35a). Application of 10t/ha CM to Okumkom which had the highest percentage weight loss in tubers differed significantly from other amended and unamended tubers at the first 4 weeks in grass storage.Apomuden on unamended treatment had the highest (69.4%) percentage weight loss in tubers with the lowest (53.6%) tuber weight loss recorded by 15-30-30kg/haNPK +5t/ha CM tubers at 8 weeks in grass storage.10t/ha CM tubers of Okumkom had the highest percentage weight loss in tubers and differed significantly from other amended and unamended treatmentat the first 8 weeks in grass storage with the lowest recorded by 30-60-60kg/haNPK tubers (Table 4.35a).At 12 week application of 15-30-30kg/haNPK+5t/ha CM and 15-15-15kg/haNPK +5t/ha CM to Apomuden which had the highest percentage weight loss in tubers differed significantly from unamended tubers in grass storage. 10t/ha CM tubers of Okumkom had the highest percentage weight loss of tubers and differed significantly from the other amended tubers with the lowest recorded by 30-60-60kg/haNPKtubers at 12 weeks in grass (Appendix 19) .There was a significant differencein variety x fertilizer interaction in percentage weight loss in tubers at 12 weeks in grass storage (Table 4.35a).

In the major season 30-45-45 kg/haNPK to Apomuden had the highest (62.50%) percentage weight loss in tubers and differed significantly from the other amended and unamended tubers at the first 6 weeks in grass storage with the least (20.73%) tuber weight loss recorded by15-15-15kg/haNPK +5t/ha CM treatment. However, unamended tubers of Okumkom which had the highest (32.64%) percentage weight loss in tubers followed by 15-30-30kg/haNPK +5t/ha CM treated tubers (31.78%) differed significantly from the other amended tubers at 6 weeks in grass storage(Table 4 35b).

30-45-45 kg/haNPK to Apomuden had the highest (81.29%) percentage weight loss with the lowest (47.30%) recorded by 15-23-23kg/haNPK +5t/ha CM tubers at 12 weeks in grass storage. A significant difference was observed between amended tubersand the unamended treatments in percentage weight loss of tubers at 12 weeks in grass storage.Application of 15-30-30kg/haNPK +5t/ha CM to Okumkom had the highest percentage (58.25%) weight loss in tubers with the least (32.13%) recorded by 10t/ha CM tubers followed by 15-15-15kg/haNPK +5t/ha CM tubers (32.16%) at 12 weeks in grass storage. A significantdifference was observed in variety x fertilizer interaction in percentage weight loss in tubers at 12 weeks in grass storage (Table 4.35b).

4.6.5.3 Percentage Tuber Weight Loss in Pit storage

Table 4.36 shows the percentage weight loss of two varieties of sweetpotato tubers as influenced by chicken manure and inorganic fertilizer sand storage in pit for 12 weeks. In the minor season (2011), 30-45-45kg/haNPK to Apomuden had the highest percentage weight loss in tubers followed by 30-60-60 kg/haNPK fertilized tubers with the lowest recorded by 15-30-30 kg/haNPK +5t/ha CM tubers at the first 4 weeks in pit (Table 4. 36a). Application of 15-30-30 kg/haNPK+5t/ha CM to Okumkom which had the highest percentage weight loss in tubers differed significantly from the other amended and unamended treatment at the first 4 weeks in pit storage.

Table 4.35a: Percentage Weight loss of Tubers in Grass Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	24.4	23.4	23.9	40.5	36.7	38.6	54.3	44.1	49.2	69.4	66.5	67.9	75.5	68.5	72.0	80.3	74.4	77.4
T 2	22.6	30.4	26.5	37.5	47.4	42.5	47.3	61.5	54.4	56.5	76.4	66.4	73.4	76.6	75.0	78.2	80.3	79.3
T 3	23.5	29.6	26.6	41.5	42.4	41.9	50.4	46.4	48.4	63.6	52.5	58.0	78.4	60.4	69.4	83.1	65.2	74.2
T 4	24.5	7.4	15.9	40.6	33.4	37.0	47.5	42.4	45.0	55.6	52.5	54.0	90.3	63.3	76.8	92.2	68.2	80.2
T 5	23.5	31.4	27.4	38.4	46.4	42.4	46.6	54.4	50.5	59.5	57.3	58.4	80.5	62.6	71.5	85.2	67.2	76.2
T 6	25.6	18.5	22.0	39.5	33.5	36.5	48.6	43.4	46.0	64.7	57.4	61.0	83.5	68.4	76.0	88.3	73.4	80.9
T 7	24.5	18.5	21.5	39.6	35.3	37.4	49.3	40.5	44.9	64.3	46.6	55.4	80.4	56.7	68.5	85.3	60.5	72.9
T 8	21.4	22.6	22.0	37.6	42.5	40.1	50.5	58.4	54.4	53.6	65.5	59.6	90.3	72.3	81.3	92.2	77.2	84.7
Mean	23.8	22.7		39.4	39.7		49.3	48.9		60.9	59.3		81.5	66.1		85.6	70.8	
LSD (P =0.05); Variety =	0.30			NS			0.44			0.41			0.43			0.81		
Fertilizer =	0.78			0.85			0.89			0.83			0.87			1.63		
Variety x Fertilizer =	1.10			1.21			1.27			1.18			1.23			2.31		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

Table 4.35b: Percentage Weight loss of Tubers in Grass Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	13.47	7.28	10.51	47.42	28.44	37.93	49.20	32.64	40.92	52.42	32.51	42.46	67.56	38.41	52.99	67.76	38.28	53.02
T 2	14.23	7.43	10.83	34.42	11.40	22.91	39.21	14.23	26.72	43.82	16.25	30.03	75.81	32.40	54.10	75.77	32.33	54.05
T 3	22.34	18.41	20.37	47.42	20.29	33.85	50.72	21.72	36.22	61.41	30.62	46.02	70.28	36.62	53.45	70.31	36.46	53.39
T 4	8.52	6.28	7.40	15.56	12.51	14.04	20.73	14.15	17.44	40.51	20.19	30.35	67.35	32.71	50.03	67.29	32.61	49.95
T 5	14.11	20.60	17.36	60.69	20.60	40.65	62.50	22.24	42.37	77.42	31.70	54.56	81.29	36.63	58.96	81.29	36.50	58.90
T 6	7.41	16.41	11.91	26.52	25.53	26.03	28.70	30.62	29.66	33.73	48.42	41.07	47.27	51.52	49.39	47.30	51.25	49.28
T 7	11.45	19.15	15.30	35.42	19.29	27.35	41.48	23.33	32.41	41.58	41.58	33.08	47.56	35.32	41.44	47.56	35.52	41.54
T 8	22.36	8.18	15.27	34.63	30.62	32.63	37.27	31.78	34.52	42.31	38.25	40.28	49.32	58.25	53.79	49.32	58.25	53.79
Mean	14.27	12.97		37.76	21.08		41.23	23.84		49.15	30.31		63.31	40.23		63.33	40.15	
LSD (P = 0.05); Variety =	0.53			0.60			0.57			0.57			0.52			0.54		
Fertilizer =	1.0			31.21			1.15			1.15			1.05			1.08		
Variety x Fertilizer =	1.46			1.71			1.63			1.63			1.49			1.53		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

At the first 8 weeks in pit storage unamended tubers of Apomuden had the highest percentage (72.4%) weight loss in tubers followed by 30-30-30kg/haNPK tubers with the lowest (33.5%) weight loss. recorded by 15-15-15kg/haNPK +5t/ha CM tubers. Tubers produced from application of 30-30-30kg/haNPK to Okumkom which produced the highest percentage (59.5%) weight loss in tubers differed significantly from the other amended and unamended treatments at the first 8 weeks in pit storage. There was a significant difference between Apomuden and Okumkom in percentage weight loss in tubers (Appendix 20). Application of 30-60-60 kg/haNPK to Apomuden produced tubers with the highest percentage weight loss in tubers which differed significantly from the other amended and unamended tretments at 12 weeks in pit storage. Application of 30-45-45kg/haNPK to Okumkom had the highest percentage weight loss of tubers with the lowest recorded by 10t/ha CM tubers at 12 weeks in pit storage. Generally, in the minor season, Apomuden and Okumkom grown on amended plots and stored in grass had the highest percentage weight loss in tubers at 12 weeks in storage, followed by ash storage and the least recorded by tubers stored in pit (Tables 4.34a. 4.35a and 4.36a).

In the major season (2012) application of 30-45-45 kg/haNPK to Apomuden had the highest (44.60%) percentage tuber weight loss with the lowest (13.49%) tuber weight loss recorded by 15-23-23 kg/haNPK +5t/ha CM tubers at the first 4 weeks in pit storage. A significant difference was observed between amended and unamended treatments in percentage weight loss in tubers of Apomuden at the first 4 weeks in pit storage (Table 4.36b). Application of 30-45-45kg/haNPK to Okumkom had the highest percentage (31.36%) weight loss in tubers and differed significantly from other amended and unamended treatments. The lowest percentage (6.38%) weight loss in tubers was recorded by 15-30-30kg/haNPK +5t/ha CM treated tuber at 4 weeks in pit storage. Apomuden grown on 30-45-45kg/haNPK plot had the highest percentage ((47.30%) weight loss in tubers followed by unamended tubers (46.32%) with the lowest (15.60%) weight loss recorded by 15-23-23kg/haNPK +5t/ha CM tubers at 8 weeks in pit storage. A significantdifference was observed between amended and unamended treatmentsin percentage weight loss in tubers at 8 weeks in pit storage. Application of 30-60-60kg/haNPK to Okumkom had the highest percentage (64.30%) weight loss in tubers and differed significantly from other amended and unamended treatments with the lowest (14.31%)recorded by 30-30-30 kg/haNPK tubers at 8 weeks in pit storage. A significant difference was observed between treatments at 8 weeks in pit storage.

At 12 weeks application of 30-45-45 kg/haNPK to Apomuden had the highest percentage (49.51%) tuber weight loss with the lowest (21.65%)tuber weight loss recorded by 30-30-30kg/haNPKtubers in pit storage. 30-60-60kg/haNPK on Okumkom had the highest percentage (90.0%) weight loss in tubers with the lowest (10.61%) weight loss recorded by 30-30-30kg/haNPKtubersat 12 weeks in pit storage. There was a significant difference in variety x fertilizer interaction in percentage weight loss of tubers at 12 weeks in pit storage (Table 4.36b).

Generally, application of amendment treatments to Apomuden and storage in ash, grass or pit during the minor season produced substantially higher percentage tuber weight loss at 12 weeks as compared to similarly treated tubers stored under the same condition during the major season (Tables 4.34, 4.35 and 4.36).

Table 4.36a: Percentage Weight loss of Tubers in Pit Storage During the 2011 Minor Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	15.5	20.4	17.9	31.6	34.6	33.1	40.3	44.6	42.4	72.4	50.6	61.5	73.4	57.5	65.5	75.2	61.2	68.2
T 2	28.1	22.5	25.3	32.6	45.5	39.1	42.5	46.6	44.6	60.5	47.7	54.1	65.4	53.5	59.5	70.3	58.3	64.3
T 3	9.6	24.7	17.1	34.2	52.5	43.3	61.4	58.4	59.9	70.5	59.5	65.0	73.5	59.5	66.5	76.4	63.2	69.8
T 4	23.6	14.5	19.1	29.7	31.1	30.4	32.5	37.4	35.0	33.5	50.4	42.0	34.7	51.4	43.1	39.6	56.2	47.9
T 5	40.2	20.6	30.4	48.6	38.3	43.5	48.5	48.6	48.5	54.4	55.5	54.9	55.1	68.4	61.7	60.2	74.2	67.2
T 6	18.2	18.5	18.3	35.1	27.3	31.2	36.5	40.8	38.7	60.7	47.6	54.2	61.0	59.6	60.3	65.2	66.2	65.7
T 7	22.6	18.7	20.6	48.5	27.7	38.1	57.6	40.7	49.2	59.3	53.8	56.5	78.0	63.4	70.7	81.4	69.2	75.3
T 8	18.2	23.5	20.8	28.5	56.7	42.6	37.5	57.5	47.5	55.6	58.3	57.0	59.4	64.7	62.1	65.4	69.3	67.4
Mean	22.0	20.4		36.1	39.2		44.6	46.9		58.4	52.9		62.6	59.8		66.7	64.7	
LSD (P = 0.05); Variety =	0.43			0.40			0.42			0.40			0.43			0.77		
Fertilizer =	0.87			0.81			0.84			0.81			0.86			1.54		
Variety x Fertilizer =	1.23			1.15			1.19			1.15			1.22			2.18		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

Table 4.36b: Percentage Weight loss of Tubers in Pit Storage During the 2012 Major Season

Variety	Week 2			Week 4			Week 6			Week 8			Week 10			Week 12		
	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer rate																		
T 1	6.61	14.41	10.51	41.52	15.47	28.49	43.36	18.80	31.08	46.32	37.38	41.85	47.63	46.56	47.09	47.63	46.80	47.21
T 2	10.31	12.60	11.46	13.55	18.79	16.17	16.31	19.72	18.01	18.68	36.40	27.54	30.65	36.44	33.55	30.59	36.44	33.51
T 3	12.40	6.34	9.37	14.25	14.28	14.27	14.45	14.35	14.40	16.30	14.31	15.31	21.78	10.71	16.25	21.65	10.61	16.13
T 4	9.03	14.72	11.88	14.46	20.42	17.44	14.43	43.30	28.86	38.40	57.40	47.90	45.00	57.30	51.15	45.00	57.37	51.18
T 5	10.28	10.75	10.51	44.60	31.36	37.98	46.54	31.49	39.01	47.30	37.50	42.40	49.51	47.55	48.53	49.51	47.48	48.50
T 6	4.81	4.81	4.81	13.49	11.27	12.38	14.82	11.23	13.03	15.60	18.23	16.91	35.45	16.53	25.99	35.39	16.53	25.96
T 7	14.72	8.77	11.75	21.41	24.33	22.87	22.73	50.69	36.71	24.23	64.30	44.27	24.36	90.00	57.18	24.46	90.00	57.23
T 8	10.18	6.41	8.30	21.26	6.38	13.82	24.06	28.47	26.26	26.28	53.68	39.98	37.42	53.28	45.35	37.38	53.45	45.42
Mean	9.79	9.85		23.07	17.79		24.59	27.26		29.14	39.90		36.48	44.80		36.45	44.83	
LSD (P = 0.05); Variety =	NS			0.60			0.61			0.62			0.43			0.52		
Fertilizer =	0.97			1.21			1.21			1.25			0.87			1.03		
Variety x Fertilizer =	1.38			1.71			1.72			1.76			1.23			1.46		

T 1 - No fertilizer

T 2 - 10t/ha CM

T3 - 30-30-30 kg/haNPK

T 4 - 15-15-15 kg/haNPK + 5t/ha CM

T5 - 30-45-45kg/haNPK

T6 - 15-23-23kg/haNPK +5t/haCM

T7 - 30-60-60kg/haNPK

T8 - 15-30-30kg/haNPK + 5t/ha CM

4.7 Beta-Carotene Content of Sweetpotato Root Tubers

4.7.1 Beta-Carotene Content of Sweetpotato Root Tubers at Harvest

Table 4.37 shows beta-carotene content of two varieties of sweetpotato tubers at harvest as influenced by chicken manure and inorganic fertilizer. In the minor season (2011), therewas a significant difference between Apomuden from Okumkomon beta-carotene content of tubers at harvest (Appendix 14). Beta-carotene content ranged from 1.4-30.3 mg/100g for Apomuden and 1.2- 8.6 mg/100g for Okumkom. The resultshowed significant effect of organic and inorganic fertilizers either singly or in combination on beta-carotene content of tubers at harvest (Table 4.37).

In the major season (2012), therewas a significant difference between Apomuden from Okumkomon beta-carotene content of tubers at harvest (Appendix 15). Beta-carotene contents ranged from 1.1-14.9 mg/100g for Apomuden and 0.2- 0.7 mg/100g for Okumkom. Apomuden grown on both amended and the control plots produced significantly higher beta-carotene content than Okumkom at harvest The result showed significant effects of organic and inorganic fertilizers either singly or in combination on beta-carotene content of tubers at harvest for both varieties.Apomuden grown on amended and the control plots gave relatively higher beta-carotene in both seasons than Okumkom (Table 4.37).

Table 4.37:Beta-Carotene Content Of Tubers at Harvest during the 2011 minor season and 2012 major season

	Beta-Carotene of tuber at Harvest (mg/100g) (minor season)			Beta-Carotene of tuber at Harvest (mg/100g) (major season)		
Variety	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer Rates						
No fertilizer	6.1	4.1	5.1	3.1	0.4	1.7
10t/ha CM	15.4	1.4	8.4	4.3	0.3	2.3
30-30-30kg/haNPK	1.4	4.3	2.9	13.1	0.4	6.7
15-15-15 kg/haNPK + 5t/ha CM	9.3	6.1	7.7	13.3	0.4	6.9
30-45-45 kg/haNPK	4.2	1.2	2.7	14.9	0.7	7.8
15-23-23 kg/haNPK + 5t/ha CM	7.5	4.6	6.1	2.9	0.4	1.6
30-60-60 kg/haNPK	4.4	2.3	3.3	7.5	0.2	3.8
15-30-30 kg/haNPK + 5t/ha CM	30.3	8.6	19.5	1.1	0.4	0.7
Mean	9.9	4.1		14.1	1.8	
LSD (P =0.05); Variety	0.62			0.026		
Fertilizer	1.24			0.052		
Variety x Fertilizer	1.75			0.074		

4.7.2 Beta-Carotene Content of Sweetpotato Root Tubers after 12 weeks in Pit Or Ash Storage

Table 4.38 shows beta-carotene content of two varieties of sweetpotato tubers for 12 weeks in pit and ash storage as influenced by chicken manure and inorganic fertilizers. In the minor season (2011), there was a significant difference between Apomuden and Okumkom for beta-carotene content of tubers in pit storage (Appendix 16). Okumkom grown on control treatment as well as amendments except 10 t/ha CM, 15-15-15 kg/ha NPK + 5t/haCM and 30-45-45kg/ha NPK recorded zero values for beta carotene and the control on beta carotene of tuberafter 12 weeks in pit storage. There was a significant effect of organic and inorganic fertilizers either singly or in combination on beta-carotene content of tubers in pit storage.

In the major season (2012), there was a significant difference between Apomuden from Okumkomon beta-carotene content of tubers in pit storage (Appendix 17). Application of 15-23-23kg/ha NPK +5t/ha CM to Apomuden which had the highest (21.07 mg/100g) beta-carotene content of tubers differed significantly from the control in pit storage at 12 weeks. Okumkom grown on 30-60-60 kg/ha NPK plot had the highest beta-carotene content (2.87mg/100g) of tubers followed by 15-23-23 kg/haNPK+5t/ha CM (2.73 mg/100g) with the lowest (0.48 mg/100g) beta-carotene recorded by 15-15-15kg/haNPK+5t/ha CM tubers at 12 weeks in pit storage. There was significant difference in variety x fertilizer interaction on beta-carotene content of tubers at 12 weeks in pit storage.There was a relatively higher beta-carotene in Apomuden grown on amended and the control plots after 12 weeks of pit storage during the minor and the major seasons than Okumkom under similar treatments. There was a relatively higher beta-carotene in

Apomuden treated with amended and the control plots and stored in pit for 12 weeks in the minor season than at harvest except for 30-45-45 kg/ha NPKplot (Table 4.38).

In the case of ash storage, Apomuden and Okumkom stored in ash did not store well recording zero values after 12 weeks in storage for beta carotene content of tubers during the minor season (Table 4.38). In the major season (2012), Apomuden tubers produced on amendment treatments except 15-23-23 kg/ha NPK+5t/ha CM and the control and stored in ash did not store well recording zero beta carotene at 12 weeks of storage. There was significant difference in variety x fertilizer interaction for beta-carotene content of tubers at 12 weeks in ash storage. Pit storage was the most effective storage method in terms of tuber beta-carotene content followed by ash storage with the least beta carotene by grass storage at 12 weeks of storage (Table 4.38).

4.8 Percentage Sugar Content of Sweetpotato RootTubers At Harvest and After 12 Weeks of Storage in Ash, Grass orPit During 2011 minor season and 2012 major season

4.8.1 Percentage Sugar Content of Root Tubers at Harvest

The results of percentage sugar content of tubers at harvest as influenced by chicken manure, inorganic fertilizers and variety is presented in Table 4.39. In the minor season (2011), there was a significant difference between Okumkom and Apomuden in percentage sugar content of tubers at harvest Apomuden grown on 15-23-23 kg/haNPK+ 5t/ha CM plot had the highest (13.5%) percentage sugar content of tubers at harvest with the lowest (10.0%) sugar content recorded by tubers grown on 30-45-45kg/haNPK tubers.

Table 4.38: Beta-Carotene Content of Sweetpotato Tubers Stored in Pit and Ash for 12 weeks during 2011 minor season and 2012 major season

	Beta-Carotene of tuber at12 weeks in storage – Pit (mg/100g) (minor season)			Beta-Carotene of tuber at 12 weeks in storage – Pit (mg/100g) (major season)			Beta-Carotene of tuber at 12 weeks in storage –Ash (mg/100g) (major season)		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomd	Okumk	Mean
Fertilizer Rates									
No fertilizer	25.4	0.0	12.7	4.26	1.83	3.04	0.0	0.0	0.0
10t/ha CM	28.7	25.2	27.0	17.6	1.79	9.72	0.0	2.19	1.09
30-30-30 kg/haNPK	36.1	0.0	18.0	10.57	1.55	6.06	0.0	2.03	1.01
15-15-15 kg/haNPK + 5t/ha CM	32.2	0.2	16.2	16.48	0.48	8.48	0.0	2.26	1.13
30-45-45 kg/haNPK	31.5	0.1	15.7	15.78	1.40	8.59	0.0	1.53	0.76
15-23-23 kg/haNPK + 5t/ha CM	34.5	0.0	17.2	21.07	2.73	11.90	1.54	0.0	0.77
30-60-60 kg/haNPK	5.5	0.0	2.7	14.78	2.87	8.82	0.0	1.31	0.65
15-30-30 kg/haNPK + 5t/ha CM	32.6	0.0	16.3	12.40	1.76	7.08	0.0	0.0	0.0
Mean	28.3	3.2		14.12	1.80		0.19	1.16	
LSD (P =0.05); Variety	0.49			0.02			0.003		
Fertilizer	0.98			0.04			0.007		
Variety x Fertilizer	1.39			0.0			0.010		

Application of 10t/ha CM to Okumkom gave the highest (24.5%) percentage sugar content of tuber at harvest and differed significantly from the other amendment treatments and the control. There was a significant difference in variety x fertilizer in percentage sugar content of tubers at harvest (Table 4.39).

In the major season (2012), there was a significant difference between Okumkom and Apomuden in percentage sugar content of tubers at harvest. Application of 30-45-45 kg/haNPK to Apomuden gave the highest (11.7%) percentage sugar content of tuber at harvest followed by 15-15-15kg/haNPK+5t/ha CM tubers (11.0%) which differed significantly from the control tubers. Okumkom grown on 30-30-30kg/haNPK, 30-45-45kg/haNPK and 30-60-60 kg/haNPK treatments recorded the same and the highest (12.0 %) percentage sugar content of tuber at harvest and the lowest (11.0%) sugar content recorded by 10t/ha CM and 15-30-30kg/haNPK+5t/ha CM tubers. There was a significant difference in variety x fertilizer interaction in percentage sugar content of tuber at harvest (Table 4.39). Generally, Apomuden and Okumkom grown on amended and unamended plots during the minor season produced substantially higher percentage sugar content of tubers at harvest than during the major season (Table 4. 39).

4.8.2 Percentage Sugar Content of Sweetpotato Root Tubers after 12 Weeks of Storage During 2011 Minor Seasonand 2012 Major Season

The result of percentage sugar of sweetpotato tubers after 12 weeks in pit or ash storage as influenced by chicken manure, inorganic fertilizers and variety is presented in Table 4.40. In the minor season (2011), there was a significant difference in variety x fertilizer interaction in percentage sugar content of tubers after 12 weeks in storage.

Table 4.39: Percentage Sugar Content OfSweetpotato Root Tubers at Harvest During 2011 Minor Season and 2012 Major Season

	Percentage Sugar of tuber at harvest (%) (minor season)			Percentage Sugar of tuber at harvest (%) (major season)		
Variety	Apomud.	Okumk.	Mean	Apomud.	Okumk.	Mean
Fertilizer Rates						
No fertilizer	12.1	17.0	14.5	9.7	11.7	10.7
10t/ha CM	11.7	24.5	18.1	8.0	11.0	9.5
30-30-30kg/haNPK	10.5	17.7	14.1	10.0	12.0	11.0
15-15-15 kg/haNPK + 5t/ha CM	12.1	19.0	15.5	11.0	11.5	11.2
30-45-45 kg/haNPK	10.0	20.0	15.0	11.7	12.0	11.8
15-23-23 kg/haNPK + 5t/ha CM	13.5	18.5	16.0	9.7	11.7	10.7
30-60-60 kg/haNPK	11.0	23.0	17.0	10.0	12.0	11.0
15-30-30 kg/haNPK + 5t/ha CM	13.0	16.5	14.7	10.7	11.0	10.8
Mean	11.7	19.5		10.1	11.6	
LSD (P =0.05); Variety	0.08			0.43		
Fertilizer	0.17			0.86		
Variety x Fertilizer	0.24			1.21		

The highest percentage (10.2%) sugar content of tubers was recorded by control tubers of Apomuden followed by 15-30-30kg/haNPK + 5t/ha CM and the lowest (8.2%) sugar content recorded by 30-45-45 kg/haNPK tubers after 12 weeks in pit storage.

However, 30-30-30 kg/haNPK and 30-60-60 kg/haNPK tubers of Apomuden did not store well recording zero values'for sugar content of tubers after 12 weeks in pit storage. Okumkom grown on 10t/ha CM recorded the highest percentage (14.2%) sugar content of tubers and differed significantly from 15-23-23kg/haNPK +5t/ha CM and 15-15-15 kg/haNPK+ 5t/ha CM tubers which recorded the lowest (11.0%) sugar content of tubers after 12 weeks in pit storage. All the other amendments and the control grown tubers of Okumkom did not store well recording zero values for sugar content of tubers after 12 weeks in pit storage (Table 4.40). Generally, Okumkom grown on amended plots and stored in pit recorded substantially higher percentage sugar content of tubers than Apomuden after 12 weeks in pit storage (Table 4.40).

In the major season (2012), there was a significant difference in variety x fertilizer interaction in percentage sugar content of tubers after 12 weeks in storage. Application of 30-45-45 kg/haNPK to Apomuden gave the highest (11.7%) percentage sugar content of tubers followed by 10t/ha CM tubers. All the other amendment except 15-15-15kg/haNPK + 5t/ha CM tubers.recorded the same mean (10.0%) after 12 weeks in pit storage. Okumkom grown on 30-45-45 kg/haNPK plot had the highest percentage (12.0%) sugar content of tuber after 12 weeks in pit storage with the lowest (11.0%) sugar content recorded by 15-30-30kg/haNPK kg/haNPK +5t/ha CM and the control tubers. However, 30-30-30 kg/haNPK and 30-60-60 kg/haNPKtubers of Okumkom did not store well recording zero values of sugar content of tuber at 12 weeks in pit storage. Generally, Okumkom grown on amendment and unamended plots recorded substantially higher percentage sugar content of tubers than Apomuden grown on the same treatment after 12 weeks in pit storage. Apomuden and Okumkom grown on amended and unamended plots and stored in pit during the major season stored better and had higher percentage sugar content of tubers than during the minor season after 12 weeks in pit storage (Table 4.40).

In the case of ash storage during the major season, Apomuden tubers produced with or without application of amenment did not store well recording zero value for ssugar content of tuber at 12 weeks in storage. Okumkom grown on 30-45-45 kg/haNPK plot had the highest (12.1%) percentage sugar content of tuber after 12 weeks in ash storage followed by 30-60-60kg/haNPK (12.0%) and the lowest (11.7%). sugar content recorded by 30-30-30kg/haNPK produced tubers. All the other amendmen tand the control grown tubers of Okumkom did not store well recording zero values for sugar content of tubers after 12 weeks in ash storage (Table 4. 40).

In both seasons Apomuden and Okumkom grown on amended and unamended plots and stored in grass did not store well recording no values after 12 weeks in storage. Pit storage was the most effective storage method followed by ash with grass storage being the least in percentage sugar content of tubers after 12 weeks in storage in both seasons (Table 4. 40).

4.9 Percentage Starch Content of Sweetpotato Root Tubers at Harvest and After 12 Weeks of Storage in Ash, Grass Or Pit During 2011 Minor Season and 2012 Major Season

4.9.1 Percentage Starch Content of Tubers at Harvest

The result of percentage sugar content of tubers at harvest as influenced by chicken manure, inorganic fertilizers and variety is presented in Table 4.41. In the minor season (2011), there was a significant difference between Okumkom and Apomuden in percentage starch content of tuber at harvest.

Table 4.40: Percentage Sugar Content of Sweetpotato Root Tubers after 12 Weeks of Storage in Pit And Ash During 2011 Minor Season and 2012 Major Season

Variety	Percentage (%) Sugar of tuber 12 weeks after storage Pit) (minor season)			Percentage (%) Sugar of tuber 12 weeks after storage (Pit) (major season)			Percentage (%) Sugar of tuber 12 weeks after storage (Ash) (major season)		
	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomd	Okumk	Mean
Fertilizer Rates									
No fertilizer	10.2	0.0	5.1	10.0	11.0	10.5	0.0	0.0	0.0
10t/ha CM	9.6	14.2	11.9	11.0	11.6	11.3	0.0	0.0	0.0
30-30-30 kg/haNPK	0.0	0.0	0.0	10.0	0.0	5.0	0.0	11.7	5.8
15-15-15 kg/haNPK + 5t/ha CM	9.7	11.0	10.3	10.5	11.7	11.1	0.0	0.0	0.0
30-45-45 kg/haNPK	9.3	0.0	4.6	11.7	12.0	11.8	0.0	12.1	6.0
15-23-23 kg/haNPK + 5t/ha CM	8.2	13.0	10.6	10.0	11.8	10.9	0.0	0.0	5.2
30-60-60 kg/haNPK	0.0	0.0	0.0	10.0	0.0	5.0	0.0	12.0	6.0
15-30-30 kg/haNPK + 5t/ha CM	10.0	0.0	5.0	10.0	11.0	10.5	0.0	0.0	0.0
Mean	7.1	4.7		10.7	8.6		0.0	4 .48	
LSD (P =0.05); Variety	0.58			0.41			0.14		
Fertilizer	1.16			0.82			0.29		
Variety x Fertilizer	1.64			1.16			0.42		

Apomuden grown on the control however, produced the highest percentage (16.8%) starch content of tubers followed by 15-23-23 kg/haNPK + 5t/ha CM and 15-30-30 kg/haNPK + 5t/ha CM tubers which had the same mean (14.9%) with the lowest (11.2%) sugar content recorded by 30-45-45 kg/haNPKtubers at harvest. Application of 10t/ha CM to Okumkom produced the highest percentage (27.9%) starch content of tubers at harvest followed by 30-60-60 kg/haNPK (25.7%) with the lowest (18.6%) starch content recorded by 15-30-30kg/haNPK + 5t/ha CM tubers. There was a significant difference in variety x fertilizer interaction in percentage starch content of tubers at harvest (Table 4.41).

In the major season (2012), there was a significant difference between Okumkom and Apomuden in percentage starch content of tuber at harvest. Application of 30-45-45kg/haNPK to Apomuden produced the highest percentage (13.2%) starch content of tubers at harvest with the lowest (9.6%) starch content recorded by 10t/ha CM tubers. However, application of 30-30-30kg/haNPK, 15-15-15kg/haNPK+5t/ha CM or 15-30-30kg/haNPK+5t/ha CM to Apomuden resulted in the same mean starch (12.0%) content. Okumkom grown on 30-45-45kg/haNPK and 30-60-60kg/haNPK plots had the highest and the same percentage (13.8%) starch content at harvest.The lowest (12.4%) percent starch content was recorded by Okumkom grown on 10t/haCM and 15-30-30kg/haNPK +5t/ha CM andwhich had the same mean. Generally, application of amendment and control to Apomuden or Okumkom during the minor season produced substantially higher percentage starch content of tubers at harvest than in the major season (Table 4.41).

Table 4.41 Percentage Starch Content of Tubers at Harvest During 2011 Minor Season and 2012 Major Season

	Percentage (%) Starch of tuber at harvest (minor season)			Percentage (%) Starch of tuber at harvest (major season)		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean
Fertilizer Rates						
No fertilizer	16.8	19.6	18.2	10.8	13.2	12.0
10t/ha CM	13.3	27.9	20.6	9.6	12.4	11.0
30-30-30kg/haNPK	11.9	20.4	16.1	12.0	13.7	12.8
15-15-15 kg/haNPK + 5t/ha CM	14.3	21.6	17.9	12.0	13.0	12.5
30-45-45 kg/haNPK	11.2	23.2	17.2	13.2	13.8	13.5
15-23-23 kg/haNPK + 5t/ha CM	14.9	20.9	17.9	10.8	13.2	12.0
30-60-60 kg/haNPK	13.2	25.7	19.4	11.0	13.8	12.4
15-30-30 kg/haNPK + 5t/ha CM	14.9	18.6	16.7	12.0	12.4	12.2
Mean	13.8	22.2		11.4	13.1	
LSD (P =0.05); Variety	1.17			0.34		
Fertilizer	0.34			0.67		
Variety x Fertilizer	0.48			0.96		

4.9.2 Percentage Starch of Sweetpotato Root Tubers after 12 Weeks of Storage in Pit, Ash or Grass Storage During the 2011 Minor and 2012 Major Seasons

The result of percentage starch content of tubers after 12 weeks in pit and ash storage as influenced by chicken manure, inorganic fertilizers and variety is presented in Table 4.42. In the minor season (2011), there was a significant difference in variety x fertilizer interaction in percentage starch content of tubers after 12 weeks of storage in pit.

Apomuden grown on 15-30-30kg/haNPK +5t/ha CM and the control plots had the highest percentage (11.5%) starch content of tubers after 12 weeks of storage in pit and differed significantly from 15-23-23kg/haNPK + 5t/ha CM which recorded the lowest percentage (9.0%) starch content of tubers. Apomuden grown on 10t/ha CM and 30-45-45kg/haNPK plots had the same percentage (10.8%) starch content of tubers after 12 weeks of storage in pit. Tubers produced from application of 30-30-30kg/haNPK and 30-60-60kg/haNPK to Apomuden did not store well recording zero mean values for stach after 12 weekso f storage in pit (Table 4.42).

Application of 10t/ha CM to Okumkom had the highest percentage (15.6%) starch content of tubers after 12 weeks of storage in pit followed by 15-23-23kg/haNPK + 5t/ha CM (13.6%) with the lowest (12.0%) starch content .recorded by 15-15-15kg/haNPK + 5t/ha CM tuber. All the other amended and unamended tubers did not store well recording zero mean values for starch after 12 weeks of storage in pit (Table 4.42).

In the major season (2012), there was a significant difference between Apomuden and Okumkom in percentage starch content of tubers after 12 weeks of storage in pi. Application of 30-45-45kg/haNPK to Apomuden produced the highest percentage (13.2%) starch content of tubers after 12 weeks of storage in pit and differed significantly from all the other amendments except 10t/ha CM and 15-15-15kg/haNPK+5t/ha CM tubers and the control which recorded the lowest and the same percentage (11.0%). starch content of tubers after 12 weeks of storage in pit. Okumkom grown on30-45-45 kg/haNPK had the highest percentage (13.8%) starch content of tubers and differed significantly from 15-30-30 kg/haNPK +5t/ha CM and the control which recorded the lowest and the same (12.0%) starch content after 12 weeks of storage in pit. Tubers produced by application of 30-30-

30kg/haNPKand 30-60-60 kg/haNPK to Okumkom did not store well recording zero mean values after 12 weeks of storage in pit (Table 4.42).

In the case of ash storage, tubers produced from application of amendment and control to both Apomuden and Okumkom during the minor season did not store well recording zero values for starch content of tuber after 12 weeks of storage. In the major season (2012), there was a significant difference in variety x fertilizer interaction in starch content of tuber after 12 weeks of storage in ash. Tubers from application of 15-23-23 kg/haNPK +5t/ha CM to Apomuden had the highest percentage (11.7%) starch content of tubers after 12 week of storage storage in ash. All the other amended and unamended tubers did not store well recording no mean values after 12 weeks ofstoragein ash. Okumkom grown on30-45-45 kg/haNPK plot had the highest percentage (14.0%) starch content of tubers at 12 weeks of storage in ash followed by 30-60-60 kg/haNPK plot (13.8%) and the lowest percentage (13.2%) starch content was recorded by 30-30-30kg/haNPK treated tubers. All the other amended and unamended tubers did not store well recording zero mean values for starch after 12 weeks of storage in ash (Table 4.42).

Generally, Pit storage proved the most effective storage method followed by ash storage with grass storage being the least in percentage starch content of tubers after 12 weeks of storage in both seasons. There was a substantial reduction in percentage starch content of tubers for both Okumkom and Apomuden grown on amended t and the control plots at 12 weeks of storage in pit than at harvest in both seasons (Table 4.42).

Table 4.42: Percentage Starch Content of Sweetpotato Root Tuber After 12 Weeks of Storage in Pit And Ash During 2011 Minor Season and 2012 Major Season

	Percentage (%) Starchof tuber 12 weeks in storage - (Pit) (minor season)			Percentage (%) Starch of tuber 12 weeks in storage- (Pit) (major season)			Percentage (%) Starch of tubers 12 weeks in storage- (Ash) (major season)		
Variety	Apomud.	Okumk.	Mean	Apomud	Okumk	Mean	Apomd	Okumk	Mean
Fertilizer Rates									
No fertilizer	11.5	0.0	5.7	11.0	12.0	11.5	0.0	0.0	0.0
10t/ha CM	10.8	15.6	13.2	12.0	13.0	12.5	0.0	0.0	0.0
30-30-30 kg/haNPK	0.0	0.0	0.0	11.0	0.0	5.5	0.0	13.2	6.6
15-15-15 kg/haNPK + 5t/ha CM	10.8	12.0	11.4	11.7	13.2	12.4	0.0	0.0	0.0
30-45-45 kg/haNPK	10.4	0.0	5.2	13.2	13.8	13.5	0.0	14.0	7.0
15-23-23 kg/haNPK + 5t/ha CM	9.0	13.6	11.3	11.0	13.4	12.2	11.7	0.0	5.8
30-60-60 kg/haNPK	0.0	0.0	0.0	11.0	0.0	5.5	0.0	13.8	6.9
15-30-30 kg/haNPK + 5t/ha CM	11.5	0.0	5.7	11.0	12.0	11.5	0.0	0.0	0.0
Mean	8.0	5.1		11.49	9.67		1.46	5.12	
LSD (P =0.05); Variety	0.60			0.45			0.14		
Fertilizer	1.21			0.91			0.29		
Variety x Fertilizer	1.72			1.29			0.42		

4.10 Correlation Matrix among Vegetative and Yield Parameters Measured on Sweetpotato at 12 Weeks after Planting and at Harvest Respectively for the 2011 Minor Season and 2012 Major Seasom

4.10.1 Correlation Matrix among Vegetative and Yield Parameters Measured on Sweetpotato at 12 Weeks after Planting and at Harvest Respectively for the 2011 Minor Season

Table 4.43 shows the relationship among number of leaves per plant, number of branches, stem diameter, vine length, marketable tuber number, marketable tuber weight, total tuber yield, average tuber diameter and average tuber weight for the minor season using correlation matrix. In the minor season (2011), there were highly significant positive correlation between 40% of the traits including total tuber weight and marketable tuber weight (0.99^{**}), number of leaves per plant and number of branches (0.89^{**}), unmarketable tuber number and unmarketable tuber weight ($0,89^{**}$), total tuber weight and marketable tuber number (0.80^{**}), marketable tuber weight and marketable tuber number (0.78^{**}), vine length and number of branches (0.64^{**}), stem diameter and number of branches (0.50^{**}), and slightly positive correlation between marketable tuber weight and average tuber diameter (0.46^{**}), and, total tuber weight and average tuber diameter (0.42^{**}). However, negative correlation occurred between number of branches and number of unmarketable tubers (-0.46^{**}). Again, vine length and number of unmarketable tubers showed negative correlation (-0.44**), number of leaves per plant and number of unmarketable tubers (-0.43^{**}), number of leaves per plant and marketable tuber number (-0.20). Generally, the vegetative growth was negatively correlated with tuber weight and market quality. While tuber market quality was highly positively correlated with total weight of tuber. The vegetative characters were positively and significantly correlated with each other (Table 4.43).

4.10.2 Correlation Matrix among Vegetative and Yield Parameters Measured on Sweetpotato at 12 Weeks after Planting and at Harvest Respectively for the 2012 Major Season

Table 4.44 shows the relationship among number of leaves per plant, number of branches, stem diameter, vine length, marketable tuber number, marketable tuber weight, total tuber yield, average tuber diameter, and average tuber weight for the minor season using correlation matrix. In the major season (2012), there were highly significant positive correlation between 40% of the traits including total tuber weight and marketable tuber weight (0.98**), number of leaves per plant and number of branches (0.93**), unmarketarble tuber number and unmarketable tuber weight (0,91**), total tuber weight and marketable tuber number (0.71 **), marketable tuber weight and marketable tuber number (0.70**), marketable tuber weight and average tuber diameter (0.0.68**), and, total tuber weight and average tuber diameter (0.0.66**), and slightly positive correlation between vine length and number of branches (0.49**), stem diameter and number of branches (0.39**). However, negative correlation occurred between number of branches and number of unmarketable tubers (-0.26). Again, number of leaves per plant and marketable tuber number showed negative correlation (-0.22), as did stem diameter and marketable tuber weight (-0.15). Generally, the vegetative growth was negatively correlated with tuber weight and market quality. While tuber market quality was highly positively correlated with total weight of tuber. The vegetative characters were positively and significantly correlated with each other (Table 4.44).

4.11 Partial budget analysis of sweetpotato as affected by chicken manure and inorganic fertilizer for the 2011 minor and 2012 major seasons

Table 4 45 shows the information used for the partial budget analysed for both Apomuden and Okumkom varieties of sweetpotato for the minor and major growing seasons. Apomuden and Okumkom grown on 30-30-30 kg/ha NPK during the minor and major growing seasons dorminated over the other amended and the control plots except during the minor season in which the unamended plot dominated over the amended plots (Tables 4.45,4 .46, 4.47 and 4. 48). In the 2011 minor season, application of 30-30-30 kg/ha NPK to Apomuden for every GH¢ 1.0 incurred as cost of applying the inorganic fertilizer you regain GH¢ 1.0 and get GH¢ 298.30 as profit. In the case of 2012 major season, for every GH¢ 1.0 incurred as cost of applying 30-30-30 kg/ha NPK you regain GH¢ 1.0 and get GH¢ 32.04 as profit for Apomuden and GH¢ 1761.61 for Okumkom respectively.

Table 4.43 Correlation Matrix among Growth and Yield Parameters During the 2011 Minor Season

	1	2	3	4	5	6	7	8	9	10	11
1. Total yield of tubers											
2. Ave. tuber diameter	0.42**										
3. Marketable tuber number	0.80**	0.01									
4. Marketable tuberweight	0.99**	0.46**	0.78**								
5. Number of branches	-0.11	0.37**	-0.18	-0.07							
6. Number of leaves per plant	-0.16	0.33**	-0.20	-0.12	0.89**						
7. Stem diameter	-0.05	0.25*	-0.23	-0.02	0.50**	0.48**					
8. Unmarketable tuber number	0.24*	-0.34**	0.35**	0.13	-0.46**	-0.43**	-0.36**				
9. Unmarketable tuber weight	0.23	-0.19	0.29*	0.11	-0.30**	-0.29**	-0.26*	0.89**			
10. Vine length	0.02	0.37**	-0.09	0.07	0.64**	0.56**	0.42**	-0.44**	-0.32**		
11. Ave. tuber weight	0.56**	0.51**	0.15	0.58**	-0.13	-0.21	0.03	-0.07	-0.07	0.08	

* Significant at 1%

** Significant at 5%

Table 4.44 Correlation Matrix among Growth and Yield Parameters During the 2012 Major Season

	1	2	3	4	5	6	7	8	9	10	11
1.Total yield of tubers											
2. Ave. tuber diameter	0.66**										
3.Marketable number	0.71**	0.32*									
4. Marketable weight	0.98**	0.68**	0.70**								
5.Number of branches	-0.13	-0.16	-0.26	-0.21							
6.Number of leaves	-0.12	-0.17	-0.22	-0.18	0.93**						
7. Stem diameter	0.09	0.12	-0.15	0.08	0.39**	0.31*					
8.Unmarketable number	0.36**	0.03	0.37**	0.24	0.34**	0.32*	0.10				
9.Unmarketable weight	0.38**	0.04	0.30*	0.24	0.46**	0.48**	0.13	0.91**			
10. Vine length	0.34**	0.36**	0.07	0.30*	0.49**	0.47**	0.45**	0.35**	0.39**		
11. Ave. tuber weight	0.70**	0.84**	0.35**	0.73**	-0.26	-0.25	0.02	0.02	0.02	0.27*	

* Significant at 1%

** Significant at 5%

Table 4.45: Information used for the partial budget analysis

Variable	Quantity/Amount
1. Farm gate price of sweetpotato(t^{-1})	GH¢450.00
2. Fertilizer cost	
• 1 bag (50kg) of 15-15-15 NPK	GH¢100.00
3. Poultry manure (1 tonne)	GH¢100.00
4. Labour for inorganic fertilizer and chicken manure application	10 man days ha^{-1}
• Labour cost for application (man day^{-1})	GH¢300.00
5. Transportation cost	
• 1 bag (50kg) of inorganic fertilizer	GH¢10.00
• 1 tonne chicken manure	GH₵30.00

Table 4.46: Partial budget analysis for Apomuden variety of sweet potato as affected by inorganic fertilizer and chicken manure during 2011 minor season

	No fertilizer (control)	**10tlha CM**	**30-30-30 kg/ha NPK**	**15-15-15 kg/ha NPK + 5t/ha CM**	**30-45-45 kg/ha NPK**	**15-23-23 kg/ha NPK + 5t/ha CM**	**30-60-60 kg/ha NPK**	**15-30-30 kg/ha NPK + 5t/ha CM**
Gross benefits								
Yield (t ha^{-1})	35.0	25.0	41.0	38.0	36.0	31.0	34.0	28.0
Adjusted yield (85%) (t ha^{-1})	29.75	21.25	34.85	32.3	30.6	26.35	28.9	23.8
Total Gross Benefit (TGB) (₵ × 10^3 ha^{-1})	13387.5	9562.5	15682.5	14535	13770	11857.5	13005	10710
Variable Cost								
Fertilizer cost (₵ × 10^3 ha^{-1})								
NPK	0	0	250	125	375	187.5	500	250
Poultry manure	0	1000	0	500	0	500	0	500
Application Cost (IFR + PM) (₵ × 10^3 ha^{-1})	0	300	300	300	300	300	300	300
Transportation Cost (₵ × 10^3 ha^{-1})								
NPK	0	0	25	12.5	37.5	18.75	50	25
CM	0	300	0	150	0	150	0	150
Total Variable Cost (TVC) (₵ × 10^3 ha^{-1})	0	1600	575	1087.5	712.5	1156.25	850	1225
Net Benefit (TGB-TVC) (₵ × 10^3 ha^{-1})	13387.5	7962.5	15107.5	13447.5	13057.5	10701.25	12155	9485
Marginal Rate of Return (MRR)	*No fertilizer (control)*	*30-30-30 kg/ha NPK*	*30-45-45 kg/ha NPK*	*30-60-60 kg/ha NPK*	*15-15-15 kg/ha NPK + 5t/ha CM*	*15-23-23 kg/ha NPK + 5t/ha CM*	*15-30-30 kg/ha NPK + 5t/ha CM*	*10 t/ha CM*
TVC (₵ × 10^3 ha^{-1})	0	575	712.5	850	1087.5	1156.25	1225	1600
Net Benefit (₵ × 10^3 ha^{-1})	13387.5	15107.5	13057.5	12155	447.5	10701.25	9485	7962.5
MRR (%) = ΔNB/ΔTVC × 100		299.13	D*	D	D	D	D	D

*D = Dominated; MRR of *30-30-30 kg/ha NPK + control*

Table 4.47 Partial budget analysis for Okumkom variety of sweet potato as affected by inorganic fertilizer and chicken manure during 2011 minor season

	No fertilizer (control)	10tlha CM	30-30-30 kg/ha NPK	15-15-15 kg/ha NPK + 5t/ha CM	30-45-45 kg/ha NPK	15-23-23 kg/ha NPK + 5t/ha CM	30-60-60 kg/ha NPK	15-30-30 kg/ha NPK + 5t/ha CM
Gross benefits								
Yield (t ha^{-1})	26	16	20	15	25	27	22	23
Adjusted yield (85%) (t ha^{-1})	22.0	13.6	17	12.75	21.25	22.95	18.7	19.55
Total Gross Benefit (TGB) (₵ × 10^3 ha^{-1})	9900	6120	7650	5737.5	9562.5	10327.5	8415	8797.5
Variable Cost								
Fertilizer cost (₵ × 10^3 ha^{-1})								
• NPK	0	0	250	125	375	187.5	500	250
• Chicken manure	0	1000	0	500	0	500	0	500
Application Cost (IFR + PM) (₵ × 10^3 ha^{-1})	0	300	300	300	300	300	300	300
Transportation Cost (₵ × 10^3 ha^{-1})								
• NPK	0	0	25	12.5	37.5	18.75	50	25
• CM	0	300	0	150	0	150	0	150
Total Variable Cost (TVC) (₵ × 10^3 ha^{-1})	0	1600	575	1087.5	712.5	1156.25	850	1225
Net Benefit (TGB-TVC) (₵ × 10^3 ha^{-1})	9900	4520	7075	4650	8850	9171.25	7565	7572.5
Marginal Rate of Return (MRR)	*No fertilizer (control)*	*30-30-30 kg/ha NPK*	*30-45-45 kg/ha NPK*	*30-60-60 kg/ha NPK*	*15-15-15 kg/ha NPK + 5t/ha CM*	*15-23-23 kg/ha NPK + 5t/ha CM*	*15-30-30 kg/ha NPK + 5t/ha CM*	*10 t/ha CM*
TVC (₵ × 10^3 ha^{-1})	0	575	712.5	850	1087.5	1156.25	1225	1600
Net Benefit (₵ × 10^3 ha^{-1})	9900	5545	5025	6800	8475	9171.25	7190	7197
MRR (%) = ΔNB/ΔTVC × 100	D*	D	D	D	D	D	D	D

*D = Dominated; MRR of control over amended plots

Table 4 48: Partial budget analysis for Apomuden variety of sweet potato as affected by inorganic fertilizer and chicken manure during 2012 major season

	No fertilizer (control)	10tlha CM	30-30-30 kg/ha NPK	15-15-15 kg/ha NPK + 5t/ha CM	30-45-45 kg/ha NPK	15-23-23 kg/ha NPK + 5t/ha CM	30-60-60 kg/ha NPK	15-30-30 kg/ha NPK + 5t/ha CM
Gross benefits								
Yield (t ha^{-1})	59	64	61	65	25	27	22	23
Adjusted yield(85%) (t ha^{-1})	50.15	54.4	51.85	55.25	21.25	22.95	18.7	19.55
Total Gross Benefit (TGB) (₵ × 10^3 ha^{-1})	22567.5	24480	23332.5	24862.5	17212.5	22185	26775	32895
Variable Cost								
Fertilizer cost (₵ × 10^3 ha^{-1})								
• NPK	0	0	250	125	375	187.5	500	250
• Chicken manure	0	1000	0	500	0	500	0	500
Application Cost (IFR + PM) (₵ × 10^3 ha^{-1})	0	300	300	300	300	300	300	300
Transportation Cost (₵ × 10^3 ha^{-1})								
• NPK	0	0	25	12.5	37.5	18.75	50	25
• CM	0	300	0	150	0	150	0	150
Total Variable Cost (TVC) (₵ × 10^3 ha^{-1})	0	1600	575	1087.5	712.5	1156.25	850	1225
Net Benefit (TGB-TVC) (₵ × 10^3 ha^{-1})	22567.5	22880	22757.5	23775	16500	21028.75	25925	31670

Marginal Rate of Return (MRR)	*No fertilizer (control)*	*30-30-30 kg/ha NPK*	*30-45-45 kg/ha NPK*	*30-60-60 kg/ha NPK*	*15-15-15 kg/ha NPK + 5t/ha CM*	*15-23-23 kg/ha NPK + 5t/ha CM*	*15-30-30 kg/ha NPK + 5t/ha CM*	*10 t/ha CM*
TVC (₵ × 10^3 ha^{-1})	0	575	712.5	850	1087.5	1156.25	1225	1600
Net Benefit (₵ × 10^3 ha^{-1})	22567.5	22757.5	16500	25925	23775	21028.75	31670	22880
MRR (%) = ΔNB/ΔTVC × 100		33.04	D*	D	D	D	D	D

*D = Dominated; MRR of *30-30-30 kg/ha NPK* + over control

Table 4.49: Partial budget analysis for Okumkom variety of sweet potato as affected by inorganic fertilizer and chicken manure during 2012 major season

	No fertilizer (control)	10tlha CM	30-30-30 kg/ha NPK	15-15-15 kg/ha NPK + 5t/ha CM	30-45-45 kg/ha NPK	15-23-23 kg/ha NPK + 5t/ha CM	30-60-60 kg/ha NPK	15-30-30 kg/ha NPK + 5t/ha CM
Gross benefits								
Yield (t ha^{-1})	38	52	66	49	62	85	93	89.3
Adjusted yield (85%) (t ha^{-1})	32.3	44.2	56.1	41.65	52.7	72.25	79.1	75.9
Total Gross Benefit (TGB) (₵ × 10^3 ha^{-1})	14535	19890	25245	18742.5	23715	32512.5	35595	34155
Variable Cost								
Fertilizer cost (₵ × 10^3 ha^{-1})								
• NPK	0	0	250	125	375	187.5	500	250
• Chicken manure	0	1000	0	500	0	500	0	500
Application Cost (IFR + PM) (₵ × 10^3 ha^{-1})	0	300	300	300	300	300	300	300
Transportation Cost (₵ × 10^3 ha^{-1})								
• NPK	0	0	25	12.5	37.5	18.75	50	25
• CM	0	300	0	150	0	150	0	150
Total Variable Cost (TVC) (₵ × 10^3 ha^{-1})	0	1600	575	1087.5	712.5	1156.25	850	1225
Net Benefit (TGB-TVC) (₵ × 10^3 ha^{-1})	14535	18290	24670	17655	23002.5	31356.25	34745	32930

Marginal Rate of Return (MRR)	*No fertilizer (control)*	*30-30-30 kg/ha NPK*	*30-45-45 kg/ha NPK*	*30-60-60 kg/ha NPK*	*15-15-15 kg/ha NPK + 5t/ha CM*	*15-23-23 kg/ha NPK + 5t/ha CM*	*15-30-30 kg/ha NPK + 5t/ha CM*	*10 t/ha CM*
TVC (₵ × 10^3 ha^{-1})	0	575	712.5	850	1087.5	1156.25	1225	1600
Net Benefit (₵ × 10^3 ha^{-1})	14535	24670	23002.3	34745	17655	31356.25	32930	18290
MRR (%) = ΔNB/ΔTVC × 100		1762.61	D*	D	D	D	D	D

*D = Dominated; MRR of 30-30-30 kg/ha NPK + over control

CHAPTER FIVE

5.0 DISCUSSION

The effect of chicken manure and inorganic fertilizer on the growth of sweetpotato revealed that percentage crop establishment during the minor and the major growing seasonsfortwo sweetpotato varieties (Apomuden and Okumkom) ranged from (59.2 – 78.8) and (53.5 – 85.5), respectively. Organic and inorganic fertilization either singly or in combination did not significantly influence crop establishment across growing seasons and cultivars. The healthy and actively growing parts of vines used as planting materials might have accounted for the high percentage crop establishment. The low crop establishment experienced for Apomuden grown on 30-30-30 kg/haNPK or 10 t/ha CM during the major growing season might be due to differences in variety and its response to soil nutrient coupled with initial low rainfall during the 2012 major season. According to Jassens (2001); Degras (2003) there is the need to use healthy and actively growing portions of planting material (Vines) and appropriate spacing as well as reduce weed competition for good plant growth later during the seasons. Percentage crop establishment for Okumkom planted and supplied with 30 – 45 – 45 kg/haNPK was lowest in both seasons. These results obtained at both experimental sites and growing seasons were similar to those found by Buresh et al., (1997), and Palm et al., (1997), who observed that the combinations of poultry manure with mineral fertilizers were more often than not more effective in supporting plant growth and yield than equivalents of manure nutrients alone or those of sole applied inorganic fertilizers. Okumkom grown on amended plots during the major season generally produced higher percentage crop establishment than those in the minor season. The high total monthly rainfall values recorded during the major season (April –

July) as compared to minor season in 2011 (September – December). (Tables 3.1 and 3.2), and cultivar differences might have contributed to such high percentage crop establishment.

Leaf number of Okumkom cultivar grown during the minor season on the amended treatments with the exception of 10t/haCM was significantly higher than the control. Significant difference in plant growth observed between amended and unamended (control) plots could be attributed to differences in organic matter and effective cation exchange capacity (ECEC) (SRI – CSIR – 2003). Apomuden cultivar did not show any significant difference in leaf number for the amended and the control treatments. Okumkom produced significantly higher leaf number than Apomuden across all treatments. This could be due to variety characteristics. Apomuden and Okumkom planted on amended plots with exception of 30-30-30 kg/haNPK and 10tlha CM gave higher leaf numbers than the control at 12 WAP during the major season. The relatively lower soil fertility status, especially, exchangeable Ca and low effective cation exchange capacity (E.C.E.C) in chicken manure during the major growing season might have contributed to the low plant growth and leaf appearance in 10t/haCM treatment. Calcium functions in plant as an essential part of plant cell structure, provides the normal transport and retention of other elements as well as strength in the plant. Generally, both cultivars planted on amended and control plots during the major season produced significantly higher leaf numbers than during the minor season. This observation might be attributed to high rainfall that resulted in better soil moisture supply coupled with a relatively higher soil N especially at the early planting stage of sweetpotato during the major season leading to better nutrient availability. According to Maynard and Hill (2000,) excessive rain or nitrogen can lead not only to vigorous vine growth but also result in poorly developed stringy root tubers.

Number of vine branches, vine diameter and vine length of both sweetpotato cultivars (Okumkom and Apomuden) grown on amended treatments were significantly higher than the control in both seasons. This might be due to differences in soil fertility status through increased availability of nitrogen on manured plots. These results obtained at both sites and growing seasons were similar to the findings of Bradbury and Holloway, (1988), who reported that in sweetpotato, high nitrogen may cause luxuriant growth of the vines at the expense of storage root yield and that excessive N rates stimulate vine growth. Similarly, according to Walker and Woodson (1987), and Mukthar *et al.,* (2010), too much nitrogen could result in excessive vine growth and that application of organic and inorganic fertilizer to two cultivars of sweetpotato produced significantly different number of branches and this was attributed to differences in genetic composition of the sweetpotato varieties. Apomuden and Okumkom grown on amended and control plots during, the major season produced significantly higher number of vine branches, diameter and length over those grown under the same treatments during the minor season at 12 weeks after planting. The differences in sweetpotato growth observed in the two seasons might be attributed to high rainfall during the major season coupled with slow and effective release of nutrients from manure applied during the major season. Raemaekers (2001), indicated that vine length and growth habit of sweetpotato depend on cultivar and environment, particularly, the climate of the growing area available to the plant and the plant’s nutrition. The results obtained during the major season were similar to those found by Hartemink *et* *al.,* (2000a and 2000b,) who observed that sweetpotato response to nutrient input was greatly affected by other factors such as rainfall and number of cropping seasons.

Apomuden and Okumkom planted on 10t/ha CM had significantly lower number of branches and vine diameter than the other amended and the control plots during the minor season compared to the major season. Perhaps the initial relatively slow release of N in chicken manure as well as initial competition for nutrients by the soil microorganisms responsible for mineralization might have accounted for the significantly lower number of branches and vine diameter of both sweetpotato cultivars grown on 10t/ha CM, during the minor season. Rice and Rice (1987) indicated that the use of well rotted manure prior to planting and a pre-planting application of complete fertilizer is generally beneficial and required for good plant growth and yield.

Chlorophyll content of leaves for Apomuden treated with 15 – 23 – 23 kg/haNPK + 5t/ha CM was significantly higher than the other amended treatments and the control at 16 weeks after planting in both seasons. This result indicates positive influence of chicken manure in combination with inorganic inputs on leaf chlorophyll content over unamended soils. The significantly higher chlorophyll content of leaves observed in Apomuden than Okumkom and in the manured plots than control plots could be due to differences in varieties as well as N, Mg and presence of Zn in chicken manure. Miller *et al.,* (1970) indicated that poultry manure helps to correct Zn and Fe deficiencies in the soils and supplements NPK fertilizers in crop production. Bandel *et al.,* (1972), shared similar opinion indicating that poultry manure helps to alleviate micro-nutrient deficiencies in most soils. According to Mascianica *et al.,* (1985), and Walker and Woodson, (1987), plants need nitrogen for growth, reproduction and photosynthesis which depend directly on chlorophyll content of leaves.

Apomuden and Okumkom grown on amended and control plots during the minor season had substantially higher chlorophyll content of leaves than the major season. Probably moderate rainfall observed during the minor cropping period might have accounted for this result. The initial high rainfall experienced during the major cropping period coupled with temporary waterlogging in the field might have resulted in nitrogen deficiency through leaching of nutrients in the soil. The growth rate and dry matter partitioning between root tubers and vegetative organs of sweetpotato are sensitive to plant structure and nutrition (Wilson, 1982; Hahn and Hozyo, (1984)).

Application of 15 – 15 – 15kg/haNPK + 5t/ha CM to Apomuden resulted in significantly higher root dry weight over the other amended treatments and control at 12 WAP in both seasons. Similarly, Okumkom grown on 15 – 23 – 23kg/haNPK + 5t/ha CM had significantly higher root fresh weight than control at 12 WAP in both seasons. These results indicate positive influence of chicken manure in combination with inorganic fertilizers on vegetative biomass over sole organic and inorganic amended or unamended soils. The advantage of manured plots over control in leaf number and vine branches was reflected in dry matter accumulation. The higher number of leaves and vine branches might have enhanced effective sunlight interception for photosynthesis, hence more dry matter accumulation in manured plants than the control.

Raemaekers (2001), in a research conducted in Guadeloupe showed that the stems and leaf stalks account for the bulk of the fresh matter produce two months after planting sweetpotato cuttings. The relatively higher soil fertility status, especially the organic matter in manured plots might have accounted for higher dry matter accumulation in cultivars treated with both organic and inorganic fertilizer. According to Dick (1992), the addition of soil organic matter as amendment to cropping soil benefits soil biota by providing not only nutrients but also energy. Edwards and Neuhauster (1988) stated that organic matter in addition to supplying nutrients to plants, animal manure when converted to vermicomposts provide certain humic acids which can stimulate plant growth. In both seasons, application of organic manure in combination with inorganic fertilizer to Apomuden and Okumkom resulted in significantly higher dry matter accumulation than organic manure alone (10t/ha CM), and the control at 12 WAP. The low growth in terms of dry matter accumulation especially of Okumkom during the major season on 10t/ha CM plot might be the result of high rates of chicken manure applied to the soil. According to Igua (1985), higher rates of poultry manure rather depress sweetpotato yield. Again, the lower leaf number recorded in Okumkom and Apomuden in both seasons at 12 WAP might have resulted in decreased sunlight interception for photosynthesis hence low dry matter accumulation. Apomuden and Okumkom grown under amended plots, especially, 15 – 15 – 15kg/haNPK + 5t/ha CM and15 – 23 – 23kg/haNPK + 5t/ha CM treatments had substantially higher dry matter accumulation during the major season than the minor season at 12 WAP. The increase in dry weight observed could be attributed to better climatic conditions during the major cropping season. Perhaps the higher total monthly rainfall values during the major cropping period (April – July) in 2012 than during the minor season cropping period (September – December) in 2011 which ranged from 938.5 mm and 381.7mm respectively might have contributed to significant fresh and dry weight gains during the major season. An indication of the need for supplementary irrigation at the early growth stage, especially, at the tuber formation stage during drought periods. According to Degras (2003), sweetpotatoes need uniform irrigation water per week for normal growth, especially, during transplant establishment and root development to reduce incidence of disease. Raemaekers (2001) also indicated that the growth potential of sweetpotato and for that matter differences in dry weight depend on cultivar and environment. Generally, the high percentage crop establishment coupled with increased number of leaves and chlorophyll content of leaves in manured plots might have also contributed to the high dry matter accumulation.

Integrated fertility management schemes of mineral fertility and organic manure (chicken manure) and manure nutrients alone did not influence days to 50% flowering of Okumkom grown in both seasons. This observation could be attributed to differences in cultivars characteristics. Apomuden grown on amended plots, especially, 15 – 15 – 15kg/haNPK + 5t/ha CM, 15 – 30 – 30kg/haNPK + 5t/ha CM, 30-60-60 kg/haNPK and 10t/ha CM during the major season were earlier to flower than those grown on the same treatments during the minor season.

This observation might be due to differences in phosphorus, nitrogen and presence of boron in chicken manure. Nelson and Tisdale (1979) indicated that poultry manure contains some minor nutrients such as iron, boron, copper and zinc. Mascianica *et al.*, (1985) and Walker and Woodson (1987), have also indicated the need for nitrogen for plant growth, reproduction and photosynthesis. Degras (2003) indicated that phosphorus is essential for energy transfer in plants and helps early growth and plant maturation including flowering. Okumkon was not influenced by soil nutrient supply to flower. This might be attributed to the fact that sweetpotato varieties utilize nutrient differently due to differences in genetic make-up.

Apomuden and Okumkom grown on amended plots in both seasons had significantly higher fresh vine weight at harvest than the control except for Apomuden grown on 30 – 30 – 30kg/haNPK during the minor season. This result is similar to the findings of Raemaekers (2001) and Edwards and Neuhauser (1988), and followed the trends in leaf number, number of branches, vine length, fresh vine weight gain and dry matter accumulation. The effect of organic and inorganic fertilization either singly or in combination on Okumkom was manifested as a significantly higher influence on fresh vine weight at harvest over Apomuden across both cropping periods except 15 – 15 – 15 kg/haNPK +5t/ha CM. This might be due to differences in cultivar characteristics.

Apomuden and Okumkom grown on amended and control plots during the minor season had significantly higher fresh vine weight at harvest than during the major season in 2012 although 15-15-15kg/haNPK + 5t/ha CM and 15-23-23kg/haNPK + 5t/ha CM had the highest fresh vine weight. The relatively high initial levels of soil nutrients, especially, total exchangeable Ca, Mg and ECEC at the experimental site during the minor cropping season might have accounted for these results obtained. Chicken manure and NPK fertilizer further improved the chemical properties of the soil resulting in high fresh vine weight at harvest.

Correlation analyses for both seasons show that the vegetative growth was negatively correlated with tuber weight and market quality, while tuber market quality was highly positively correlated with total weight of tuber. The vegetative characters were positively and significantly correlated. This suggests a weak association among number of leaves and yield parameters. This observation might be due to high soil nitrogen. According to Nandpuri *et al*., (1971) and Sanchez (1973) high nitrogen encourages vine growth and tends to cause a decline in yields.

Crop yield is a measurement of the amount of a crop that was harvested per unit of land area and is normally measured in metric tonnes per hectoare or kilograms per hectare. In both seasons Apomuden grown on chicken manure and inorganic fertilizer alone 10t/ha CM and 30 – 30 – 30 kg/haNPK respectively and combination of organic and inorganic fertilizer, 15 – 15 – 15 kg/haNPK + 5t/ha CM had significantly higher marketable tuber numbers than Okumkom grown on the same treatments. Hartemink *et al.*, (2000) have reported of significant marketable tuber increases with both poultry manure and inorganic nitrogen inputs. But for the relatively lower soil fertility status, especially, nitrogen and ECEC (SRI, 2007), at both sites, the amended treatments would have supported better root tuber formation in terms of root tuber numbers and weight as observed. These results obtained at both sites were similar to those found by SRI – CSIR (2003), which observed that when the soil nitrogen level is zero or low increasing nitrogen fertilization is beneficial to yield and that nitrogen affects the number and weight of tuberous roots. Mukthar *et al.*, (2010) similarly indicated that addition of organic matter in combination with fertilizer can create a beneficial interaction. The findings of Bouwkamp (1985), however indicated that sweetpotato clones utilize N differently and may require different N fertilization rates.

Generally, both sweetpotato cultivars grown on amended and control plots during the major season had marketable tuber numbers which were higher than those obtained during the minor season. The poor climatic conditions due to long periods of drought that occurred at tuber bulking stage during the cropping period (September – December) (Table 3.1) might explain the lower numbers of marketable tubers during the minor season. Hartemink *et al.,* (2000a), have indicated that rainfall can affect sweetpotato response to nutrient input. According to Degras (2003), regular irrigation of sweetpotato is required, especially during the tuber formation stage.

The number of unmarketable tubers of Apomuden grown on amended and control plots was significantly higher than Okumkom during the minor season. The differences in cultivar characteristics with regard to lower number of branches and leaf numbers of Apomuden compared with Okumkom might have accounted for late canopy closure and subsequent dryer soils and higher soil temperatures. Degras (2003) indicated that very dry soil results in small-sized tubers. Janseen (2001), also indicated that a relatively small increase in soil temperature can have direct effect on tuber quality.

Generally, both Apomuden and Okumkom grown on amended and control plots had significantly higher unmarketable tuber number during the major season than during the minor season. High initial rainfall during the major cropping period (April – July) might have negatively affected the quality of tubers. Maynard and Hill (2000) indicated that excessive rain prevent proper root formation and that luxurious growing conditions caused by excessive watering or nitrogen supply can lead to vigorous vine growth and result in poorly developed stringly roots.

The organic and inorganic fertilization either singly or in combination on both cultivars had a significant influence on tuber yield during minor cropping season. The significantly higher total tuber yield observed in Apomuden grown on amended and control plots in the minor season compared to Okumkom might be attributed to the differences in cultivar.

Over fertilization with nitrogen may lead to reduced yields as it may encourage excessive vine growth at the expense of the storage roots as observed in the major season. Nandpuri *et al.,* (1971) emphasized the significant role of fertilizer especially N on yield of sweetpotato based on the type of soil, cultivar and the climate. Apomuden grown on 15 - 30 – 30kg/haNPK + 5t/ha CM had a significantly higher total tuber yield during the major season than during the minor season which might be due to better climatic conditions coupled with perhaps the high initial fertility status of the soil (Hartemink *et al.,* (2000a) and Mukthar *et al.,* (2010).

There was no significant difference between amended and the control plots in marketable tuber weight per plot during the minor growing season. Application of 15-30-30kg/haNPK + 5t/ha CM to Apomuden produced significantly higher marketable tuber weight per plot than Okumkom grown on the other manured and the control plots during the major season. Apomuden and Okumkom grown on amended plots during the major season had higher marketable tuber weight per plot than in the minor season. This observation might be due to the high nitrogen in chicken manure. SRI – CSIR (2003) when the soil nitrogen level is zero or low increasing nitrogen fertilization affects the weight of tuberous roots.

No significant difference occurred between amended and the control plots in unmarketable tuber weight per plot during the minor season. Apomuden grown on amended and the control plots produced significantly hugher unmarketable tuber weight in the minor season than Okumkom grown on the same plots for the same season. Significant increase in unmarketable tuber weight per plot occurred between Apomuden grown on 30-60-60 kg/haNPK and 15-23-23kg/haNPK +5t/ha CM during the major growing season. Okumkom grown on amended plots except10t/ha CM, 30-30-30 kg/haNPK and 15-15-

15kg/haNPK -+ 5t/ha CM and the control differed significantly from Apomuden grown on the same plots in the major season. The significant increase in unmarketable tuber weight per plot in Okumkom compared to Apomuden might be attributed to differences in genetic composition of the two varieties. Okumkom grown on amended plots and the control plots during the major season had higher unmarketable tuber weight per plot than Okumkom on same treatments during the minor season. The excessively high rainfall experienced during the major season might have affected the tuber size. Wilson (1982) and Hahn and Hozyo (1984) indicated that sweetpotato is intolerant to high rainfall that may result in water logging especially, during tuber initiation, but the crop is at times tolerant to drought.

The total tuber yield for both varieties grown on amended treatments, especially, 10t/ha CM during the minor season was relatively lower than during the major cropping season. The high rate of chicken manure applied combined with intermittent long period of drought during the cropping season might have accounted for the low tuber yield in the 10t/ha CM plot. This result obtained during the minor cropping season with 10t/ha CM is similar to those reported by Igua (1985), who observed that over fertilization with chicken manure rather depressed yield. The high vine fresh weight at harvest might have also contributed to the low total tuber yield. The relatively high initial levels of soil nutrients, especially, total exchangeable Ca, Mg and ECEC at the experimental site during the minor cropping season might explain the high vine fresh weight at harvest. Bradbury and Holloway (1988) also observed that high luxuriant growth of the vines as a result of high nitrogen levels results in low storage root yield.

Integrated fertility management schemes of inorganic fertilizers and chicken manure did not influence marketable and unmarketable tuber diameter for both varieties although Apomuden grown on amended treatments, especially, 15 – 30 – 30kg/haNPK + 5t/ha CM and 15 – 23 – 23kg/haNPK + 5t/ha CM had higher marketable and unmarketable tuber diameter respectively in both seasons. The higher marketable tuber diameter observed especially, with Apomuden grown on amended plots than control in both seasons apparently resulted from improved soil chemical and physical properties that were induced by manure application especially, the exchangeable potassium substantiating the findings of Martin-Prevel (1989) and Perrenoud (1993), who indicated that potassium nutrition influences tuber size and also improves tuber yield by increasing tubers size. Generally, the high nitrogen level especially in chicken manure might resulted in high vine growth at the expense of tuber formation hence affecting tuber size in Apomuden grown on 15-23-23kg/haNPK + 5t/ha CM plot.

A significant difference occurred between Apomuden and Okumkom in average tuber weight in both seasons. Generally, Apomuden and Okumkom under amendment and unamended plots during the major season produced higher average tuber weight than during the minor season. This observation might be due to differences in genetic composition of the sweetpotato varieties and their response to soil nutrients coupled with better climatic conditions during the major cropping period.

Okumkom grown on amended plots had higher tuber length than the control plots in both seasons except 15 – 15 – 15 kg/haNPK + 5t/ha CM treatment. However, Apomuden grown on amended and the control plots recorded significantly higher tuber length than Okumkom in both seasons although Apomuden grown on 15 – 23 – 23 kg/haNPK +5t/ha

CM recorded the lowest tuber length in the major season. The increase in tuber length on amended plots might be due to differences in soil fertility and structural stability of the manured soil, especially, the presence of chicken manure which might have enhanced penetration of tuber in the soil combined with differences in cultivar responses to soil nutrients. Dennis *et al.,* (1993) indicated that the combination of organic and inorganic fertilizers not only improved crop yields but also improved the physical status of the soil. According to Hileman (1967) and Bonsu (1986), poultry manure improves the physical conditions of soil in terms of better water holding capacity, improved soil microbial activity, water infiltration and structural stability of the soil.

A significant difference occurred between Apomuden grown on 15-30-30 kg/haNPK + 5t/ha CM and the other amended and the control plots in tuber dry matter accumulation at harvest during the major season. The difference in tuber dry matter accumulation of Apomuden and Okumkom at harvest might be due to differences in genetic composition of varieties and their response to balanced soil nutrition coupled with better climatic conditions (Anochili (1984) and SRI-CSIR (2003). There was no significant difference between Apomuden and Okumkom grown on amended and the control plots interms of tuber dry matter accumulation at harvest in both seasons. Application of chicken manure either alone or in combination with inorganic fertilizers to especially, Apomuden during the major season led to production of substantially higher tuber dry matter accumulation at harvest than during the minor season.

Results obtained in both seasons did not elicit significant effect of the inorganic fertilizer either alone or in combination with chicken manure on either harvest index or commercial harvest index in both varieties. In both seasons Apomuden grown on 30 – 30 – 30 kg/haNPK had the highest harvest index. These results obtained might be due to the relatively high total tuber yield observed in both seasons with corresponding lower fresh vine weight at harvest. Okumkom grown on amended and unamended plots in both seasons recorded lower harvest index than Apomuden grown on the same treatments. The high vine fresh weight at harvest for Okumkom with corresponding lower total tuber yield, especially, in the minor cropping season might have resulted in this observation. Higher fresh vine weight at harvest tends to lower tuber yield and consequently lower harvest index and could be attributed to high partitioning of assimilates to vegetative biomass at the expense of tuber (sinks). Bradbury and Holloway (1988) have observed that high luxuriant growth of the vines as a result of nitrogen results in low storage root yield and cosequently lower harvest index.

Apomuden grown on amended and the control plots had higher commercial harvest index during the major season than during the minor season. This observation might be due to high soil nitrogen and potassium coupled with better climatic condition that resulted in higher marketable tuber weight and the consequent higher commercial harvest index in the major season compared to the minor season. According to SRI-CSIR (2003), balanced fertilization gives large tubers hile the number of tubers harvested decreases.

With regards to root tuber quality, there was no significant effect in variety x fertilizer interaction on market qualities in both seasons except for forked tubers, and pest infestation where significant effects were observed between varieties across both experimental sites. The significant difference between varieties in forked and pests infested tubers might be attributed to differences in genetic composition of the sweetpotato varieties. During the major season, a relatively higher percentage of tuber cracking was recorded for both Apomuden and Okumkom grown on amended and control plots than during the minor season. The slow and effective release of N especially from amended plots coupled with high total monthly rainfall values during the cropping period (April – July) could explain these observations. According to Lerner (2001), excessive amounts of N may encourage excessive vine growth and result in cracked and poor storage quality. Degras (2003) also reported that over watering of sweetpotato late in the cropping season may cause the tuber to crack.

Generally, a relatively higher percentage of rotten tuber was recorded, especially, on the amended plots during minor season for both varieties than during the major season. Although total monthly rainfall values during tuber initiation (October – November) in the minor season were relatively high, the long dry period of drought and the high maximum temperature might have resulted in higher tuber rot during the minor season than in the major season. Wilson (1982), Hahn and Hozyo (1984) and Degras (2003) indicated that under favourable conditions (optimum temperature of 30 – 34^{o} C) soil-borne bacteria destroys tuberous root that results in soft or wooly forms of rot. Okumkom grown on amended and control treatments during the major season recorded zero tuber rot. Similarly, Apomuden and Okumkom grown on 15 – 30 – 30 kg/haNPK + 5t/ha CM had zero values for rotten tubers in both seasons. These results might be attributed to differences in genetic composition of cultivars and their responses to manure treated soil and environmental adaptation.

Okumkom grown on 15 – 15 – 15kg/haNPK + 5t/ha CM had the highest forked tubers in both seasons. The organic and inorganic fertilizer inputs in terms of high N from poultry manure in the soil might have accounted for the result obtained. According to Lerner (2001), excessive amounts of N may cause excessive vine growth, misshapen roots and poor storage quality. A significantly high numbers of forked tubeer were produced during the minor season by both varieties planted on amended and control plots than during major season. This observation might be attributed to difference in climatic conditions and soil nutrient levels especially nitrogen as indicated by Lerner (2001).

Percentage deformed tubers was varied depending on the composition of NPK in the compound fertilizer. Apomuden grown on 30-45-45kg/haNPK had the highest number of deformed tubers with the lowest number of deformed tubers occurring on plots treated with 30-30-30 kg/haNPK in both seasons. Increased potassium nutrition in the soil might have accounted for the observed outcome. Kleinkopf *et al.,* (1988), and Bergmann (1992), reported that sweetpotato grown under higher K concentration results in stress at the early part of tuber bulking that leads to absorption of water due to the osmotic effects of increased tissue salt concentration and low specific gravity that result in high level of internal and external defects resulting in misshapen tubers. Okumkom and Apomuden grown on both amended and the control plots during the major season gave substantially higher percentage of deformed tubers than during the minor season. A relatively slow and effective release of nutrients from amended plots in the soil combined with better climatic condition during the major cropping period could have accounted for this observation. Kleinkopf *et al.*, (1988) observed that during water stress, the low availability of nutrients may temporarily stop tuber growth. Under good climatic condition tuber growth resumes, especially, at the active site of most active cell growth that result in malformed tubers.

The level of pest infestation for Apomuden grown on amended and the control plots was more severe than Okumkom in both seasons. The differences in variety, cultural and environmental adaptation probably accounted for this result. Rajamma and Pillar, (1991) observed that resistance traits of sweetpotato roots is strongly confounded with environmental effects, differences in tuber variety and cultural practices employed such as mounding and earthing up both at planting and during tuberous root development. Generally, the level of pest infestation of Apomuden and Okumkom grown on amended and control plots during the minor season was higher than during the major season except for Apomuden grown on 15 – 30 – 30kg/haNPK + 5t/ha CM treated plot. Although total monthly rainfall values were relatively high during the initial cropping period (September – October) during the minor season intermittent long periods of drought during root development might have resulted in high incidence of pest infestation during the minor season. The findings of CIP (1995), and Sowley (1999) indicated that weevil attack is most serious when drought persists for a long time, more especially, in the minor season and also when wet and warm conditions increase the likelihood of serious pest infestations respectively.

Mean sprouted tuber for Apomuden grown on amended and control plots was higher than Okumkom in both seasons. Generally, Apomuden grown on amended plots during the major season had higher sprouted tuber than during the minor season. Differences in variety, climatic condition and soil temperature probably accounted for this result. According to IITA (1996), high moisture content leading to high perishability of tubers, lack of storage skills which discourages production, sprouting and chilling injury during low temperature storage are some of the pre and post harvest problems associated with sweetpotato.

On sensory characteristics of cooked tubers of two sweetpotato varieties at harvest for 2011 minor season and 2012 major season the application of organic and inorganic fertilization either singly or in combination had no significant effect tuber colour, taste, texture and flavour at harvest and after cooking in both minor and major seasons for both varieties. The overall acceptability showed that Okumkom grown on 30-45-45 kg/haNPK had higher preference in both seasons than Apomuden. Okumkom's higher preference is probably due to lower sugar content of tubers and also to the fact that most of its cooking qualities were preferred to Apomuden. This result is similar to that found by Opare-Obisaw *et al.,* (2000).

Okumkom grown on 10t/haCM had the highest preference with regard to texture at harvest during the major season, while Apomuden and Okumkom grown on 15-23-23 kg/ha/NPK +5t/ha CM emerged as the best with most of its qualities preferred (colour, flavour and palatability) in both seasons. According to Thybo and Martens (2000) the sensory attributes that define cooked sweetpotato quality are internal colour, intensity of aroma and flavour, sweetness and after taste, hardness and moistness. Overall acceptability showed that Okumkom grown on 30-45-45 kg/haNPK was the most preferred (colour, taste, texture, and palatability) at harvest during the minor season. The overall acceptability of Okumkom grown on amended plots might be due to the better nutrient supply and the good climatic condition that resulted in high starch content and fibrous texture associated with low sugar content of roots. Degras (2003) indicated that starch content is influenced by climatic variations during the year and cropping season and especially location, .and that dry textured tubers are generally preferred in the tropics and in other traditional growing areas.

Apomuden grown on 15-30-30kg/haNPK + 5t/ha CM was the least accepted in both seasons. The high sugar level in Apomuden tubers, disagreeable smell experienced while being eaten, yellow colour observed after cooking and while being eaten coupled with waxy or wet texture which are not preferred by the population probably accounted for the relatively low values as reported by Degras (2003).

On beta-carotene content of sweetpotato root tubers at harvest and after 12 weeks of storage in ash, grass and pit theresults in both seasons indicate significant effects of organic and inorganic fertilization either singly or in combination on beta-carotene content of root tubers at harvestfor both varieties. The significant differences could be due to differences in cultivar, fertilizer input and climatic factors. According to Degras (2003), the range of vitamin A found in sweetpotato is quite wide and that the range of values within a specific vitamin depends primarily on cultivar, but there is strong interaction with management and environmental factors. Apomuden grown on amended and the control plots gave relatively higher beta-carotene in both seasons than Okumkom. According to Degras, (2003) N and P increase the carotene content of the tuber roots during bulking and also affect the unit weight of tuberous roots especially, under good environmental conditions.Villagaria (1999), reported that nitrogen fertilizer application for optimum Beta-carotene yield depend on variety and environmental variations.

There was a relatively higher beta-carotene in Apomuden grown on amended and the control plots and stored in pit 12 weeks of storage in minor season than at harvest except for 30-45-45kg/haNPK. The positive response of Apomuden to pit storage with regard to increase in beta-carotene in this study had similarly been reported by Tumuhimbise *et al*., (2010). Apomuden and Okumkom stored in ash did not store well recording zero values at 12 weeks of storage during the minor season. Relatively low beta-carotene values recorded by Okumkom in pit storage as well as zero values recorded by both Okumkom and Apomuden in ash storage in the minor season might probably be due to high storage temperatures. This result is similar to that found by Tumuhimbise *et al.,* (2010), who indicated that sweetpotato roots stored using methods that maintain low temperature lead to high retention of Beta-carotene. Pit storage was the most effective storage method followed by ash with the least by grass storage for beta- carotene content of tuber at 12 weeks in storage. These results might be attributed to the fact that in pit storage the tubers protected from direct sunlight and therefore the transfer of moisture was biased towards gain rather than loss while storage in grass and ash resulted in moisture losses which were also accompanied by the nutrient losses.

The starch content of the sweetpotato root tubers at harvest and after 12 weeks of storage in ash, grass and pit revealed that in both seasons there were significant effects of the chicken manure and inorganic fertilizer either alone or in combination with starch content of tuber for both varieties at harvest. The significant difference in starch content on both varieties and for the two cropping seasons might be explained in terms of differences in cultivar and climatic variations during the year and cropping season. Metabolic activity is temperature dependent for the formation of starch based on the cultivar. In both seasons significantly higher starch content was produced by Okumkom than Apomuden grown on amended and control plots at harvest although application of 30-45-45kg/haNPK and 15-

30-30kg/haNPK + 5t/ha CM to Okumkom did not show any significant effect from Apomuden in the major season. This observation could be due to differences in cultivar and their responses to soil nutrients for the formation of starch during tuber bulking. Degras (2003) indicated that there is a significant role of starch content for determination of fresh and dry matter with the range dependent on cultivar for its classification.

In both seasons there was a significant difference between Okumkom grown on amended plots and Apomuden in tuber starch content at harvest. This observation might be due to differences in cultivar. Apomuden and Okumkom grown on amended and control plots except Okumkom grown on 30-30-30kg/haNPK and 30-45-45kg/haNPK had higher tuber starch content at harvest in the minor season than in the major season. The relatively higher rainfall during the major season than the minor season combined with the amended plots might have supported faster plant growth in terms of leaf appearance during the major season. Excessive rainfall might have accounted for the excessive vine growth and delayed tuber bulking and maturation which resulted in low starch content during the major season (Bradbury and Holloway (1988).

Apomuden and Okumkom under 30- 45-45 kg/haNPK and stored in pit had the highest tuber starch content during the major season compared to the minor season. The increased starch content in both varieties under 30-45-45 kg/haNPK and storage in pit during the major season might be due to high moisture level under the pit storage during the major season as well as the influenced of P and K in the chicken manure applied during crop cultivation. .According to Degras (2003) starch content falls during tuberous root storage especially, under moisture stress and that the effectiveness of different storage treatments is closely linked with the conditions in terms of management under which the crop was grown. Starch synthesis increased with increasing K concentration up to an optimum tuber concentration of 1.8%. Kiraly (1976) and Degras (2003) indicated that P tends to increase starch synthesis and hasten maturity.

Tubers stored in pit showed the most effective storage method with regard to tuber starch content followed by ash and grass storage in that order at 12 weeks in storage in both seasons. The inability of tuber to store well under grass storage conditions might probably be due to the fact that grass storage was not protected from direct sunlight and therefore storage in grass resulted in moisture losses which were also accompanied with the nutrient losses. Bechoff (2011) indicated that post- harvest physiological processes that may affect storability include evaporation of water from the product and changes in chemical composition. Okumkom and Apomuden grown on amended and control plots and stored in pit for 12 weeks for both seasons gave a relatively low starch content compared to the starch level at harvest. The relatively low temperature especially, during the major season storage period and high respiration rate due to the long storage for tubers of both varieties stored in pit might have contributed to the drop in starch content. Starch content of tubers tends to reduce during long term storage as a result of high respiration rate. According to Degras (2003), both α–amylase and β–amylase enzymes present in tuberous root act effectively under low temperature storage conditions and have the effect of converting starch to sugars during storage thereby reducing the starch content below the level at harvest.

The sugar content of sweetpotato root tubers at harvest and after 12 weeks af storage in ash, grass and pit revealed that Apomuden and Okumkom grown on amended and the control plots had higher sugar content at harvest during the minor season than in the major season. The relatively high total maximum temperature values during the cropping season (September to December) in the minor season compared to the major season might have resulted in the higher tuber sugar content at harvest. Similarly, high soil moisture experienced during the major cropping season might have accounted for the low sugar content of tuber at harvest. Similar result was obtained by Watamabe and Nakayama (1969), who indicated that both field and storage temperature has a large impact on tuber sugar content and that high soil temperatures result in tuber sugar ends or other sugar-related problems in sweetpotato. Lehminger (1981) reported that enzymes (B- amylase) are protein compounds whose building blocks comprise principally of carbon and nitrogen. The higher organic carbon content of the soil from the minor season site implies a higher capacity for the synthesis of carbon and subsequently sugar in both varieties.

Application of chicken manure either alone or in combination with inorganic fertilizers to Okumkom and storage in pit had higher sugar content than Apomuden at 12 weeks in storage in both seasons. The significant increase in sugar content in Okumkom over Apomuden might be due to differences in cultivar and their ability to respond to manure treatment and storage condition. Degras (2003) indicated that the amount of glycosides (sugar) found in cellular and ligneous membranes of sweetpotato vary largely in accordance with the cultivar. Apomuden grown on amended and control plots and stored in pit during the major season had better storability with higher sugar content than during the minor season at 12 weeks in storage. The high relative humidity and water content in tuber coupled with low temperature in the pit during the major season storage period might have accounted for the results obtained. According to Ahn *et al*., (1980), takahat *et al.,* (1992), Woolfe (1992) and Tumuhimbese *et al.,* (2010), higher humidity during long-term storage are likely and that the extent of enzyme amylase depends on temperature and tuber water content. Pit storage was the most effective storage method followed by ash with grass storage being the least in sugar content for both cultivars at 12 weeks in storage in both seasons. Mutandwa and Tafara (2007) indicated that if quality of the stored crop and weight variation of tubers is considered then the use of soil banks (pit) is the most effective compared to ash and grass.

On storability of sweetpotato after 12 weeks under pit, ash or grass storage Apomuden grown on 15-23-23 kg/haNPK +5t/ha CM and stored under grass had the highest percentage pest infested tuber at 12 weeks of storage in both seasons. Similarily, Okumkom grown on 30-30-30 kg/haNPK and 30 -60-60 kg/haNPK and stored under grass recorded the highest pest infested tuber at 12 WAS in both seasons. Although both varieties were grown under high level of K before storage in grass, probably the high temperatures of the storage condition might have resulted in high pest infestation. According to Martin-Prevel (1989) and Perrenoud (1993) potassium nutrition influences storage quality of tuber. Kushman (1975) indicated that storage room above 19^{o} C results in loss of root quality and marketability.

Apomuden and Okumkom grown on amended and control plots had relatively higher pest infested tubers during the major season than during the minor season in all the three storage conditions at 12 WAS. The relatively high total monthly rainfall (September - November) combined with high relative humidity during the day and relatively high maximum temperature during the storage period in the major season compared to the minor season storage period (January – March of 2012) might have accounted for these observations . CIP (1995) indicated that wet and warm conditions increased the likelihood of serious pest infestation.

Okumkom grown on 15-30-30kg/haNPK + 5t/ha CM plot and stored in grass had the lowest pest infested tubers at 12 WAS in both seasons. The good keeping quality in terms of least pest infestation in Okumkom might be attributed to differences in cultivars and their response to manure treatment and storage conditions. The relatively high K from chicken manure and inorganic fertilizer used to treat tubers before storage might also contributed to the least pest infestation. According to Bergmann (1992), K promotes the thickening of tuber cell wall and growth of meristematic tissues and thus prevents penetration of the epidermis by parasites.

Apomuden grown on amended plot and stored in pit at 12 WAS recorded the highest pest infested tubers followed by Apomuden under ash storage with the least recorded by grass storage at 12 WAS in both seasons. The high pest infestation ofApomuden grown on amended plot and stored in pit might be due to the manure treatments on the tuber and storage conditions. Ahn *et al.*, (1980) indicated that the effectiveness of different storage treatments is closely linked with the conditions under which the crop was grown. In the course of the study it was observed that under the pit storage condition .apart from sweetpotato weevils which were the common pest identified among all the three storage conditions cricket and millipede were also identified, especially, during the major season which produced the result obtained.

Apomuden grown on 30-45-45kg/haNPK plot and stored in ash and pit had the highest number of rotten tubers at 12 WAS in both storage periods and differed significantly from those grown on amended and control plots. However, Okumkom grown on amended plots and stored in grass at 12 WAS in the minor season had no values rotten tubers. The highest severity of decay observed in Apomuden grown on 30- 45- 45 kg/haNPK plot and stored in ash and pit compared to other treatments might be due to high weevil damage, especially, in pit storage at 12 WAS. Apomuden and Okumkom grown on amended and control plots and stored in grass had higher number of rotten tubers followed by storage in ash with the least number recorded in pit storage during the major season than during the minor season. The severity of decay under grass storage condition might be due to the high temperatures that existed during the long-term storage period coupled with high weevil infestation (Kushman (1975), Woolfe (1992) and Tortoe *et al.*, (2010).

A significant difference in weight loss of root tubers was observed between Apomuden and Okumkom grown on amended and control plots and stored in ash, grass and pit in both seasons.

The significant difference in weight loss of root tuber might be due to cultivar differences as influenced by mineral fertilizer and organic manure application during the growth period combined with the differences in storage conditions. Weight loss of tubers for both Apomuden and Okumkom grown on amended and control plots and stored in ash, grass and pit increased linearly from the begining of storage in both season (Amoah *et al.,* 2011). Okumkom grown on 15-15-15kg/haNPK + 5t/ha CM plot and stored in ash had the highest tuber weight loss at 12 WAS in both season. This observation might be due to combined effect of organic and inorganic fertilizers applied to the tuber during growth coupled with application of ash. Biswas *et al.,* (1988) and Mutandwa and Tafara (2007) indicated that application of ash to sweetpotato tubers act as an absorbent to moisture resulting in low relative humidity in the storage condition with resultant high water loss through the tuber skin surface.

Generally, amended tubers of Apomuden stored in ash, grass and pit during the minor season storage at 12 WAS gave higher tuber weight loss than the during major season storage. This observation might be attributed to differences in cultivar, low relative humidity coupled with relatively high maximum temperature during the storage period in minor season (January – March, 2012) than during the major season storage period (September – November). High temperature under storage condition are likely to result in high rates of respiration, increased rates of metabolic breakdown which could result in increased levels of tuber weight loss. During the storage period, tuberous roots lose weight owing to respiration and transpiration (Woolfe, 1992 and Degras 2003).

Apomuden grown on 30-60-60 kg/haNPK and stored in ash, grass or pit gave the highest and the same percentage shrinkage tuber (49.3 %) at 12 WAS in the minor season. Shrinkage of tubers, especially, during the minor season storage period became apparent for both varieties only after 2 weeksof storage and rose linearly (Amoah *et al.,* 2011). Apomuden grown on amended and the control plots and stored in grass or ash differed significantly from pit storage in tuber shrinkage at 12 WAS during the major storage period. The increased tuber shrinkage in grass or ash storage for Apomuden might be due to dry storage condition coupled with increased temperature and high severity of tuber decay. Increased temperature during tuber storage results in high rates of metabolism by changing the carbohydrate composition or in the extreme case by metabolizing so much starch that air spaces form and the texture of the root becomes spongy (Takahata *et al.*, (1992) and Woolfe, (1992). The spongy texture of tubers due to high temperature might have resulted in severity of tuber decay with observed tuber shrinkage in grass and ash storage than in the pit.

Apomuden and Okumkom grown on amended and control plots and stored in pit at 12 WAS during the minor season storage period showed higher tuber shrinkage than in the major season. The relatively high total monthly temperature, low relative humidity and low total monthly rainfall during the minor season storage period (January to March, 2012) compared to the major season period, might have accounted for the high temperature under the pit storage condition. According to Woolfe (1992); Tumuhimbise *et al.*, (2010), high temperature and low relative humidity in the storage environment result in increased respiration and rapid water loss through the skin surface and lignifications of tuber cell wall.

Apomuden under amended plots except 15-15-15kg/haNPK +5t/ha CM or the control and stored in pit gave higher tuber sprouting than Okumkom grown under the same treatments at 12 WAS in both seasons. The results obtained might be due to differences in cultivar and thier responds to fertilizer and resultant physiological changes. Rees (unpublished results) indicated that sweetpotato cultivars differ very markedly in the tendency to sprout during storage. Apomuden and Okumkom grown on amended and control plots and stored in pit during the major season storage period differed significantly from ash and grass storage at 12 WAS in tuber sprout. The relatively low total monthly temperature, high relative humidity and high total monthly rainfall during the storage period in the major season compared to the minor season storage period might have resulted in humid and cool storage condition in pit. According to NSPRI (2002), low temperature storage can result in sprouting which is one of the post-harvest problems associated with sweetpotato cultivated and stored in Nigeria. Slight accumulation of water in the pit due to high rainfall observed during the major season storage period might have also contributed to high tuber sprout in pit storage. According to Dandago and Gungula (2011), accumulation of moisture in soil based technique which involves digging of pits at a certain level of inclination could lead to germination of tubers.

Okumkom grown on amended plots, especially, 15-15-15kg/haNPK +5t/ha CM and 30 – 45 – 45 kg/haNPK and stored in grass recorded zero values tuber sprout at 12 WAS in both seasons. This observation might be due to differences in cultivar and their response to amended treatment during growth combined with the dry grass used during storage of tuber. Biswas *et al.,* (1988) and Setiawate *et al.,* (1994) indicated that the effectiveness of different storage treatments is closely linked with the conditions under which the crop was grown and that storage condition are more effective when the tuberous roots have matured in dry soils. Similarly, root damage is lower if the roots are covered with humid rice straw mulch, although the roots tend to sprout. Probably the dry grass used to store tuber reduced or caused no tuber sprout in grass storage due to the dry storage condition. Apomuden and Okumkom grown on amended and control plots and stored in pit gave higher tuber sprout than under ash and grass storage at 12 WAS in both seasons. Sprouting was initiated in pit storage at two weeks of storage. This observation might be due to humid grass straw mulch as a result of high relative humidity in pit storage condition substantiating the finding of Setiawate *et al.*, (1994), and Amoah *et al., (*2010).

With regard to partial budget analysis, the application of 30-30-30 kg/ha NPK proved to be more cost effective for the production of both sweetpotato varieties in both seasons than the other amended and the control plots. This result obtained was similar to the findings of SRI-CSIR. (2003) that sweetpotato response to nutrient balances showed that when nitrogen levels are increased above zero, yield levels of sweetpotato increase, but when nitrogen levels are increased above the optimum level of 30 kg/ha to 60 or 90 kg/ha, the yield decreases, relative to the optimum rate of 30-30-30 kg/ha.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

On the basis of the results of the field and storage studies across both seasons the following conclusions were drawn:

Objective 1:

- Increased organic matter from chicken manure and inorganic fertilization in combination improved both soil physical and chemical properties compared to inorganic fertilizer alone and the control. The p^H and exchangeable cations increased with organic manure and inorganic fertilizer as mineral supplements either singly or in combination. Bulk density also decreased with chicken manure and inorganic fertilizer application. A combination of chicken manure and inorganic fertilizer is paramount for increased sweetpotato yield.

Obective 2:

- The application of chicken manure and inorganic fertilizer as mineral supplements either singly or in combination influenced the yield of sweetpotato in both vegetative biomass and fresh tuber production and enhanced sensory characteristics, tuber nutritional composition for example beta-carotene, sugar as well as starch content of tubers at harvest and after three months storage. Market quality of tubers at harvest and physiological changes or quality of tuber during storage of the two varieties of sweetpotato under three different storage conditions (pit, ash and grass) across both seasons was also improved.

- Apomuden grown on 15 – 15 – 15kg/haNPK +5t/ha CM was the earliest to flower, produced the highest fresh vine weight at harvest during the major cropping season and the highest root dry weight and marketable tubers in both seasons but produced the highest percent cracked tuber and non- sprouted tubers at harvest in the minor season.
- Apomuden grown on 15 – 30 – 30kg/haNPK + 5t/ha CM had the highest total tuber yield and tuber dry matter accumulation at harvest during the major season, the lowest percentage pest infested tubers, non- rotten tubers in both seasons and non-sprouted tubers during the minor season but produced the highest percent cracked tubers during the major cropping season.
- Okumkom grown on 15 – 23 – 23 kg/haNPK + 5t/ha CM had the highest number of branches, fresh vine weight and tuber dry matter accumulation at harvest during the major season but produced the highest percent forked tubers in both seasons.
- Both Apomuden and Okumkom grown on 10t/ha CM produced the lowest total tuber yield during the minor season at harvest in both seasons.
- Apomuden grown on 30 – 45 – 45 kg/haNPK and 30 – 30 – 30 kg/haNPK produced the highest and the lowest percent deformed tubers at harvest respectively in both seasons.
- Generally, Apomuden grown on amended and control plots gave higher levels of pest infestation at harvest in both seasons than Okumkom planted on the same treatments. However, Okumkom grown on amended plots gave higher number of vine branches, vine diameter and vine length in both seasons than Apomuden planted under similar treatments.

- Okumkom grown on both amended and control plots produced higher marketable and unmarketable tuber numbers during the major season than during the minor season.
- In both seasons correlation analyses showed that the vegetative growth was negatively correlated with tuber yield and market quality and tuber market quality was highly positively correlated with total yield of tuber. The vegetative characters were also positively and significantly correlated.
- Apomuden and Okumkom grown on amended plots produced higher percent cracked tuber and higher percentage of deformed tubers at harvest during the major season than during the minor season.
- No tuber sprouting at harvest occurred in both Apomuden and Okumkom grown on 10t/ha CM and 30 – 30 – 30 kg/haNPK plots during the major season and Okumkom grown on amended and the control plots produced no rotten tubers at harvest during the major cropping season.
- Apomuden and Okumkom grown on amended and control plots produced higher rnumber of forked, pest infested and rotten tubers at harvest during the minor season than during the major season.
- Both Apomuden and Okumkom grown on 30 – 30 – 30 kg/haNPK and 30 – 60 – 60 kg/haNPK produced no sprouted tuber at harvest during the major and minor seasons.

Objectice 3:

- On the basis of physiological quality of tuber during storage using the three storage methods, Apomuden grown on 15 – 15 – 15 kg/haNPK + 5t/ha CM and stored in pit had lower sprouted tuber than the other amended tubers at 12 WAS in both seasons.
- Higher percent rotten tubers were produced in Apomuden and Okumkom grown on amended and control plots and stored in ash at 12 WAS during the major season than during the minor season.
- Generally, both varieties showed higher percent sprouted and pest infested tubers during the major season compared to the minor season at 12 WAS.
- Tuber weight loss and tuber shrinkage increased in Apomuden grown on amended plots and stored in ash, grass or pit during the minor season at 12 WAS compared to the major season.
- There was an increase in tuber sprouting in both Apomuden and Okumkom grown on amended and control plots and stored in pit. Pest infested tubers and rotten tubers increased in both varieties stored in grass or ash compared to pit storage at 12 WAS in both seasons.

Objective 4:

- Tubers of Okumkom produced on 30 – 45 – 45 kg/ha NPKwere more acceptable at harvest and after cooking during the minor season than Apomuden on the same treatments during the major season. This suggests the need to modify the nutrient supply according to environmental conditions.

- Tubers of Apomuden and Okumkom produced on 15 – 23 – 23kg/ha NPK + 5t/ha CM emerged the overall best accepted tubers with regard to colour flavour and palatability at harvest and after cooking in both seasons.
- Sweetpotato tuber nutritional composition in terms of beta-carotene, sugar and starch contents at harvest and after 12 weeks of storage increased under chicken manure and inorganic fertilizer application. Higher beta-carotene content of tubers occurred in Apomuden grown on 15 – 30 – 30 kg/ha NPK + 5t/ha CM treatment at harvest during the minor season than Okumkom tubers produced on the same treatment in the major seasons.
- Higher beta-carotene content was obtained with Apomuden grown on both amended and control plots at harvest in both seasons than Okumkom grown on similar treatments and cropping seasons. Generally, higher beta-carotene content of tubers was obtained in Apomuden on amended and control plots and stored in pit at 12 WAS in both seasons than Okumkom. This confirms varietal difference in Beta-carotene content.
- Apomuden and Okumkom grown on amended and control plots produced higher tuber starch content at harvest during the minor season than the major season except for Apomuden grown on 30 – 30 – 30 kg/ha NPK and 30 – 45 – 45 kg/ha NPK treatments which recorded lower values in the minor season. Also, higher stuber tarch content at harvest was obtained in Okumkom compared to Apomuden grown on amended and control plots in both seasons. This suggests the influence of variety and nutrient supply on starch production in sweetpotato and also that starch production in the tubers is better in the minor season than the wet season.

- Apomuden and Okumkom grown on amended and the control plots had higher sugar content at harvest during the minor season than during the major season.

Objective 5:

- Okumkom and Apomuden grown on amended and control plots and stored in pit produced a relatively higher mean beta-carotene content at 12 WAS, especially, during the minor season than at harvest, suggesting an improvement in beta-carotene content in sweetpotato tubers under pit storage.
- Okumkom and Apomuden grown on amended and the control plots and stored in pit had a relatively lower mean tuber starch content at 12 WAS in both seasons than at harvest.
- Higher sugar content of tubers occurred in Okumkom grown under amended plots and stored in pit than Apomuden under the same treatments at 12 WAS in both seasons, although not all the amended treatments of Okumkom stored well.
- Both varieties grown under amended and control plots and stored in pit during the major season stored better in terms of tuber sugar content at 12 WAS than during the minor season.
- Pit storage appeared to be more efficient for the storage of sweetpotato tubers with regard to beta- carotene, starch and sugar content than ash or grass storage systems.

Objective 6:

- Apomuden and Okumkom grown on 30-30-30 kg/ha NPK dominated in terms of cost benefit analysis than the other amended plots and the control in both growing seasons especially in the major season.

6.2 Recommendations

On the basis of the experimental results it is recommended that:

Objective 1:

- A combination of chicken manure and inorganic fertilizer for soil fertility supplementation for sweepotato production is a better option than either chicken manure or inorganic mineral input applied singly.

Objective 2:

- Apomuden should be grown on a combination of 15 – 30 – 30 kg/haNPK + 5t/ha CM for higher marketable and total fresh tuber yields in the forest transitional zone or similar environments, while a combination of 15-23-23 kg/haNPK + 5t/ha CM and 30 – 45 + 45 kg/haNPK especially, and other amendments with Okumkom is recommended for higher vegetative biomass that can serve as animal feed in other agro-ecologies.

Objective 3:

- For effective reduction of number of rotten, sprouted and pest infested tubers, Okumkom and Apomuden tubers may be stored under ash, pit or grass storage conditions during the minor season. However, Okumkom and Apomuden on15 – 15 – 15 kg/haNPK + 5t/ha CM, especially, and stored in pit during both seasons is recommended for lower tuber sprouting during storage.
- Similarly, for effective storage of Apomuden and Okumkom on amended and control plots with regard to lower root tuber weight loss and tuber shrinkage tubers may be stored under any ofl the three storage methods during the major season.

Objective 4:

- Apomuden and Okumkom grown on amended plots, especially, 10t/ha CM, 30-30-30 kg/haNPK, 15-15-15 kg/haNPK + 5t/ha CM and 15-30-30 kg/haNPK + 5t/ha CM is recommended for no root tuber sprouting at harvest during the major and minor seasons respectively for the forest transitional zone.
- Apomuden and Okumkom under 15 – 23 – 23 kg/ha NPK + 5t/ha CM is recommended as the most preferred with regard to colour, flavour and palatability at harvest and after cooking in both seasons. However, growing Okumkom on 30 – 45 – 45 kg/ha NPK is recommended for overall best acceptable root tuber during the minor season at harvest and after cooking.
- Production of Apomuden on amended plots especially, 15 – 30 – 30 kg/ha NPK + 5t/ha CM should be promoted and attempts made to reduce the cultivation of Okumkom among rural farmers in the country, especially, during the minor season to improve vitamin A among children.

Objective 5:

- Pit storage of Apomuden and Okumkom grown on amended and control plots is recommended for both the major and the minor seasons since the concentration of beta-carotene in the tubers increased and also after storage was better than in ash or grass storage systems.
- Production of Okumkom and Apomuden on amended plots should be promoted and attempt made to increase the cultivation for high tuber starch content during the minor season whereas for production of low root tuber sugar content cultivation should be preferably done during the major season.

- For effective storage of Apomuden and Okumkom pit storage method is recommended for improved starch and sugar content of tubers after storage than in ash or grass storage methods in both seasons.

Objective 6:

- For farmers to appreciate the benefits of amendment and also for high sweetpotato yield, it is recommended that farmers should apply 30- 30- 30 kg/ha NPK on their fields.

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LIST OF APPENDICES

Appendix 1: Percentage crop establishmentduring the 2011 minor season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps stratum	3	1470.2	490.1	2.09	
Reps.*Units* stratum					
Variety	1	281.7	281.7	1.20	0.279
Fertilizer	7	796.6	113.8	0.49	0.840
Variety.Fertilizer	7	781.4	111.6	0.48	0.847
Residual	45	10546.4	234.4		
Total	63	13876.2			

Appendix 2: Number of marketable tubers during the 2011 minor season

Analysis of Variance

Source Of Variation	D.F.	S.S.	M.S.	V.R.	F Pr.
Reps Stratum	3	83.38	27.79	0.54	
Reps.*Units* Stratum					
Variety	1	232.56	232.56	4.53	0.039
Fertilizer	7	304.00	43.43	0.85	0.555
Variety.Fertilizer	7	345.19	49.31	0.96	0.471
Residual	45	2308.62	51.30		
Total	63	3273.75			

Appendix 3: Number of marketable tubers during the 2012 major season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REPS stratum	2	447.0	223.5	1.42	
REPS.*Units* stratum					
Variety	1	1419.2	1419.2	9.05	0.005
Fertilizer	7	812.3	116.0	0.74	0.640
Variety.Fertilizer	7	925.0	132.1	0.84	0.562
Residual	30	4707.0	156.9		
Total	47	8310.5			

Appendix 4: Number of unmarketable tubers during the 2011 minor season

Analysis of Variance

Source Of Variation	D.F.	S.S.	M.S.	V.R.	F Pr.
Reps Stratum	3	282.38	94.12	2.99	
Reps.*Units* Stratum					
Variety	1	1040.06	1040.06	33.03	<.001
Fertilizer	7	123.25	17.61	0.56	0.785
Variety.Fertilizer	7	148.19	21.17	0.67	0.694
Residual	45	1417.12	31.49		
Total	63	3011.00			

Appendix 5: Number of unmarketable tubers during the 2012 major season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REPS stratum	2	90.5	45.2	0.25	
REPS.*Units* stratum					
Variety	1	808.5	808.5	4.55	0.041
Fertilizer	7	3339.6	477.1	2.68	0.028
Variety.Fertilizer	7	3160.6	451.5	2.54	0.035
Residual	30	5331.5	177.7		
Total	47	12730.8			

Appendix 6: Marketable tuber weight per plot during the 2011 minor season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps Stratum	3	12.284	4.095	2.48	
Reps.*Units* Stratum					
Variety	1	8.851	8.851	5.36	0.025
Fertilizer	7	11.923	1.703	1.03	0.422
Variety.Fertilizer	7	4.754	0.679	0.41	0.890
Residual	45	74.246	1.650		
Total	63	112.058			

Appendix 7: Marketable tuber weight per plot during the 2012 major season
Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps Stratum	2	104.940	52.470	10.17	
Reps.*Units* Stratum					
Variety	1	107.700	107.700	20.87	<.001
Fertilizer	7	113.110	16.159	3.13	0.013
Variety.Fertilizer	7	95.525	13.646	2.64	0.030
Residual	30	154.820	5.161		
Total	47	576.095			

Appendix 8: Unmarketable tuber weight per plot during the 2011 minor season
Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps Stratum	3	0.14607	0.04869	2.14	
Reps.*Units* Stratum					
Variety	1	0.35775	0.35775	15.70	<.001
Fertilizer	7	0.18241	0.02606	1.14	0.354
Variety.Fertilizer	7	0.18700	0.02671	1.17	0.338
Residual	45	1.02553	0.02279		
Total	63	1.89877			

Appendix 9: Unmarketable tuber weight per plot during the 2012 major season
Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REPS stratum	2	0.8717	0.4358	2.82	
REPS.*Units* stratum					
Variety	1	1.6133	1.6133	10.43	0.003
Fertilizer	7	3.6200	0.5171	3.34	0.009
Variety.Fertilizer	7	3.6400	0.5200	3.36	0.009
Residual	30	4.6417	0.1547		
Total	47	14.3867			

Appendix 10: Average tuber weight during the 2011 minor season
Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps Stratum	3	0.080784	0.026928	4.15	
Reps.*Units* Stratum					
Variety	1	0.046991	0.046991	7.24	0.010
Fertilizer	7	0.014996	0.002142	0.33	0.936
Variety.Fertilizer	7	0.054451	0.007779	1.20	0.323
Residual	45	0.292035	0.006490		
Total	63	0.489257			

Appendix 11: Average tuber weight during the 2012 major season
Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REPS stratum	2	365604.	182802.	20.87	
REPS.*Units* stratum					
Variety	1	250724.	250724.	28.63	<.001
Fertilizer	7	71803.	10258.	1.17	0.348
Variety.Fertilizer	7	86728.	12390.	1.41	0.236
Residual	30	262764.	8759.		
Total	47	1037622.			

Appendix 12: Average tuber length during the 2011 minor season
Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps Stratum	3	125.910	41.970	4.84	
Reps.*Units* Stratum					
Variety	1	201.995	201.995	23.28	<.001
Fertilizer	7	25.180	3.597	0.41	0.888
Variety.Fertilizer	7	54.656	7.808	0.90	0.515
Residual	45	390.497	8.678		
Total	63	798.239			

Appendix 13: Average tuber length during the 2012 major season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps Stratum	2	165.688	82.844	25.95	
Reps.*Units* Stratum					
Variety	1	104.537	104.537	32.74	<.001
Fertilizer	7	37.212	5.316	1.67	0.156
Variety.Fertilizer	7	61.706	8.815	2.76	0.024
Residual	30	95.774	3.192		
Total	47	464.916			

Appendix 14: Beta-carotene content of tubers at harvest during the 2011 minor season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps stratum	3	28.683	9.561	6.31	
Reps.*Units* stratum					
Variety	1	1154.640	1154.640	762.15	<.001
Treatment	7	5534.040	790.577	521.84	<.001
Variety.Treatment	7	8106.237	1158.034	764.39	<.001
Residual	45	68.174	1.515		
Total	63	14891.774			

Appendix 15: Beta-carotene content of tubers at harvest during the 2012 major season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps stratum	2	2.812E-03	1.406E-03	0.70	
Reps.*Units* stratum					
Variety	1	6.118E+02	6.118E+02	3.063E+05	<.001
Treatment	7	3.270E+02	4.671E+01	23386.90	<.001
Variety.Treatment	7	3.138E+02	4.483E+01	22445.92	<.001
Residual	30	5.992E-02	1.997E-03		
Total	47	1.253E+03			

Appendix 16: Beta-carotene content of tubers after 12 weeks in pit storage during the 2011 minor season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps stratum	3	26.3811	8.7937	9.16	
Reps.*Units* stratum					
Variety	1	10126.6736	10126.6736	10549.01	<.001
Treatment	7	2499.1260	357.0180	371.91	<.001
Variety.Treatment	7	2408.5081	344.0726	358.42	<.001
Residual	45	43.1984	0.9600		
Total	63	15103.8873			

Appendix 17: Beta-carotene content of tubers after 12 weeks in pit storage during the 2012 major season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps stratum	2	6.050E-03	3.025E-03	2.47	
Reps.*Units* stratum					
Variety	1	1.822E+03	1.822E+03	1.487E+06	<.001
Treatment	7	2.915E+02	4.164E+01	33990.65	<.001
Variety.Treatment	7	2.674E+02	3.820E+01	31180.85	<.001
Residual	30	3.675E-02	1.225E-03		
Total	47	2.381E+03			

Appendix 18: Percentage weight loss of tubers at 12 weeks in ash storage during the 2011 minor season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps stratum	3	17.105	5.702	2.33	
Reps.*Units* stratum					
Variety	1	3445.203	3445.203	1408.32	<.001
Treatment	7	1069.489	152.784	62.45	<.001
Variety.Treatment	7	1335.142	190.735	77.97	<.001
Residual	45	110.084	2.446		
Total	63	5977.022			

Appendix 19: Percentage weight loss of tubers at 12 weeks in grass storage during the 2011 minor season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps stratum	3	6.499	2.166	0.82	
Reps.*Units* stratum					
Variety	1	3496.210	3496.210	1325.32	<.001
Treatment	7	820.141	117.163	44.41	<.001
Variety.Treatment	7	1135.930	162.276	61.51	<.001
Residual	45	118.710	2.638		
Total	63	5577.489			

Appendix 20: Percentage weight loss of tubers at 12 weeks in pit storage during the 2011 minor season

Analysis of Variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Reps stratum	3	25.100	8.367	3.57	
Reps.*Units* stratum					
Variety	1	62.182	62.182	26.53	<.001
Treatment	7	3507.916	501.131	213.83	<.001
Variety.Treatment	7	2235.074	319.296	136.25	<.001
Residual	45	105.459	2.344		
Total	63	5935.732			

APPENDIX 21: Sensory Evaluation of Sweetpotato Tubers as Influenced by Chicken manure And Inorganic Fertilizers

Panelist Code………………

Age :……………………….(Years)

Sex :……………………….(Male/Female)

ATTRIBUTES	RATING SCALE	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
Colour Appearance of the tuber flesh as it is served	1= very light 2=slightly light 3=moderate 4=Slightly intense 5=Very intense																
Taste The flavor that is experienced when the tuber is chewed	1=Very bad 2=Slightly tasty 3=Neither tasty nor tasteless 4=very tasty 5=Extremely tasty																
Flavour Is a combination of taste while chewing and swallowing tuber	1= very light 2=slightly light 3=moderate 4=Slightly intense 5=Very intense																
ATTRIBUTES	RATING SCALE	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
Texture Chew sample tuber with little action. The impression of	1=Very tender 2=Slightly tender 3=Neither tender nor tough																

texture is whether tuber breaks easily between the teeth(tenderness)or difficult to bite through(Toughness)	4=Slightly tough 5=Very tough																
Palatability Is a combination of taste and colour while chewing and swallowing the tuber	1=highly unpalatable 2=slightly unpalatable 3=neither unpalatable nor palatable 4=slightly palatable 5=highly palatable																

ATTRIBUTES	RATING SCALE	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
Overall Acceptability. Consumption of tuber with pleasure. General preference and choice of tuber	1=Highly unacceptable 2=Slightly unacceptable 3=Neither unacceptable nor acceptable 4=Slightly acceptable 5=Highly acceptable																

APPENDIX 22

CALCULATIONS

Concentration OfPurified Carotenoid Standards

The concentration of the purified carotenoids standards were spectrophotometrically determined based on their extinction coefficient ($E^1\%$) at a maximum wavelength of 450 nm. In the standard 1cm quartz cuvette, the $E^1\%$ of the supplied standards are given below

B-carotene = 2592

The concentrations of these carotenoids standards were calculated according to Beer-Lambert Law.

Conc.(ng/µl) = $\frac{ABs \ X \ 10{,}000}{E^1\%}$, where

ABs = Absorbance of the carotenoids

$E^1\%$= Extinction coefficient of the 1cm quartz cuvette.

The absorbance of the carotenoids standards were determined as shown below,

B-carotene =0.750

Concentrations of Carotenoids in the Extracts of the Different Varieties of the Sweetpotatoes.

The concentrations of the carotenoids in the extracts were calculated by comparing the concentrations and areas under the peak of the standard carotenoids with the areas under the peak of the carotenoids in the extract. The formular below was used to calculate the concentrations of the carotenoids (Rodriguez- Amaya and Kimura, 2004).

$\frac{A_x \chi C_s}{As}$ (ng/µl) ,   where

A_x = peak area of carotenoids (β-carotene)

C_s = Concentration of β-carotene standard

A_s = Peak area of the standard

Concentration (levels) of carotenoids in the White/ orange fleshed sweetpotato.

Concentration of β-carotene in the sweetpotato extracted at room temperature (OF_1)

The following parameters were used to calculate the concentration of β-carotene in the sweetpotato:

Example;

Sample weight	=	0.600 g
Volume of cold acetate	=	20 mls
Volume of petroleum spirit	=	20mls
Total (final) volume of extract	=	25mls
Volume of extract evaporated	=	2mls
Volume of reconstitution	=	800 µ

Area of β-carotene standards peak:

First area	=	175562
Second area	=	20093
Area of β-carotene peak in the extract	=	204888

Concentration of β- carotene in the orange-fleshed sweetpotato heated 50°C (OF3)

The following concentration of β- carotene in the sweetpotato was calculated based on the following:

Sample weight	=	0.9340g
Volume of cold acetate	=	25mls
Volume of petroleum spirit	=	20mls
Total volume of extract	=	20mls
Volume of extract evaporation	=	2mls
Volume of reconstitution	=	600µ/s
Concentration of β-carotene standard	=	57.870ng/20µl
Area of β-carotene standards peaks		
First area	=	175562
Second area	=	20093
Peak area of β-carotene in the extract	=	592890