# EFFECT OF PLANTING DATE AND VARIETY OF COWPEA [*Vigna unguiculata* (L.)Walp.] ON GREEN POD PRODUCTION

**BY**

**YAKUBU EMMANUEL ANSOBA**

**(10048080)**

**THIS THESIS IS SUBMITTED TO THE DEPARTMENT OF CROP SCIENCE, UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MPHIL CROP SCIENCE (HORTICULTURE OPTION)**

**CROP SCIENCE DEPARTMENT**
**COLLEGE OF AGRICULTURE AND CONSUMER SCIENCE**
**FACULTY OF AGRICULTURE**
**UNIVERSITY OF GHANA**

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# DECLARATION

I declare that I designed and executed this research work hereby submitted to the Crop Science Department of the University of Ghana Legon, for the award of Master of Philosophy in Crop Science (Horticultural option), and that it has not previously been submitted by me for a degree at this or any other university; and that all material contained has been duly acknowledged.

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**YAKUBU EMMANUEL ANSOBA**

**(Student)**

……..……

**SUPERVISOR: PROF J. C. NORMAN**

**(University of Ghana, Crop Science Department)**

……..……

**CO-SUPERVISOR: DR. R. A. L. KANTON**

**(CSIR – Savanna Agricultural Research Institute)**

……..……

**DR. C. A. AMOATEY (MRS)**

**(University of Ghana, Head of Department)**

# ABSTRACT

A study was carried out in 2012 in a Sudan savanna ecology in Ghana aimed at identifying the optimal planting dates and suitable cowpea varieties for green pod production. Six planting dates were considered starting from the onset of the rainy season (20th June, 30th June, 12th July, 25th July, 2nd August and 12th August), and four improved cowpea varieties released by Savanna Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research (CSIR) as Baawutawuta, Padi-tuya, Songotra and Zaayura. The experimental design used was a factorial Randomised Complete Block with five replications. Growth and yield parameters including plant height, stem diameter, number and weight of leaves, number and weight of branches, pods per plant, mean pod weight, pod diameter, pod length, leaf area, plant canopy and fibre content of the green pods were determined. Results indicated that the interaction effect of planting date and varieties on plant height was not significant during the early ages of plants but became significant from the fifth week onwards. Leaf area, pod diameter and fibre content of green pods were also significantly affected by interaction effect between variety and planting date. Pod length, pod number per plant and green pod yield per plant were not influenced by the interaction effect of planting dates and cowpea varieties but the different varieties responded differently to the different planting dates. The highest mean pod number per plant and green pod yield per plant did not follow the same trend as Baawutawuta recorded the highest mean pod number but was not the highest yielder per plant; while Padi-Tuya which did not produce the highest mean pod number per plant was the highest yielder per plant. The improved varieties proved to be suitable materials for green pod production but the date of planting for higher pod yield varied with variety considering the fact that Baawutawuta and Padi-Tuya produced highest pods per plant when planted on 12th August while Songotra and Zaayura recorded their highest number of pods per plant when planted on June 30th.

# DEDICATION

I dedicate this work to the sweet memories of my late wife (Madam Angelina Affi-Pungu), and to my beloved children whose love I so much cherish.

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Thanks to the Almighty God for His divine guidance, protection and good health that has brought me this far in the academic laurel.

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| | |
|---|---|
| Bno.FH | Number of branches at first harvest |
| DAP | Days after planting |
| DFF | Days to 50% flowering |
| LA | Leaf area |
| Lno.FH | Number of leaves at first harvest |
| MPW | Mean pod weight |
| PD | Pod diameter |
| PHFH | Plant height at first harvest |
| PL | Pod length |
| PltCano | Plant canopy |
| PPlt | Pods per plant |
| SDFH | Stem diameter at first harvest |
| WAS | Weeks after sowing |
| Yld/Ha | Yield per hectare |

# CHAPTER ONE

## INTRODUCTION

Cowpea [*Vigna unguiculata* (L.)Walp.] is a diploid species (2n = 2x = 22) belonging to the section catiang, subspecies *unguiculata*, genus *Vigna*, tribe *Phaseoleae* and the family *Fabaceae* (Maréchal *et al.*, 1978). Cowpea is an annual legume that belongs to the family Leguminoceae and the subfamily Papilionaceae (Cobbley, 1976).

The general classification and nomenclature of the plant has been uncertain. However, Sellsschop (1962) and Pursglove (1976) opined that all its cultivars belong to the wild cowpea, *Vigna unguiculata* (L) Walp which is indigenous to tropical Africa. Faris, (1965) also agreed that it is likely the crop was first domesticated in Africa and spread to Asia and the Mediterranean since the wild species of the crop is widely distributed in Tropical Africa. Pursglove, (1976) also reported that the Spaniards introduced cowpea to the West Indies and the United States of America. Despite all reports as above, different centres of origin of cowpea have been reported by various researchers as Central Africa, South America, Asia and Persia (Faris, 1965, Summerfield *et al.*, 1974). Davis, (1991) reported of the history of cowpea dating back to ancient West African cereal farming, 5 to 6 thousand years ago, where it was closely associated with the cultivation of sorghum and pearl millet, and therefore believed to have its origin in Africa.

In Africa, Nigeria and Niger are predominant in cowpea production and is cultivated primarily for seed, but also as a vegetable (for leafy greens, green pods, fresh shelled green peas, and shelled dried peas), a cover crop and for fodder (Duke, 1983; Davis *et al.*, 1991; Quin, 1997). Cowpea is a tropical drought tolerant crop that is well distributed throughout Central and West Africa, and Asia, but West Africa accounts for about 70% of total world production of cowpea (IITA, 1997). The drier savanna and the Sahelian region of West and Central Africa produce about 70% of cowpea's worldwide production, with Nigeria, Niger and Brazil being the largest producers (Singh *et al.*, 2002).

A wide range of soil conditions supports cowpea growth but does best on well-drained and medium fertile soils. In tropical Africa, the wild u*nguiculata* is widespread, which suggest that it was domesticated here and later to other parts of the world (Purseglove, 1976). Johnson, (1970) also reported that in Tropical Africa, the cowpea crop is mostly grown in the savanna regions and the leading producers of cowpea include Nigeria, Benin, Burkina Faso and Niger. Cowpea is comparable to corn in climatic adaptation except that it requires greater heat and as such sensitive to frost.

Though cowpea is this crop's popular name, it has a number of common names. In the United States, it is called black-eyed beans, black-eyed peas or southern peas, whereas in India and Brazil, it is referred to as lobia and caupi, respectively. In French speaking countries of Africa, Niébé is the common name, but there are local names depending on the ethnic group, such as 'niao' in Senegal, 'wakye' in Nigeria and 'luba hilu' in the Sudan. In Ghana we have local names like 'tuya',

'twue', 'teh', 'yor' and 'adua', featuring for the same crop in Dagbani, Buili, Grunie, Ga, and Akan languages respectively.

Cowpea is grown as a vegetable and both mono and poly-cropping are practiced in West Africa. Fields are located in rural areas because of cheap land and labour availability and the produce transported to both local and distant markets (Norman, 1992). Assorted meals are processed from mature cowpea pods and the immature pods eaten as vegetables. In especially the northern parts of Ghana, cowpea young leaves and shoots are eaten as spinach and that can be beneficial to consumers considering its rich nutritional and medicinal values. Fibre which is especially needed in the diet of man (Lindsay, 2010) is high in dried beans. The seed protein contents range from 23 to 32% of seed weight, rich in lysine and tryptophan, and a substantial amount of mineral and vitamins (folic acid and vitamin B) necessary for preventing birth defect during the pregnancy stage (Nielson *et al.*, 1993; Hall *et al.*, 2003). Cowpea is also known as containing a low amount of fat and high level of fibre which can prevent heart diseases by reducing the low-density lipoprotein (Phillips *et al.*, 2003). In addition, cowpea consumption increases glucose blood more slowly because of the slowly digestibility of the legume starch promoting its usage for diabetic patients (Phillips *et al.*, 2003). In the diets of most African families, cowpea constitutes an important component and also serves as a major source of cheap quality protein especially for smallholder rural dwellers that have little access to animal protein (Tanzubil, 1986).

Seeds of cowpea, leaves and green pods are used solely or in combination to prepare soups and stews. Various parts of cowpea are also used in the preparation of different meals like traditional cakes ('kose'), 'waakye' (rice and beans cooked together), and 'yorke-gari' (beans served with 'gari' – a product of cassava).

Cowpea is one of the most important grain legumes in Ghana in terms of production and consumption, and the second most important legume grown after groundnut (Tanzubil, 1986). Worldwide production of cowpeas is approximately 20 million acres and the increasing agricultural production became an urgent issue since projections suggest that the global population will reach 9 billion people by the middle of this century (Godfray *et al.*, 2010). According to the estimation, one billion people will suffer from hunger because they do not have access to food in terms of quantity (protein deficit) and quality (micronutrient deficit), while the vast majority will be living in the developing countries.

For most smallholder farmers in sub-Saharan Africa cowpea is not only a source of income but also contributes to the sustainability of cropping systems and soil fertility improvement in marginal lands through the provision of ground cover and crop residue, suppression of weeds and fixing nitrogen (Abayomi *et al.*, 2008). In West Africa, growing cowpea as a vegetable is also on part-time and in gardens as production is for both subsistence and for cash (Norman, 1992). Various types of production are practiced in Ghana as explained by Norman (1992) which includes truck farming, home gardening, market gardening, and dry season vegetable production.

Grain yields of cowpea are usually very low in Africa which range between 240 and 300 kg/ha (Rachie, 1985). However, between 1,000 and 4,000 kilogrammes of grain yield per hectare are possible under optimum conditions with plants protected against insect pests attack. Several arthropod pests seriously reduce the production potential of cowpea. It is reported that post flowering insect pests cause economically significant grain yield losses (Jackai *et al.*, 1985).

The low productivity of cowpea is also associated with the fact that farmers still grow unimproved landraces because improved landraces and locally adapted improved cultivars are unavailable (Shiringani, 2011). Norman (1992) also highlighted a range of factors that limit vegetable production. Producing cowpea as a vegetable is certainly affected by some of such factors as climate, lack of capital, lack of extension services, poor cultural practices, danger of chemicals, transportation and lack of suitable varieties. Little or no attention is also given to research and development of cowpea green pod production just as is the case with indigenous leafy vegetables in Africa (Norman, 1992, Norman, 2003 and Adebooye, 2011).

Eating of green pods has been a practice by Ghanaians since the introduction of cowpea. People, especially in the Upper East Region cook and eat fresh bean pods that are not dry, and also bean leaves plus young pods that have not yet been filled as a meal and soup respectively. These meals are prepared from only local cowpea varieties which take long periods to mature. Production of green pods is however not a common practice in the northern parts of Ghana, though one can find green beans being sold by some few vegetable venders. The introduction of cowpea

green pod production in Bawku will be of immense benefit to the population of not only Bawku but the Upper East Region and Ghana as a whole. The choice of the four varieties being evaluated is mainly due to the fact that they have recently been released by Savanna Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research (CSIR), in 2008 as also appropriate for seed production in the region. These early yielding cowpea varieties are well suited to the agro-ecological conditions of the area, which has of late been experiencing insufficient and erratic rainfall distribution as a result of climate change. The attribute of early maturity of these cowpea varieties will be beneficial to find reasons to produce multiples of the crops especially as green pods in the short rainy season that the area experience.

Even though early maturing varieties have been developed to mitigate the maturity period yet no conscious attempt has been made to establish the possibility of cultivating these varieties for green pods, and also to establish especially the crude-fibre content of green pods. Considering the importance of green pods and the possibility of several croppings and harvests in one season, this study was undertaken to find suitable cowpea varieties and also explore their possible use for green pod production and appropriate planting periods for maximum yield.

### 1.5 Objectives of the Study

#### 1.5.1 Main Objective:

To identify the optimal planting dates and suitable cowpea varieties for green pod production.

#### 1.5.2 Specific Objectives:

1. To identify suitable cowpea varieties with high green pod yield.
2. To determine the optimal planting date for high green pod yield.
3. To determine the fibre content of the green pods of the different cowpea varieties evaluated.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

Cowpea production in Ghana is largely dependent on rainfall. As almost every cowpea farmer primarily grows cowpea for seed, the crop especially the improved varieties, are planted late in the season sometimes after harvesting an early crop like early millet. In order to harvest clean seed, farmers intentionally delay planting so that harvesting will coincide with the end of rains thereby giving them a clean seed harvest. Quite often the time of planting is misjudged and yields are adversely affected as accurate time of planting is a key factor that influences production in rain-fed agriculture (Ati *et al.* 2002). In the Upper East region of Ghana, just as in many rain-fed agricultural areas of Africa, the rains start with light drizzles and even with intermittent dry spells making moisture a limiting factor for germination of seeds, emergence and possible death of young plants (Makarau, 1995). While rain is not adequate at the early periods of the year for growing some crops, most weeds grow which later compete with crops thereby reducing yields (Frimpong, 2002). Unlike in the Transition and Guinea Savanna zones of Ghana where planting starts late August and early April respectively (Kumaga *et al.* 2002), planting in Manga/Bawku which is also in the Sudan Savanna, is usually in June.

## 2.1 Effect of planting date on growth of cowpea

### 2.1.1 Planting date on germination

Shaw *et al.*, 1994 reported that sufficient surface soil moisture was essential to permit early spring germination of Spiny hopsage *(Gruyiu spinosa* [Hook.] Moq.), and so it is necessary to sow in late fall or early winter. Hybrid types of sorghum influence seed germination as far as temperature requirement is concerned. Krieg, 1994 reported that temperate hybrids had higher minimum temperature requirement than tropical adapted hybrids. Germination of cowpea could be poor if planted too early (Republic of South Africa National Department of Agriculture, 1995). Slow and incomplete emergence caused by chilling damage can occur when sowing is done too early in soils with temperature cooler than 19ºC (Ismail *et al.*, 1997). Kawube *et al.*, (2005) reported from a study that 15% salt solution density can be used as an alternative to seed dressing in reducing transmission of rice and cowpea seed-borne diseases and improving rice germination and yield in the field. Storage materials influence the viability of seed as determined by its germination percentage while varietal influences occur on the germination percentage of cowpea (Ihejirika, 2007). Cowpea varieties were evaluated in a rain forest environment to determine the physiological qualities of cowpea seeds produced, and reported that variety and location had significant effects on germination percent, germination rate index and seedling length. The study further deduced that high quality seeds of cowpea can be produced in transition environments (Olasoji *et al.*, 2013).

### 2.1.2 Planting date on seedling establishment

Factors that affect seedling emergence rate and establishment include planting depth, soil temperature and available soil water content. A key factor that also contributes to better sorghum stand establishment is hybrid selection. Selected genotypes must be tolerant to low temperatures during seed germination, seedling emergence, and early plant growth if early planting is to be practiced (Keim and Garden, 1984). It has been reported that when planting of corn is delayed until soil conditions are nearer the optimum for early plant growth and development, it is a plus to management strategies useful in overcoming early plant development problems (Herbek *et al.*, 1986). Available and sufficient rainfall has an influence on seedling establishment of cowpea which can contribute to maximum seed yield (Republic of South Africa National Department of Agriculture, 1995). Emergence rate of sorghum may be affected by unfavourable soil environment if planting is done early and that can produce poor establishment of the crop (Heiniger *et al.*, 1997).

### 2.1.3 Planting date on stem diameter

Peduncle thickness of pineapple was not significantly affected by planting date (Norman, 1981). Congo jute planted late produced small basal diameter when planted in Ghana which also led to low yield of dry fibre (Amankwatia, 1979). Relatively big stalks were produced when roselle (*Hibiscus sabdariffa* L.) was grown early in Ghana (Amankwatia, 1992).

### 2.1.4 Planting date on plant height

Delayed planting can reduce dry weight, leaf area, plant height and number of internodes of soyabeans (Adjei-Twum, 1978). Apart from the yield of okra being significantly affected by planting date, the first sowing date also produced highest plant height when three planting dates (17th March, 2nd April, and 17th April) were evaluated (Sayeed, 1988). Shorter plants of Congo jute were also produced with late planting which also contributed to low dry fibre yield (Amankwatia, 1979). In a study of roselle (*Hibiscus sabdariffa* L.) involving sowing date in Ghana, it was reported that roselle produced relatively tall plants (Amankwatia and Asante, 1992). Babatunde *et al*. (2002) reported of highly significant effects of sowing dates, intra-row spacing and the use of nitrogen fertilizers on plant height in roselle production. Okra planted early produced higher plant height and fruit length than late planted okra (Yadev, 1999; Incalcaterra *et al.*, 2000). Obadoni, (2009) observed that plant height of cowpea was not significantly influenced by weed densities between 3 and 9 weeks inclusive. Time of first harvest of roselle in the Guinea savanna agro-ecological zone of Ghana had significant effect on plant height of the crop (Osei-Kwateng *et al*, 2012).

### 2.1.5 Planting date on flowering

Early flowering of cowpea cultivars has been reported to lead to drought escape and production of high yields at some locations and in some years (Ismail *et al*., 1997). Good flowering for maximum seed yield of cowpea is achieved with the availability of sufficient rainfall and planting cowpea too early in the season could also cause abscission of flowers during flowering (Republic of South Africa

National Department of Agriculture, 1995). Norman, (1981) reported that planting date did not significantly affect flowering and fruit maturity of pineapple. Yama, (2006) found significant differences in flowering among cowpea varieties. Planting dates did not influence floral initiation and opening in egg-plants when planted in both main and minor seasons (Nsowah, 1970).

In terms of number of days to 50% flowering, there were significant differences among cowpea varieties studied under different weed densities (Obadoni, 2009). In a study in New York, when planting was done in December and January which was supposed to be the onset of flowering, it was reported that fewer numbers of days to 50% flowering of beans was recorded in one location that was noted to have high temperature (Wallace *et al.*, 1995).

Genotype adaptation is influenced also by a crop's flowering period, and this period is a key phase in the development of crop as it is vulnerable to environmental stress. It is therefore the timing of this developmental stage that is responsible for determining a crop's maturity and subsequent harvest (Summerfield, 1980). Wilson and Robinson (1995) reported that a crop's climatic adaptation and yield is influenced by the period it flowers and the duration of its growth. Wien and Summerfield, (1984) noted that species of various crops have adaptive features that contribute to timely flowering.

## 2.2 Planting date on yield of cowpea

### 2.2.1 Planting date on fruiting and pod filling

Three planting dates (17th March, 2nd April, and 17th April) were evaluated in an okra crop and it was found that the first sowing date produced the highest green fruits (Sayeed, 1988). It has been reported that good pod filling stages for maximum seed yield of cowpea is also achieved with sufficient and available rainfall (Republic of South Africa National Department of Agriculture, 1995). Yadev, (1999) and Incalcaterra *et al.*, (2000) both reported of higher number of fruits per plant of okra planted early, than late planted okra. Nsowah, (1970) reported that planting date of egg-plant varieties did not significantly influence fruit maturity but number of fruits and fruit weight were higher in the main season than in the minor season. Weight of first mature fruit, number of fruits and fruit weight decreased considerably with late sowings. Adcock and Lawes, (1976) reported that in *Vicia faba* L., it is possible to find two or three pods per peduncle but most often four or more pods are carried on a single peduncle.

### 2.2.2 Planting date on yield and yield components of cowpea

One of the important cultural practices that can result in significant differences in the growth and yield of grain legumes is planting date (Republic of South Africa National Department of Agriculture, 1995). It is also reported that the type of cultivars planted have an influence on their optimum planting date. Good seedling establishment, flowering and pod filling stages for maximum seed yield of cowpea are achieved with the availability of sufficient rainfall. Though planting of cowpea can be done at the beginning of the rainy season, planting too early could make

germination poor and also cause abscission of flowers during flowering while on the other hand, planting too late may reduce yields that may be caused by early frost or lack of enough time for pod production (Republic of South Africa National Department of Agriculture, 1995).

High yields of cowpea can be achieved in some locations and years when drought is escaped by cowpea cultivars that begin to flower early (Ismail *et al*., 1997). A report by Doku and Karikari (1970) indicates that high rains reduce seed yield of Bambara groundnuts. Except that leaf senescence was significantly delayed, yield components and yield of snap beans (*Phaseolus vulgaris*) were enhanced with the application of a growth hormone, Accel (Emongor, 2008).

Peksen, (2002) reported that sowing dates on individual pod weight was not significant, but there were significant differences between cowpea genotypes in terms of pod characteristics. However, green pod yield per plant was influenced by sowing dates and cowpea genotypes with planting in April and May giving the highest green pod yield per plant.

Early maturing varieties of soyabeans were advantageous in yield over late maturing varieties, but the result was not dependent on planting date (May *et al.*, 1989). High grain yield of cowpea can be achieved with early sowing if also the early sowing leads to escape of the hot weather conditions that hinder reproductive development (Marfo and Hall, 1992). A report highlighted that delayed planting of early maturing cultivars of cowpea substantially delayed maturity and that eliminated the advantage of early harvest of the early planted

and early maturing cowpea cultivars (Fatokun *et al*., 2002). Significant differences between varieties of egg-plant were observed on growth characters in two planting dates. However, planting dates did not influence floral initiation, floral opening and fruit maturity but number of fruits and fruit weight were higher in the main season than in the minor season. In later sowings in two different years, weight of first mature fruit, number of fruits and fruit weight reduced considerably within each season (Nsowah, 1970).

Plant growth and yield are influenced by planting date as a result of differences in air temperature, radiation and available soil moisture which occur at different growth stages. These factors could also interact with different dates of sowing on the development of plants (Osafo, 1975). Nafziger, (1994) reported that crop yields fast declined when planting date of crops is advanced or planting is done beyond optimum planting date. Vegetative growth of maize far exceeds ear and grain yield when planted late as compared with early planted maize that produce high ear and grain yield (Free *et al.*, 1966; Pendleton, 1969). Best yields of maize were obtained when planted mid-March in the forest zones of Ghana and planting late- May to mid-June gave best yields in the Guinea savanna zone, while best yields were obtained in the coastal savanna zone when maize was planted in the $2^{nd}$ – $3^{rd}$ week in April (Koli, 1970). Crop yield losses between 40 – 55% can occur when planting is done 2 weeks earlier or later than the optimum planting date. September to November has been adjudged the period of optimum growing condition for maize in the minor season of the coastal savanna (Wills, 1962). Early planting of maize in the minor season of the coastal savanna region of Ghana especially planting under irrigated conditions contribute to high or

increased grain yield than yields of the major season (Leyenaar and Hunter, 1978). These increased yields were attributed to the availability and intense solar radiation since that is very vital in the plants' photosynthetic processes. It has been found that planting date did not significantly affect the growth and yield of sweet corn (Norman, 2002). A confirmed report by Laner *et al.*, (1999) has it that highest grain yields of corn are got with early sowing but delays over two weeks in sowing recorded declining yields at a rate of between 0.2 to 1.7%. Early planting gives maximum grain yield as better weather conditions are met while planting in the later parts of the growing season bring about gradual losses in potential grain yield of maize (Shioga, 2010).

Fruit yield performance was highest with okra planted between March and April than with planting between October and January (Kamalanathan *et al.*, 1970). Okra responded positively to sowing date and plant spacing highlighting that earliest sowing (25$^{th}$ May) produced highest average yield generally and that yields decreased with each sowing date until 5$^{th}$ November sowing (Gupta *et al.*, 1981). Apart from the yield of okra being significantly affected by planting date, the first sowing date produced highest green fruit, plant height and number of leaves per plant when three planting dates (17$^{th}$ March, 2$^{nd}$ April, and 17$^{th}$ April) were evaluated (Sayeed, 1988). Iremiren and Akly, (1986) observed vigorous plant growth of okra, number of pods per plant and pod yield was highest with early sowing (1$^{st}$ April) as compared to late planting (1$^{st}$ June). A report by Singh *et al.*, (1986) has it that seed yields of okra was highest in plots planted first (15$^{th}$ June). Plant height, number of fruits per plant, and fruit length of okra planted in June was higher and above okra planted 12$^{th}$ August (Yadev, 1999). The findings

of Incalcaterra *et al.*, 2000 was not too different when they reported that plant height, number of pods and yield of okra were highest in the first sowing date than in the second sowing date (1st and 15th April respectively).

In Ghana, Congo jute planted late produced shorter plants, small basal diameter, low fresh stalk yield, less retted fibre and consequently low yield of dry fibre (Amankwatia, 1979). Relatively tall plants, big stalks, short vegetative period and short flowering time were some of the findings of Amankwatia, 1992 when roselle (*Hibiscus sabdariffa* L.) was grown in Ghana. Sweet potatoes produce highest tuber yields including component values when planted early while lower yields are recorded when planted late (Singh, 1992).

An experiment conducted in South Africa registered results of seed yield of cowpea that revealed that there was highly significant interaction among planting dates, genotypes and locations (Shiringani, 2011). Year sown, sowing date, and season influenced the first harvesting date and yield in both pole and dwarf bean varieties (Saglam, 2000). Significant differences were also observed among varieties while interaction between season and sowing date in both pole and dwarf bean varieties, and also interaction between season and year in pole bean varieties significantly affected the yield of beans. In three seasons, cowpeas infested with scab were sown on different dates. Results revealed higher scab incidences when cowpea was sown early and also yield and yield components of this early sown cowpea were lower than those from late sown crops. Poor quality grain with plenty of shriveling was realised in the early sown crops when compared with the late sown crops (Mbong, 2010). In a first season (April – June 1976) four bean

genotypes were planted on three planting dates while four planting dates involving the four genotypes were carried out in a second season (Nov. 1976 – Jan. 1977). Generally there was yield decline with delayed sowing in the two seasons though in the second season yields were lower with the first planting. Also in the second season yields declined less rapidly (Fisher, 1980).

Fatokun *et al*., (2002) reported that the advantage of early harvest of early planted early maturing cultivars of cowpea was eliminated when delayed planting of early maturing cultivars substantially delayed maturity. Planting cowpea early (April and May) was superior to planting in June and July as seeds with better hydration properties were produced. Better light reception, dry matter accumulation and more cells contributed to this result (Ibeawuchi, 2004). Cowpea seeds with lower water imbibition percentage and seed protein content were produced when harvested mature green whereas seeds with higher water imbibition percentage and seed protein content were produced when harvested dry.

Obadoni, (2009) found that number of pods of cowpea and consequently yield was significantly influenced by varying weed densities and varieties.The yield potential of a crop is strongly influenced by its period of flowering and growth duration and therefore factors such as planting date and site are of immense importance since they contribute to the development and subsequent responsibility for variability in yield and yield components (Wilson and Robinson (1995).

A report by Schou *et al*. (1978) has it that yield is influenced greatly by changes that occur during flowering to physiological maturity as compared with the period

from emergence to flowering. While Moot, (1993) in his report suggested that the variability in yield of grain legumes is correlated with changes in seed number, other scientists reported that yield components have been used widely to explain variations in the yield of grain legumes such as *Vicia faba*, *Phaseolus vulgaris*, *Cicer arietinum*,and *Pisum sativum* (Husain *et al.*, (1988), Dapaah *et al*., (2000), Verghis (1996) and Nicholas *et al*. (1985) respectively. Dhital *et al.* (1998) reported of planting dates influencing both yield and yield components of cowpea highlighting that early planting produced both the highest number of pods per plant, number of seeds per pod and subsequently seed yield per hectare as compared with late planting which produced the lowest number of pods per plant, seeds per pod and seed yield per hectare respectively.

In studies on planting cotton in Ghana, it was reported that planting early (late May to June) in the season produced significantly higher yields than planting later in the season (after early July) for northern Ghana, while in the southern parts, significantly higher yields was recorded when cotton was planted July to August than planting later in September. June to early July and August to early September planting of cotton in the north and south respectively was best for higher yields as pests are escaped and with sufficient moisture for growth (Koli,1973).

### 2.3 Fibre development

In a study conducted to examine the influence of mutation induction on nutritional quality of cowpea involving two plant types of cowpea; 'IT84S 2246 D' mutants and the non-irradiated parent, results showed non-significant variation between

the plant types for crude fibre content (Olabisi, 2007). Improved and local varieties of cowpea both contribute significant amounts of micro and macro nutrients with other plant parts like leaves having greater mineral content than the grains; and therefore consumption of the leaves alongside the grains would be of nutritional advantage and should be promoted in addition to encouraging farmers to plant the higher yielding cowpea varieties and preferred local varieties (Mamiro, 2011). Low fibre (0.5% - 0.7%) was one of the findings when Akpapunam, (1995) studied the effects of traditional lactic acid fermentation and the addition of malt on the physicochemical properties of maize-cowpea blends.

# CHAPTER THREE

## 3.0 Materials and Methods

### 3.1 The Study Area and Experimental Site

The study was carried out at the sub-Station of the Council for Scientific and Industrial Research (CSIR) – Savanna Agricultural Research Institute (SARI) at Manga near Bawku. The station is about 4 kilometres off the Bolgatanga – Bawku highway southwards on entering Bawku township and lies between latitude 11º 01' N, and longitude 00º 16'W, and has an altitude of 249 metres above sea level. Manga is in the Sudan-Savanna agroecology in northern Ghana. The vegetation is predominantly Sudan savanna, which consists of short grasses and a few and widely spaced trees and shrubs that have fire resistance as a characteristic (Atta-Quayson, 1985).

Environmental factors are the main factors that crop growth depend on and therefore influence the yielding potential of the crops. Bawku has a climate that is characterized by a mono-modal rainfall starting in June and stops at the end of September but in exceptionally wet seasons it extends into part of October. The rest of months are usually hot and dry. The average annual rainfall is less than 1000 mm and is erratic in distribution, and for the year 2012 a total rainfall of 1030.3 mm was recorded at the Manga meteorology station; showing that the season was an exceptional one (Table 1). In the past the rains normally started in May, but in recent years the rains start in June. The total rainfall received within the cropping season only (June to September), was 842.5 mm. Table 1 also shows that the mean monthly minimum air temperature ranged from 22.6ºC (July) to

30.2°C (September) while the maximum temperature ranged from 30.5°C (August) to 32.8°C (June). The lowest mean relative humidity was recorded during the month of June (68.3%) and the highest in September (93.2%).

**Table 1**: Some Climatic Data of 2012 for the Period of Experimentation at Manga Station (Experimental Site).

| Month | Total Rainfall (mm) | Mean Temperature (°C) | | Mean Relative Humidity (%) | |
|---|---|---|---|---|---|
| | | Minimum | Maximum | Minimum | Maximum |
| June | 147.6 | 23.2 | 32.8 | 68.3 | 88.5 |
| July | 256.3 | 22.6 | 31.5 | 74.8 | 91.6 |
| August | 214.8 | 22.9 | 30.5 | 78.6 | 92.6 |
| September | 223.8 | 30.2 | 31.4 | 72.1 | 93.2 |

Source: Meteorological unit of CSIR – SARI at Manga sub-Station

### 3.2 Soil of the experimental area

The soils of the Manga sub-Station of the Council for Scientific and Industrial Research – Savanna Agricultural Research Institute (CSIR – SARI) though has been mentioned as comprising of three soil series (ie Verempere series that occupy the upper part of the station, Tafali series occupying the middle part and Berenyasi series occupies the lower or valley of the station), is generally classified only as Verempere series (Obeng, 2000, and Affipungu, 2005). This subgroup of soils is a product of weathered granite and found to be deep to very deep, red and brown, and mostly sandy soils. The particular field that was used was a flat land and according to soil classification by FAO-UNESCO (1988) the soil is Plinthic

Lixisol and developed from granite. The soil is well drained and moderately deep, and the texture of it is light to medium that also qualifies it as sandy-loam (Anane, 2005). Using an auger, a bulk soil sample was taken from a depth of 0 – 25cm before sowing for analysis in the Soils Chemistry laboratory of Savanna Agricultural Research Institute, at Nyankpala and some physical and chemical properties are presented in Table 2 below. Soil was taken diagonally from both diagonals at approximately 10 metre intervals and put together, mixed thoroughly and a part of it taken for the analysis. The results revealed that the soil of the experimental area is mainly sandy and acidic. All other plant growth requirements in the soil are below average except the levels of potassium which is moderate (Table 2).

**Table 2**: Physical and chemical properties of the soil surface (0 – 25) of the experimental plot (2012)

| **Soil Properties** | **Experimental Plot at Manga – Bawku** |
|---|---|
| FAO-UNESCO Soil Classification | Plinthic Lixisol |
| Sand (%) | 84.56 |
| Silt (%) | 12 |
| Clay (%) | 3.44 |
| Soil Texture | Loamy sand |
| Soil pH ($CaCl_2$) | 4.26 |
| Organic Carbon (%) | 0.35 |
| Total Nitrogen (%) | 0.06 |
| Available P (mg $kg^{-1}$ | 7.77 |
| **Exchangeable Cations cmol (+) $kg^{-1}$** | |
| Ca | 0.80 |
| Mg | 0.30 |
| K | 33.20 |
| CEC [cmol (+) $kg^{-1}$] | 2.93 |

Agriculture is one of the main occupations of the people in the Bawku Municipality and crops cultivated include maize, sorghum, sweet potatoes, groundnut, cowpea, and a variety of vegetables. In the field of animal production, almost every household traditionally rears poultry and keeps few animals like goats, sheep, cattle, donkeys and pigs.

### 3.3 History of land

For the past three years the entire field has been put under pearl millet and maize production. From 2003 to 2008 the field was cropped interchangeably with maize and cowpea in alternate years.

### 3.4 Materials

Four cowpea varieties; IT 95 K 193 – 2, IT 97 K – 499 – 35, SARC 3 – 122 – 2, and SARC 4 – 75 given the names Baawutawuta, Padi-Tuya, Songotra and Zaayura respectively which were released by Council for Scientific and Industrial Research – Savanna Agricultural Research Institute (CSIR – SARI, 2008) and have been recommended for mass cultivation in northern Ghana were used. Baawutawuta (IT 95 K 193 – 2) and Songotra (IT 97 K – 499 – 35) are two best selections from advanced breeding lines obtained from the International Institute of Tropical Agriculture (IITA), Nigeria. Padi-Tuya (SARC 3 – 122 – 2) and Zaayura (SARC 4 – 75) were developed from exotic material derived from the University of Riverside, California, USA and crosses among genotypes already available within the Savanna Agricultural Research Institute's germplasm.

Six (6) planting dates were involved in the experiment with the first planting done when there was sufficient moisture for seeds to germinate. The planting dates were 20$^{th}$ June, 30$^{th}$ June, 12$^{th}$ July, 25$^{th}$ July, 2$^{nd}$ August, and 12$^{th}$ August of 2012.

### 3.5 Experimental Design and Layout

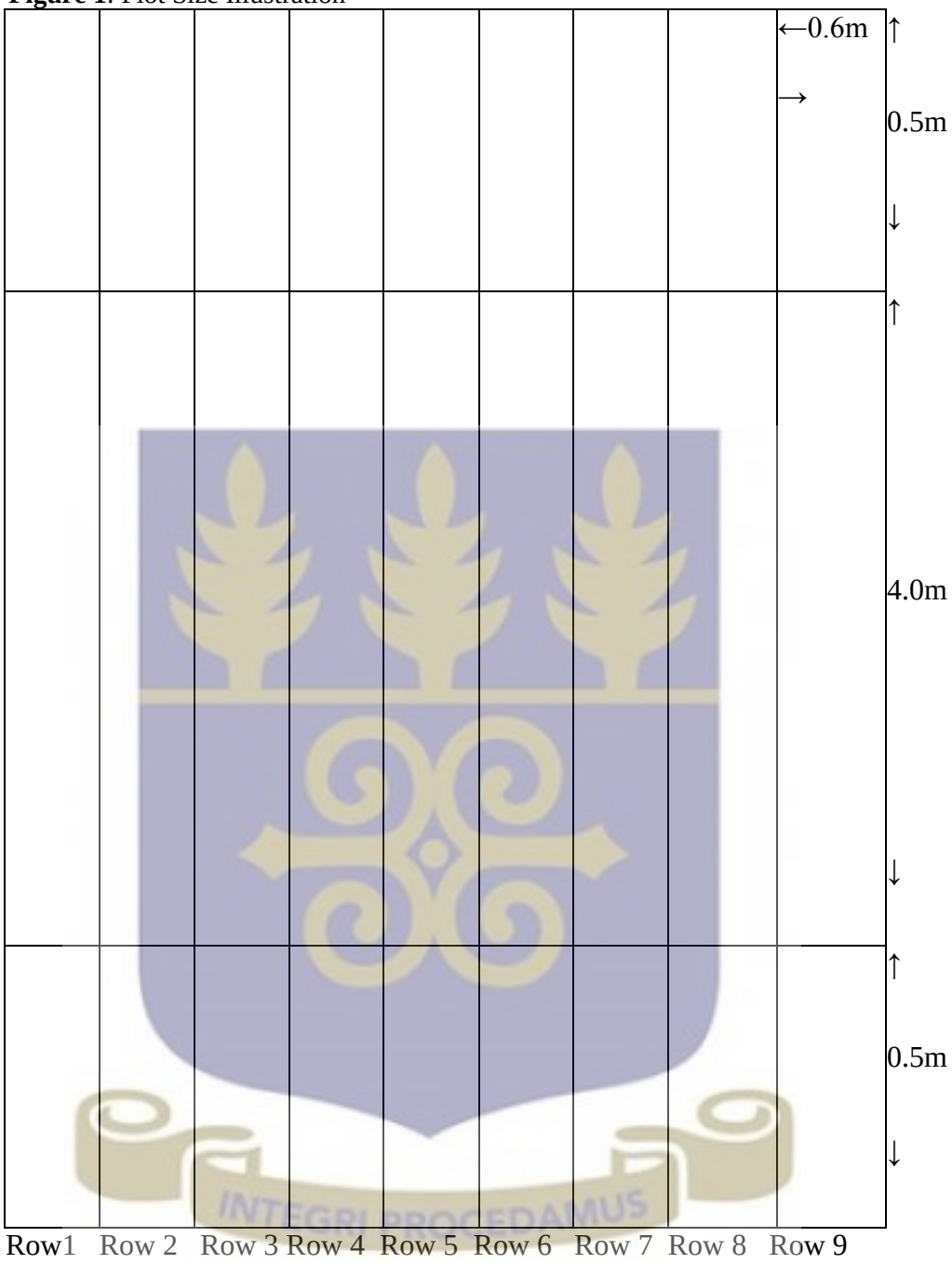
The experiment was laid as a factorial experiment comprising the four varieties of cowpea and the six planting dates using a Randomized Complete Block Design with five replications. The factors were Six Planting dates (20$^{th}$ June, 30$^{th}$ June, 12$^{th}$ July, 25$^{th}$ July, 2$^{nd}$ August, and 12$^{th}$ August) as one factor, and the Four varieties of Cowpea (Baawutawuta, Songotra, Padi-Tuya and Zaayura) constitute the second factor.

Plot size was 5m long and 5.4m wide (5m x 5.4m) = 27m$^2$.

Spacing used was 60cm between rows giving a total of 9 rows, and 20cm between plants giving a total of 25 plant–hills per row or 225 plant–hills per plot.

A net plot area of 7.2 m$^2$ was considered for harvest. Four metres long, cutting off ½ metre each at beginning and end of rows, of the 2$^{nd}$, 3$^{rd}$, and 4$^{th}$ rows constituted this net plot area (Figure 1). Three other rows; the 6$^{th}$, 7$^{th}$, and 8$^{th}$ rows were those that were used for destructive sampling records. The three rows left (i.e. 1$^{st}$, 5$^{th}$, and 9$^{th}$ rows) served as guard rows.

**Figure 1**: Plot Size Illustration




### 3.6 Land Preparation and Cultural Practices

Land was not ploughed but harrowed with a tractor and after lining and pegging, ridges were made using bullocks. In order to have straight ridges, two straight lines along the length linking the ends of the field were ruled with the help of a

garden line to create paths that the bullocks first followed to make the ridges. The experiment was laid out and labeled on 15 June 2012; ready for the first planting with the next rain.

Three seeds per hill were planted and thinned to one plant two weeks after planting. To ensure the field was free from weeds, one manual weeding was done two weeks after planting. Bullocks were used to reshape the ridges at the end of the third week after planting which also controlled weeds. A third manual weed control was done in the fifth week and thereafter, hand–pulling of big weeds was carried out as and when necessary.

Insect pests that are a problem to cowpea production in Ghana like leafhoppers, leaf miners, *Aphid* spp, *Thrips* spp, *Mylabris* sp, and pod sucking bugs (Agyen-Sampong, 1978) were controlled by spraying plants weekly with Lamda cyhalothrin at a rate of 60ml per 15 litre knapsack, starting from 2$^{nd}$ week after planting and stopped after the 6$^{th}$ week.

### 3.7 Data collected

#### 3.7.1 Growth Parameters:

##### 3.7.1.1 Plant Stand

Three weeks after planting all plants were counted in the three middle rows.

##### 3.7.1.2 Plant Height

Heights of 10 plants in each plot, that were randomly selected, were taken and average plant heights per plot recorded from four weeks after planting and at weekly intervals for four times. The periods involved were: at early vegetative stage {28 days after planting (DAP)}, late vegetative stage {35 days after planting (DAP)}, at flowering {42 days after planting (DAP)} and at first harvest {49 days after planting (DAP)}. Plant height was taken using a graduated measuring pole in centimetres (cm). The heights of the 10 plants were taken from the base of the plant to the terminal bud of the main stem and the average recorded.

##### 3.7.1.3 Number of leaves per plant

Leaf number per plant was taken at early vegetative stage (28 DAP), late vegetative stage (35 DAP), at flowering ({42 DAP) and at first harvest (49 DAP). 10 plants in each plot were hand pulled (destructive sampling) and leaves detached from them. The average number of leaves per plant was recorded after counting all the leaves.

### 3.7.1.4 Fresh and dry leaves weight per plant

After recording leaf number from weekly destructive samplings of plants at early vegetative stage (28 DAP), late vegetative stage (35 DAP), at flowering (42 DAP) and at first harvest (49 DAP), fresh weights were taken in the laboratory with a sensitive electronic scale. Small-sized electronic ovens in the laboratory were used to dry materials that needed to be dried. Due to the fact that ovens available were small in size, sub-samples of the leaves were taken and their weights recorded and then dried in an electronic oven at a temperature of 70ºC for 30 hours (by which period leaves were very dry) and their dry weights recorded. From the dry weights of samples taken, dry weight of the leaves per plant was determined by proportion.

### 3.7.1.5 Fresh and dry stem weight per plant

The fresh stem weight of the 10 plants that were used for determining leaf fresh weight was used to determine mean fresh stem weight. Dry stem weight per plant was determined after known weights of samples of the stems were oven-dried at 70ºC for 48 hours (by which time the stems were fully dry) and extrapolated. The stems were not chopped into pieces but folded and placed on an electronic scale and their weights determined. To dry samples that were taken for that purpose, the samples were put in large-sized brown envelopes before putting them into the electronic oven. After drying, the samples were removed and immediately weighed and the dry stem weight per plant was determined by first converting the result to reflect that for the 10 stems, and then their average calculated and recorded.

### 3.7.1.6 Fresh and dry root weight per plant

The roots from the 10 plants destructively sampled at the four ages of the plant growth were cut and the fresh root weight per plant determined by weighing them in the laboratory with a sensitive electronic scale and finding their average which was recorded as fresh root weight per plant. Known weights of sampled roots were oven-dried at 70$^{o}$C for 48 hours (by which period roots were fully dry) in the laboratory with an electronic oven and their dry weight per plant determined.

### 3.7.1.7 Leaf Area

In every plot, the length and width of two leaves each from mid-height of five plants were measured with a ruler graduated in centimetres at 50 DAP giving a total of 10 leaves per plot at each measurement. The length was measured following the mid-rib starting from the attachment of the leaf to the petiole through to the end of the mid-rib per leaf. Leaf width was measured at the broadest part of the leaf. Their areas were then calculated by multiplying their lengths by their widths and also multiplied by 0.75 (Agueguia, 1999; Adeoye, *et al.*, 2011). Average leaf area was recorded in centimetres.

**Calculation**

Leaf area was determined by the formula:

Leaf area (LA) = Laminal length x Maximum width x 0.75

### 3.7.1.8 Days to first flower appearance:

Following daily field observations, the number of days from planting to the day the first flower bud opened was recorded in each plot.

### 3.7.1.9 Days to 50% flowering

By visual observation, the number of days from planting to the day that approximately 50% of plants were carrying open-flower buds was recorded per plot.

### 3.7.1.10 Days to first pod set

The number of days from planting to first pod initiation in each plot was recorded as days to first pod set.

### 3.7.1.11 Days to first harvest

This was taken as the number of days from planting to the day that green pods were first harvested in each plot.

### 3.7.1.12 Number of branches from main stem per plant

The number of branches on the main stem per plant was counted from four weeks after planting at weekly intervals for four weeks. The periods involved were: at early vegetative stage (28 DAP), late vegetative stage (35 DAP), at flowering (42 DAP) and at first harvest (49 DAP). The total number of branches from the main

stems of the 10 plants used in determining leaf number, weights of both leaves and stems, were counted and averages recorded as number of branches per plant.

### 3.7.1.13 Stem diameter

Stem diameter was taken starting from early vegetative stage (28 DAP; the diameters of 10 plants randomly selected in each plot were recorded weekly using a digital caliper in millimetres. This was done at weekly intervals for 4 times (at early vegetative stage (28 DAP DAP), late vegetative stage (35 DAP), at flowering (42 DAP) and at first harvest (49 DAP). Their averages were calculated and recorded as stem diameter. All stem measurements on selected plants were taken at approximately five centimetres (5cm) above ground level.

### 3.7.1.14 Plant canopy diameter per plant

In the absence of a leaf canopy analyzer, manual canopy diameter measurements using a measuring tape were taken at the top of 5 plants per plot. Four different measurements were taken on each plant and their averages recorded as plant canopy diameter for each of the five plants per plot. The average canopy diameter of the five plants from each plot were then computed and recorded as the canopy diameter per plant.

### 3.7.2 Yield Parameters:

#### 3.7.2.1 Pod number per plot

The total number of green pods harvested in each plot was recorded at the growing end of plants. This is when plants have especially reached their maximum life spans and that, not only do they not flower and form pods again but are senescing. Pods in each plot were harvested at different periods when they were matured (green pod stage); so all green pods harvested at the different times were added together and recorded as the number of pods per plot.

#### 3.7.2.2 Pod weight per plot

The overall weight in kilograms of all green pods harvested in each plot was recorded as the pod weight per plot. This was arrived at by adding up all the various harvest weights taken with a sensitive electronic scale in the laboratory at the different times harvested.

#### 3.7.2.3 Pod length

10 randomly selected green pods from each harvest were measured individually with a ruler and their average length taken as pod length per plot in centimetres. These measurements were done in the laboratory.

### 3.7.2.4 Pod diameter

An average pod diameter was recorded after 10 pods per plot were randomly harvested and their diameter measured with a digital caliper in the laboratory and recorded. Measurements were taken from approximately mid-length of each pod.

### 3.7.2.5 Number of seeds per pod

Total seed grooves were counted from the 10 randomly selected pods for pod length and diameter records, and their average number recorded as the number of seeds per pod that probably would have been formed if left to grow to full maturity.

### 3.7.2.6 Number of pods per plant

The total number of green pods harvested from five randomly selected plants was obtained and the average calculated to arrive at the number of green pods per plant.

### 3.7.2.7 Pod weight per plant at harvest

The total weight of pods harvested from five plants determined. The average of the result obtained from the five plants was recorded as weight of pods per plant in grammes.

### 3.7.2.8 Pod yield per hectare

The green pod yield per hectare was recorded using the following formula: Pod yield per plant in grams x plant population of 83,333 plants per hectare (that is when one plant is maintained at a spacing of 20cm x 60cm), and the result converted into tons.

### 3.7.3 Fibre content of green pods

Green pods were harvested at a developmental stage that though pods were almost fully developed, seeds were not fully developed, and also when pods could snap. Samples of these green pods were sent to Food Research Institute in Accra and analysed in their Chemistry Laboratory for the crude fibre content of the pods. The procedure used involved Pearson's method of food analysis (Ronald *et al.*, 1991). 3g of each sample was stirred in petroleum spirit, settled and decanted 3 times. Air-dried extracted samples were put in 1000 ml conical flasks and 200 mls 0.255 N sulphuric acid measured at ordinary temperature added. These were gently boiled for 30 minutes while rotating flasks every few minutes in order to mix contents and removing particles from the sides. After the 30 minute boiling, the acid mixture was allowed to stand for approximately one minute and then poured into a shallow layer of hot water through a prepared paper-funnel, which was completed in 10 minutes. The insoluble matter was washed with boiling water until free from acid, then washed back into the original flasks by using wash bottles containing 200ml 0.313N sodium hydroxide solution. These collections were boiled again and cooled for one minute and then filtered immediately through a suitable filter paper. These insoluble materials were again transferred to

the filter paper by means of boiling water, washed first with boiling water and then with 1% hydrochloric acid and finally with boiling water until they were free from acid. Samples were then washed two times with alcohol and 3 times with ether. The insoluble samples were dried on an ash-less filter paper of known weight at 100$^{o}$C to a constant weight. Finally the papers and contents were incinerated to ash and weighed; the weights of the ash were then subtracted from the increase of weight on the paper due to the insoluble material and the result is the fibre contained.

### 3.8 Data analysis

Statistical analysis of the data was done by the Analysis of Variance (ANOVA) using Excel 2010 and GenStat 2011 programme packages and where differences were significant, means were separated at the 5% using the Fisher's Least Significant Difference (LSD = 0.05) test procedure.

### 3.9 Correlation matrix

To establish possible relationship among parameters observed, correlation analysis was carried out. Plant height at first harvest (PHFH), stem diameter at first harvest (SDFH), number of leaves at first harvest (Lno.FH), number of branches at first harvest (Bno.FH), days to 50% flowering (DFF), pods per plant (PPlt), mean pod weight (MPW), leaf area (LA),plant canopy (PltCano), pod diameter (PD), pod length (PL) and yield of green pods per hectare (Yld/Ha) were the parameters involved in the relationship analysis.

# CHAPTER FOUR

## 4.0 RESULTS

### 4.1 Vegetative growth

#### 4.1.1 Plant height

There were significant interactions between planting date and variety for plant heights at late vegetative stage (35 DAP), flowering (42 DAP) and first harvest (49 DAP). At late vegetative stage, Padi-Tuya produced significantly taller plants compared to the other three varieties (Table 3). Baawutawuta produced the shortest plants. At all the three growth stages, planting on the fourth date (25$^{th}$ July) produced the tallest plants except for Baawutawuta which produced its tallest plants when planted on 12$^{th}$ August. Second highest plant heights were obtained at the sixth planting date (12$^{th}$ August), which is especially true for Padi-Tuya, Songotra, and Zaayura but Baawutawuta differed again from this trend by producing its second tallest plants when planted on the fifth date (2$^{nd}$ August). For both Baawutawuta and Songotra, shortest plants were produced with the second planting date (30$^{th}$ June). Padi-Tuya registered its shortest plant height with the first planting (20$^{th}$ June) while that of Zaayura was with the fifth planting date (2$^{nd}$ August).

Padi-Tuya produced plants that were significantly different in height from Baawutawuta, Songotra and Zaayura at flowering (Table 4). For Padi-Tuya, tallest plants were produced with the planting on 25$^{th}$ July and the shortest when planted on 20$^{th}$ June. Plant heights of Padi-Tuya, Songotra and Zaayura showed similar trend with planting date as tallest plants of each variety was found with plantings

of 25th July followed closely by plantings on 12th August . Though Baawutawuta did not follow the exact order as the earlier varieties, its fourth planting (25th July) produced its tallest plants but this time followed by its first planting of 20th June (Table 4).

**Table 3**: Effect of planting date and variety of cowpea on plant height (cm) at late vegetative stage (35 DAP).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 13.80 | 13.04 | 13.96 | 14.56 | 14.60 | 14.68 | 14.11 |
| Padi-Tuya | 17.64 | 21.64 | 26.16 | 41.40 | 23.02 | 28.40 | 26.38 |
| Songotra | 15.48 | 15.30 | 16.70 | 20.36 | 15.88 | 19.56 | 17.21 |
| Zaayura | 17.76 | 18.28 | 19.24 | 23.32 | 16.22 | 21.28 | 19.35 |
| Mean | 16.17 | 17.07 | 19.02 | 24.91 | 17.43 | 20.98 | |

Lsd (P=0.05): Planting date = 3.03, variety = 2.47, planting date x variety = 6.06

**Table 4**: Effect of planting date and variety of cowpea on plant height (cm) at flowering (42 DAP).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 17.36 | 15.08 | 15.92 | 19.78 | 16.48 | 16.76 | 16.90 |
| Padi-Tuya | 24.64 | 36.36 | 38.36 | 75.06 | 38.52 | 64.48 | 46.24 |
| Songotra | 20.80 | 18.64 | 20.98 | 27.78 | 18.08 | 26.56 | 22.14 |
| Zaayura | 23.96 | 22.36 | 24.64 | 35.44 | 18.62 | 33.16 | 26.36 |
| Mean | 21.69 | 23.11 | 24.98 | 39.52 | 22.93 | 35.24 | |

Lsd (P=0.05): Planting date = 4.86, variety = 3.96, planting date x variety = 9.71

Results in Table 5 show that interaction effect of planting date and variety for plant heights at first harvest was significantly different with Padi-Tuya planted on 25th July producing significantly taller plants. The varieties also showed significant differences in mean heights at this plant age. Padi-tuya produced plants significantly taller than the other three varieties; Zaayura had plants also taller than both Songotra and Baawutawuta while Songotra was significantly taller than Baawutawuta. Significant differences in plant height among planting dates at this plant age indicate that except for the sixth planting date (12th August), planting on 25th July produced significantly taller plants than the other planting dates. The first planting date (20th June) and the last planting date (12th August) did not show significant difference in plant height, but both produced significantly taller plants than planting on both 30th June and 2nd August.

**Table 5**: Effect of planting date and variety of cowpea on plant height (cm) at first harvest (49 DAP).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 22.0 | 16.3 | 21.4 | 29.4 | 18.6 | 20.4 | 21.35 |
| Padi-Tuya | 61.2 | 53.4 | 75.7 | 102.5 | 77.8 | 99.8 | 78.40 |
| Songotra | 33.3 | 24.6 | 26.8 | 33.1 | 27.0 | 31.8 | 29.43 |
| Zaayura | 47.6 | 33.0 | 38.7 | 53.4 | 25.6 | 40.6 | 39.82 |
| Mean | 41.03 | 31.83 | 40.65 | 54.6 | 37.25 | 48.15 | |

Lsd (P=0.05): Planting date = 7.44, variety = 6.08, planting date x variety = 14.90

### 4.1.2 Stem diameter

There was no significant (P<0.05) sowing date by variety interaction at all the stages of plant age for stem diameter. However there were significant differences among sowing dates and among cowpea varieties evaluated. Mean stem diameter recorded at the late vegetative growth stage (35 DAP) of the plants indicated that planting on both 25th July and on 12th August produced stems that were not significantly different in diameter but were different from all the other planting dates planted (Table 6). Planting on 20th June was also not different from both plantings of 30th June and 2nd August but was significantly larger than plants of 12th July planting. Mean stem diameter among varieties at this age of plants show that Padi-Tuya and Zaaayura were not significantly different in diameter but were both significantly larger than Songotra and Baawutawuta which were also not significantly different from each other (Table 6).

**Table 6**: Effect of planting date and variety of cowpea on stem diameter (mm) at late vegetative stage (35 DAP).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 4.10 | 3.89 | 3.79 | 4.64 | 4.10 | 4.77 | 4.21 |
| Padi-Tuya | 4.80 | 4.44 | 4.56 | 5.27 | 4.52 | 4.95 | 4.76 |
| Songotra | 4.06 | 3.98 | 3.73 | 4.77 | 4.19 | 4.92 | 4.28 |
| Zaayura | 4.94 | 4.76 | 3.88 | 5.32 | 4.41 | 5.01 | 4.72 |
| Mean | 4.48 | 4.27 | 3.99 | 5.00 | 4.30 | 4.91 | |

Lsd (P=0.05): Planting date = 0.35, variety = 0.29, planting date x variety = NS

At flowering there were significant differences in mean stem diameter among varieties. Zaayura and Padi-Tuya produced plants with marginally bigger stems, whilst Bawutawuta produced plants with the smallest stems (Table 7). A similar trend was exhibited by the varieties at first harvest with Zaayura and Padi-Tuya producing plants with the biggest mean stems whilst Songotra produced plants with the smallest stems (Table 8). Generally, planting on 25th July produced bigger mean stems at both flowering and at first harvest (Tables 7 and 8). At flowering, planting on 20th June, 25th July and 12th August were similar in mean stem diameter but were all significantly different from plantings of 30th June, 12th July and 2nd August (Table 7). Bawutawuta, Padi-Tuya and Songotra all produced plants with the biggest stems when planted on the 25th of July.

**Table 7**: Effect of planting date and variety of cowpea on stem diameter (mm) at flowering (42 DAP).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 5.26 | 4.64 | 4.33 | 5.68 | 5.05 | 5.45 | 5.07 |
| Padi-Tuya | 6.22 | 4.91 | 4.96 | 6.45 | 5.24 | 5.87 | 5.61 |
| Songotra | 5.43 | 4.70 | 4.51 | 5.60 | 4.88 | 5.56 | 5.12 |
| Zaayura | 6.65 | 5.45 | 4.75 | 6.31 | 5.43 | 5.80 | 5.73 |
| Mean | 5.89 | 4.92 | 4.64 | 6.01 | 5.15 | 5.67 | |

Lsd (P=0.05): Planting date = 0.43, variety = 0.35, planting date x variety = NS

At first harvest (Table 8), planting on 20th June and 25th July were not significantly different in mean stem diameter, but produced mean stem diameters that were significantly different from the rest of the planting dates. Bawutawuta, Padi-Tuya and Zaayura all produced plants with the biggest stems when planted on the 25th of July and plants with the smallest stems for Baawutawuta and Padi-Tuya only when planted on the 30th of June while Zaayura produced smallest plants with the planting of 12th July (Table 8). However, Songotra produced plants with bigger stems when planted on the 20th of June and plants with the smallest stems when planted on 30th of June.

**Table 8**: Effect of planting date and variety of cowpea on stem diameter (mm) at first harvest (49 DAP).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 6.17 | 5.28 | 5.43 | 6.73 | 6.34 | 6.12 | 6.01 |
| Padi-Tuya | 7.05 | 5.47 | 5.92 | 7.27 | 6.92 | 6.44 | 6.51 |
| Songotra | 6.44 | 5.48 | 5.56 | 6.36 | 6.04 | 5.90 | 5.96 |
| Zaayura | 7.11 | 6.27 | 5.89 | 7.28 | 6.72 | 6.14 | 6.57 |
| Mean | 6.69 | 5.63 | 5.70 | 6.91 | 6.50 | 6.15 | |

Lsd (P=0.05): Planting date = 0.47, variety = 0.39, planting date x variety = NS

### 4.1.3 Dry stem weight

No significant interaction effects between planting date and varieties of cowpea on dry stem weight per plant was observed at the various ages of plant growth (Tables 9, 10, and 11). However, varieties and planting dates showed significant differences among dry stem weight per plant at certain stages of growth. At 35 DAP, the 2nd, 3rd and 4th planting dates (30th June, 12th July and 25th July) stem dry weights were all significantly different from the other planting dates but were in themselves non-significant (Table 9). Planting on 20th June, 2nd August and 12th August also produced stem dry weights that were not significantly different.

Significantly different dry stem weight among varieties was also observed at the vegetative stage (35 DAP) with Padi-Tuya producing significantly higher stem dry

weight compared with the other varieties. Zaayura was also significantly different from both Baawutawuta and Songotra (Table 9).

**Table 9**: Effect of planting date and variety of cowpea on stem dry weight (g) at late vegetative stage (35 DAP).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 1.54 | 1.84 | 1.80 | 1.82 | 1.38 | 1.22 | 1.60 |
| Padi-Tuya | 2.46 | 3.26 | 3.26 | 3.28 | 2.46 | 1.72 | 2.74 |
| Songotra | 1.64 | 1.78 | 1.68 | 1.76 | 1.64 | 1.56 | 1.68 |
| Zaayura | 2.04 | 2.36 | 2.34 | 2.90 | 2.22 | 1.76 | 2.27 |
| Mean | 1.92 | 2.31 | 2.27 | 2.44 | 1.92 | 1.57 | |

Lsd (P=0.05): Planting date = 0.38, variety = 0.31, planting date x variety = NS

At flowering stage, stem dry weight was significantly different among planting dates (Table 10). Planting on 25th July resulted in significantly different stem dry weight than all the other planting dates. It is observed that planting on 30th June produced dry stem weights that were significantly different from plantings of 20th June, 12th July, 2nd August and 12th August. There was no significant difference among plantings of 20th June, 12th July and 12th August (Table 10).

**Table 10**: Effect of planting date and variety of cowpea on stem dry weight (g) at flowering (42 DAP).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 2.66 | 4.20 | 3.00 | 7.24 | 1.48 | 2.68 | 3.54 |
| Padi-Tuya | 3.22 | 5.20 | 3.72 | 8.64 | 3.02 | 3.64 | 4.57 |
| Songotra | 3.42 | 4.76 | 3.42 | 8.24 | 2.40 | 3.98 | 4.37 |
| Zaayura | 2.78 | 4.16 | 3.06 | 8.12 | 1.90 | 3.36 | 3.90 |
| Mean | 3.02 | 4.58 | 3.30 | 8.06 | 2.20 | 3.42 | |

Lsd (P=0.05): Planting date = 1.07, variety = NS, planting date x variety = NS

For stem dry weight at first harvest, the interaction between planting date and variety was not significant. However, there were significant differences among planting dates as well as varieties (Table 11). Padi-Tuya and Zaayura produced stem dry weights that were both significantly higher than both Baawutawuta and Songotra. Stem dry weights among the first four planting dates were similar at first harvest. However, plantings of 30th June and 25th July produced stem dry weights that were significantly different from those produced for both plantings in August (Table 11).

**Table 11**: Effect of planting date and variety of cowpea on stem dry weight (g) at first harvest (49 DAP).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 6.10 | 7.90 | 6.76 | 6.86 | 2.02 | 3.82 | 5.58 |
| Padi-Tuya | 7.10 | 9.46 | 8.96 | 8.38 | 5.00 | 7.18 | 7.68 |
| Songotra | 4.36 | 5.62 | 6.12 | 6.12 | 4.58 | 4.82 | 5.27 |
| Zaayura | 6.98 | 9.06 | 7.14 | 10.28 | 3.38 | 5.24 | 7.01 |
| Mean | 6.14 | 8.01 | 7.25 | 7.91 | 3.75 | 5.27 | |

Lsd (P=0.05): Planting date = 2.01, variety = 1.65, planting date x variety = NS

### 4.1.4 Number of leaves

Significant differences of planting dates and varieties on number of leaves per plant at late vegetative stage (35 DAP) were observed. There was no significant variety x planting date on cowpea number of leaves (Table 12). Songotra produced significantly lower number of leaves at this stage of plant growth. Though Baawutawuta and Padi-Tuya were not significantly different in their leaf numbers at 35 DAP, they both produced significantly different leaf numbers than Zaayura (Table 12). Planting dates also showed significant differences among leaf numbers at late vegetative growth stage (35 DAP). Planting on 25th July was significantly different from planting on 12th July and also different from all the other planting dates in number of leaves produced per plant was observed. Also plantings of 12th July and 2nd August were similar but produced leaf numbers significantly different from planting of 12th August (Table 12).

At flowering there was no significant interactions between cowpea varieties and planting dates, however, there were significant differences among varieties and the contrasting planting dates (Table 13). Baawutawuta produced significantly higher mean number of leaves than Padi-Tuya and Zaayura. The mean leaf numbers of Padi-Tuya and Songotra were not significantly different but were both significantly different from Zaayura. The 2nd, 3rd, 4th and 6th planting dates didn't produce significantly different mean leaf numbers at flowering but were all significantly different from mean number of leaves produced at the 5th planting date (Table 13).

Table 14 shows number of leaves per plant at first harvest (49 DAP). There were no significant differences among varieties and also interaction between planting dates and varieties was not significant. However, there was significant difference in planting dates. The 3rd planting date (12th July) produced significantly higher number of leaves at first harvest than the 20th June, 25th July, 2nd August and 12th August planting dates (Table 14).

**Table 12**: Effect of planting date and variety of cowpea on number of leaves at late vegetative stage (35 DAP).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 40.80 | 45.60 | 52.80 | 60.40 | 48.20 | 36.40 | 47.37 |
| Padi-Tuya | 40.80 | 44.00 | 49.80 | 56.40 | 46.80 | 38.00 | 45.97 |
| Songotra | 33.20 | 34.40 | 36.00 | 38.00 | 34.80 | 32.20 | 34.77 |
| Zaayura | 36.80 | 37.20 | 40.00 | 43.60 | 40.00 | 36.80 | 39.07 |
| Mean | 37.90 | 40.30 | 44.65 | 49.60 | 42.45 | 35.85 | |

Lsd (P=0.05): Planting date = 5.04, variety = 4.12, planting date x variety = NS

**Table 13**: Effect of planting date and variety of cowpea on number of leaves at flowering (42 DAP).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 52.2 | 65.8 | 65.8 | 85.6 | 39.0 | 72.8 | 63.53 |
| Padi-Tuya | 52.0 | 52.8 | 52.8 | 52.4 | 52.0 | 54.0 | 52.67 |
| Songotra | 53.4 | 61.0 | 61.0 | 67.4 | 46.2 | 69.4 | 59.73 |
| Zaayura | 39.0 | 44.2 | 44.2 | 48.6 | 34.2 | 49.8 | 43.33 |
| Mean | 49.1 | 56.00 | 56.00 | 63.50 | 42.80 | 61.50 | |

Lsd (P=0.05): Planting date = 10.00, variety = 8.17, planting date x variety = NS

**Table 14**: Effect of planting date and variety of cowpea on number of leaves at first harvest (49 DAP).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 59.4 | 77.0 | 85.2 | 69.4 | 38.4 | 45.6 | 62.50 |
| Padi-Tuya | 58.8 | 68.2 | 87.4 | 49.4 | 49.4 | 49.2 | 60.40 |
| Songotra | 52.0 | 56.0 | 66.6 | 46.0 | 47.8 | 48.8 | 52.87 |
| Zaayura | 57.8 | 68.4 | 78.6 | 59.0 | 41.8 | 53.6 | 59.87 |
| Mean | 57.00 | 67.40 | 79.45 | 55.95 | 44.35 | 49.30 | |

Lsd (P=0.05): Planting date = 12.20, variety = NS, planting date x variety = NS

### 4.1.5 Dry leaf weight per plant

There was no significant variety by planting date interaction across the various sampling dates on leaf dry weight at flowering and at first harvest (Tables 15, and 16). However, there was significant variety and planting dates effects on cowpea leaf dry matter. Planting on 25th of July produced significantly greater leaf dry matter than the rest of the planting dates at the flowering stage (Table 15). Plantings of 30th June, 12th July and 12th August were similar but all yielded significantly higher leaf dry matter than planting on 2nd August. Means of varieties indicate that Padi-Tuya produced significantly higher leaf dry matter than the rest of the varieties (Table 15).

At first harvest, planting on 12th July produced significantly higher leaf dry matter than the rest of the planting dates (Table 16). At this stage also, Padi-Tuya

produced significantly higher leaf dry matter than the other three varieties (Table 16).

**Table 15**: Effect of planting date and variety of cowpea on weight (g) of dry leaf weight at flowering (42 DAP).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 4.02 | 5.38 | 5.34 | 7.86 | 2.72 | 5.46 | 5.13 |
| Padi-Tuya | 5.72 | 6.26 | 6.32 | 6.90 | 5.22 | 6.80 | 6.20 |
| Songotra | 4.52 | 5.06 | 5.02 | 5.82 | 4.00 | 5.24 | 4.94 |
| Zaayura | 3.64 | 4.12 | 4.34 | 5.42 | 3.24 | 4.36 | 4.19 |
| Mean | 4.48 | 5.21 | 5.26 | 6.50 | 3.80 | 5.47 | |

Lsd (P=0.05): Planting date = 0.99, variety = 0.81, planting date x variety = NS

**Table 16**: Effect of planting date and variety of cowpea on weight (g) of dry leaf weight at first harvest (49 DAP).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 5.14 | 6.88 | 8.12 | 5.66 | 2.62 | 4.16 | 5.43 |
| Padi-Tuya | 6.94 | 7.10 | 8.52 | 5.66 | 5.82 | 7.66 | 6.95 |
| Songotra | 5.10 | 5.54 | 6.88 | 4.22 | 4.84 | 4.44 | 5.17 |
| Zaayura | 5.42 | 6.14 | 6.68 | 5.64 | 4.40 | 4.92 | 5.53 |
| Mean | 5.65 | 6.42 | 7.55 | 5.30 | 4.42 | 5.30 | |

Lsd (P=0.05): Planting date = 1.57, variety = 1.28, planting date x variety = NS

### 4.1.6 Number of branches

At flowering, information on interaction between planting date and variety indicated not significant but the production of branches by Songotra was significantly different from both Baawutawuta and Padi-Tuya but not different from Zaayura (Table 17). Baawutawuta recorded the least number of branches while Songotra recorded the highest number. There was significant difference ($P<0.05$) within planting dates in the number of branches on the main stems were determined (Table 17). Planting on the 12th August produced significantly lower number of branches than the other planting dates while planting on 30th June produced significantly higher number of branches than planting in July and August (Table 17). Baawutawuta and Padi-Tuya recorded high numbers of branches on the main stem when planted on 25th July while both Songotra and Zaayura recorded high branch numbers when planted on 30th June but all varieties recorded lowest number of branches when planting was done on 12th August.

**Table 17**: Effect of planting date and variety of cowpea on number of branches from main stem at flowering (42 DAP).

| | **Planting Dates** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 3.80 | 4.20 | 4.00 | 4.40 | 2.80 | 2.40 | 3.60 |
| Padi-Tuya | 4.00 | 4.40 | 3.60 | 4.80 | 4.20 | 1.00 | 3.67 |
| Songotra | 4.60 | 6.00 | 4.20 | 4.60 | 4.80 | 2.00 | 4.37 |
| Zaayura | 4.00 | 4.40 | 3.80 | 4.20 | 3.80 | 3.00 | 3.87 |
| Mean | 4.10 | 4.75 | 3.90 | 4.50 | 3.90 | 2.10 | |

Lsd (P=0.05): Planting date = 0.67, variety = 0.55, planting date x variety = NS

Data taken on branch numbers at first harvest did not show any significant effect of planting date or varieties (Table 18). The interaction between variety and planting date was also not significant. However, Baawutawuta recorded high branch number with plantings of 25th July and 2nd August and recorded its lowest number with plantings of 30th June and 12th August. Padi-Tuya on the other hand recorded higher branch numbers when planted on 2nd August than when planted on 12th August. For both Songotra and Zaayura, high branch numbers were recorded when planted on 30th June while planting on 12th August recorded the least branch numbers. Generally the lowest number of branches at this stage were with 12th August planting. Baawutawuta produced the highest number of branches while Zaayura produced the least (Table 18).

**Table 18**: Effect of planting date and variety of cowpea on number of branches from main stem at first harvest (49 DAP).

| | **Planting Dates** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 2.00 | 1.80 | 2.00 | 2.20 | 2.20 | 1.80 | 2.00 |
| Padi-Tuya | 1.40 | 2.00 | 1.80 | 1.40 | 2.40 | 0.60 | 1.60 |
| Songotra | 1.40 | 2.00 | 1.20 | 1.40 | 1.40 | 1.00 | 1.40 |
| Zaayura | 1.20 | 1.60 | 1.20 | 1.20 | 1.40 | 1.00 | 1.27 |
| Mean | 1.50 | 1.85 | 1.55 | 1.55 | 1.85 | 1.10 | |

Lsd (P=0.05): Planting date = NS, variety = NS, planting date x variety = NS

### 4.1.7 Roots dry weight

Dry weight of roots was not significantly different at all three stages of plant growth when tested for interaction effect of planting dates and varieties of cowpea. There were however significant differences exhibited by planting dates and also varieties at all stages of growth. For the two growth stages, dry weights of roots were significantly different with planting on 25th July (Tables 19, and 20). The trend was almost the same with the different varieties as highest root dry weight was recorded for each variety on the planting of 25th July except Songotra which recorded highest root dry weight at first harvest with the planting of 12th July.

Significant differences were observed with planting dates at flowering stage for dry weight of roots (Table 19). The fourth planting date (25th July) was significantly different from all the other planting dates but the third planting date (12th July) and sixth planting date (12th August) were not significantly different. Planting on 12th August was significantly different from plantings of 20th June, 30th June and 2nd August, and again planting on both 12th July and 2nd August were not different but they were both significantly different from plantings of 20th and 30th June. Planting on 20th June was also significantly different from planting on 30th June in root dry weight. At this age of plants Padi-Tuya produced significantly higher root dry weight than the other varieties involved (Table 19). Zaayura was also significantly different from Baawutawuta. But Zaayura and Songotra as well as Baawutawuta and Songotra were not significantly different from each other.

**Table 19**: Effect of planting date and variety of cowpea on dry weight (g) of roots per plant at flowering (42 DAP).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 0.56 | 0.30 | 0.78 | 1.26 | 0.70 | 0.88 | 0.75 |
| Padi-Tuya | 0.90 | 0.50 | 1.02 | 1.62 | 1.00 | 1.36 | 1.07 |
| Songotra | 0.46 | 0.24 | 0.90 | 1.58 | 0.80 | 0.76 | 0.79 |
| Zaayura | 0.64 | 0.36 | 0.96 | 1.62 | 0.62 | 0.98 | 0.86 |
| Mean | 0.64 | 0.35 | 0.92 | 1.52 | 0.78 | 1.00 | |

Lsd (P=0.05): Planting date = 0.14, variety = 0.12, planting date x variety = NS

From Table 20 there were significant differences at first harvest stage of plants among planting dates and varieties. Both plantings of 12th July and 25th July did not show significant differences among themselves but were significantly different in weight of dry root per plant from the rest of the dates planted. Planting on 30th June was also significantly different with weight of dry roots per plant from planting on 12th August. However, planting on 20th June, 30th June and 2nd August were not significantly different. Root dry weight for Padi-Tuya was significantly different from that of Baawutawuta, Songotra and Zaayura but there was no significant difference among the three latter varieties (Table 20).

**Table 20**: Effect of planting date and variety of cowpea on dry weight (g) of roots per plant at first harvest (49 DAP).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 0.92 | 1.14 | 1.50 | 1.36 | 0.74 | 0.78 | 1.07 |
| Padi-Tuya | 1.28 | 1.44 | 1.76 | 1.94 | 1.34 | 1.20 | 1.49 |
| Songotra | 0.92 | 1.04 | 1.42 | 1.30 | 0.96 | 0.88 | 1.09 |
| Zaayura | 0.94 | 1.18 | 1.46 | 1.92 | 1.06 | 0.76 | 1.22 |
| Mean | 1.02 | 1.20 | 1.54 | 1.63 | 1.03 | 0.91 | |

Lsd (P=0.05): Planting date = 0.26, variety = 0.21, planting date x variety = NS

### 4.1.8 Dry biomass weight per plot

At the vegetative stage, both planting date and interaction effect of planting date x variety did not show significant difference in dry biomass weight per plot (Table 21). All the same Baawutawuta planted on 25th July produced the highest biomass weight per plot and planting on 12th August produced the least biomass weight. The highest biomass weight per plot for Padi-Tuya was recorded when planted on 2nd August while its least figure was recorded when planted on 12th July. If not for the lowest dry biomass weight of Songotra, both Songotra and Zaayura reacted oppositely to Padi-Tuya with regard to dry biomass weight per plot. Their highest weights were recorded with the planting of 12th August while their lowest weights recorded when planted on 12th July and 25th July for Songotra and Zaayura respectively (Table 21). Significant difference was indicated with variety reactions at the vegetative stage with Padi-Tuya being significantly different from Songotra and Zaayura but similar to Baawutawuta which is also significantly different from

Songotra (Table 21). Baawutawuta was not significantly different from Zaayura and also Songotra and Zaayura were not significantly different from one another too.

**Table 21**: Effect of planting date and variety of cowpea on dry biomass (stems and leaves only) weight (kg) per plot after last harvest.

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 1.16 | 1.12 | 1.12 | 1.38 | 1.21 | 0.94 | 1.15 |
| Padi-Tuya | 1.37 | 1.36 | 1.00 | 1.28 | 1.66 | 1.56 | 1.37 |
| Songotra | 0.89 | 0.94 | 0.74 | 0.82 | 0.93 | 1.06 | 0.90 |
| Zaayura | 1.02 | 1.04 | 1.00 | 0.90 | 1.00 | 1.20 | 1.03 |
| Mean | 1.11 | 1.12 | 0.97 | 1.10 | 1.20 | 1.19 | |

Lsd (P=0.05): Planting date = NS, variety = 0.23, planting date x variety = NS

### 4.1.9 Leaf area

Interaction effect of planting date and varieties on leaf area were all significant (P<.05). Leaf area of Padi-Tuya was significantly different from that of Zaayura, Songotra and Baawutawuta (Table 22). Leaf area of Zaayura was also different from Baawutawuta and Songotra , while those of Baawutawuta and Songotra were similar. Planting on 25th July was significantly different from all the other dates invovled. Padi-Tuya produced largest leaves when planted on the 25th July and smallest leaf area with the planting of June 30th. Zaayura recorded its largest leaf area with the planting of 25th July and smallest when planted on 2nd August. Baawutawuta produced largest leaf area when planted on 20th June and smallest

leaf area when also planted on 2nd August. Songotra was similar to Padi-Tuya with largest leaf area produced when planted on 25th July and smallest when planted on 30th June. However, Padi-Tuya produced the largest leaf area than the other varieties while Songotra produced the smallest leaves in terms of area (Table 22).

**Table 22**: Effect of planting date and variety of cowpea on leaf area ($cm^2$).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 38.73 | 35.95 | 31.83 | 37.26 | 29.86 | 30.79 | 34.1 |
| Padi-Tuya | 47.69 | 39.33 | 42.97 | 62.03 | 56.70 | 55.70 | 50.7 |
| Songotra | 31.46 | 28.30 | 25.34 | 37.99 | 32.23 | 31.89 | 31.2 |
| Zaayura | 47.45 | 42.10 | 39.21 | 56.29 | 30.49 | 32.54 | 41.3 |
| Mean | 41.33 | 36.42 | 34.84 | 48.39 | 37.32 | 37.73 | |

Lsd (P=0.05): Planting date = 4.71, variety = 3.85, planting date x variety = 9.43

### 4.1.10 Plant canopy

Plant canopy diameter was not significantly different with interaction effect between planting date and varieties. Planting dates also did not show significant difference (Table 23). However, there were significant differences among varieties. Songotra developed significantly smaller plant canopy than the other varieties. For Baawutawuta and Padi-Tuya, broadest diameters were recorded when planting took place on 25th July and smallest diameters were recorded when planting was done on the sixth planting date (12th August). Songotra developed broadest plant canopy diameters with the planting on 12th July and small

diameters when planting was done on 12th August, while Zaayura developed broadest canopy diameters with planting of 12th July and smallest diameter with planting on 2nd August. Considering the varieties (Table 23), Padi-Tuya generally developed broader canopy than the other varieties and Songotra developed smallest canopy.

**Table 23**: Effect of planting date and variety of cowpea on canopy diameter (cm).

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 38.08 | 40.64 | 41.48 | 42.44 | 38.62 | 36.00 | 39.54 |
| Padi-Tuya | 40.36 | 41.18 | 41.28 | 41.86 | 40.74 | 37.40 | 40.47 |
| Songotra | 35.52 | 36.34 | 36.72 | 35.66 | 36.14 | 34.64 | 35.84 |
| Zaayura | 40.46 | 40.46 | 40.94 | 39.64 | 37.24 | 37.60 | 39.39 |
| Mean | 38.61 | 39.66 | 40.11 | 39.9 | 38.19 | 36.41 | |

Lsd (P=0.05): Planting date = NS, variety = 2.97, planting date x variety = NS

## 4.2 Flowering and podding

### 4.2.1 Days to first flower opening

Number of days from planting to the day the first flower opened was not significantly affected by planting date and variety interaction (Table 24). The results however indicated that planting date produced significant differences. Planting on 25th July was significantly different from all other planting dates involved. It resulted in fewer numbers of days to first flower opening across all the varieties. The other dates on which planting was done were not significantly

different from one another even though mere figure differences in the number of days to first flowers opening are observed. Higher number of days to first flower opening for Baawutawuta was when it was planted on 2nd August. Padi-Tuya was late to produce first flowers when planting was on 12th August, while Songotra also delayed in producing first flowers with plantings of 30th June. Zaayura on the other hand was late to produce first flowers when planted on both 20th June and 12th July.

There were also significant differences among varieties used (Table 24). Baawutawuta took significantly higher number of days to produce first flowers than all the other varieties. Padi-Tuya was also significantly different from both Songotra and Zaayura in the number of days to first flower. Songotra and Zaayura did not exhibit significant differences among themselves with first flowers opening. Generally, Songotra was the earliest to flower (Table 24).

**Table 24**: Effect of planting date and variety of cowpea on days to first flower opening.

| | **Planting Dates** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 40.20 | 40.20 | 39.20 | 37.60 | 40.40 | 39.60 | 39.5 |
| Padi-Tuya | 37.40 | 38.40 | 37.80 | 36.60 | 38.00 | 38.60 | 37.8 |
| Songotra | 36.00 | 37.60 | 36.60 | 34.80 | 36.00 | 36.60 | 36.3 |
| Zaayura | 37.60 | 37.20 | 37.60 | 35.60 | 36.00 | 36.80 | 36.8 |
| Mean | 37.80 | 38.35 | 37.80 | 36.15 | 37.60 | 37.90 | |

Lsd (P=0.05): Planting date = 0.85, variety = 0.69, planting date x variety = NS

### 4.2.2 Days to 50% flowering

Interaction between planting dates and varieties was significant (Table 25). With all varieties, planting on 25th July produced plants that reached fifty percent (59%) flowers earliest. Planting any of the varieties earlier or later than 25th July generally produced plants that took longer days to reach 50% flowering.

**Table 25**: Effect of planting date and variety of cowpea on days to 50% flowering.

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 42.60 | 44.40 | 44.00 | 42.20 | 44.00 | 43.00 | 43.4 |
| Padi-Tuya | 41.20 | 41.80 | 41.20 | 40.20 | 43.40 | 41.80 | 41.6 |
| Songotra | 40.40 | 41.00 | 40.40 | 38.20 | 40.40 | 38.40 | 39.8 |
| Zaayura | 41.60 | 41.60 | 42.20 | 38.40 | 40.00 | 38.40 | 40.4 |
| Mean | 41.45 | 42.20 | 41.95 | 39.75 | 41.95 | 40.40 | |

Lsd (P=0.05): Planting date = 0.75, variety = 0.61, planting date x variety = 1.50

### 4.2.3 Podding

The number of days from planting to the day first pods appeared was observed. There was no significant interaction effect of planting date and varieties (Table 26). Planting date however produced significant differences. Planting on 25th July had plants producing pods earlier than planting on other dates involved; and that planting on 20th June resulted in late podding. Planting on 20th June was significantly different from all other planting dates involved. 30th June, 12th July,

2nd August and 12th August planting dates were not different from one another but were all significantly different from the planting of 25th July. The Baawutawuta variety was the latest to set pods and was significantly different from the other 3 varieties while Padi-Tuya was also significantly different from Songotra and Zaayura, but the latter two varieties were not significantly different (Table26).

**Table 26**: Effect of planting date and variety of cowpea on days to first pod set.

| | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| **Varieties** | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 42.00 | 41.80 | 40.40 | 39.20 | 41.60 | 41.40 | 41.1 |
| Padi-Tuya | 41.00 | 40.00 | 40.00 | 38.00 | 39.80 | 40.40 | 39.9 |
| Songotra | 39.80 | 39.20 | 39.60 | 36.60 | 38.00 | 38.20 | 38.6 |
| Zaayura | 40.80 | 39.20 | 39.20 | 37.20 | 38.00 | 38.20 | 38.8 |
| Mean | 40.90 | 40.05 | 39.80 | 37.75 | 39.35 | 39.55 | |

Lsd (P=0.05): Planting date = 0.78, variety = 0.64, planting date x variety = NS

### 4.2.4 First harvest

Significant interaction between planting date and varieties was observed for number of days taken from planting to first harvest (Table 27). For all varieties, number of days to first harvest was significantly lower with planting on 30th June than the other dates. Higher number of days to first harvest was observed with both planting on 20th June and 12th August.

**Table 27**: Effect of planting date and variety of cowpea on days to first harvest.

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 55.00 | 45.60 | 50.80 | 51.20 | 50.80 | 51.00 | 50.7 |
| Padi-Tuya | 51.40 | 44.00 | 49.60 | 50.40 | 48.00 | 53.60 | 49.5 |
| Songotra | 49.80 | 44.40 | 48.20 | 48.20 | 48.00 | 51.00 | 48.3 |
| Zaayura | 51.40 | 44.00 | 49.00 | 49.20 | 49.40 | 51.00 | 49.0 |
| Mean | 51.90 | 44.50 | 49.40 | 49.75 | 49.05 | 51.65 | |

Lsd (P=0.05): Planting date = 1.05, variety =0.86, planting date x variety = 2.10

## 4.3 Yield and yield components

### 4.3.1 Pod number per plant

The number of green pods per plant when subjected to analysis of variance did not show any significant interaction effect between planting dates and cowpea varieties. There was also no significant difference among planting dates. However, there were significant differences among varieties (Table 28). Baawutawuta produced significantly higher number of green pods per plant than Padi-Tuya, Songotra and Zaayura while no significant differences were found among Padi-Tuya, Songotra and Zaayura.

**Table 28**: Effect of planting date and variety of cowpea on number of pods per plant.

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 12.40 | 12.20 | 12.40 | 14.40 | 11.00 | 13.00 | 12.6 |
| Padi-Tuya | 10.20 | 8.60 | 10.60 | 10.80 | 11.40 | 11.60 | 10.5 |
| Songotra | 9.20 | 10.80 | 9.80 | 8.80 | 8.80 | 8.40 | 9.3 |
| Zaayura | 9.00 | 12.60 | 10.60 | 10.20 | 9.40 | 9.40 | 10.2 |
| Mean | 10.20 | 11.05 | 10.85 | 11.05 | 10.15 | 10.60 | |

Lsd (P=0.05): Planting date = NS, variety = 1.82, planting date x variety = NS

### 4.3.2 Green pod weight per plant

The weight of green pods was not significantly different among planting dates, and the interaction between planting dates and varieties. However, varieties exhibited significant differences among themselves (Table 29). Padi-Tuya was significantly different from both Songotra and Zaayura but not different from Baawutawuta. Songotra, Zaayura and Baawutawuta were similar in the amount of green pod weight produced. Generally Padi-Tuya recorded the highest weight of green pods per plant while Zaayura recorded the least weight of green pods per plant (Table 29).

**Table 29**: Effect of planting date and variety of cowpea on weight (g) of green pods per plant.

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 51.1 | 41.7 | 44.3 | 53.2 | 41.3 | 47.9 | 46.6 |
| Padi-Tuya | 61.5 | 47.9 | 51.6 | 50.6 | 53.3 | 50.8 | 52.6 |
| Songotra | 50.6 | 49.5 | 43.8 | 43.1 | 39.4 | 32.5 | 43.1 |
| Zaayura | 38.3 | 46.3 | 33.3 | 39.4 | 41.0 | 48.6 | 41.1 |
| Mean | 50.38 | 46.35 | 43.25 | 46.58 | 43.75 | 44.95 | |

Lsd (P=0.05): Planting date = NS, variety = 8.81, planting date x variety = NS

### 4.3.3 Green pod yield per hectare

Table 30 shows green pod yield per hectare. This was not significantly affected by planting date, variety, and interaction effect of planting date and variety (Table 30).

**Table 30**: Effect of planting date and variety of cowpea on green pod yield (tons) per hectare.

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 4.26 | 3.47 | 3.69 | 4.44 | 3.44 | 3.99 | 3.9 |
| Padi-Tuya | 5.12 | 3.99 | 4.30 | 4.21 | 4.44 | 4.23 | 4.4 |
| Songotra | 4.21 | 4.13 | 3.65 | 3.59 | 3.28 | 2.70 | 3.6 |
| Zaayura | 3.19 | 3.86 | 2.78 | 3.28 | 3.42 | 4.05 | 3.4 |
| Mean | 4.19 | 3.86 | 3.60 | 3.88 | 3.64 | 3.74 | |

Lsd (P=0.05): Planting date = NS, variety = NS, planting date x variety = NS

### 4.3.4 Mean pod weight

Table 31 shows mean green pod weight. There were significant differences in planting date effect, variety effect. The interaction between planting date and varieties was also significant. Planting Baawutawuta on 30th June produced significantly lower mean pods than planting on 20th June. Except with the planting of 30th June, Padi-Tuya planted on 20th June produced mean pod weighst that were significantly higher than pods from plantings of the other dates. Planting Padi-Tuya on 30th June produced significantly heavier pods than planting on 25th July, 2nd August and 12th August. Songotra planted on 20th June and 25th July did not show any significant difference in mean pod weight but planting on 20th June produced significantly heavier pods than planting on the other dates, while planting on 25th July was significantly different from planting on 12th August. Planting Zaayura on 12th August produced significantly heavier mean pods than planting on 20th June, 30th June, 12th July and 25th July.

**Table 31**: Effect of planting date and variety of cowpea on mean pod weight (g) of green pods.

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 4.12 | 3.32 | 3.57 | 3.67 | 3.70 | 3.63 | 3.7 |
| Padi-Tuya | 6.02 | 5.52 | 4.87 | 4.53 | 4.56 | 4.33 | 5.0 |
| Songotra | 5.50 | 4.62 | 4.47 | 4.90 | 4.50 | 4.14 | 4.7 |
| Zaayura | 4.17 | 3.72 | 3.09 | 3.77 | 4.41 | 4.98 | 4.0 |
| Mean | 4.95 | 4.29 | 4.00 | 4.22 | 4.29 | 4.27 | |

Lsd (P=0.05): Planting date = 0.36, variety = 0.29, planting date x variety = 0.72

### 4.3.5 Number of seeds per pod

Table 32 shows the number of seeds per pod. There were significant differences in planting dates, varieties of cowpea, and the interaction between planting dates and varieties. The interaction between planting date and variety indicated that planting Songotra on 25th July produced significantly greater number of seeds per pod than planting on 2nd August, while planting Zaayura on 12th August produced significantly greater number of seeds per pod than planting it on both 30th June and 12th July (Table 32). Both Baawutawuta and Padi-Tuya did not show significant interaction with planting dates.

**Table 32**: Effect of planting date and variety of cowpea on number of seeds per pod.

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 12.20 | 12.00 | 12.60 | 12.40 | 12.80 | 12.80 | 12.5 |
| Padi-Tuya | 9.40 | 9.20 | 9.00 | 9.00 | 10.60 | 9.60 | 9.5 |
| Songotra | 10.60 | 10.40 | 10.60 | 12.00 | 9.20 | 10.80 | 10.6 |
| Zaayura | 9.00 | 8.40 | 6.60 | 8.80 | 9.80 | 10.60 | 8.9 |
| Mean | 10.3 | 10 | 9.7 | 10.55 | 10.6 | 10.95 | |

Lsd (P=0.05): Planting date = 0.98, variety = 0.80, planting date x variety = 1.96

## 4.4 Pod quality

### 4.4.1 Pod length

Significant differences were recorded with planting dates and varieties but their interaction was not significant (Table 33). Planting on 20th June produced significantly longer pods than planting on 30th June, 25th July, 2nd August and 12th August but this was not significantly different from planting on 12th July. Planting on 12th July was also significantly different from planting on 30th June, 2nd August and 12th August. There were no significant differences in pod length among planting on 30th June, 25th July, 2nd August and 12th August. Significantly longer pods were produced by the Padi-Tuya variety than the other varieties. Though Baawutawuta produced the shortest mean pod, this was not significantly different from those of Baawutawuta, Songotra, and Zaayura.

**Table 33**: Effect of planting date and variety of cowpea on pod length (cm).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 16.28 | 14.82 | 15.98 | 15.81 | 15.04 | 14.40 | 15.4 |
| Padi-Tuya | 17.80 | 16.57 | 17.24 | 16.07 | 16.42 | 15.30 | 16.6 |
| Songotra | 16.28 | 14.65 | 16.86 | 15.93 | 15.20 | 15.70 | 15.8 |
| Zaayura | 16.10 | 15.31 | 15.40 | 15.40 | 14.58 | 15.83 | 15.4 |
| Mean | 16.61 | 15.34 | 16.37 | 15.80 | 15.31 | 15.31 | |

Lsd (P=0.05): Planting date = 0.72, variety = 0.59, planting date x variety = NS

### 4.4.2 Pod diameter

There were significant differences among varieties, sowing dates and also the interaction between varieties and sowing dates with regards to pod diameter. All the varieties produced significantly larger pods when planted on the 12th August than planting on all the other dates (Table 34). Baawutawuta, Padi-Tuya and Zaayura planted on 20th June, 30th June, and 2nd August did not show significant differences in pod diameter, but were all significantly different from both plantings in July. Planting of Songotra on 20th June, 30th June and 2nd August all produced pods that were significantly larger than pods produced when planted in July. There was a significant pod diameter difference when Songotra was planted on 20th June than when planted on 2nd August (Table 34).

**Table 34**: Effect of planting date and variety of cowpea on pod diameter (mm).

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 6.95 | 6.91 | 4.74 | 5.06 | 6.47 | 10.34 | 6.7 |
| Padi-Tuya | 7.58 | 7.48 | 5.96 | 6.34 | 7.03 | 12.56 | 7.8 |
| Songotra | 7.76 | 7.49 | 5.33 | 5.83 | 6.75 | 13.34 | 7.7 |
| Zaayura | 7.40 | 7.48 | 5.93 | 6.28 | 7.31 | 13.59 | 8.0 |
| Mean | 7.42 | 7.34 | 5.49 | 5.88 | 6.89 | 12.46 | |

Lsd (P=0.05): Planting date = 0.31, variety = 0.25, planting date x variety = 0.61

### 4.4.3 Pod fibre content

Results obtained from analysis of green pods for their fibre content showed significance in interaction between planting date and variety (Table 35). Planting of all the varieties on 12th August was significantly different from all other planting dates and for Baawutawuta planting also on 20th June and on 2nd August were both significantly different from planting on both 12th and 25th July. Results obtained from planting on 20th June, 30th June and 2nd August were not different from one another just as planting on 12th and 25th July were also not different from each other. For the other three varieties: Padi-Tuya, Songotra and Zaayura, except for planting on 12th August, all the other planting dates were not different from one another (Table 35).

**Table 35**: Effect of planting date and variety of cowpea on fibre content (g/100g) of green pods.

| Varieties | Planting Dates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20th June | 30th June | 12th July | 25th July | 2nd August | 12th August | Mean |
| Baawutawuta | 2.70 | 2.69 | 2.64 | 2.61 | 2.71 | 2.78 | 2.7 |
| Padi-Tuya | 1.88 | 1.87 | 1.88 | 1.83 | 1.84 | 1.99 | 1.9 |
| Songotra | 2.00 | 1.99 | 1.99 | 1.99 | 2.04 | 2.07 | 2.0 |
| Zaayura | 2.13 | 2.16 | 2.13 | 2.14 | 2.17 | 2.20 | 2.1 |
| Mean | 2.18 | 2.18 | 2.16 | 2.14 | 2.19 | 2.26 | |

Lsd (P=0.05): Planting date = 0.02, variety = 0.02, planting date x variety = 0.05

### 4.5 Correlation among some parameters of the cowpea experiment

Correlation analysis was carried out on some of the parameters and the results revealed that there were also positive correlations among some of them as shown in the correlation matrix in Table 36. Plant height at first harvest (PHFH) positively correlated with Stem diameter at first harvest (SDFH), Number of leaves at first harvest (Lno.FH), Pods per plant (PPlt), Mean pod weight (MPW), Leaf area (LA), Plant canopy (PltCano), Pod diameter (PD) and Pod length (PL) while pods per plant (PPlt) was positively correlated with Leaf area (LA), Plant canopy (PltCano) and Pod length (PL). In other relations, Stem diameter at first harvest (SDFH) also was positively correlated with Number of branches at first harvest (Bno.FH), Pods per plant (PPlt), Mean pod weight (MPW), Leaf area (LA), Plant canopy (PltCano), and Pod length (PL) while Mean pod weight (MPW) was positively correlated with Leaf area (LA), Pod diameter (PD) and Pod length (PL).

**Table 36:** Correlation matrix of some parameters

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PHFH | 1.000 | | | | | | | | | | | |
| SDFH | 0.411** | 1.000 | | | | | | | | | | |
| Lno.FH | 0.056 | -0.121 | 1.000 | | | | | | | | | |
| Bno.FH | -0.063 | 0.077 | 0.380** | 1.000 | | | | | | | | |
| DFF | -0.136 | -0.191 | 0.132 | -0.042 | 1.000 | | | | | | | |
| PPlt | 0.081 | 0.406** | 0.245* | 0.043 | 0.207* | 1.000 | | | | | | |
| MPW | 0.268* | 0.116 | -0.198 | -0.004 | -0.320 | -0.109 | 1.000 | | | | | |
| LA | 0.701** | 0.481** | 0.082 | 0.016 | -0.066 | 0.190* | 0.142 | 1.000 | | | | |
| PltCano | 0.177 | 0.290* | 0.251* | 0.062 | 0.077 | 0.350** | -0.001 | 0.271* | 1.000 | | | |
| PD | 0.140 | -0.011 | -0.223 | -0.494 | -0.258 | -0.057 | 0.161 | -0.006 | -0.210 | 1.000 | | |
| PL | 0.292* | 0.165 | 0.082 | -0.024 | -0.082 | 0.182* | 0.530** | 0.194* | 0.220* | -0.091 | 1.000 | |
| Yld/Ha | 0.268* | 0.446** | 0.120 | 0.046 | 0.017 | 0.826** | 0.441** | 0.273* | 0.308 | 0.035 | 0.457** | 1.000 |
| | PHFH | SDFH | Lno_FH | Bno_FH | DFF | PPlt | MPW | LA | PltCano | PD | PL | Yld/Ha |

***=p=0.05**, ****=0.01**

**Legend: PHFH** = Plant height at first harvest, **SDFH** = Stem diameter at first harvest, **Lno.FH** = Number of leaves at first harvest, **Bno.FH** = Number of branches at first harvest, **DFF** = Days to 50% flowering, **PPlt** = Pods per plant, **MPW** = Mean pod weight, **LA** = Leaf area, **PltCano** = Plant canopy, **PD** = Pod diameter, **PL** = Pod length, Yld/Ha

# CHAPTER FIVE

## 5.0 DISCUSSION

In this chapter the results obtained from the field experiments conducted at the Manga Out-Station of the Savanna Agricultural Research Station (S. A. R. I.) during the 2012 cropping season on the effect of planting date and four varieties o cowpea on green pod production are discussed.

### 5.1Effect of Planting Date and Varieties on:

#### 5.1.1 Crop Growth

##### 5.1.1.1 Plant Height

Interaction effects were observed from the fifth week after sowing (WAS). Data on plant heights taken on 5th, 6th, and 7th WAS generally showed that there were significant differences among planting dates, some of the varieties, and also interaction between planting dates and varieties. Both Baawutawuta and Songotra did not show significant interact on differences at the three growth stages that plant height was recorded but Padi-Tuya and Zaayura showed. Both varieties: Padi-Tuya and Zaayura, planted on 25th July produced significantly taller plants when plant height was recorded at 35, 42 and 49 DAP. At 35 DAP, Padi-Tuya planted on 12th August produced significantly taller plants than both plantings in June but was similar to plantings on both 12th July and 2nd August while both plantings in June were also not significantly different in plant height. Zaayura planted on 25th July produced significantly taller plants than when it was planted on 2nd August but similar in height to all other dates it was planted. Plant height

records indicated that at 42 DAP, Padi- Tuya planted on 12th August also produced significantly taller plants than the other dates it was planted on except 25th July. Planting on 30th June, 12th July and 2nd August to Padi-Tuya were similar but produced significantly taller plants than planting on 20th June. At 42 DAP Zaayura planted on 12th August also produced plants that were significantly taller than those planted on 30th June and 2nd August but was similar to planting of 25th July, while planting on 20th June, 12th July and 12th August were not significantly different in height. At 49 DAP, except 25th July, Padi-Tuya planted on 12th August produced plants that were significantly taller than the other planting dates. Planting on 2nd August was also significantly different in height from both plantings in June but was similar to the planting of 12th July. Planting of Padi-Tuya on 12th July was not significantly different from planting on 20th June but significantly different in height from planting on 30th June. At 49 DAP Zaayura planted on 20th June, 30th June, 12th July and 12th August did not produce plants that were significantly different in height from one another; meanwhile planting the variety on 2nd August also produced plants that were significantly shorter than those planted on 20th June and 12th August. There was no significant difference among planting Zaayura on 30th June, 12th July and 2nd August. Generally, at all the plant growth stages that plant height measurements were taken, planting the varieties on 25th July yielded significantly taller plants (Tables 3, 4 and 5). There were differences in plant height among the varieties and that may be due to genetic variations. Cowpea varieties exhibited taller plants with late planting in each of the months that planting was done and with planting on 25th July producing tallest plants (Tables 3 and 4). This contradicts the findings of Adjei-Twum, (1978); Sayeed, (1988); Yadev, (1999); Incalcaterra *et al.*, (2000);

Abdou-Razakou, (2013) and Rajesh, (2010) who all reported higher plants with early planting, but agrees with the findings of Norman, (1981) that planting in April to August produced significantly higher length of pineapple peduncle. It is therefore important to consider planting these cowpea varieties after mid-July if taller plants that also keep green pods above ground, thereby avoiding soil contamination are a goal. It is also evident from the results that plant height is positively correlated to other parameters (Table 37) including stem diameter (r = 0.411**), pods per plant (r = 0.081), mean pod weight (r = 0.268*) and yield per hectare (r = 268*). Though some of the correlations are weak, the results show that plant height has a reflection on the number of pods per plant and mean pod weight. This finding is similar to the reports by Kuruvadi and Escobar (1987) that worked on soya bean and found that, yield and number of pods per plant is associated.

### 5.1.1.2 Stem Diameter

Stem diameter was observed with the aim of finding varieties and planting dates that will produce thick stems. Thick stems have an added advantage of being able to support heavy vegetative growth and pods. There was no stage of plant growth that stem diameter showed significant interaction between planting date and varieties. Varieties exhibited significant differences among themselves which is in agreement with the report of Abdou-Razakou, (2013) in his study to select drought tolerant varieties of cowpea. Baawutawuta and Songotra generally recorded thin stems that were not significantly different from one another. Baawutawuta increased slowly in stem diameter as observed during the first 42

DAP; considering that it all along to this period produced the thinnest stems. Padi-Tuya and Zaayura produced larger stems which were not significantly different from one another but were both significantly different from both Baawutawuta and Songotra. Stems were also thick enough and held plant parts including pods above ground, which is a vital characteristic of erect varieties. Except Baawutawuta and Songotra at 35 DAP, Zaayura at 42 DAP and again Songotra at 49 DAP, planting the varieties on 25th July constantly produced larger stems across all planting dates. This observation does not agree with the report by Norman, (1981) that planting date had no significant difference on peduncle of pineapple, while Amankwatia, (1979) and Singh, (1992) reported of reduced stems of Congo jute and sweet potato respectively when planted late. At 35 DAP, the 25th July and 12th August plantings were not significantly different from one another in stem diameter but were both significantly larger than the rest of the planting dates. Planting on 30th June, 12th July and 2nd August did not produce stems that were significantly different from one another, while both plantings in June and on 2nd August were also similar, but planting on 20thJune produced stems that were significantly different from those produced when planted on 12th July. At 42 DAP, plantings of 20th June, 25th July and 12th August produced stems that were significantly larger than each other but were all significantly larger than stems produced when planted 30th June, 12th July and 2nd August. Planting on 30th June and on 2nd August were similar to plantings of 30th June and on 12th July as they did not produce stems that were significantly different in each set, but planting on 2nd August produced stems that were significantly larger than those produced when planted on 12th July. At 49 DAP, while planting on 20th June, 25th July and 2nd August were not significantly different in stem diameter, planting on

30th June and on 12th July were also not significantly different. No significant difference was shown with both plantings in August too. However, planting on 20th June, 25th July and on 2nd August produced stems that were significantly larger than stems produced when planted on both 30th June and 12th July. It is therefore necessary to look critically at the various varieties against planting dates that will produce thicker stems that are capable of supporting crop yield. Planting both Padi-Tuya and Zaayura on June 20th June and 25th July are appropriate varieties and planting dates that will produce thicker stems.

### 5.1.1.3 Dry stem weight per plant

Dry stem weight followed similar trend as for stem diameter. No significant interaction was observed but differences among the varieties, except during floweing, generally indicated Padi-Tuya and Zaayura produced bigger stems while Baawutawuta and Songotra produced smaller stem weights. Consistently, the varieties planted on 25th July produced bigger stems across all planting dates except Padi-Tuya at 49 DAP which produced the biggest dry stem weight with planting of 30th June. Baawutawuta in the first 42 DAP was again the variety that recorded the least dry stem weights while Padi-Tuya plants produced heaviest dry stems. Rajesh, (2010) also reported significant increase in vegetative characters in his study on *Glycine max* and *Phaseolus mungo*. At 35 DAP, the 30th June, 12th July and 25th July plantings were not significantly different from one another in stem dry weight per plant but both plantings on 30th June and 25th July produced stems that were significantly different from plantings of 20th June and both plantings in August. Planting on 12th July was similar in stem dry weight per plant

to planting on 20th June and 2nd August but significantly different from planting on 12th August. At 42 DAP, the planting on 25th July produced stems that were significantly heavier than those produced when planted on all the other dates. Except with the planting of 30thJune that was also significantly different from the planting of 2nd August, the other planting dates produced stems that were not significantly different from one another. At 49 DAP, the first four dates planted were not significantly different from one another in stem dry weight per plant but were all significantly bigger than stems produced when planted on 2nd August, while both plantings of 30th June and 25th July were also significantly different from stems produced when planted on 12th August. The results generally reveals that bigger stem dry weights are achieved when planting of the cowpea varieties is done at the end of June (30th June) to the fourth week of July (25th July); and so such dates should be considered when dry matter production, as an added benefit, is conceived.

### 5.1.1.4 Number of Branches from Main Stem

Interaction effect between planting date and varieties was not significantly affected at 35, 42 and 49 DAP when number of branches from the main stem was considered. There were however, significant differences among varieties and this was recorded only at flowering. Reports by Babatunde *et al.*, (2002) and Osei-Kwateng *et al.*, (2012) both confirm significant differences in number of branches observed among varieties of roselle. The significant differences recorded in the number of branches of the cowpea varieties may be attributed to inherent variety characteristics or their genetic make-up. At flowering (42 DAP) Baawutawuta,

Baawutawuta, Padi-Tuya and Zaayura did not show significant differences among themselves, while Songotra and Zaayura were not also significantly different in number of branches on main stem, but Songotra showed significantly higher number of branches than both Baawutawuta and Padi-Tuya. Zaayura in this study appears to be a poor branching variety while Baawutawuta had more branches especially at maturity and also with shorter internodes which have contributed to the low heights of that variety. Significant differences in planting date with regards to branches on main stem was also recorded at flowering only and the means suggest that planting at the end of June produced the highest number of branches. There was no significant difference in the number of branches among plantings on 20th June, 12th July, 25th July and 2nd August but all were significantly different from planting on 12th August.

### 5.1.1.5 Number of leaves per plant

Interaction effects between planting dates and the four varieties was not significant in the number of leaves per plant. However, as individual factors, planting dates were significantly different among treatments with planting on 25th July significantly outstanding. At 35 DAP except planting on 12th July, planting on 25th July resulted in significantly higher number of leaves per plant than the rest of the dates (Table 12). Planting on 30th June, 12th July and 2nd August were not significantly different while planting on 20th June, 30th June, 12th July and 2nd August were also similar. Planting on 20th June and 12th August were also not significantly different but planting on 12th July produced leaf numbers that were significantly different from those obtained with the planting of both 20th June and

12th August. Also at 35 DAP, planting very early in August produced leaf numbers that were significantly different from planting on 12th August. At 42 DAP, planting on 30th June, 12th July, 25th July and 12th August did not show significant differences in leaf numbers per plant but were all significantly different from both plantings on 20th June and 2nd August, while planting on 20th June and on 2nd August were not significantly different in leaf numbers (Table 13). At first harvest (49 DAP), planting on 12th July produced leaf numbers that were not significantly different from leaves per plant produced from planting of 30th June, and planting on 20th June, 30 June and 25th July were not also significantly different, but both plantings in June were significantly different from planting on 2nd August. Planting on 30th June was also significantly different from planting on 12th August.

Considering the varieties involved in the experiment, except at first harvest, significant cowpea varietal differences occurred as was reported by Osei-Kwateng *et al*, (2012) on roselle. The varieties Baawutwuta and Padi-Tuya possibly by their genetic make-up (Wien and Summerfield, 1984) significantly produced more leaves than Songotra and Zaayura at 35DAP and at 42DAP. Songotra produced significantly lower number of leaves than the other three varieties (Table 12 & 13). There was no significant difference in the number of leaves per plant among the varieties at 42 DAP (Table 14) and this suggests that Songotra and Zaaayura progressively increased in number of leaves with age and that Baawutawuta and Padi-Tuya produced more leaves at early growth stage (35 DAP) when planted on 25th July. Production of leaves from the varieties could contribute to the production of a lot of biomass that can be harvested for animal feeding or

incorporated to improve the soil. There was a positive relationship (r = 0.056) between number of leaves and plant height (Table 36) which shows that increase in plant height resulted in increase in number of leaves.

### 5.1.1.6 Leaf Area

Significant differences in leaf area were recorded with planting date, varieties and even their interaction effects. The findings are in agreement with Muoneke *et al*. (2002) who reported significant leaf area on a roselle and cowpea intercrop, and Sreelatha *et al*. (1997) and Begum *et al*. (2003) who both found significant differences in leaf area in French beans. With the exception of Baawutawuta, planting of the varieties on 25$^{th}$ July generally produced significantly larger leaves than the other dates planted. Padi-Tuya produced leaves significantly larger than the other varieties. Padi-Tuya, even though was not significantly different from the other varieties in leaf number especially at first harvest (7 WAP), yet it recorded significantly higher leaf dry weight. This result might have been influenced by the large leaf area that the variety registered and that may have influenced the plants' photosynthetic activity and therefore growth and yield. Leaf area also correlated positively (r = 0.190* and r = 0.481**) with number of pods per plant and stem diameter at first harvest (Table 36).

### 5.1.1.7 Plant canopy

Except for varieties there was no significant difference observed on plant canopy (Table 23). Songotra produced significantly smaller canopy as compared with the other varieties and this might have contributed to the significant difference among

varieties in weight of biomass per plot (Table 21). There was no significant difference in plant canopy among Baawutawuta, Padi-Tuya and Zaayura. Results of correlation analysis of some of the parameters (Table 36), revealed that there was positive correlation between plant canopy and stem diameter at first harvest (r = 0.290*), number of leaves at first harvest (r = 0.251*) and number of pods per plant (r = 0.350**).

### 5.1.1.8 Dry weight of leaves per plant

The interaction planting date and variety was not significant at all the stages of plant growth. Padi-Tuya produced the highest dry leaf weight per plant (Tables 15 & 16). Baawutawuta also significantly out yielded Zaayura in leaf dry weight per plant while Songotra and Zaayura were not different at 42 DAP. Baawutawuta, Songotra and Zaayura did not record significant differences among them in leaf dry weight at first harvest.

At flowering stage (42 DAP), planting in July and especially the fourth planting date (25$^{th}$July) gave best results as it produced significantly higher leaf dry weight than the other planting dates. While significant differences were not found among planting on 20$^{th}$ June, 30$^{th}$ June, 12$^{th}$ July and 12$^{th}$ August, and also among planting on 20$^{th}$ June and 2$^{nd}$ August, planting on 2$^{nd}$ August also significantly produced lower dry leaf weights per plant than planting on 30$^{th}$ June, 12$^{th}$ July and 12$^{th}$ August. Planting on 12$^{th}$ July was not significantly different from planting on 30$^{th}$ June but yielded significantly higher leaf dry weight per plant at the first harvest stage than the other dates planted (Table 16). While planting on 20$^{th}$ June,

30th June, 25th July 12th August did not produce significantly different results, planting on 30th June significantly out-yielded planting on 2nd August in leaf dry weight. This is in agreement with reports by Osei-Kwateng *et al*, (2012) and Addo-Quaye, (2011a) that dry matter of roselle and cowpea respectively to be significantly high.

**5.1.1.9 Dry weight of roots per plant**

There was no significant interaction between planting date and varieties on dry weight of roots per plant at the different stages of plant growth that this parameter was determined (35, 42, & 49 DAP). Root dry weight Padi-Tuya was significantly higher than those of the other varieties (Tables 19 & 20). From visual observation on the field, this variety actually never showed any sign of lodging during the growing period and could be good for planting on windy sites. Root dry weight at flowering showed that planting on 25th July produced results that were significantly different from the other planting dates. There were no significant differences among plantings on 12th July and 12th August, 12th July and 2nd August, and 20th June and 2nd August respectively, but planting on 12th July and 12th August significantly out-yielded both plantings in June. Planting on 20th June and on 2nd August also significantly produced higher root dry weight than planting on 30th June at 42 DAP. At first harvest (49 DAP), planting on 12th July and on 25th July were not significantly different from one another but were both significantly different from the other planting dates and therefore the appropriate dates of planting if good root establishment is to be achieved. Planting 20th June, 30th June and 2nd August did not produce significant differences among them, but

planting on 20th June was significantly different from planting on 12th August. Results at first harvest (49 DAP) further indicated that lower root dry weight were achieved with planting too early (June) and too late (August).

#### 5.1.1.10 Dry biomass weight per plot

There were no significant differences in planting dates and also interaction between planting date and varieties. This is not in agreement with reports by Rutkowski and Fordonski (1987) and Kurmawanshi *et al.* (1994) in experiments conducted on field bean (*Vicia faba*), and Sreelatha *et al.* (1997) on French beans, who concluded that early sowing resulted in significantly higher biomass yield compared to late sowing. Padi-Tuya produced significantly higher dry biomass than Songotra and Zaayura but was similar to Baawutawuta. Baawutawuta also produced dry biomass that was significantly higher than Songotra. It therefore stands that Padi-Tuya and Baawutawuta, apart from yield can be grown by farmers for their additional benefit depending on farmers' choice. Additional benefits include working biomass back into the soil to increase its organic matter content and therefore improving soil fertility and water holding capacity, and also animal farmers can have the plenty dry biomass to feed their animals during the dry season when animal feed is scarce.

#### 5.1.1.11 Days to first flower appearance

There was no significant planting date by variety interaction but it was observed that for all the varieties, earliest first flowers appeared with planting on 25th July. Songotra was the variety that produced the earliest first flower across all dates

planted while Baawutawuta was the latest to produce flowers. There was no significant difference between Songotra and Zaayura but they both had significantly less number of days to first flowers than both Baawutawuta and Padi-Tuya. Baawutawuta also produced first flowers significantly later than Padi-Tuya. The difference among the varieties on days to first flower appearance might be due to the varietal character. This is supported by Nsowah, (1970) who reported that planting dates did not influence floral initiation and opening in egg-plants, and Norman, (1981) who reported that flowering and fruit maturity in pineapple was not significantly affected by planting date. Early flowering varieties of cowpea such as Songotra can escape drought in an area such as this experimental area which mostly has few months of erratic rainfall. This agrees with the report of Ismail *et al.*, (1997) that early flowering cowpeas can escape drought and produce high yields. Yama, (2006) disagrees with this in his report that a cowpea variety was earliest to flower but produced the smallest and shortest pods and consequently the lowest yield. Planting on 25$^{th}$ July was different from all other dates as significantly fewer numbers of days to first flower was observed with planting on this date than all the other dates planted. All other dates planted did not show significant differences in number of days to first flower.



**5.1.1.12 Days to 50% flowering**

Planting dates, varieties of cowpea and also their interaction between planting date and variety showed significant differences when days to 50% flowering was recorded. Planting any of the four varieties on 25$^{th}$ July emerged best if early flowering is to be achieved. Baawutawuta planted on 25$^{th}$ July recorded

significantly less number of days to 50% flowering than planting on 30th June, 12th July and 2nd August but there were no significant differences with planting the variety on all the other dates. With Padi-Tuya, planting on 25th July recorded significantly less number of days to 50% flowering than planting on both 30th June and 12th August. Apart from 25th July, planting on 2nd August resulted in significantly higher number of days to 50% flowering than the rest of the dates, meanwhile there was no significant differences among the other dates. Songotra when planted on 25th July took significantly fewer days to 50% flowering than planting it on 20th June, 30th June, 12th July and 2nd August but not with planting it on 12th August. Planting of Songotra in June, 12th July and 2nd August did not register significant differences among them.

Planting Zaayura on the first three planting dates (20th June, 30th June and 12th July) did not show significant differences among them but all registered significantly higher number of days to 50% flowering than planting it on the later three planting dates (25th July, 2nd August and 12th August). The significant difference among varieties is in agreement with the report by Obadoni, (2009) that significant differences in the number of days to 50% flowering among cowpea varieties. In contrast to this finding, Nsowah, (1970) reported non-significant effects of planting date on flowering in egg-plants, whiles in another study, Norman (1981) reported of planting date not significantly affecting flowering and fruit maturity of pineapple. Wallace *et al.* (1995) and Husain *et al.*, (1988) reported that temperature is undoubtedly the dominant factor, which affects flowering and maturity in field beans and navy beans respectively, while Marfo and Hall (1992) suggested that floral bud development is inhibited by the

combination of high temperatures and long days that finally result in few flowers produced. Songotra was the variety that was ealiest to reach 50% flowering in the study and should be first to select if early flowering is the objective and considering that early flowering is a good characteristic in locations like Upper East Region of Ghana where the rainfall pattern is short and erratic.

#### 5.1.1.13 Days to first pod set

Number of days to first pod set followed the same trend as for days to first flower in that, there was no significant difference in the interaction between planting date and varieties and that planting on 25$^{th}$ July was more appropriate as planting on this date produced earliest pods as compared with the other planting dates. Significantly less number of days to first pod set was recorded when planting was done on 25$^{th}$ July than all the other planting dates. With the exception of planting on 25$^{th}$ July, planting on 20$^{th}$ June was significantly different from the rest of the planting dates, while the rest of the planting dates (30$^{th}$ June, 12$^{th}$ July, 2$^{nd}$ August and 12$^{th}$ August) did not differ from each other significantly. Songotra and Zaayura did not show significant difference among them but both reached 50% flowering at significantly lesser number of days than both Baawutawuta and Padi-Tuya and therefore were earliest pod setters and could be chosen if earliest pod setting is a priority and seed yield is envisaged.

#### 5.1.1.14 Days to first harvest

Significant differences were observed among planting dates, cowpea varieties and also the interaction between planting dates and cowpea varieties when days to first

harvest from planting was studied. All varieties responded significantly to planting on 30th June by taking fewer numbers of days to first harvest. The difference in harvesting days of the varieties was most likely due to the varietal differences as has been observed that species of various crops have adaptive features that contribute to timely flowering (Wien and Summerfield, 1984) and subsequent yield and harvesting. Earliness plays an important role when it comes to mitigating hunger, meeting market demand and fetching higher market price and more income. Songotra which was the first to flower was equally first to be harvested and planting on the 30th June was also significantly different from the other planting dates. Songotra which flowered earlier matured earlier and was the first to be harvested but did not significantly out-yield the other varieties. This contradicts the findings of Yama, (2006) that a variety that was earliest to flower, and harvested first, produced the smallest and shortest pods and subsequently the lowest yield.

### 5.1.2 Crop Yield

#### 5.1.2.1 Pod number per plot

The response of number of pods to the interaction between planting date and cowpea varieties was not significant. However the varieties in themselves produced varying numbers of pods which were significantly different among them. Possibly by their inherent genetic make-up, Baawutawuta produced significantly more pods than the other three varieties but there were no significant differences recorded among Padi-Tuya, Songotra and Zaayura though Songotra produced the lowest number of pods per plant. Planting dates actually did not

produce any significant effect on pod yield. This is in contradiction to the report by Nsowah, (1970) when he studied sowing dates on egg-plant varieties in which number of fruits were significantly different.

### 5.1.2.2 Number of pods per plant

There was no significant interaction between planting date and cowpea varieties. Also planting dates did not produce any significant difference as inconsistent and fluctuating numbers of pods per plant were obtained with the different dates. However, differences among varieties with regards to planting were significant with Baawutawuta being significantly different from all the varieties as it produced the highest pod number per plant. Padi-Tuya was similar to Zaayura but also produced significantly higher number of pods per plant than Songotra. The difference between Songotra and Zaayura was also not significant. Though Adcock, (1976) reported that most often four pods are carried on peduncles of *Vicia faba*, the cowpea varieties produced varying numbers of pods per plant ranging from 8 to 14. Iremiren and Akly, (1986), Yadev, (1999) and Incalcaterra *et al.*, (2000) reported of higher number of fruits per plant on early sown okra than late sown. If pod-setting ability is to be used in the determination of overall yield, Baawutawuta was the best in this study. There was a negative correlation (r = -0.109) between number of pods per plant and mean pod weight which does not agree with reports by Kambal, (1969); Ishag, (1973); and Husain *et al*. (1988) in their studies of *Vicia faba* L., that there was not only consistent but also strong correlation between the number of pods per plant and yield.

### 5.1.2.3 Weight of pods per hectare

Pod weight is a major parameter that is used to estimate yield and therefore it was measured on per plot basis so that other projections could be made if necessary. Planting dates and cowpea varieties even as independent factors were not significantly different and so was the interaction effect of the factors. Pods of Padi-Tuya had higher mean weight than the others they were not significantly different from each other. The variety, Zaayura recorded the lowest mean pod weight. The result suggests that pod weight was similar among the varieties even when planted on different dates as reported by CSIR – SARI (2008) in their variety release of cowpeas publication that all four varieties have comparable yields. This lack of significant difference in yield however does not agree with the reports by Dhital *et al.* (1998) which showed that planting date influenced yield of cowpea and that early planting produced higher yield than late planting. Nsowah, (1970) also reported that early planting produced higher fruit weight of egg-plant than late planting while reports of both Iremiren and Akly (1986) and Sayeed, (1988) indicated that okro pod yield was highest with early sowing as compared to late planting.



### 5.1.2.4 Weight of pods per plant

Weight of pods per plant showed significant differences only for varieties with Padi-Tuya being significantly higher than the other varieties though among the other three varieties there was no significant differences in weight. Zaayura recorded the lowest weight of pods per plant. Though planting date did not show any significant difference for weight of pods per plant, the earliest planting date

(20th June) recorded the highest weight and planting on 25th July recorded the lowest weight of pods per plant.

### 5.1.2.5 Mean pod weight

Considering weights of individual pods (mean pod weight) there were significant differences among planting dates, varieties and also with their interaction. The results from mean pod weight confirms reports of Dhital *et al.*, (1998), Nsowah, (1970) and both Iremiren and Akly, (1986) and Sayeed, (1988) who worked on cowpea, egg-plant and okro respectively. Significantly higher pod weight of Baawutawuta was recorded with the planting on June 20ththan planting on June 30th only. Any other date planted to Baawutawuta was not significantly different from each other. With the exception of planting on June 30th, planting Padi-Tuya on 20th June produced significantly higher pod weight than all other dates it was planted. Padi-Tuya planted on 30th June was not significantly different from planting it on 12th July, but was significantly different from the last three dates which among themselves were similar. Except with the planting of 25th July, Songotra planted on 20th June produced significantly higher pod weight than all dates it was planted. Also planting on 25th July for Songotra produced significantly higher pod weight than planting on 12th August, while there was no significant difference among the other dates planted to Songotra. Zaayura deviated from the other varieties because it produced significantly higher pod weight with the planting on 12th August than all the other dates that it was planted except with the planting on 2nd August. Zaayura planted on 20th June and on 2nd August were not significantly different from each other but were both significantly different

from planting on12th July. Significant differences were not recorded when Zaayura was planted on 30th June, 12th July and 25th July.

### 5.1.2.6 Pod length

Pod length did not show significant interaction between planting date and varieties. However, differences among the varieties and planting dates on pod length were significant. Pods of Padi-Tuya were significantly longer than the pods of the other three varieties, while significant differences in pod length were not recorded among the other three varieties. Longer pods were produced when planting was done on 20th June and 12th July; meanwhile they were not significantly different from one another. However, planting on 20th June produced significantly longer pods than on the other dates planted. Both plantings in July produced pod lengths that were similar but planting on 12th July produced significantly longer pods than plantings on 30th June and both planting dates in August. Planting of the cowpea varieties especially in the month of August yielded shortest pods and were not significantly different from one another. Pod length is one of the major criteria for selecting better variety for higher yield and preferable pod size, which is a preferred market appealing character, Padi-Tuya will best satisfy this purpose. Longer pods of cowpea contribute to more yield than shorter pods (Yama, 2006). Other workers who reported of significantly higher yields include Yadev, (1999) on okro, and Peksen, (2002) on cowpea. If for some reason any of the other varieties are to be planted, planting on 20th June and 12th July will yield longer pods.

### 5.1.2.7 Pod diameter

A larger pod is also a criterion for selecting better cowpea varieties that best suits the market and satisfy the consumer in addition to higher yields that may be achieved. It has been established that big pods of cowpea produce the highest green pod yield that has a potential of being recommended for commercial production (Yama, 2006). Highly significant differences were recorded with planting dates, cowpea varieties and the interaction of both factors. Pod diameter measurement of all the varieties showed significant difference when planted on 12$^{th}$ August compared to the other planting dates. Planting on 12$^{th}$ and 25$^{th}$ July produced significantly smaller pods in diameter than the other dates but were not different from each other. Planting Baawutawuta, Padi-Tuya and Zaayura on 20$^{th}$ June, 30$^{th}$ June and 2$^{nd}$ August did not show significant differences in pod diameter, while Songotra planted on 2$^{nd}$ August was significantly different in pod diameter from both plantings of 20$^{th}$ June and 30$^{th}$ June, but both planting in June were not different. It is therefore evident that planting on 12$^{th}$ August produced larger pods while smaller pods were produced from both 12$^{th}$and 25$^{th}$July plantings.

### 5.1.2.8 Number of seeds per pod

Though pods were harvested before seeds were fully developed, seed numbers per pod were recorded which showed significant differences in planting dates, varieties and their interaction. Baawutawuta produced the highest number of seeds per pod while Zaayura produced the lowest number of seeds. Planting Songotra on 25$^{th}$ July produced significantly higher number of seeds per pod than planting it on

2nd August. Zaayura planted on 12th August produced significantly higher number of seeds per pod than both plantings of 30th June and 12th July while planting it on 20th June, 25th July and 2nd August produced significantly higher number of seeds than planting on 12th July. Significant seed numbers of varieties agree with reports by Razaq, (1995) who attributed differences in mung beans to genotype differences. Also Ahmad *et al.,* (2001) observed that genotypic makeup of wheat varieties influence number of seeds per pod, and Board *et al.,* (1999) assigned significant variations to some soyabean plants failing to develop pods. The findings of Dhital *et al.*, (1998) that number of seeds per pod of cowpea varieties was influenced by planting dates of cowpea is similar to the current results, while Singh *et al.*, (1986) reported that seed yields of okra was highest in early planted plots.

The result confirms reports by Dantuma and Thompson, (1983) and Ishag, (1973) that the number of seeds per pod of fababean (*Vicia faba* L.) can vary considerably. However, the result contradicts that of Thompson and Taylor (1981) who reported that the number of seeds per pod had proved to be the most consistent component of yield.

### 5.1.3 Fibre Content

The interaction between planting date and cowpea varieties was significant.. Higher fibre content was recorded with planting in August while planting in July recorded the lowest. Baawutawuta and Padi-Tuya planted on 12th August produced significantly higher fibre content than planting on the other dates.

Planting Baawutawuta on 20th June and on 2nd August produced fibre content that was significantly different from fibre content produced when planted in July, while planting in June and 2nd August were not significantly different. With Padi-Tuya, planting on all the other dates except planting on 12nd August, did not produce significant differences in fibre content. Songotra and Zaayura followed the same trend. Planting on 12th August produced significantly higher fibre than the other dates planted to them, but there were no significant differences recorded when planted on the other dates. Mean fibre content of the varieties suggests, in a descending order, that more fibre was contained in Baawutwuta, Zaayura, Songotra and Padi-Tuya. This indicates that the varieties contained varying amounts of fibre and therefore depending on the need the appropriate variety could be chosen.

# CONCLUSIONS

The interaction between planting date and varieties was not significant for most of the growth parameters, including stem diameter, stem dry weight, number of leaves, leaf dry weight, number of branches from the main stem and number of pods per plant were determined. However, there were significant differences among planting dates and among varieties for these parameters showing that if any of the above parameters is considered as a main purpose then planting dates and or varieties which gave best results could be used.

Padi-Tuya produced plants that were significantly taller than Baawutawuta, Songotra and Zaayura. Both Padi-Tuya and Zaayura produced significantly bigger stems than the Baawutawuta and Songotra. The stems of Padi-Tuya and Zaayura can support pods well above soil surface thereby avoiding soil contamination and planting on 25$^{th}$ July significantly influenced the results.

Baawutawuta produced more leaves than Padi-Tuya, Songotra and Zaayura, while Padi-Tuya produced larger leaves than the other three varieties and with both parameters, planting on 25$^{th}$ July yielded the best results.

Earliest flowering and harvesting was associated with Songotra as compared to Baawutawuta, Pad-Tuya and Zaayura and planting on 25$^{th}$ July induced the earliest flowering while planting on 30$^{th}$ June was associated with earliest harvest.

All four varieties involved in this study performed differently in terms of yield and yield components across planting dates and are good materials for green pod production and again, planting date is an important factor to be considered when selecting varieties for specific productions. From this study, planting on 25th July posed to be most appropriate.

Both mean green pod number and number of seeds per pod revealed significant interaction between planting dates and varieties. Padi-Tuya produced highest mean pod weight while Baawutawuta produced pods with greater number of seeds.

Generally, the results indicate that pod size (length and diameter) and number of seeds in pods are major determining factors for yield estimation in that, the bigger the pods and or the more the number of seeds in pods, the higher the yield. This might have accounted for the yield similarity of the Zaayura and Baawutawuta varieties since Zaayura produced bigger green pods and also recorded less seeds in pods than Baawutawuta and vice versa but their green pod yields were similar.

Longest pods and largest pods were produced by Padi-Tuya and Zaayura respectively and planting on 20th June produced the longest pods while the largest pods were produced with the planting on 12th August.

The results indicate that there were varying levels of fibre in the green pods of the cowpea varieties and that Baawutawuta registered the highest amount of fibre

while Padi-Tuya recorded the lowest. Planting in the month of August produced the highest fibre content.

# RECOMMENDATIONS

Based on the results of the experiment the following recommendations are made:

This current study should be considered as preliminary as results are reported using one year data; so my recommendation is that further studies involving more varieties, and in different seasons and locations should be done, and if the findings are confirmed, then such varieties are recommended for commercial production of green pods.

Songotra should be grown in locations that have short periods of rainfall since they bloom earliest and therefore will pod early.

Plant and pod sizes of Padi-Tuya and Zaayura are significantly bigger and growing these varieties especially in areas of strong winds and continuously moist soils should be encouraged as their large stems can support many and heavy pods, while pods still carried high above ground level to avoid soil contact.

Early planting should be recommended as favourable weather conditions and less insect attacks could be advantageous.

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