EFFECT OF COWPEA VARIETY AND SEED YIELD IN SCREEN HOUSE

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CERTIFICATION

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DEDICATION

My research work is heartily dedicated to God almighty and to my family for their drive, motivation and inspiration given to me to this very moment.

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ABSTRACT

This study was carried out to evaluate the seed yield of cowpea varieties grown in a screen house in Benin City, Edo state. The study was conducted at the Faculty of Agriculture Research and Experimental Farm, University of Benin, Benin city. Nine (9) cowpea varieties were collected from the Institute for Agriculture Research (IAR), Samaru Zaria and two (2) from an open market on Benin City. The experiment was laid in a completely randomized design (CRD) with eleven treatments and three replications. Data on pod length, number of seeds, total number of pods, weight of seeds and pod weight were collected. The data collected were analyzed using SAS version 9.0. Pod length was highest (13.54) in S19 and lowest in 1.1. There were significant differences among all the cowpea varieties for the measured variable except number of seeds. However, several varieties were statistically equal in performance for all the variables. Samaru varieties were better than the open market varieties in all cases hence it is recommended to sow with samaru varieties.

CHAPTER ONE

1.0 INTRODUCTION

Cowpea (*Vigna unguiculata* (L) Walp) is the most important grain legume in many parts of the world (Takim and Uddin, 2010) and its production is an integral part of the traditional cropping system throughout Africa (Isubikalu *et al.,* 2000). It is mostly grown as an intercrop with maize. It is preferred by farmers because of its role in maintaining soil fertility through nitrogen fixation (Asiwe *et al.,* 2009), and its nutritive value as fodder for livestock (Dzemo *et al*., 2010) and high protein food for human. Among several production constraints of cowpea, activities of insect pests and diseases, while in the field are recognized as major limiting factors in cowpea growth (Asiwe, 2009). Other causes of low cowpea productivity include; parasitic weeds, drought and low soil fertility; however, insect pests constitute the major constraint (Karungi *et al.,* 2000).

Over 130 species of insect pests were recorded on cowpea and they attack virtually every part of the crop including the roots, leaves, flowers and pods (Singh and Jackai, 1995). Insect-pests attack and damage cowpea at all growth stages (Jackai *et al*., 1998) and yield losses due to their activities is about 70 percent (Edema and Adipala, 2006). These insects include (i) the cowpea aphid, *Aphis craccivora*, Koch which attacks the seedlings, flowers and pods (ii) the flower bud thrips, *Megalurothrips sjostedti* Tryb which attacks the flower buds and flowers (iii) the legume pod borer, *Maruca vitrata* Fab (Karungi *et al*., 2000) which damages the flowers, young stems, cowpea pods and seeds and (iv) a complex of pod sucking bugs such as *Clavigralla tomentosicollis* Stal, *Anoplocnemis curvipes* Fab and *Aspavia armigera* Fab. (Karugi *et al*., 2000) Without controlling insects, no meaningful grain yields can be obtained by cowpea (Remison, 2005). Various methods of control are however available (Jackai, 1993) but the most reliable one is the use of synthetic pesticides (Ayoade, 2015). However, commercial cowpea farmers especially in rural area over spray their farms-from 8 to 10 times (Omongo *et al.,* 2007). Excessive and unwise use of conventional pesticides have adverse effect on the users and consumers as it kills non-target organisms (e.g. pollinators, predators, parasites and parasitoids and ultimately pollute the environment thereby reducing the growth and yield of crops (Alabi *et al*., 2003). Furthermore, excessive use of chemical insecticides removes potential natural enemies, negatively impacts human and livestock health, leads to resistance development in target pests and increases crop production costs. In general, the excessive usage of insecticides and its associated risks have raised food safety and sustainability concerns. In order to minimise the use of synthetic pesticides, other control measures that are environmentally friendly (Use of resistant pest varieties, botanical insecticides) are presently being advocated. Hence this study seeks as a major objective to investigate the potential of producing cowpea varieties to seed stage without the use of pesticides.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Cowpea

Cowpea (*Vigna unguiculata* (L.) Walp.) is an important grain legume in the tropics and subtropics. It is native to central Africa and belongs to the family Fabaceae (Cobley, 1956), and is eaten in the form of grain, green pods, and leaves (Adejumo, 2012). The roots are eaten in Sudan and Ethiopia, and the peduncles and stems are used as fibres in Nigeria (Cobley, 1956). Cowpea is known as vegetable meat due to high amount of protein in the grain with better biological value on dry weight basis. The grain contains 26.61 % protein, 3.99 % lipid, 56.24 % carbohydrates, 8.60 % moisture, 3.84 % ash, 1.38 % crude fibre, 1.51 % gross energy, and 54.85% nitrogen free extract (Owolabi, *et al.*, 2012). It is mostly grown as an intercrop with sorghum, maize and millet (Asiwe, 2006). Cowpea is preferred by farmers because of increases soil fertility through nitrogen- fixation (Blade *et al.,* 1997) and produces nutritious fodder for livestock. Under sole cropping, the potential grain yield is high (1.5 - 3.0 t ha^{-1}), especially, when insecticide was applied. However, the actual yields obtained by farmers in Nigeria are much lower averaging less than 500 kg ha^{-1} (Asiwe and Belane, 2006). Insect pests are considered to be largely responsible for this, as their attack can result in 90 – 100 % yield reduction (Jackai and Daoust, 1998).

2.2 Importance of cowpea in Africa

Cowpea (*Vigna unguiculata* (L) Walp) is an important grain legume in the diet of many people in the third world countries as it provides not only high quality protein (25.4 %) but also constitute the cheapest source of dietary protein for low income sectors of the population (Rachie, 1985 and Stanton, 1966). It is also a good source of carbohydrate (56.8 %) calcium, iron, vitamin B and carotene. Although cultivated primarily for its edible seeds, direct consumption of cowpea leaves is also widespread in Africa (Rachie, 1985). In fresh form, the young leaves, immature pods and peas are used as vegetables, while snacks and main meal dishes are prepared from the dried grain (Nelson *et al.,* 1997). Beside its usefulness in human diet, it serves as an important fodder crop in different parts of Africa (Quin, 1997). The haulm containing about 20 % protein is a highly valued feed and is sold for almost the same price as cowpea grain on dry weight basis (IITA, 1997). Thus, cowpea promotes crop livestock integration, thereby leading to a better nutrient cycling and enhanced income generation (Alghali, 1993). Although cowpea has high grain yield potentials ranging from 1.5 to 3.0 tha^{-1} (Alghali, 1993), actual yields in the traditional cropping systems in Africa are consistently low and between 50 to 350 kg/ha (Mortimore, 2006; Emechebe and Singh, 1997).

2.3 Cowpea Production

Cowpea is grown in all countries in sub-Saharan Africa and in Asia, South America, Central America, the Caribbean, the United States of America (USA) and around the Mediterranean Sea (Hall, 2004). However, the vast majority of the world's cowpea production is from Africa, with about 12.61 million hectares under cultivation in 2014 (FAOSTAT, 2016). In Africa, cowpea is the second most important grain legume (NRC, 2006); and in Nigeria, ranks third after groundnuts and soybean (Ronner and Giller, 2013). Cowpea is grown by approximately 2.2 million smallholder farmers, mainly in eastern and northern regions using traditional methods (Ddungu *et al.*, 2015) with an annual total area coverage and production of 114,210 ha and 71,181.82 tons, respectively (FAOSTAT, 2012)

2.4 Constraints of cowpea production

In Nigeria, cowpea yield is very low, grain yield ranges between 100 and 300 $kgha^{-1}$. This is due to several constraints such as weather, parasitic weeds, insects, and diseases. However, production can be improved through the use of improved pest-resistant and high-yielding varieties. Good land preparation, pest control, fertilizer application, harvesting and storage also help to improve production. In addition, adequate and good distribution of rainfall especially from sowing till mid- podding is very vital for high yield of cowpea. Tamo *et al.* (2003) reported that the reasons for low yields are numerous but most of the time it involves a combination of limiting factors such as low plant density, shading by cereal crops, abiotic (e.g. drought, poor soil fertility) and biotic (e.g.

arthropod pests, birds and rodents) factors. However, in most parts of West Africa, insect pests are the most important constraint to cowpea production (Jackai and Daoust, 1986) Singh and Jackai, (1985) listed at least 20 major insect pest species in various cowpea producing regions of the world in which the number vary from region to region. The most damaging of all the insect pests are the flowering and post flowering insect pests. The major flowering and post flowering insect pest of cowpea in tropical Africa are the flower bud thrips, (*Megalurothrips sjostedti* Tryb.), cowpea pod borer (*Maruca vitrata* F.) and a complex of pod sucking bugs out of which *Clavigralla tomentosicollis* Stal is the dominant species (Jackai and Daoust, 1986). Complete crop failure may occur especially in situation where management strategies are not applied.

2.5 Insect Pest of Cowpea

Plant insect pests, diseases and weeds impose a serious threat to crop production in Nigeria. Population of weeds, insect pests and diseases have increased over the years especially by the introduction of monoculture farming in the country (Jackai and Adalla, 1997). Insect pests which severely damage cowpea during all growth stages are the cowpea aphids (*Aphis craccivora* Koch), foliage beetles (*Ootheca spp,* and *Medythia spp*), flower bud thrips (*Megalurothrips sjostedti Trybom*), legume pod borer (*Maruca vitrata Fabricius*) and the sucking bug complex, of which *Clavigralla spp, Anoplocnemis spp, Riptortus spp, Mirperus spp, Nezara viridula Fab and Aspavia armigera* L. are the most important and prevalent (Egho, 2010; Jackai and Adalla, 1997). The most important pre-flowering pests are *Ootheca mutabilis* and *Zonocerus variegatus* but the most damaging of all pests are those that occur during flowering and podding stages. They include flower thrips dominated by *Megalurothrips sjostedi*, the legume pod borer *Maruca vitrata; Clavigralla tomentosicollis* and a complex of pod sucking bugs. The legume pod borer, *Maruca vitrata,* is a tropical pest of legume crops, particularly cowpeas (Jackai, 1995). Without control measures, its infestation rate can reach 80 % and cause seed damage rates of up to 50 % (Dreyer *et al*., 1994). Pod borers are important pests of the reproductive structures of cowpea with early feeding leading to flower bud and flower abortions, hence poor pod set (Tamo *et al.,* 1997). Insect pests are considered to be largely responsible for up to 90 – 100 % yield reduction (Jackai and Daoust, 1986). In Africa, average cowpea yields vary dramatically from 0.05 to 0.55 t ha^{-1} (Cisse *et al*., 1995), due to insect pests which damage cowpea from seedling emergence to storage (Karungi *et al.,* 2000).

According to Jackai *et al.* (1985), it is not feasible to grow cowpea commercially without the use of insecticide sprays. In Kenya a report indicates grain yield losses of up to 80 % in indigenous cowpea varieties as a result of pod borer attack (Okeyo-Owuor *et al*., 1983).

Traditionally, Nigerian farmers have been relying heavily on pesticides for the control of various weeds, insect pests and diseases, leading to the high importation of these products and their price have become so high that it is becoming impossible for local farmers to afford. These have created the need for alternatives to synthetic pesticides. But inadequate infrastructure for research and extension remains a constraint to the advancement and continuity of such important activity in the country (Okrikata and Anaso, 2008).

2.6 Roles of Pesticide in Controlling Cowpea Pests

Due to the devastating effect of insect pests of Cowpea at almost every stage of its development, several approaches have been adopted in their control. Research into the control of these insect pests has centred primarily on the use of synthetic insecticides (Echendu *et al.,* 1991). Amongst the insecticides are Azodrin, Thiodan DDT, Dursban and Dimecron, which are effective against the leafhoppers. Over the years, chemical pesticides had made a great contribution to the fight against pests and diseases. However, their widespread and long-term use resulted in insecticide resistance and biomagnifications of insecticides, which in turn resulted in restrictions on their export. Problems, like soil and /water contamination and dramatic increase of the harmful residues in many primary and derived agricultural products arose, which endangered both the general environment and human health. It is estimated that the financial cost of the damage to the environment and social economy is about $ 8.1 billion a year. Insect pests of cowpea have mainly been controlled with synthetic insecticides (Shen *et al.,* 2000). Most insecticidal compounds fall within four main classes - organophosphates, organochlorines. carbamates and pyrethroids. Protecting the crop with insecticide application increased yields several fold and for the improved varieties, virtually no yields were obtained under no insecticide protection. The results confirm the economic impact of chemical control in cowpea production and further show that with proper timing; two insecticide applications (at flowering and again at podding) could produce as good a cowpea crop as 4 sprays. This would be advantageous from the perspectives of lower costs and environmental pollution (Alao and Adebayo 2011)

2.7 Growth of cowpea without the use of pesticides

2.7.1 Insect Resistant Cowpea Varieties

The use of leafhopper resistant cowpea varieties was also adopted at the International Institute of Tropical Agriculture. The varieties include Tvu59, Tvu123, VITA -1, VITA-3 that do not need insecticide protection against leafhoppers. *Bt* is an abbreviation for *Bacillus thuringiensis*, a soil bacterium that is common around the world. These bacteria produces specialised proteins, called *Bt,*. *Bt* crops have significantly improved the cost effectiveness and sustainability of crop production in North and South America, Europe, Africa, the Middle East, Asia and Australia. *Bt* proteins selectively kill certain types of insects without affecting other living organisms (IITA 1974). As such, *Bt* bacteria and *Bt* proteins have been used for years as biological controls for certain insect pests in farming, especially in the organic food industry. Modern biotechnology has produced *Bt* crops which are modified to produce specific *Bt* proteins in the plant cells to protect against specific pests. These crops do not need conventional pesticide sprays to destroy the pests that are controlled by the specific *Bt* protein. The *Bt* gene comes from a soil bacterium called *Bacillus thuringiensis*. The *Bt* gene used in *Maruca*-resistant cowpeas (*cry1Ab*) is the same gene used in several *Bt* maize that have been approved for use in different countries.

Chemical control using synthetic insecticides therefore remains the most popular control tactic especially when these pests have exceeded the economic injury level (Jackai *et al.,* 2001). Without their control, reasonable grain yield cannot be obtained (Jackai and Daoust 1986; Tamo *et al*., 1993). Several management strategies are available (Jackai 1985) but chemicals are most effective, giving several fold increase in grain yield (Jackai 1993). Sometimes, however, farmers spray their farms as many as eight to ten times during the growing season (Omongo *et al.,* 1998). Because of the danger of the use of chemicals such as environmental pollution, toxicity to mammals, hazards to users and consumers (Alabi *et al.,* 2003), alternative control measures are being sought. But total abandonment of chemicals could however, spell doom to man as this will worsen the present food situation (Stem, 1973). Chemicals could be judiciously used in consonance with other control measures so as to minimise the large number of sprays in farms.

2.7.2 Using Botanical Insecticide

As a result of the problems of pesticide resistance and negative effects on non-target organisms including man and the environment, organochlorine has been reportedly banned in developed countries. These resurcitated the idea of botanical insecticides as a promising alternative to pest control. Botanical insecticides are naturally occurring chemicals extracted from plants which break down readily in the soil and are not stored in plant or animal tissue. Often their effect are not long lasting as those of synthetic pesticides (Ebenezer, 2010). Botanical insecticides are generally pest – specific and are relatively harmless to non-target organisms. They are biodegradable and harmless to the environment. Also, the possibility of insects developing resistance to botanical insecticide is less likely (Isman, 2010). Over 2000 species of plants possesses insecticidal activities. Despite this only a few have been scientifically evaluated (Ebenezer 2010), *Petiveria alliacea* which is commonly known as Anamu belongs to the family Phtolaccacea Ojo (1996) reported several biological compounds in the root of *P. alliacea* which include: benzalhyde, dibenzyltrisulfide, cis and trans-stibene *e.t.c* of which dibenzyltrisulfide is an insecticidal compound. Laboratory and field tests have shown the effectiveness of this plant extract against armyworm, leaf-cutting caterpillars, ants, whiteflies and the three stages of mosquitoes (Shen and Zhang 2001).

Fish bean (*Tephnosia vogelii*) which has been listed among plants that possess insecticidal properties (Jackai and Adalla, 1997), contains rotenoids (Lungu and Gichia, 2010) of which the leaves contain the highest concentrations (McDavid and Lesseps, 1995). Rotenone is both a stomach and contact poison, useful against sucking and biting insects. *T. vogelii* extracts were reported to be effective in the control of ticks, lice and flies on animals (Lungu and Gichia, 2010). Formulation of *T.vogelii* + locust lotion was as effective as Lambdacyalothrin in the management of insect pests of Okra in the field (Shen and Zhang 2000). *Caryedon serratus* on groundnut was effectively controlled by *T.*

vogelii (Delobel and Malonga, 1987). In addition, *T.vogelii* was observed to have had negative effect on the fecundity of *Tribolium casteaneum*. Research in recent years has focused more towards selective biorational pesticides, generally perceived to be safer than synthetics (Delobel and Malonga 1987).

The use of Cashew Nut Shell Liquid (CNSL) has been gaining more attention due to its possession of the active Phenolic compounds, Anacardic acid and Cardol, which also have corrosive and abrasive properties (Lale, 1995). It was demonstrated that low concentration of CNSL could be effective in the management of *Callosobruchus maculatus* (Echendu 1991).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Site

The experiment was carried out at the screen house of the Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria. The site is located at latitude of 5º 37' North and longitude 6º 24' East at an altitude of 162 m above sea level. Benin city is located at the tropical lowland rainforest with a bimodal rainfall and annual mean of 2300mm, with a temperature of 25.10º C. It lies within the rainforest region.

3.2 Cowpea Varieties

Eleven (11) Cowpea varieties were used in the experiment. Two (2) of out of the eleven (11) cowpea varieties were purchased from the open market at Benin city, Lagos street, Benin city. While the other nine (9) were obtained from IAR.

3.3 Experimental Design and Treatments

Experimental design used was Randomized Complete Block Design (RCBD) and 11 cowpea varieties that were replicated three times. The 33 buckets which served as plots is the experiment.

3.4 Land Preparation

Prior to planting, the screen house was cleared from debris. Top soil obtained from the AGR305 farm was filled into the buckets into which the seeds were sown.

3.5 Sowing of Seeds

Seeds were sown 5 per plot and later thinned to 3 per plot at 2 weeks after sowing.

3.6 Weed Control

Weeding was done whenever weeds were observed. Weeding was done manually by hand picking.

3.7 Pest Control

During the course of the experiment, no form of pesticide was applied because incidence of pest attack was not observed.

3.8 Data collection

Measurement of variables started at 12 weeks after sowing. Variables measured were pod length, number of seeds, total number of pods, weight of seeds and pods weight. Pod length was measured using thread and metre rule, number of seed and total number of pod were counted, Weight of seed and pod weight was obtained using weighing balance.

3.9 Data Analysis

Data obtained were subjected to analysis of variance with SAS software packages. significant differences among treatment means were compared using Least Significant Difference (LSD) at 5 % level of significance.

CHAPTER FOUR

4.0 RESULT

4.1 Effect of varieties on some yield variable of cowpea

Table 1 shows the effect of varieties on some yield variables of cowpea. All measure variables were significantly different except number of seeds. In the case of pod length, S19 furnished the largest seeds that were significantly at par with all other varieties except S6, L1 and L2. Weight of seeds and pod weight followed a similar trend. In both cases, all Samaru varieties were similar and significantly heavier than the two local varieties

TABLE 1: Effect of varieties on some yield variable of cowpea

Variety	Pod length	Number of seed	Total number of pods	Weight of seed (g)	Pod weight (g)
S6	8.85bc	5.72	4.66bc	1.18ab	1.37ab
S7	9.04abc	6.00	5.33bc	1.02ab	1.25ab
S11	11.63abc	7.38	6.33bc	1.26ab	1.53ab
S14	10.16abc	6.61	7.33b	1.26ab	1.49ab
S15	12.72ab	7.16	9.66b	1.37ab	1.70ab
S16	13.27ab	7.22	8.33b	1.60a	1.86a
S17	11.91abc	7.16	9.33b	1.18ab	1.40ab
S18	11.39abc	6.22	8.00b	1.49a	1.66ab
S19	13.54a	6.88	17.66b	1.45a	1.76ab
L1	2.47d	1.27	1.33c	0.28c	0.34c
L2	8.07c	5.11	5.66bc	0.78bc	1.03bc
LSD	4.535		5.646	0.635	0.754
SIG	*	ns	*	*	*

* Significant at 5 % level of probability

Means with the same letters in the same column are not significantly different at 5% level of probability ($P < 0.05$)

CHAPTER FIVE

5.0 DISCUSSION AND CONCLUSION

5.1 Discussion

The study showed marked differences in performance of yield components among the different cowpea varieties evaluated. The differences between varieties might be due to their genetic make-up and adaptation to the environment (Screen house). These findings are in accordance with Manore and Wolde-Meskel (2017) who reported cowpea varietal differences for yield components. The environment in the screen house could have contributed to the better performance of some of the varieties. The higher performance in pod length for S16 is associated with the varietal behavior. In agreement with this, Peksen (2004) has reported a large variation in pod length among cowpea varieties.

Regarding to the number of seeds, the varieties S11 performed better than other varieties. The better performance could be attributed to the late-maturing nature of these varieties. The suitability of the pH value, the textural class, and the other properties observed for the soils of the study sites (Onyibe *et al*., 2006), could also been contributed to the better performance of the cowpea varieties in the current experiment. The higher yield for Total number of pod (TNOP) could also be associated with the higher number of pods plant^{-1} and seeds pod^{-1}.

In contrast, the lower seed yield performance of L1 and S6 varieties could be attributed to the lower number of seeds per pod. According to Benjamin *et al.* (2020), lower performance in yield component would be expected to restrict grain yield. A significant difference in seed yield among cowpea varieties has also been previously reported by Iqbal *et al.* (2015), Miheretu and Sarkodie-Addo (2017) in other environments and into other varieties.

The climate conditions (Kunert *et al.*, 2016) and fertility of the soil (Kyei-Boahen *et al*., 2017) are among factors that influence yield response of cowpea. Therefore, the unaviable direct rainfall, and the relative difference in soil condition of the study sites could explain the difference in the yield variation among the cowpea varieties.

5.2 Conclusion

Amongst the different cowpea varieties used for this study, variety S16 gave significantly higher yield. Variety S16 produced the highest pod length compared to other varieties. Higher seed yield was obtained from variety S11 followed by variety S16. The lack of significance on the seed yield of the different cowpea varieties could be attributed to inadequate rainfall pattern of the location at a particular point in time as the crop does not perform well in an environment with erratic rainfall or waterlogging. The observed variations in the performance of the cowpea varieties used could due to the fact that some of the genotypes used responds well to environment (Screen).

Samaru varieties were better than the open market variety in all cases.

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