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GROWTH AND YIELD OF COWPEA (TVX 3236) AS INFLUENCED BY ORGANIC PHOSPHORUS SOURCES AND INSECT CONTROL METHODS IN EJIBA, NIGERIA

S.K. Ogundare and S.D. Bodunde

Kabba College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, Zaria

ABSTRACT

An experiment was carried out in late season of 2015 and early season 2016 at the research site of the Lower Niger River Basin Development Authority, Ejiba, Kogi State of Nigeria to investigate the organic phosphorus effect of insect control methods and different sources on insect population density, growth and yield of cowpea variety TVX 3236. Four insect control methods [dimethoate (Contact insecticide) (2.0l/ha), cypermetrin best **(**Systemic insecticide) (2.0l/ha), dimethoate (1.0l/ha) + cypermetrin (1.0l/ha) and No insect control] and three organic phosphorus sources [steam bone meal, fish bone meal, chicken manure and control] were considered. The treatments were laid out in a split plot design with three replications. Data were collected on insect population density, growth and yield of cowpea. Unprotected plots had higher damage than insecticide protected plots. Plots with dimethoate combined with cypermetrin had tallest plant, largest leaf area when compared with plots with either dimethoate or cypermetrin alone. Plots with poultry manure application had the tallest plant and largest leaf area when mean data of both years were considered. Insect controlled plots had more nodules that were heavier than the control plots in both years. Higher number of nodules and heavier nodules were produced in plots treated with poultry manure. Yield and yield components of plots treated with either dimethoate or cypermetrin were similar and better than the control plots. Pod length, number of seeds per plant, 1000 grains weight and dry grain yield per hectare were better in plots with chemical insect control whether applied alone or combined. Phosphorus application improved growth and yield characters of cowpea. Poultry manure (30 kg/ha) improved growth and yield of cowpea best. However, plots with combined use of dimethoate and cypermetrin gave highest number of pods per plant (46.90). Cowpea field should be amended with poultry manure as source of phosphorus and cowpea insects should be controlled using both dimethoate and cypermetrin for optimum productivity.

Keywords: Dimethoate; Cypermetrin; Bone meal; Fish meal; Poultry manure

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is an important crop grown in many countries of tropical Africa, Asia and South America. Both grain and leaves are rich and cheap sources of high-quality protein. They supplement to the lower quality cereal or root and tuber protein commonly consumed in tropical Africa (Kitch *et al.,* 1998; Karikari and Molatakgosi, 1999). On average cowpea grains contain 23 - 25% protein and 50 - 67% starch in dry bases (Quin, 1997). Phosphorus is critical to cowpea yield because of its multiple effects on nutrition and nitrogen fixation (Muleba and Ezumah, 1985). It also influences the contents of other nutrients in cowpea leaves (Kang and Nangju, 1983) and seed (Omueti and Oyenuga, 1970). Cowpea requires more phosphorus than nitrogen. About 30 kg of P/ha in the form of single super phosphate is recommended for cowpea production to help the crop to nodulate well and fix its own nitrogen from the air (FAO, 2005). Tropical soils are inherently low in nutrients (Haruna and Aliyu, 2011). Phosphorus is critical to cowpea yield because it stimulates growth, initiate nodule formation as well as influence the efficiency of the rhizobium-legume symbiosis (Haruna and Aliyu, 2011). It is required in large quantities in young cells such as shoot and root tips (Haruna and Aliyu, 2011). It aids flower initiation, seed and fruit development (Ndakidemi and Dakora, 2007). Many tropical soils are P - deficient (Osodeke, 2005). The deficiency can be so acute in some soils of the savannah zone of western Africa that plant growth ceases as soon as the P stored in the seed is exhausted (Mokwunye and Bationo, 2002). Application of phosphorus is therefore recommended for cowpea production on soils low in phosphorus. Careful application of phosphorus fertilizer to legumes is geared towards enhancing not only their growth and yield, but also nitrogen fixation. In Nigeria, legumes do not receive any form of phosphorus fertilizer, they therefore entirely rely on the natural available soil phosphorus and other nutrients for nitrogen-fixation and growth and this has resulted in lower yields (Singh *et al*., 2011). One of the options of reducing low yields due to soil phosphorus content is to determine the best organic phosphorus source that give optimum yield so as to increase returns from cowpea.

Yields are however, generally low (Olatunde *et al*., 1991), sometimes total yield losses and crop failure occur (Singh and Jackai, 1985) due to the activities of a spectrum of insect pests which ravage the crop in the field at different growth stages (Singh and van Emdem, 1979). The major insect pests which severely damage cowpea during all growth stages are the cowpea aphid (*Aphis craccivora* Koch), foliage beetles (*Ootheca* spp, *Medythia* spp), the flower bud thrips (*Megalurothrips sjostedti* Trybom) the 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 most important and are prevalent (Egho, 2011). Without their control, reasonable grain yield cannot be obtained (Jackai and Daoust, 1986; Suh *et al*., 1986). Several control measures are available but chemicals are most effective, giving several fold increase in grain yield (Jackai, 1993). However, despite concerted efforts by scientists to develop varieties with resistance to the cowpea insect pest complex, resistant varieties are still unavailable to farmers (Dzemo *et al.,* 2010). Chemical control using synthetic insecticides therefore remains the most popular control tactic (Jackai *et al*., 2001).

This study therefore aims to determine the effect of insect control methods and different organic phosphorus sources on insect population density, growth and yield of cowpea variety TVX 3236 in Ejiba, Kogi state, Nigeria.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out for two consecutive growing seasons (late season 2015 and early season 2016) at the research site of the Lower Niger River Basin Development Authority, Ejiba, Kogi State of Nigeria (Lat. 8˚18'N and Long. 5˚39'E). The site is 453 m above sea level, in the southern Guinea Savanna Agro-Ecological Zone of Nigeria, having hot dry season and also cool wet season. The rainy season spans from April to November and attains peaks in July/August while the dry season extends from December to March. The mean annual rainfall is 1350 mm per annum with annual temperature range of 18 ˚C – 32 ˚C and mean relative humidity of 60%. The major soil order within the experimental site is ultisol (Ajiboye and Ogunwale, 2010). The experiment was sited within a 14 ha agricultural field that has been continuously mechanically tilled for arable crops (maize, cowpea, sorghum, garden egg, okra, tomato and cassava) production for over 20 years.

Experimental Design and Field Methods

The experiment comprised of four insect control methods [dimethoate (Contact insecticide) (2l/ha), cypermetrin best **(**Systemic insecticide) (2l/ha), dimethoate (1L/ha) + cypermetrin (1L/ha) and no insect control] and three organic phosphorus sources [steam bone meal (30 kg/ha P), fish bone meal (30 kg/ha P), chicken manure (30 kg/ha P) and no organic phosphorus source application (control)].The treatments were laid out in a split plot design with three replications. The insect control method was assigned to the main plots while the organic phosphorus sources were assigned to the subplots. The land was prepared by ploughing and harrowing with a tractor in the two seasons. The experimental plots measured each 3 x 5 m with inter-plot space of 1 m. TVX 3236 seeds were sourced from the Agricultural Development Project office, Aiyetoro, Kogi State, Nigeria. Three seeds were planted per hole at planting space of 60 x 30 cm which was later thinned down to two plants per stand at two weeks after planting. Each plot consisted of 5 rows of 30 plants.

Insect Population Density

Insect infestation was measured according to the procedure used by Egho (2011). For number of aphids on the plants, observations commenced 26 DAP, at 7 days' intervals, between 8 and 10 a.m. Thirty cowpea stands from the two middle rows of each plot were randomly selected and tagged. Each stand was then inspected for aphid infestation. Six observations were made from each treatment. Infestation of cowpea flowers by *Maruca vitrata* larvae was assessed at 45 days after planting (DAP). Twenty flowers were randomly selected from the two outer rows. The flowers were carefully opened and examined on the spot for *Maruca* damage from 3.00 - 5.00 p.m. Presence of holes or larvae in a flower was used as index of *Maruca* infestation. Observation was done four times, at 5 days intervals.

For Pod sucking bugs**,** observations commenced at 45 DAP at 5 days' intervals. From the two middle rows, observations were made between 8.00 and 10.00 a.m. Pod sucking bugs (PSBs) that rested on the plant were counted and recorded. All bugs were counted together since their damage is similar.

Organic Phosphorus Sources Application

Bones were steam boiled, air dry and milled to produce bone meal, dry fish bone was collected from Kabba market; it was milled into fish bone meal while chicken manure was collected from the poultry unit of Kabba College of Agriculture. Organic phosphorus was applied using the broadcast method. All these were applied at the rate of 30 kg P per hectare.

Data Collection and Analysis

Yield and yield attribute parameters such as number of pods per plant, seed per pod, seed yield, hundred seed weight and total yield were recorded. The data were subjected to analysis of variance using SAS package and treatment means were separated by Least Significant Difference (LSD 0.05) method (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results of the laboratory analysis of the soil physical and chemical properties prior to cropping are presented in Table 1. The soil classified as Ultisol (Ajiboye and Ogunwale, 2010) and used for the field study was slightly acidic and characterized by low levels of organic matter, nitrogen and phosphorus.

Table 1: Pre-planting soil analysis at the experimental site

Properties	Values
Particle size (%)	
Sand	60.7
Clay	21.4
Silt	17.9
Soil texture	Sand clay loam
Soil pH	6.7
Bulk density (g/cm^3)	1.36
Total porosity (%)	42.1
Organic matter (%)	2.66
Total N (%)	0.21
Available P (mg/kg)	0.84
Exchangeable cation (Cmol/kg)	
Exchangeable K	0.22
Exchangeable Ca	2.52
Exchangeable Mg	3.55

The fertility of the soils was low as indicated by the generally low values of exchangeable bases and other nutrients including phosphorus. Soil test (Table 1) before the experiment indicated that the soil used in this study was very low in available P (0.84 mg/kg) as determined by the procedure described by Laverty (1961). The chemical characteristics of steam bone meal, fish bone meal and chicken manure used showed they were relatively high in phosphorus (Table 2).

Table 2: % Phosphorus application rate

Organic phosphorus sources	Application rate
Steam bone meal	30kg P/ha
Fish bone meal	30kg P/ha
Poultry manure	30kg P/ha

Effects of insect control methods on insect infestation are presented in Table 3. Number of aphids on the plant, number of flower with hole and number of pod bug insect on cowpea pod were significantly affected by the treatment in both years.

Table 3: Effect of insect control methods on insect infestation on cowpea in 2015, 2016 and mean of the two years (combined)

Insect control methods	Number of aphids on the plant			Number of flower with hole			Number of Pod bug insect on cowpea pod		
	2015	2016	mean	2015	2016	mean	2015	2016	mean
DCI	06.0^{b}	14.0^{b}	10.0^{b}	23.0^{b}	41.0^{b}	32.0^{b}	04.0^{c}	16.0^{a}	10.0^{b}
CBSI	08.0^{b}	11.0^{b}	09.5^{b}	26.0^{b}	13.0^{c}	19.5^{c}	19.0^{a}	08.0^{b}	13.5^{b}
DCI + CBSI	00.0^{b}	03.0^{b}	01.5^{b}	03.0^{c}	03.0^{c}	03.0^{d}	04.0^{c}	03.0^{c}	03.5^{c}
NIC	97.0^{a}	114.0^{a}	105.5^{a}	76.0^{a}	109.0^{a}	92.5^{a}	11.0^{b}	17.0^{a}	14.0^{a}
LSD	23.23	18.42	28.19	8.47	21.71	10.66	2.74	4.11	3.64

DCI = dimethoate Contact insecticide, CBSI = cypermetrin best Systemic insecticide, DCI + CBSI= dimethoate + cypermetrin) and NIC = No insect control

The results show that plots with insect control methods had significant reduction in number of aphids on the plant, number of flower with hole and number of pod bug insect on cowpea pod compared with plots with no insect control. The results show that unprotected plots had higher damage than insecticide protected plots. The result is consistent with Egho (2011), Karungi, *et al*. (2000) and Jackai and Daoust (1986) that application of insecticide generally reduced cowpea pest infestation and markedly increase crop yield. Among the plots with insect control methods, cowpea plots treated with dimethoate + cypermetrin had the least number of aphids on the plant, number of flowers with hole and number of pod bugs on cowpea pod compared with either dimethoate or cypermetrin. Plots with combined use of both contact and system insecticide were better in term of insect population control. This could be linking to almost immediate effect of contact insecticide (Bezerra- Silva *et al*., 2012) combined with longer residue effect of systemic insecticide when both were used. Systemic insecticides are used for insect control due to their longer residual action compared to contact insecticides. Therefore, they provide a longer protection period to the plant, with few applications and consequently with lower production cost. Systemic insecticides also have the advantage of being selective to natural enemies, whose preservation can contribute to an increase in the biological control of crop pests (Gravena *et al*., 1997).

Growth characters of cowpea as influenced by insect control methods and organic phosphorus sources are presented in Table 4. Significant differences were observed in plant height, number of branches and leaf area due to the insect control methods. However, days to 50% flowering was not affected significantly. Mean of the data from the two years show that plots with dimethoate combined with cypermetrin had tallest plants, largest leaf area when compared with plot with either dimethoate or cypermetrin alone. Plots with cypermetrin recorded the greatest number of branches among the treated plots. Leaf area was significantly lower in control plots compared with other treatments. This shows that effect of insects on cowpea could be severe during vegetative stage. The reduction in leaf area of the control plots could be attributed to defoliation of leaves due to insect infestation.

Different organic phosphorus sources significantly affected plant height and leaf area of cowpea in both years, but days to 50% flowering was not affected significantly and also number of branches was significantly affected in 2015 but not in 2016. Plots with poultry manure application had the tallest plants and largest leaf area respectively when mean data of both years were considered. Plots with no phosphorus amendment had the least values of plant height, number of branches and leaf area. The result shows better growth character in the plots treated with organic phosphorus sources compared to the control plots. This result is in conformity with the Nkae *et al*. (2014); Krasilnikoff *et al*. (2003) and Nyoki *et al*. (2013). This could be attributed to the fact that phosphorus is required in large quantities in shoot and root tips where metabolism is high and cell division is rapid (Ndakidemi and Dokora, 2007). Thus, an indication that the cowpea variety used utilized the organic phosphorus applied judiciously in growth process.

Nodules characters as influenced by different phosphorus sources and insect control methods are presented in Table 5. Insect control methods applied significantly affect the number of nodules produced, fresh and dry weight of nodules. Nodules in plots with insect control were significantly more and heavier than those of control plots in both years. Mean of the two years show that plots treated with dimethoate + cypermetrin recorded significantly highest and heaviest nodules, followed by plots with dimethoate alone while, plots with cypermetrin alone recorded least and lightest nodules among the treated plots. No insect control plots (NIC) had the least number of nodules, fresh and dry weight of nodules (Table 5).

Table 4: Effect of insect control methods and organic phosphorus source on growth characteristics of cowpea in 2015, 2016 and combined

	Plant height (cm)			Number of branches			Leaf area (m^2)			Days to 50% flowering		
	2015	2016	mean	2015	2016	mean	2015	2016	mean	2015	2016	mean
DCI	44.7^{a}	42.7^{b}	43.7^{ab}	4^{b}	4^{a}	4^{b}	24.6^{a}	23.2^{a}	23.9^{a}	36	40	38
CBSI	43.8^{a}	41.8^{b}	42.8^{b}	6^{a}	4^{a}	5^{a}	22.7^{a}	24.7^{a}	23.7^{a}	39	39	39
DCI+CBSI	45.6^{a}	43.2^{b}	44.4^{a}	6^{a}	2^{b}	4^{b}	26.3^{a}	24.9^{a}	25.6^{a}	39	37	38
NIC	39.4^{b}	48.8^{a}	44.1^{a}	2^{c}	4^{a}	3^{c}	14.4^{b}	15.4^{b}	14.9^{b}	38	38	38
LSD	2.66	1.64	1.01	1.58	1.12	0.93	6.83	5.55	4.85	ns	ns	ns
Organic phosphorus sources												
SBM	48.1^{a}	45.1^{a}	46.6^{a}	3	7^{a}	5	25.1^{a}	23.1^{a}	24.1^{a}	37	39	38
FBM	46.8^{ab}	44.6^{a}	45.7^{a}	4	4^{b}	4	24.6^{a}	23.0^{a}	23.8^{a}	37	39	38
PTM	47.7^{a}	45.5^{a}	46.6^{a}	3	5^{b}	4	22.9^{b}	24.9^{a}	23.9^{a}	38	38	38
NPS	44.6^{b}	37.0^{b}	40.8^{b}	4	2^{c}	3	23.2^{b}	11.6^{b}	17.4^{b}	38	38	38
LSD	2.31	1.66	2.31	ns	1.68	ns	1.41	4.32	4.88	ns	ns	ns
Interaction ICM vs OPS	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

DCI =dimethoate Contact insecticide, CBSI = cypermetrin best Systemic insecticide, DCI + CBSI= dimethoate + cypermetrin) and NIC =No insect control. SBM= steam bone meal, FBM=fish bone meal, PTM= chicken manure and NPS= no organic phosphorus source application

Table 5: Effect of insect control methods and organic phosphorus source on number of nodules produced

Treatments	Number of nodules			Fresh weight			Dry weight		
1nsect control methods	2015	2016	mean	2015	2016	mean	2015	2016	mean
DCI	37.44^{a}	38.84^{a}	38.14^{a}	0.76^{a}	0.90^{a}	0.83^{a}	0.14^{b}	0.40^{a}	0.26^{a}
CBSI	38.26^{a}	35.16^{a}	36.71^{a}	0.84^{a}	0.64^{b}	0.74^{a}	0.26^{a}	0.20^{b}	0.23^{a}
DCI+CBSI	37.21^{a}	41.67^{a}	39.44^{a}	0.94^{a}	0.84^{ab}	0.89^{a}	0.23^{a}	0.31^{ab}	0.27^{a}
NIC	30.11^{b}	22.71^{b}	26.41^{b}	0.67^{b}	0.45^{c}	0.56^{b}	0.16^{b}	0.12^{c}	0.14^{b}
LSD	2.21	07.14	5.41	0.29	0.21	0.27	0.07	0.14	0.08
Organic phosphorus sources									
SBM	38.66^{a}	35.76^{a}	37.21^{a}	0.88^{a}	0.54^{bc}	0.71^{ab}	0.19^{b}	0.27^{a}	0.23^{a}
FBM	41.23^{a}	37.09^{a}	39.16^{a}	0.94^{a}	0.82^{ab}	0.88^{a}	0.30^{a}	0.22^{a}	0.26^{a}
PTM	48.91^{a}	44.91^{a}	46.68^{a}	0.82^{a}	1.06^{a}	0.94^{a}	0.31^{a}	0.23^{a}	0.27^{a}
NPS	31.12^{b}	11.74^{b}	21.43^{b}	0.51^{b}	0.37^{c}	0.44^{b}	0.20^{b}	0.08^{b}	0.14^{b}
LSD	7.42	14.63	8.41	0.26	0.33	0.31	0.09	0.07	0.09
Interaction ICM vs OPS	ns	ns	ns	ns	ns	Ns	ns	ns	ns

DCI =dimethoate Contact insecticide, CBSI = cypermetrin best Systemic insecticide, DCI + CBSI= dimethoate + cypermetrin) and NIC =No insect control. SBM= steam bone meal, FBM=fish bone meal, PTM= chicken manure and NPS= no organic phosphorus source application

Nodules characters were significantly influenced by organic phosphorus sources applied (Table 5). Number of nodules produced, fresh and dry weights of nodules were significantly higher in treated plots than the control. Plots treated with poultry manure produced more nodules and these nodules were heavier than either plots treated with steam bone meal or fish bone meal. Similar effects were observed in plots treated with steam bone meal and fish bone meal and these were better than control in this experiment. Plots with no organic phosphorus sources had the lowest number and lightest nodules.

The significant response of the cowpea variety to different organic phosphorus application in terms of increase in number and weight of nodules is an indication that P is an important nutrient element influencing the performance of cowpea on the field. The result support the finding of Okeleye and Okelana (1997) and Owolade *et al.* (2006), they observed significant increase in number and weight of cowpea nodulation but contradict the findings of Kolawole *et al.* (2002) who reported a decrease in number of nodules due to P application.

Poultry manure applied plots had the highest number of nodules in this experiment. Poultry manure contains both macro and micro nutrients. This could be responsible for the higher number of nodules produced by cowpea treated with poultry manure. Plots without organic phosphorus recorded the least values of nodules characters. This could be attributed to the fact that the crop depend only on the inherent nutrient from the soil.

Table 6 presents the damage done to pods due to insect attack as influenced by insect control methods and organic phosphorus sources. Number of pods per plant, number of damage pods per plant and % pod damage by insect were significantly affected by the insect control method used (Table 6). Number of pods was higher in the treated plots compared with control plots but number of damage pods per plant and % pod damage by insect was highest in the control plots. Plots with combine used of dimethoate and cypermetrin had highest number of pods, least pod damage and lowest % pod damage by insect.

Table 6: Effect of insect control methods and organic phosphorus source on damage pods due to insect

Treatments	Number of pods / plant			Number of damaged pods/plant			% pod damage by insect		
Insect control methods	2015	2016	mean	2015	2016	mean	2015	2016	mean
DCI	32.61^{a}	43.35^{b}	37.98^{a}	04.28^{b}	06.28^{b}	5.28^{b}	13.19^{b}	14.49^{b}	13.84^{b}
CBSI	28.43^{a}	41.91^{b}	35.17^{a}	02.66^{b}	02.90^{b}	2.78^{b}	09.36^{c}	6.92^{c}	08.14^{c}
DCI+CBSI	32.92^{a}	60.88^{a}	46.90^{a}	02.93^{b}	03.15^{b}	3.04^{b}	08.90^{c}	5.17^{c}	07.03^{c}
NIC	21.52^{b}	25.32^{c}	23.42^{b}	15.40^{a}	20.04^{a}	17,72^{a}	71.56^{a}	79.15^{a}	75.35^{a}
LSD	5.6	8.97	10.31	5.06	5.94	6.11	3.21	3.44	4.87
Organic phosphorus sources									
SBM	40.42^{a}	44.46^{b}	42.44^{b}	09.40^{a}	13.60^{b}	11.50^{a}	23.26^{b}	30.59^{b}	26.92^{b}
FBM	38.71^{a}	42.71^{b}	40.71^{b}	10.20^{a}	14.22^{b}	12.21^{a}	26.35^{b}	33.29^{a}	29.82^{a}
PTM	43.82^{a}	60.46^{a}	52.14^{a}	13.40^{a}	18.34^{a}	15.87^{a}	30.57^{a}	30.33^{b}	30.45^{a}
NPS	19.43^{b}	26.05^{c}	22.74^{c}	04.80^{b}	08.44^{c}	06.62^{b}	24.70^{b}	32.40^{a}	28.55^{ab}
LSD	11.23	10.66	6.12	5.13	3.61	4.99	4.44	1.89	2.13
Interaction	ns	ns	ns	ns	ns	ns	ns	ns	ns

DCI =dimethoate Contact insecticide, CBSI = cypermetrin best Systemic insecticide, DCI + CBSI= dimethoate + cypermetrin) and NIC =No insect control. SBM= steam bone meal, FBM=fish bone meal, PTM= chicken manure and NPS= no organic phosphorus source application

Jackai (1985) reported that insects were controlled better in the treated plots compared to the control. Also, insect were control better with dimethoate and cypermetrin in this experiment. This could be linking to almost immediate effect of contact insecticide (Bezerra- Silva *et al*., 2012) combined with longer residue effect of systemic insecticide when both were used. Systemic insecticides are used for insect control due to their longer residual action compared to contact insecticides. Therefore, they provide a longer protection period to the plant, with fewer application times and consequently with lower production cost. Systemic insecticides also have the advantage of being selective to natural enemies, whose preservation can contribute to an increase in the biological control of crop pests (Gravena *et al*., 1997).

Table 7 present yield and yield components of cowpea as influenced by insect control methods and organic phosphorus sources. Pod length, number of seeds per plant, 1000 grains weight (g) and dry grain yield per hectare were significantly affected by different insect control methods used. Mean of the two years shows that pod length, number of seeds per plant, 1000 grain weight and dry grain yield per hectare were better in plots with chemical insect control whether applied alone or combined. Among the plots with insect control, plots treated with dimethoate plus cypermetrin had the longest pods, largest number of seed per plant, greatest weight of 1000 seeds and highest grain yield per hectare. Yield and yield component of plots treated with either dimethoate or cypermetrin were similar and better than the control plots. No insect control plots had the least values of pod length, number of pods per plant, 1000grains weight and dry grain yield per hectare.

Results from this study therefore, clearly indicate that insect pest infestations are a significant limiting factor to increased and sustainable cowpea grain production. This corroborates the findings of Asiwe (2009), Karungi *et al*. (2000), Kyamanywa (1996) and Amatobi (1995), who have shown that pod borers and pod-sucking bugs are important insect pests of cowpea. Pod borers are important pest of the reproductive structures of cowpea with early feeding leading to flower bud and flower abortions, hence poor pod set (Tamo *et al*., 1997). Results from yield parameters indicated that insecticide applications enhanced cowpea growth and yield performance. This resulted in increased number of pods per plant, pod weight per plant, seeds per pod, seed weight per plant and hence more grain yield. Results from this study also clearly indicate that insecticide application remains an important strategy for suppressing cowpea insect pests on the field if properly managed to coincide with high infestation levels.

Organic phosphorus sources significantly affected pod length, number of seed per plant, 1000 grain weight and dry grain yield per hectare. Plots with no phosphorus application were significantly lower in yield compared with plots amend with phosphorus irrespective of the sources. Plots amended with poultry manure had the highest values of pod length, number of pods per plant, 1000 grain weight and dry grain yield per hectare, followed by plots with steam bone meal, while plots with fish bone meal gave the least values of pod length, number of pods per plant, 1000 grain weight and dry grain yield per hectare among the phosphorus amended plots.

Phosphorus application also improved some yield attributes. Number of pods per plant, length of pods, dry grain yield and weight of 1000 seeds. These were found to be significantly different at 0.05 level of significance and this is in conformity with the findings of other workers (Okeleye and Okelana, 1997; Haruna and Usman, 2013) who also discovered significant increase in yield of cowpea in response to phosphorus application. However, Agboola and Obigbesan (2001) reported that phosphorus application did not significantly increase cowpea yield but rather enhanced nodulation and phosphorus content of leaf and stem.

Table 7: Effect of insect control methods and organic phosphorus source on yield characters

Treatments	Pod length (cm)			Number of seeds per plant			1000 grain weight (g)			Dry grain yield per ha		
1nsect control methods	2015	2016	mean	2015	2016	mean	2015	2016	mean	2015	2016	mean
DCI	12.6^{b}	14.2^{a}	13.9^{a}	168^{b}	256^{a}	212^{a}	849^{ab}	963^{a}	906^{ab}	0.96^{a}	1.30a	1.13a
CBSI	11.4^{c}	15.2^{a}	13.3^{a}	194^{b}	208^{a}	201^{a}	783^{b}	959^{a}	871^{b}	0.85^{a}	1.26a	1.05a
DCI+CBSI	13.8^{a}	14.4^{a}	14.1^{a}	273^{a}	253^{a}	263^{a}	900^{a}	1084^{a}	992^{a}	0.99^{a}	1.83a	1.41a
NIC	12.6^{b}	09.4^{b}	11.0^{b}	096^{c}	162^{b}	129^{b}	760^{c}	566^{b}	663^{c}	0.20^{b}	0.16b	0.18b
LSD	0.96	2.00	1.57	56	72	68	96	151	86	0.47	0.38	0.41
Organic phosphorus sources												
SBM	14.4^{a}	12.4^{b}	13.4^{a}	241^{a}	299^{a}	235^{a}	941^{a}	807^{b}	874^{a}	1.21^{a}	1.33a	1.27a
FBM	12.6^{ab}	14.0^{a}	13.3^{a}	236^{a}	212^{b}	224^{a}	903^{a}	823^{b}	863^{a}	1.16^{a}	1.28a	1.22a
PTM	10.9^{b}	15.1^{a}	13.0^{a}	301^{a}	281^{a}	291^{a}	769^{a}	1197^{a}	983^{a}	1.31^{a}	1.81a	1.56a
NPS	06.8^{c}	12.4^{b}	09.6$^{\mathbf{b}}$	86^{b}	160^{c}	123^{b}	473^{b}	453^{c}	463^{a}	0.58^{a}	0.78b	0.68b
LSD	2.44	1.68	2.87	101	67	78	297	366	126	0.41	0.39	0.32
Interaction ICM vs OPS	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

DCI =dimethoate Contact insecticide, CBSI = cypermetrin best Systemic insecticide, DCI + CBSI= dimethoate + cypermetrin) and NIC =No insect control. SBM= steam bone meal, FBM=fish bone meal, PTM= chicken manure and NPS= no organic phosphorus source application

CONCLUSION

In conclusion, it could be inferred that phosphorus application improved growth and yield character of cowpea irrespective of the sources. Among the different sources, poultry manure improves growth and yield of cowpea best. Plots with insecticides were better in growth and yield than the control. However, plots with combined use of dimethoate and cypermetrin gave highest number of pods per plant and lowest number of damage pods. Cowpea field should be amended with poultry manure as source of phosphorus and cowpea insects should be controlled using both dimethoate and cypermetrin for optimum productivity.

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