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EFFICACY OF COMBINING VARIETAL RESISTANCE WITH ORGANIC FERTILIZER APPLICATION IN REDUCING INFESTATION OF CUCUMBER (*CUCUMIS SATIVUS* L.) BY INSECT PESTS IN THE NIGER DELTA

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ABSTRACT: *Efficacy of combining varietal resistance with organic fertilizer application in reducing infestation of cucumber (Cucumis sativus) by insect pests was studied during the early cropping season of 2013 at the Teaching and Research Farm, Faculty of Agriculture, University of Port Harcourt located in the Niger Delta region of Nigeria. Three varieties of C. sativus (Starke ayres, Bakker brother and Griffaton) were used for the experiment. Poultry manure (PM) was applied at four rates (4.2t/ha, 8.3t/ha, 16.7t//ha and 33.3t/ha); an inorganic fertilizer NPK 15:15:15 was applied at the recommended rate (0.3t/ha) and a control plot was also included. The fertilizers were broadcast and mixed thoroughly with soil to ensure even distribution as soon as the beds were ready and PM was allowed to cure for 14 days before sowing the cucumber seeds. Plant spacing of 50cm x 50cm and planting depth of 2-3cm were adopted with 20 plants sown per plot. The experiential land area was 18m x 14m and each treatment plot measured 2.0m x 1.5m. The experiment was laid out in a Randomized Complete Block Design (RCBD) and each treatment was replicated three times. Parameters studied included days to 50% germination and flowering, number of undamaged and damaged fruits and their corresponding weights and insects which were collected each week for three consecutive weeks (HVT 1, HVT 2 and HVT 3, respectively). The insect species were mainly in the order Coleoptera followed by Diptera, Homoptera and Orthoptera in a decreasing order. The major species collected were Epilachna chrysomellina F., Cheilomenes sulphurea Oliv., Kanahiiphaga aeneipenni Lab., Aulacopora vinula Eric., Aulacophora africana Weise, and Dinorettix africana Bol. Others included Lagria villosa F., Diopsis sp., Locris erythromela Walker, Chrysolagria sp., Lema calcrata Dalm., Planiseta sp., Coenochilus nr ventricosus Gyril, and Monolepta nigeriae Bryant. Organic manure (PM) or inorganic fertilizer (NPK 15:15:15) had no significant effect on days to 50% germination and flowering. Poultry manure applied at the rate of 33.3t/ha increased the number both of the undamaged and damaged fruits and their corresponding weights followed by plots treated with 16.7t/ha PM and the least number of fruits and weights were recorded in untreated plots (control). Higher numbers of insect pests were collected from C. sativus treated with 33.3t/ha PM and NPK. Stark ayres variety treated with 33.3t/ha PM had the highest number of fruits (155.85g) followed by Bakker brother treated with 16.7t/ha PM (142.89g) and the least was recorded in Griffaton variety that received no treatment (control). Fruit weight and number were in the order harvest 2> harvest 1> harvest 3 (HVT2>HVT1>HVT3). The study suggests that fertilizer application may lead to increased crop productivity but it may also intensify pest infestation in cultivated cucumber.*

KEYWORDS: Cucumber, Cucumis Sativus, Insect Pests, Infestation, Poultry Manure.

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INTRODUCTION

Cucumber (*Cucumis sativus* L) consists of approximately 125 genera and 960 species, mainly in tropical and subtropical regions (AVRDC, 1990). It is a creeping vine that roots in the ground and grows up trellises or other supporting frames, wrapping around supports with thin, spiraling tendrils (Maynard and Donald, 2001). The plant has large leaves that form a canopy over the fruit that is roughly cylindrical, elongated with tapered ends, and may be as large as 60cm long, 10cm in diameter (Robinson *et al.*, 1997).

Cucumis sativus is conventionally placed into three main varieties "slicing", "pickling" and "burpless" (Clark *et al.,* 1991).Within these varieties, several different cultivars have emerged. Cucumber bears edible fruits when ripe (Binder *et al.,* 1989) and much like tomato and squash they are often perceived, prepared and eaten as vegetables (Jacques *et al.,* 2002). Cucumber is usually more than 90% water (Loy, 1990; Maynard and Donald, 2001). Cucumber is a good source of B vitamins, the fruit contains 95% water, keeping the body hydrated while helping the body eliminate toxins (Seng, 2002). The skin of cucumber fruits can be used for treatment of skin irritation and sun burn, as aloe would be used (Holmes, 2000). The fruit contains lariciresinol, pinoresinol, and secoisolariciresinol lignans which have strong history of research in connection with reduced risk of several cancer types, including breast cancer, ovarian cancer, uterine cancer and prostate cancer (Shetty and Wehner, 2002). It relieves bad breath (Holmes, 2000) and also contains enough sugars and electrolytes to replenish many essential nutrients, reducing the intensity of both hangover and headache (Seng, 2002). Due to its low caloric and high water content, cucumber is an ideal diet for people who are looking for weight loss. The high water content and dietary fiber in cucumbers are very effective in ridding the body of toxins from the digestive system, thus aiding digestion (Holmes, 2000). The juice of cucumber contains a hormone which is needed by the cells of the pancreas for producing insulin which has been found to be beneficial to diabetic patients. The fruits also contain a lot of potassium, magnesium and fiber for treating both low and high blood pressure (Holmes, 2000). Cucumber is an excellent source of silica, which is known to help promote joint health by strengthening the connective tissues, which include muscles, tendons, ligaments, cartilage and bone.

Cucumber is a versatile food item with countless numbers of nutritional benefits and can also save both time and money for households (Ngouajio *et al.,* 2006). Some self-evident nutritional benefits of cucumbers along with some lesser known uses include aid in weight loss and rehydration (Shetty and Wehner, 2002). Cucumbers encourage the elimination of waste products from the body through urination (diuretic) (Ngouajio *et al.,* 2006) and is a source of carbohydrates that can provide energy, antioxidants and cucumber juice can be used for skin tightening. Ascorbic acid and caffeic acid present in cucumbers can bring down the water retention rate which in turn diminishes the puffiness and swelling under the eyes. Cucumber seeds are used as a natural remedy for treating tapeworms, swellings of the mucous membranes of the nose and throat (Boucher and Durgey, 2003) and the high silica content of cucumbers helps to prevent splitting and spoiling of nails and frozen slices of cucumber help soothe babies' gums (Boucher and Durgey, 2003).

Cucumis sativus is a warm weather crop which is sown, grown and harvested over dry and rainy seasons (Hector *et al.,* 2005). When compared with other vegetables, cucumber occupies fourth place in importance in the world, following tomato, cole crops and onion (Jeffrey, 1990) but this can be marred by insect pests such as spotted cucumber beetle (*Diabrotica undecimpunctata),* striped cucumber beetle (*Acalymma vitatum),* banded

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cucumber beetle (*Diabrotica balteata)*, squash bug (*Anasa tristis)* and squash vine borer (*Melittia cucurbitae).* Others include melon aphid (*Aphis gossypii)*, cowpea aphid (*Aphis* craccivora), potato aphid (*Macrosiphum euphorbiae)*, green peach aphid (*Myzus persicae)*, cutworm (*Agrotis spp)* and pumpkin beetle (*Aulcophora spp)* (Loy, 1990; Seng, 2002). Insect pests generally do not inflict very serious damage on cucumber, but they are a serious concern for the grower because the very low tolerance for insect damage in the crop makes strict insects control necessary (Ngouajio *et al*., 2006). Entire loads can be rejected for slight damage or for the presence of as few as 20 pickle worm holes. None of the pests needs routine control measure, but they do need to be regularly monitored and treated when the pest becomes a problem (Seng, 2002).

Organic farming relies on use of ecosystem friendly techniques rather than external agricultural inputs such as synthetic fertilizers and pesticides where management practices that maintain and increase soil fertility and prevent pest and disease within a tolerable measure is adopted (Ajayi, 2015). Cucumber being a vegetable, protecting it against insect pests should depend totally on non-chemical control measure in order to avert food poisoning, environmental contamination, pest resistance, adverse effect on non-target organisms and pest outbreaks (Ngouajio *et al*., 2006). It is for this reason that techniques that are environmentally friendly, more effective and cheap which fit readily into an integrated pest management strategy are actively being researched. The present study was carried out to determine the effectiveness of combining varietal resistance with organic fertilizer application on infestation of cucumber by insect pests.

MATERIAL AND METHODS

Materials

Three cucumber varieties (Starke Ayres, Bakker Brother and Griffaton) treated with "Thiram" and which had 99% purity were obtained from Jos, Nigeria and used for the experiment. Poultry manure (organic fertilizer) was obtained from the Teaching and Research Farm, Faculty of Agriculture, University of Port Harcourt, Port Harcourt, Nigeria and NPK 15:15:15 (inorganic fertilizer) was obtained from a commercial source in Port Harcourt.

Study area

The study was conducted at the Teaching and Research Farm of the Faculty of Agriculture, University of Port Harcourt. Port Harcourt is situated at latitude 4.5^0N and longitude 7.01^0E and on an elevation of 18m above sea level, with a bimodal rainfall pattern with peaks in June and September which ranged from 2,400 to 3,600 mm per annum. Mean daily temperatures varied from 25.6 to 29.1^0C (NMA, 2009). The soil type is sandy loam and poor in nutrients (especially cations) but perfectly well drained ultisols. The experimental area was manually cleared to remove the existing vegetation with cutlass and hoe.

Poultry manure processing

The poultry manure (PM) was left to cure for 21 days and later sundried in the open before pulverizing it and applied at four rates as: Treatment 1 (4.2t/ha), treatment 2(8.3t/ha), treatment 3(16.7t/ha) and treatment 4(3.33t/ha) while NPK 15:15:15 (inorganic fertilizer) was applied at the recommended rate (300kg /ha). Each treatment was replicated three times. A control plot was included in each treatment. The fertilizers were broadcast and mixed

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thoroughly with soil to ensure even distribution as soon as the beds were ready and allowed to cure for 14 days before sowing the cucumber.

Experimental design

The experiment was laid out in a Randomized Complete Block Design (RCBD) and each treatment was replicated three times. The experimental total land area was 18m x 14m while treatment plots measured 2.0m x 1.5m and a 1m alley separating the blocks and treatment plots was included; 2.0m distance was used to separate replications in order to minimize overlapping by the trailing vines. There were 18 plots for each treatment combination giving a total of 54 treatment plots. The experiment was conducted for a period of three (3) months, from April to June, 2013.

Sowing, cultural practice and harvesting

A 50cm x 50cm planting space at a depth of 2-3cm was adopted with 20 plants sown per plot. Sowing was done manually and two seeds of cucumber per hole were sown and this was later thinned down to one plant per hole after 2weeks. Weeding was done manually using a hoe and when the cucumber had covered the ground surface any weed seen was hand pulled. Cucumbers were harvested when fruits turned dark to medium green, without any signs of yellowing. During the period of the experiment harvesting was done three times at weekly intervals.

Soil analysis

Soil samples were collected randomly at two depths, 0 to 13 and 13 to 25cm. The samples were transferred to the laboratory for analysis. The chemical properties of the poultry manure were also determined before application.

Data collection and analysis

Data on days to 50% germination and flowering were taken; insects collection started at 4WAS (weeks after sowing) and lasted for five weeks. After each collection, the insects were preserved in a vial containing 85% ethanol and later sent to the Entomological Museum of the Ahmadu Bello University (ABU) Zaria, Nigeria for identification. The data were subjected to Analysis of Variance (ANOVA). Differences between means were determined using Student Newman Keuls test (SNK) or Least Significant Difference (LSD) at 0.05 error limits.

RESULTS

Table 1 shows the chemical composition of soil samples and poultry manure (PM) used. The results indicate that the soil was sandy with organic matter content of 2.42 % while PM had 9.18 %. Percentage nitrogen in the soil and PM were 0.03 and 2.35, respectively. The result also shows that before the start of the experiment the soil had 4.32mg/kg phosphorus and PM had 76.67mg/kg. Available potassium (K), magnesium (Mg) and calcium (Ca) were 0.08 cmol/kg, 0.07 cmol/kg and 0.11 cmol/kg in the soil and 22.18 cmol/kg, 31.19 cmol/kg and 26.88 cmol/kg in PM, respectively and pH values of the soil and PM were 6.82 and 5.70 respectively.

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The result of days to 50 % germination of cucumber varied between varities and fertilizer types and rates: Stark ayres and Bakker brother varieties treated with 8.3t/ha PM recorded the highest number of days (5 days) before attaining 50% germination and Stark ayres, Bakker brother and Griffaton varieties treated with 300kg/ha NPK and Bakker brother variety without treatment also took a similar duration to attain 50% germination. The least number of days to 50% germination was 4.3 days recorded on Stark ayres variety treated with 8.3t/ha PM, Bakker brother and Griffaton varieties treated with 16.7 t/ha PM, Stark ayres variety treated with 33.3t/ha PM and Griffaton without treatment (control) (Fig. 1).

Figure 2 shows that cucumber variety Bakker brother treated with 300 kg/ha NPK recorded the highest number of days (35 days) to attain 50% days to flowering, followed by Griffaton variety treated with 33.3t/ha PM and Stark ayres treated with 300kg/ha NPK that took 34.7 days to flowering. The least number of days (33.3 days) was recorded on Stark ayres without treatment (control) to attain 50% flowering.

Table 1: Physicochemical properties of soil and poultry manure used to cultivate cucumber in the Niger Delta region of Nigeria.

Chemical parameters	sandy soil	poultry manure
Organic matter (%)	2.42	9.18
N (%)	0.03	2.35
P (mg/kg)	4.32	76.67
K (cmol/kg)	0.08	22.18
Mg (cmol/kg)	0.07	31.19
Ca (cmol/kg)	0.11	26.88
pH	6.82	5.70

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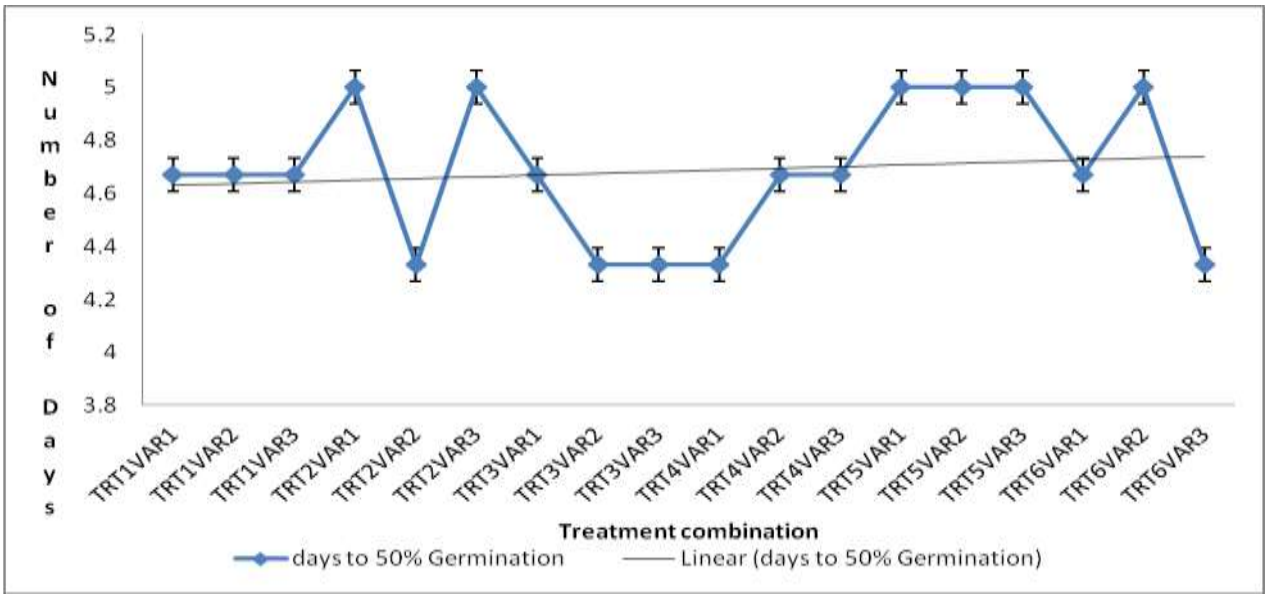

Fig 1: Number of days to 50% germination in cucumber fertilized with organic and inorganic fertilizer.

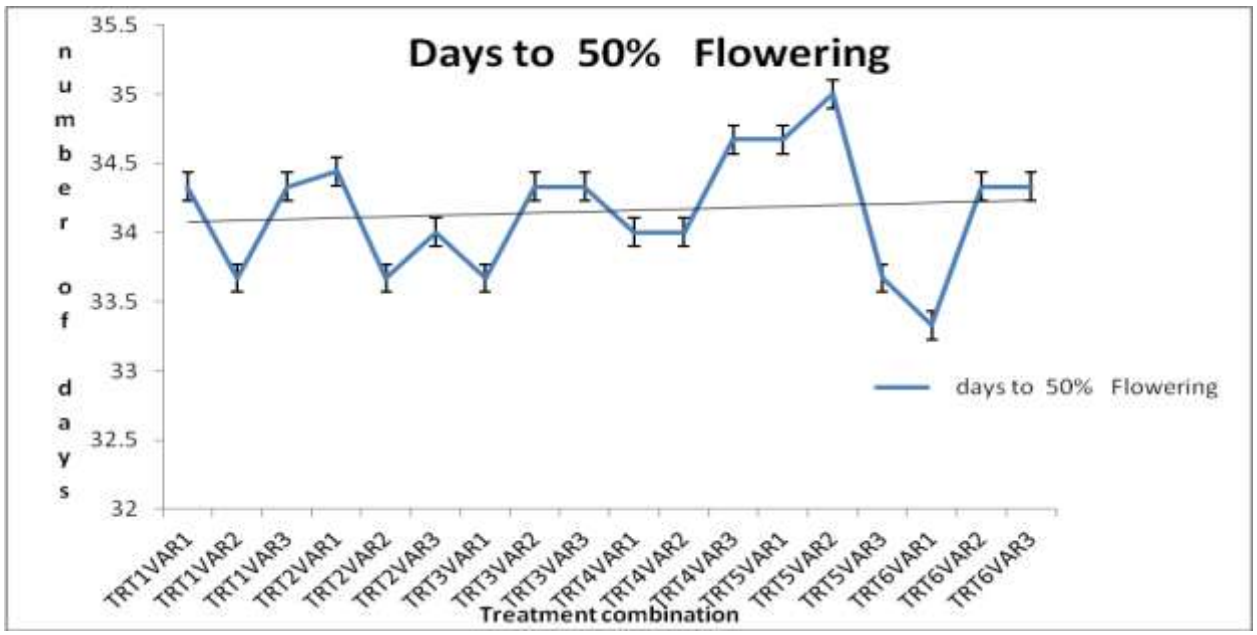

Fig 2: Number of days to 50% flowering in cucumber fertilized with organic and inorganic fertilizer.

Treatment / varietal key

TRT 1	4.2 t/ha PM	VAR 1 Stark ayres
TRT2	8.3 t/ha PM	VAR 2 Bakker brother
TRT3	16.7t/ha PM	VAR 3 Griffaton
TRT4	33.3/ha PM	
TRT5	300kg/ha NPK	
TRT6	control	

ISSN 2055-0057(Print), ISSN 2055-0065(Online)

The number of undamaged and damaged cucumber fruits harvested from each treatment combination (Table 2) shows that the highest number (155.85) of undamaged cucumber fruits was recorded on Stark ayres variety treated with 33.3t/ha PM. The least was on Griffaton variety that received no treatment (control). The number of damaged fruits was significantly higher ($p<0.05$) on Stark ayres variety treated with 16.7t/ha PM than on other varities and those treated with other types and rates of fertilizers. The least was on Bakker brother variety that received no treatment (control).

Table 3 shows the results of the mean weight of undamaged and damaged fruits from each treatment combination. Mean weight of undamaged fruits was higher on Stark ayres variety treated with 33.3t/ha PM and 16.7t/ha PM (467.66 and 434.67, respectively) followed by Bakker brother variety treated with 16.7t/ha PM. The least weight of fruits was on Griffaton variety that did not receive any treatment (control). Mean weight of damaged fruits was significantly ($p<0.05$) higher on Stark ayres treated with 16.7t/ha PM followed by Bakker brother treated with 16.7t/ha PM.

TABLE 2: Number of undamaged and damage fruits harvested from cucumber varieties grown with organic and inorganic fertilizers.

Treatment	Number of undamaged fruit			Number of damaged fruit		
	Stark ayres	Bakker brother	Griffaton	Stark ayres	Bakker brother	Griffaton
4.2t/ha PM	106.56^{a-c}	105.07^{a-c}	38.67^{bc}	23.52^{a-c}	25.19^{a-c}	19.96^{a-c}
8.3t/ha PM	134.30^{ab}	98.41^{a-c}	76.63^{a-c}	45.93^{a-c}	14.78^{bc}	22.70^{a-c}
16.7t/ha PM	144.89^{a}	142.89^{a}	86.96^{a-c}	72.00^{a}	70.30^{ab}	26.04^{a-c}
33.3t/ha PM	155.85^{a}	120.41^{ab}	108.63^{a-c}	45.52^{a-c}	36.59^{a-c}	39.26^{a-c}
300kg/ha NPK	81.56^{a-c}	111.44^{a-c}	70.11^{a-c}	16.67^{a-c}	30.37^{a-c}	59.48^{a-c}
Control	104.52^{a-c}	64.70 $^{a-c}$	17.19^{c}	35.52^{a-c}	11.11^{c}	19.96^{a-c}

Means with the same letters in a column are not significantly ($P\leq 0.05$) different.

Table 3: Mean weight of undamaged and damaged fruits of cucumber varieties grown with organic and inorganic fertilizers

Treatment	Mean weight of undamaged fruit			Mean weight of damaged fruit		
	Stark ayres	Bakker brother	Griffaton	Stark ayres	Bakker brother	Griffaton
4.2 t/ha PM	319.67^{b-d}	315.22^{b-d}	116.00^{ef}	70.56^{de}	75.56^{de}	59.89^{de}
8.3 t/ha PM	402.89^{ab}	295.22^{bc}	229.89^{c-e}	136.78^{a-d}	44.33^{de}	68.11^{de}

ISSN 2055-0057(Print), ISSN 2055-0065(Online)

16.7t/ha PM	434.67^{ab}	428.67^{ab}	251.22^{c-e}	216.00^{a}	210.89^{ab}	78.1^{de}
33.3 t/ha PM	467.56^{a}	361.22^{a-c}	325.89a-d	137.56^{a-d}	109.78^{c-e}	117.78^{b-e}
Control	313.56^{b-d}	194.11^{ed}	51.56^{f}	106.56^{c-e}	33.33^{e}	59.89^{de}

Means with the same letters a column are not significantly (P<0.05) different.

Table 4 shows the number of insect species recorded from cucumber treated with the different rates of PM and NPK. Significantly higher (P<0.05) number of insects were collected plots treated with 33.3t/ha PM though this did not differ from those treated with NPK applied at 300kg/ha. The least number of insects was recorded in plots treated with 4.2t/ha PM.

Results on numbers and status of insects collected during the research (Table 5) shows that *Cheilomenes sulphrea* Oliv. from the family Coccinellidae was the only predator found while the remaining insects collected were pests. Table 5 also shows that of the species of insect collected, 10 belonged to Coleoptera, two to Diptera, and one each to the orders Homoptera and Orthoptera. The species were from eight families with five from Chrysomelidae, two from Cocccinellidae, two from Lagriidae and a species from each of the other family members.

Table 4: Mean number of insects species collected from cucumber varieties grown with organic and inorganic fertilizers

Treatment	Number	Mean
4.2t/ha PM	55	2.36^{b}
8.2t/ha PM	61	2.77^{ab}
16.7t/ha PM	65	2.93^{ab}
33.3t/ha PM	71	3.23^{a}
300kg/ha NPK	71	3.23^{a}
Control	66	3.09^{ab}

Means with the same letters in a column are not significantly (P≤0.05) different.

Table 5: Identity and status of the insects collected on cucumber varieties grown with organic and inorganic fertilizers

Order	Family	Scientific name	Status	Part of plant attacked	Number of insects
Coleoptera	Chrysomelidae	*Aulacophora african* Weise	pest	leaf	10.65^{a}
Coleoptera	Chrysomelidae	*Kanahiiphaga aeneipennis* Lab	Pest	Leaf/flower	10.46^{b}
Coleoptera	Coccinellidae	*Epilachna chrysomelina* F	Pest	Leaf/flower	8.36^{c}
Coleoptera	Chrysomelidae	*Aulocophora vinula* Eric	Pest	Leaf/flower	5.87^{d}

ISSN 2055-0057(Print), ISSN 2055-0065(Online)

Coleoptera	Lagriidae	*Lagria villosa* F	Pest	Leaf/flower	4.74[e]
Coleoptera	Coccinelidae	*Cheilomenes sulphrea.* Oliv	Predator	Leaf	4.42[f]
Coleoptera	Lagriidae	*Chrysolagria* sp	Pest	Leaf/stem	2.74[g]
Orthoptera	Tetrigonidae	*Dinorettix africanus* Bol	Pest	Leaf	1.87[h]
Diptera	Diopsidae	*Diopsis* sp	Pest	Lower part of the stem	1.58[i]
Coleoptera	Chrysomelidae	*Lema calcurata* Dalm	Pest	Leaf/flower	1.58[i]
Coleoptera	Scarabaeidae	*Coenochilus ventricosus* Gyll	Pest	Leaf/flower	1.23[j]
Coleoptera	Chrysomelidae	*Monolepta nigeriae* Bryant	Pest	Leaf/flower	1.23[j]
Diptera	Muscidae	*Planiseta* sp	Pest	Leaf	1.23[j]
Homoptera	Cercopidae	*Locris erythromela* Walker	Pest	Leaf/stem	1.23[j]

Means for number of insects followed by the same letters in a column are not significantly ($P \geq 0.05$) different.

DISCUSSION

Effect of organic and inorganic fertilizer on germination and flowering in cucumber crop

Germination of *C. sativus* in various treatment combinations took 5 days as the highest number of days to attain 50% germination. This maximum number of days concurs with the findings of Hermer (1990) who reported that the main development processes and organ development of cucumber seeds take a maximum of 6days. However, the observation is at variance with the finding of Christo and Madukwe (2011) who reported that poultry manure increased the germinability of fluted pumpkin seeds and Hussein (1997) who reported that poultry manure is superior to other sources of organic manure in terms of germination.

The results of the study revealed that the sources of fertilizer (organic and inorganic) had no significant effect on 50% anthesis. A similar observation was reported by Atijegbe *et al.* (2014) who did not record a significant effect on number of days taken to flowering at different levels of NPK fertilizer and PM. The result also shows that the least number of days to 50% anthesis ranged from 33.3 days observed in Starke ayres to 35 days observed in Bakker brother treated with 300kg/ha NPK to 49 days in control plots recorded by Atijegbe *et al.* (2014).

Cucumber flowers are unisexual, with male and female flowers on different plants (dioecious) or on the same plant (monoecious) (Tindall, 1983). The variation in the duration of days to 50% flowering therefore can be explained as Kraup *et al.* (2002) opined that NPK had been reported to depress flowering and encourage male flowers rather than female flowers. Utobo *et al.* (2010) however reported that unpruned cucumber varieties take a shorter duration (26 days) to 50% anthesis. It is also known that days to 50% anthesis can be high in the staked than the non-staked cucumber (Nweke *et al.*, 2013). Jansen (1985) also observed that staking prolongs vegetative growth and delays fruit formation; however, Than (1996) is of the view that pruning prolongs number of days to flowering in cucumber.

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The role of poultry manure and inorganic fertilizer on the potential yield of cucumber crop

Application of PM to soil improves productivity and yield in terms of quality and quantity (Akande *et al*., 2010). An increase in yield associated with an increase in poultry manure rates observed confirms a similar work by Atijegbe *et al*. (2014) who reported a corresponding increase in both vegetative and reproductive traits in okra with successive increase in the levels of PM. This suggests that poultry manure as reported by John *et al*. (2004) contains essential nutrients which are associated with high photosynthetic activities that promote root and vegetative growth thereby leading to increased fruit yield. Ayoola and Adeniran (2006) observed that variation in nutrient source among treatments will result in significant variation in fruit yield in most crops.

The cucumber grown in the control plots without the application of inorganic fertilizer (NPK) or poultry manure resulted in poor growth and yield performance. This observation agrees with the finding of Hamma *et al.* (2012) that residual nutrient content in soil does not support optimum growth and yield of cucumber. It is probable that the nutrient content of the soil was below the critical level needed for optimum performance of the crop. However, those plants that received higher rates of poultry manure supplied enough nutrients that could support appropriate nutrition and growth of the plants. The improved ability of these plants to photosynthesize may have caused an increase in growth and development of the crop resulting in higher productivity. This observation was made earlier by Ayuso *et al.* (1996) and Eifediyi and Remison (2010) who reported that organic manures can sustain cropping systems through better nutrient recycling which would give rise to crop improvement in growth and development as well as yield. In a more recent study, Atijegbe *et al.* (2014) reported an increase in cucumber growth parameters with increase in application rate of NPK and PM. Adilakshmi *et al.* (2007) and Akande *et al.* (2010) also reported similar findings in okra stem circumference with an increase in nitrogen application.

Aduloji *et al.* (2010) and Dada and Fayinminnu (2010) reported earlier that nutrients from mineralization of organic matter promoted growth and yield of cucumber. Palm *et al.* (2010) concluded that there is a potential to increase crop yields by maintaining soil organic matter through use of organic manure. The high fruit weight recorded with increased application of poultry manure is probably due to improved nutrient availability in the soil. This result is in conformity with the work of Dauda *et al.* (2008) who reported increased number of fruits and average weight attributed to the ability of poultry manure to increase meristematic and physiological activities in the plant and improvement in soil properties, resulting in synthesis of more photoassimilates used in producing fruits.

Inorganic fertilizers have been reported to increase growth and yield components of cucumber by many authors (EI-Badawi, 1994; Lawal, 2000; Agba and Enya, 2005). The improved supply of NPK would lead to better utilization of carbon and subsequent synthesis of assimilates (Lawal, 2000). Similarly, Ibrahim *et al.* (1997) reported an increase in vegetative growth in watermelon treated with NPK fertilizer. Although these reports are all not in consonance with the current finding as our observations show relative poor performance in terms of yield and fruit weight in NPK- treated plots. Rather, cucumber dry matter weight increased with increase in the rate of organic fertilizer application. In an earlier study, however, Lawal (2000) and El-Badawi (1994) reported a significant increase in cucumber growth and yield with increasing NPK fertilizer level up to 75kgN/ha in Samaru, Zaria, Nigeria. Eifedeyi and Remison (2009) also reported that increase in inorganic fertilizer

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up to 400kg/ha gave higher yield for two cucumber varieties. This could be attributed to improved development and photosynthetic capacity of the crop which enhanced assimilates production and accumulation. The assimilates produced during photosynthesis were translocated to the various sinks which resulted in the increase in the number of fruits per plant and total yield. However, the poor performance observed in NPK-treated plots in this study could be as a result of the lower rate applied relative to the 400 kg NPK/ha reported in the study by Eifedeyi and Remison (2009).

Varietal differences in yield components

The results show a significant difference among varieties in yield characters such as mean number of fruits and fruit weight with Starke ayres variety being superior to Bakker brother and Griffaton. These yield characters had been postulated by Ramirez *et al.* (1988), Tizhe (1994), Phu (1998) and Wehner and Guner (2004) to be a function of the variety used. The differences in yield characters can be attributed to genetic composition of the varieties used. The Starke ayres variety may have been quicker in adapting to the environment than the Bakker brother and Griffaton and therefore had a strong source to sink relationship which resulted in the high yield experienced in the variety. This observation agrees with the findings of Ibrahim *et al.* (2001) who opined that differentials of growth rate and yield indices of vegetable crops are normally attributed to their genetic make-up. Again, Bodunde *et al.* (1993*)* and Ibrahim (1994) also posited that cucumber varieties with high yield are semi-determinate and as such directed most of their nutrient flow to their reproductive organ growth (in this case fruits).

Influence of organic and inorganic fertilizer on the incidence of insect pests

Many workers have amply demonstrated the increased susceptibility of N-fertilized crops to insect infestation. Patriquin *et al.* (1995) for instance, reported that many of the factors influencing susceptibility to pests and diseases do so through their effects on plant N-metabolism. The results show a high number of species of insect pests associated with plots treated with NPK and 33.3t/ha PM. Miguel and Clara (2003), nonetheless, reported that crops grown with organic matter generally exhibit less insect herbivores. Godase and Patel (2001) also reported a reduction in aphid population due to the application of organic manure in brinjal crops in India. Results similar to those of current study were reported by earlier workers who observed that application of poultry manure and NPK fertilizers increased pest populations and consequently decreased the head weight of crops (Yardim and Edwards, 2003; Mochiah *et al.,* 2011). Karnataka (2008) and Surekha and Rao (2001), on the other hand, showed that soil amendment with organic fertilizer was effective in bringing down populations of aphids in okra. In support of the current finding, other workers opined that increasing soluble nitrogen levels in plants from organic manure sources can decrease their resistance to insect pests (Phelan *et al.,* 1996; Stone *et al.,* 2000). Prestige and Mc Neill (1993) also noted that high levels of protein amino acids commonly stimulate the growth and fecundity of herbivorous insects. Fertilizing crops with N may therefore make crops more susceptible to pests by increasing the level of free amino acids (Mattson, 1980; Koritsas and Garsed, 1985).

In this study, *Cheilomenes sulphrea* Oliv (Coleoptera: Coccinelidae) was identified as the only predator out of the 14 insect species collected on cucumber. In the study by Atijegbe *et al.* (2013) two pollinators out of 21 insect species were identified on cucumber; this could mean that in this region there are few species of beneficial insects associated with cucumber

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cultivation. However, the insect pest complex recorded is in agreement with the works of Hill (1999) and Youdeowei (2004) who showed that insect pests are of economic importance on cucurbits. Although the result shows an increase in yield corresponding to an increase in poultry manure rates, the increased incidence of insect pests needs to be taken into consideration when cultivating cucumber in this region. Yield increased with increasing rates of fertilizer and pest incidence. It has been shown that higher rates of nitrogen fertilizer probably ensure healthy compensatory plant growth. This conclusion was reached by Echezona and Nganwuchu (2006) who reported that high nitrogen supply ensures healthy compensatory plant growth which enabled the plant to withstand high levels of infestation. Atijegbe *et al.* (2013) while working in the same agro-ecological zone reported a similarly high insect pest incidence in NPK-treated plots. Yardim and Edwards (2003) reported that greater numbers of arthropods usually occur on plants grown with inorganic fertilizers than on plants grown with organic amendments because chemical fertilizers could dramatically influence the balance of nutritional elements in plants and it is likely that excessive use would create nutrient imbalance which could in turn reduce resistance to insect pests (Patriquin *et al*., 1995).

CONCLUSION

The study clearly indicates that production of cucumber can be enhanced by the application of poultry manure. Applying the PM at the rate of 33.3t/ha PM resulted in increased yield of cucumber than the application of 300kg/ha NPK. It was further observed that application of nutrients to boost the growth and yield of cucumber increased the incidence of insect pests on cucumber but this did not depress fruit yield as the crop was able to withstand this level of pest infestation through the resistance phenomenon known as tolerance.

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