Journal of Crop Nutrition Science
ISSN: 2423-7353 (Print) 2538-2470 (Online)
Vol. 4, No. 2, 2018
http://JCNS.iauahvaz.ac.ir
OPEN ACCESS

Podagrica Uniforma and Nisota dilecta (Coleoptera: Chrysomalidae) Infestation on Okra (*Abelmoschus esculentus*) in Response to Nutrient Sources

Jacobs Mobolade Adesina[1]*, Kayode David Ileke[2] and Raphael Adebayo[3]

1-Department of Crop, Soil and Pest Management Technology Rufus Giwa Polytechnic, P. M. B. 1019, Owo, Ondo State, Nigeria.
2-Department of Biology, School of Science Federal University of Technology, P. M. B. 704, Akure, Ondo State, Nigeria.
3-Department of Crop, Soil and Pest Management, Federal University of Technology, P. M. B. 704, Akure, Ondo State, Nigeria.

RESEARCH ARTICLE

ARTICLE INFO.
Received Date: *25 Mar. 2018*
Received in revised form: *22 May. 2018*
Accepted Date: *2 June. 2018*
Available online: *23 Jun. 2018*

To Cite This Article: Jacobs Mobolade Adesina, Kayode David Ileke and Raphael Adebayo. Podagrica uniforma and Nisota dilecta (Coleoptera: Chrysomalidae) Infestation on Okra (*Abelmoschus esculentus*) in Response to Nutrient Sources. ***J. Crop. Nutr. Sci.,*** 4(2): 45-55, 2018.

ABSTRACT

BACKGROUND: The ability of a plant to resist or tolerate pests is grounded partially in favorable physical, chemical and biological properties of soil.

OBJECTIVES: Investigate the influence of nutrient sources on *Podagrica uniforma* and *Nisota dilecta* infestation, population dynamics and performances of okra.

METHODS: The experiment was conducted in a Randomized Complete Block Design with 4 treatments (5 $t.ha^{-1}$ poultry manure, 5 $t.ha^{-1}$ pig manure, 5 $t.ha^{-1}$ cattle manure and control (no manure), replicated three times. *P. uniforma* and *N. dilecta* (Coleoptera: Chrysomalidae) infestation on okra in respond to nutrient sources application were investigated at the Teaching and Research Farm of Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria during 2015 and 2016 cropping seasons.

RESULT: The experiment showed that pig manure recorded the lowest amount of defoliation (17.0 ± 6.15 and 8.66 ± 2.62) in both planting season, it also recorded a low number of fruits in 2015 and 2016 planting season (3.00 ± 3.46 and 2.11 ± 1.92) and fruit weight (21.04 ± 26.37 and 12.26 ± 10.52) respectively. The highest yield (number of fruits) was recorded in poultry manure in 2015 (6.00 ± 3.61) and control in 2016 (4.66 ± 4.25), the highest fruit weight was recorded in control plot in both planting seasons (61.75 ± 52.00 and 43.04 ± 40.36). Poultry manure recorded moderate amount of defoliation (19.73 ± 21.42 and 9.57 ± 3.10) along the season. Also poultry manure record moderate amount of defoliation also record the highest number of yield (3.58 ± 3.52) when compared to other treatment (pig, cattle and control). It was concluded that poultry manure is best suitable for the production of okra.

CONCLUSION: Both pig and poultry manure are best for controlling *P. uniforma* and *N. dilecta* infestation on okra as they both show greater tolerant and compensatory ability and thus recommended for the management and suppression of *P. uniforma* and *N. dilecta* population in studied area.

KEYWORDS: *Defoliation, Planting season, Poultry manure.*

***Corresponding Author:** Jacobs Mobolade Adesina ✉ mobolade72@gmail.com

1. BACKGROUND

Okra is one of the most widely known and utilized species of the family Malvaceae for its immature fibrous fruits or pods consumed owing to its medicinal value and as nutrient sources (Naveed *et al*., 2009). However, in spite of the great demand for okra due to its medicinal and nutritional importance its production is constrained by poor cultural practices, insect pest infestation and most importantly low soil fertility. Several insect pests such as whitefly, jassid aphid, spotted bollworm, American bollworm, cotton stainer, etc severely hampered okra cultivation. Rao and Rajendra (2003) reported that as high as 72 species of insects have been recorded on the crop. Among them *Podagrica* species is noted as major and most damaging insect pest of okra causing tremendous yield losses due to the insect feeding habit which defoliate the leaves thereby reduced the plant photosynthetic capability. The insect also acts as a vector transmitting certain viral diseases (Adesina and Afolabi, 2014). *N. dilecta* and *P. uniformis* are serious and destructive insect pests of okra infesting the leaves of the okra plants. Defoliation or skeletonization of the leaf surface due to its infestation has been reported to be up to 80% owing its biting and chewing mouthparts and severity of damage varies (Clementine *et al.,* 2009). Soil fertility and plant nutrition are important aspect of cropping system and these include adequate supply of essential nutrients for soil productivity, plant nutrition and qualitative crop yield. Tropical soils are inadequate in soil nutrients and if available contribute a lot to plant growth and yield (Aluko *et al.,* 2014). Conventionally, inorganic fertilizers have been used to correct poor or low soil fertility problems to meet crop demands, soil fertility management and to ensure food security, but in recent times, high cost of synthetic fertilizer and its availability to rural farmers has been a discouraging factor (Okonmah, 2012). Inorganic fertilizers used in conventional agriculture contain just a few minerals, which dissolve quickly in damp soil and give the plants large doses of minerals (Olaniyi *et al*., 2010) necessitating the application of manure for amelioration of soil fertility to become an integral part in any vegetable production. The use of organic wastes such as crop residues, manures and compost has large potential for improving soil productivity and crop yield through improvement of the physical, chemical and microbiological properties of the soil as well as nutrient supply (Akande and Adediran, 2004). These are attributed to the fact that nutrients are slowly released with the application of organic fertilizer, and nutrient losses are prevented or minimal because humic materials takes a longer time to deteriorate, thereby ensuring continuous availability of nutrient even till harvest. Soil fertility improvement practices apart from providing crops with the needed nutrients, can impact the physiological susceptibility of crop plants to insect pests by either affecting the resistance of individual plant to attack or by altering plant acceptability to certain insect pests. Organic manure has long been maintained to produce the healthy soils, ensure quality and healthy plants capable of enhancing plant resistance to pests and diseases (Phelam *et al*., 1995). Ramesh *et al*. (2005) concluded that organic crops have been shown to be more tolerant as well as resistant to insect attacks. Meyer (2000) proposed that soil nutrient availability not only affects the amount of damage that plants receive from insect pests infestation but also the ability of plants to recover from such damages and injuries.

Merill (1983) opined that application of organic manure and organic farming practices are likely to reduce pest outbreaks which will also facilitate establishment and maintenance of healthy soil. The shift from organic soil management to inorganic fertilizer is the outcome of neglecting the importance of soil organic matter in crop production and prolonged overuse of soluble agro-chemicals on lowering land productivity, has increased the potential of insect pests and diseases infestation and infection to cause economic losses, human health hazards and pollution of the environment are becoming increasingly evident (Huber and Graham, 1999). It is now considered that restricted use of inorganic fertilizers, synthetic insecticides and inclusion of organic materials could be the alternative to come out of vicious spiral of agrochemicals menace (Rao, 1996). Cardoso *et al*. (2009) reported that, among the organic fertilizers used in vegetable production, livestock manures stand out due to their positive effects on soil conditioning and nutrient availability. Presently, the use of organic manure in okra production is yet unpopular in Nigeria and has not been well studied and in order to improve yield and maintain good fruit quality, the insect pests of okra must be properly managed devoid of synthetic insecticides.

2. OBJECTIVE

The goal of this study therefore, is to investigate the influence of nutrient sources on *Podagrica uniforma* and *Nisota dilecta* infestation, population dynamics and performances of okra.

3. MATERIALS AND METHODS

3.1. Experimental Location

Field experiment was conducted at the Teaching and Research Farm of Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria (Latitude 7º12'N and 5º35'E Longitude) in 2015 and 2016 cropping seasons. The experimental site lies within the rainforest transition agro-ecological zone of South Western Nigeria. Generally, the monthly rainfall distribution pattern for Owo is bi-modal with peaks in June and September. Annual rainfall ranges from 1200mm to 1750mm spanning over eight months (March to October) with a dry spell in August. The land was predominated by *Pannisetum purpurem* and *Imperata cylindrica* (Poaceae), though the land has been under continuous cultivation for 4 years prior to the experiment without organic manure or inorganic fertilizer application.

3.2. Land Preparation and Experimental Design

The total experimental plot area was $117m^2$ and this was manually cleared, debris packed and made into seed beds measuring 3m x 2.6m for planting using hand hoe with 1m x 0.5m pathway. The experiment was conducted in a Randomized Complete Block Design with four (4) treatments (5 t ha^{-1} poultry manure, 5 t ha^{-1} pig manure, 5 t ha^{-1} cattle manure and control (no manure), replicated three times. Cow manure, poultry manure and pig manure were collected from the livestock unit, Teaching and Research Farms, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria. The manures were shade dried and sample taken for routine laboratory analysis to determine its nutrient composition (Table 1). The manures were measured as required (2 t ha^{-1}) and worked into soil with hand hoe two (2) weeks before planting to allow for proper decomposition, mineralization and nutrient release into soil. Okra seed (NH-47) an early maturing variety was sourced from Agricultural Development Project (ADP) Akure, Ondo State, Nigeria.

Table 1. Mineral content of organic manure used

Parameters	Poultry manure	Cattle Manure	Pig Manure
pH (H_2O)	7.46	5.48	7.20
Organic carbon (%)	24.48	32.47	58.12
Total nitrogen (mg/kg)	1.67	1.09	3.73
Available P (ppm)	8.37	3.04	6.84
Exchangeable cations			
Na ($cmol.kg^{-1}$)	4.06	3.48	3.40
Ca ($cmol.kg^{-1}$)	5.32	1.00	2.85
K ($cmol.kg^{-1}$)	3.05	1.05	6.50
Mg ($cmol.kg^{-1}$)	1.43	0.50	3.30

The okra was planted two (2) seeds per hole at a spacing of 50cm x 50cm and later thinned to one stand two weeks after the planting. All agronomic practices except insect pest control necessary for the optimum growth of okra and ensure efficient utilization of the manure were carried out as at when due (Adesina and Ileke, 2014).

3.3. Pre-cropping Soil Analysis

Before the beginning of experiment for both seasons (2015 and 2016), core soil samples (0-20 cm) were randomly collected with an auger and bulked together. The composite soil sample collected was air-dried in a room temperature for three days, crushed and sieved using 2 mm aperture. Thereafter the soil sample subjected to routine laboratory procedure to determine the following; particle size, pH, organic carbon (OC), total nitrogen, available phosphorus, exchangeable cations/bases (K, Mg, Ca, Na) and cation exchange capacity (CEC) following the procedures outline by IITA (1979) and Enujeke (2013).

3.4. Data Collection and Analysis

Seven (7) representative plant stands were randomly selected and properly tagged per plot to make a total of 84 samples for data collection. Data collected include growth parameters: plant height (cm), numbers of leaves, stem girth (cm); insect pest counting carried out at 4 Weeks After Planting (WAP), 6 WAP and 8 WAP in both seasons, severity of leaf damage; number of fruits and fruit weight (g). The counting of insect was done visually at the early hour of 6 am–7 am when the insect are still inactive and not able to fly (Adesina and Afolabi, 2014). The counting was done for both *Nisota dilecta* and *Podagrica uniforma* beetles at upper and lower parts of the leaves.

3.5. Statistical Analysis

Data collected were analyzed in completely randomized design and subjected to separate Analysis of Variance (ANOVA). Treatment means were compared with Duncan Tests via SPSS software (Ver.23).

4. RESULTS

4.1. Nutrient Composition of Organic Manure Used

The chemical analysis of the organic manure indicates that that both pig and poultry manure are alkaline in nature and are all moderately rich in soil basic nutrient required for optimum crop productivity (Table 1).

4.2. Soil Fertility Status of Experimental Soil

The soil properties of for study are presented in Table 2. The soil at the experimental location was a well-drained sandy loam, strongly acidic in nature with pH of 5.49 and 5.77 for 2015 and 2016 seasons respectively.

Table 2. Physiochemical properties of experimental soil for 2015 and 2016 seasons

Parameters	2015	2016
Sand (%)	67	70
Silt (%)	14	10
Clay (%)	19	20
Textural class	Sandy Loam	Sandy loam
Soil pH (H_2O)	5.49	5.77
Organic carbon (%)	0.54	0.89
Total nitrogen (%)	0.13	0.18
Available P ($mg.kg^{-1}$)	9.18	10.0
Exchangeable cation		
Na ($cmol.kg^{-1}$)	0.93	0.78
Ca ($cmol.kg^{-1}$)	1.42	1.27
K ($cmol.kg^{-1}$)	0.96	0.62
Mg ($cmol.kg^{-1}$)	0.64	0.57

Seemingly low in fertility, as reflected by low organic carbon, organic matter, total N, available P and exchangeable bases.

4.3. Effect of Nutrient Sources on Incidence of N. dilecta and P. uniforma on Okra

Results of table 3 and 4 showed effect of organic manure use on incidence of *P.uniforma* and *N. dilecta* infestation on okra for 2015 and 2016 cropping seasons. There was no significant difference between *P. uniforma* and *N. dilecta* population on control plot and manure treated plot at 4 WAP, 8 WAP and 10 WAP, statistical significance was, however, observed in plot amended with pig manure at 4 WAP and different nutrient sources at 6 WAP in 2015 planting season. Treatments with pig manure recorded higher number of *N. dilecta* population in the earliest part of growth in 2015 and 2016 planting seasons, and where not significantly different from other treatments (Table 3). Infestation of okra amended with cattle manure soon increased and was highest in later part of growth (8WAP and 10WAP) in year 2015 and 2016 planting season. Infestation by *P. uniforma* was observed to be higher on no manure treated plots and pig manure treated okra in the early stage of growth in 2016 but not statistically significant different.

4.4. Effect of Different Nutrient Sources on Growth and Yield Performances of Okra

The nutrient sources significant influenced okra plant vegetative growth parameters as presented in Table 5. For 2015 cropping season okra planted on plots amended with pig manure recorded the maximum vegetative growth parameters (number of leaves 15.36, plant height 30.06 cm and stem girth 3.67 cm^3) followed by cattle manure (number of leaves 13.44, plant height 27.53cm and stem girth 2.98 cm^3) and with control plot recorded minimum. While for 2016 cropping season, similar trend was observed with pig manure still maintaining the maximum vegetative growth parameters (number of leaves 17.42, plant height 46.61 cm and stem girth 4.39 cm^3) followed by poultry manure (number of leaves 15.59, plant height 24.82 cm and stem girth 3.04 cm^3) and control recorded minimum vegetative growth parameters.

4.5. Effect of Nutrient Sources on Severity of Okra Leaf Damage

Table 6 shows effect of manure application on severity of leaf damage of okra in 2015 and 2016 planting season.

Table 3. Effect of manure application on incidence of *Nisota dilecta* on Okra

Treat-ment	*Nisota dilecta* population							
	4WAP		6WAP		8WAP		10WAP	
	2015	2016	2015	2016	2015	2016	2015	2016
Pig manure	0.43 ± 0.38*a	0.09 ± 0.08a	0.81 ± 0.70a	0.09 ± 0.08a	1.09 ± 0.72a	1.09 ± 0.08a	0.52 ± 0.30a	0.52 ± 0.08a
Poultry manure	0.19 ± 0.08a	0.05 ± 0.08a	0.52 ± 0.22a	0.05 ± 0.08a	1.23 ± 0.21a	1.23 ± 0.08a	0.37 ± 0.08a	0.37 ± 0.08a
Cattle manure	0.14 ± 0.14a	0.05 ± 0.08a	1.23 ± 1.53a	0.05 ± 0.08a	1.14 ± 0.38a	1.14 ± 0.16a	0.66 ± 0.08a	0.66 ± 0.08a
Control	1.24 ± 0.41a	0.09 ± 0.08a	1.81 ± 0.68a	0.79 ± 0.08a	2.85 ± 0.52a	2.85 ± 0.21a	1.85 ± 0.52a	1.85 ± 0.08a

*Data are the mean ± SE of three replicates. Values followed by the same letters in each column are not significantly different (Duncan Test, P ≤ 0.05).

Results showed severity of leaf damage (number of holes on leaves) was highest in plot with no amendment (24.60 and 9.71) as compared to amended soil; pig manure recorded the lowest amount of leaves damage (17.0) in 2015 while cattle manure recorded the lowest leaves damage (6.57) in 2016. Insect damage in 2016 was numerically very low as compared to previous year and there was significant difference in severity of leaf damage in okra fertilized with organic manures. Table 7 shows significant response of okra yield to sources of manure application. In 2015 plating season, okra planted on plots amended with poultry manure recorded maximum number of harvested fruits (6.00 fruits) in 2015 closely followed by pig manure amended plots (5.02 fruits), least yield was recorded of control plot (2.30 fruits). Similar trends were observed in 2016 planting season also for fruit weight in both cropping seasons. Statistically, there was no significant difference in number of harvested fruits obtained of okra plots amended with pig and poultry manure in 2016 and fruit weight for both 2015 and 2016.

4.6. Insect Found on Okra During 2015 and 2016 Cropping Seasons

Result presented in table 8 showed other insect found infesting the various growth stages of okra plant during the study. The result indicated that insect found belongs to the following order; Hemiptera, Coleoptera, Lepidoptera, Orthoptera and Hymenoptera; of all the insect found infesting okra plant only honey bee is beneficial to okra being a pollinator while the remaining ones are found causing minor damage.

5. DISCUSSION

Okra production often recorded low yield, which has been attributed to insect infestation, poor soil fertility and deficiency in important mineral nutrients. The ability of plant to resist or tolerate pests is grounded, partially, in favorable physical, chemical and biological properties of soil (Luna, 1988); and that farming practices that cause nutrition imbalances can lower plant resistance or tolerance to insect pests infestation (Magdoff and Van-Es, 2000). The pre-cropping soil analysis revealed that experimental soil was well suitable for cultivation of okra which requires well drained sandy loam with a pH between 5.5-5.80. FMANR (1996); Akinrinde and Obigbesan (2000) revealed critical level of organic carbon, N, P, K, Ca and Mg for crop production in the Southwest Nigeria is 1.74 $gr.kg^{-1}$, 0.20%, 10.0 $mg.kg^{-1}$, 0.16-0.20 $cmol.kg^{-1}$, 2.0 $cmol.kg^{-1}$ and 0.40 $cmol.kg^{-1}$ respectively, but soil analysis result obtained from study shows that experimental site is deficient in basic soil nutrients.

Table 4. Effect of manure application on incidence of *Podagrica uniforma* on Okra

Treatment	*Podagrica uniforma* population							
	4WAP		6WAP		8WAP		10WAP	
	2015	2016	2015	2016	2015	2016	2015	2016
Pig manure	3.18 ± 0.72*[b]	0.33 ± 0.30[a]	2.85 ± 0.50[a]	0.33 ± 0.22[a]	1.47 ± 1.46[a]	1.47 ± 0.25[a]	1.52 ± 0.22[a]	1.52 ± 0.22[a]
Poultry manure	2.09 ± 0.36[a]	0.14 ± 0.14[a]	2.57 ± 0.43[a]	0.28 ± 0.14[a]	1.18 ± 0.81[a]	1.18 ± 0.38[a]	1.38 ± 1.15[a]	1.38 ± 0.14[a]
Cattle manure	1.47 ±0.09[a]	0.14 ± 0.24[a]	3.19 ± 0.88[ab]	0.28 ± 0.38[a]	1.04 ± 0.88[a]	1.04 ± 0.22[a]	1.28 ± 0.51[a]	1.28 ± 0.38[a]
Control	1.42 ± 0.43[a]	1.38 ± 0.17[a]	4.95 ± 1.70[b]	0.93 ± 0.08[a]	1.47 ± 0.91[a]	1.47 ± 0.21[a]	1.47 ± 0.91[a]	1.47 ± 0.14[a]

*Data are the mean ± SE of three replicates. Values followed by the same letters in each column are not significantly different (Duncan Test, P ≤ 0.05).

The low N levels observed in the soil can be attributed to continuous cropping and increased land use intensity. The low soil OC, N, P, K, Mg status and its acidic nature are expected to benefit from application of poultry, cattle and pig manure. Thus for sustainable crop production and optimum crop growth and yield to be achieved on the experimental soil, there is need for soil amendment supplementary nutrients with either organic or inorganic fertilizers and okra is expected to response positively. Application of different organic manure as envisaged positively influenced the growth and yield of okra for both season. The performance of the crop could be as a result of the varying level of nitrogen, phosphorus and potassium contained in the different nutrient sources and the increases in growth rate and yield attributes can also be attributed to the role of soil nutrients in physiological metabolic functions in plant tissues. These nutrients deficient were probably the limiting factor of plant growth and productivity in control treatment. This is in support of findings of Ewulo (2005) who reported that application of organic material could ameliorate soil nutrient to improve crop production.

Table 5. Effect of different nutrient sources on growth performances of Okra

Treatments	2015			2016		
	No. leaves	Plant height	Stem girth	No. leaves	Plant height	Stem girth
Control	10.84 ± 0.19*[d]	21.33 ± 1.42[d]	1.62 ± 1.14[c]	12.28 ± 2.80[c]	20.83±2.43[c]	1.89 ± 0.12[d]
Poultry manure	12.39 ± 1.02[c]	25.30± 1.88[c]	2.80±1.10[b]	15.59 ± 2.06[b]	24.82±1.04[c]	3.04 ± 0.27[b]
Pig manure	15.36 ± 1.12[a]	30.06 ± 1.01[a]	3.67 ± 1.28[a]	17.42 ± 3.10[a]	46.61 ± 1.20[a]	4.39 ± 0.35[a]
Cattle manure	13.44 ± 1.14[b]	27.53 ± 1.43[b]	2.98 ± 1.23[b]	14.46 ± 1.35[b]	30.24±2.88b	2.30 ± 0.38[c]

*Data are the mean ± SE of three replicates. Values followed by the same letters in each column are not significantly different (Duncan Test, P ≤ 0.05).

Ikpe and Powel (2002) reported that the animal manure is known to be effective in maintenance of the adequate supply of the organic matter in soil, with improvement in the soil physical and chemical condition and enhanced crop performance. Santana-Gomes *et al.* (2013) concluded that nutrients availability to crop can directly or indirectly predispose such plants to insect pest infestation, because they have the ability to reduce or increase damage severity, affect the environment to attract or deter/repel infestation and also induce resistance or tolerance in the host plant.

Table 6. Effect of nutrient sources on severity of Okra leaf damage by insect

Treatment	Severity of Leaf Damage	
	2015	**2016**
Pig Manure	17.0 ± 1.15[c]	8.66 ± 2.62[a]
Poultry Manure	19.73 ± 1.42[b]	9.57 ± 3.10[a]
Cattle Manure	20.40 ± 2.14[b]	6.57 ± 3.29[b]
Control	24.60 ± 1.89[a]	9.71 ± 4.13[a]

The application of different organic manure was observed by this study to had better reduction in *P. uniforma* and *N. dilecta* infestation and severity and as well as an improvement in vegetative growth and increased fruit yield compared with the unfertilized infested okra. The significant reduction effect of *P. uniforma* and *N. dilecta* incidence and severity of leaves damage in okra plant by the application of organic manure as soil fertilizer treatment, might be due to the availability of constant slow release of required nutrient to the plant, which facilitated improvement in vigour of the plant to develop a tolerance level to the insect infestation. Results from this study clearly showed that addition of organic manure reduced the incidence of *Nisota dilecta* and *Podagrica uniforma* in both planting seasons (2015 and 2016), this is in agreement with Adilakshimi *et al*. (2007); and Atijegbe *et al.* (2014) who reported that the addition of organic manure (poultry manure) significantly have a suppressing effect on the incidence of fruit borer, aphid, *Podagrica* spp. and other insect pest infestation on okra. This supports the fact that balanced nutrient availability that ensures optimal plant growth induces resistance or tolerance to insect pest infestation and diseases infection. This is in agreement with Ramesh *et al*. (2005). Nutrient absorption by plants facilitates normal physiological function and photosynthetic processes, which made okra plants in this treatments to possess the ability to suppress or withstand *P. uniforma* and *N. dilecta* attack, thereby influenced vegetative growth increase fruits yield. The normal physiological processes were hampered by unavailability of nutrients to the plants, making the plants to be susceptible to these insects infestation as observed in the okra grown on the unfertilized plots. Plants suffering from soil mineral nutrient deficiency have lower tolerance to pathogens and insect pests, which can be increased by supplying the deficient nutrient. Raikar *et al*. (2009) observed that the continuous and balanced supply of both major and minor nutrient elements to rice due to application of he farm yard manure resulted in the better resistance and higher tolerance to the pathogens and insect pests apart from recouping soil health.

Table 7. Effect of nutrient sources on Okra yield

Treatment	Number of Fruits/plant		Fruit weight (kg) plant	
	2015	**2016**	**2015**	**2016**
Pig Manure	5.02 ± 3.46[ab]	4.66 ± 1.92[a]	0.06± 2.37[a]	0.04± 0.52[a]
Poultry Manure	6.00 ± 3.61[a]	4.55 ± 0.69[a]	0.06± 1.39[a]	0.04± 1.69[a]
Cattle Manure	4.67 ± 1.53[b]	3.44 ± 1.68[b]	0.04± 3.34[b]	0.03± 1.75[ab]
Control	2.30 ± 4.58[c]	2.11 ± 4.25[c]	0.02± 2.00[c]	0.01± 0.36[b]

Data are the average ± SE of three replicates. Values followed by the same letters in each column are not significantly different (Duncan Test, $P \leq 0.05$).

Table 8. Other Insect found on okra during 2015 and 2016 cropping seasons

Scientific name	Common name	Order	Family	Pest status	Parts of plant found			
					Leave	Shoot	Flower	Fruits
Dysdercus supertitous	Cotton stainer	Hemiptera	Pyrrocoridae	2				x
Bemisia tabaci	White fly	Hemiptera	Aleyrodidae	2	x	x		
Aphis gossypii	Aphid	Hemiptera	Aphididae	2	x			
Mylabris pustulata	Flower beetle	Coleoptera	Meloidae	1			x	
Amrasca biguttula	Jassid	Hemiptera	Cicadellidae	1	x			
Earias insulana	Fruit borer	Lepidoptera	Noctuidae	1				x
Grasshopper	Various species	Orthoptera		1	x	x		
Epilachna spp	Epilachna	Coleoptera	Coccinellidae	1	x			
Apis mellifera	Honey bee	Hymenoptera	Apidae	3			x	

Key: 1= minor insect pest, 2= major insect pest 3= beneficial

Such a relationship is expected because vigorously growing plants usually have higher capacity to compensate, for losses of photosynthetic or damage to leaf area due to feeding by insect pests (Huber and Ghraham, 1989). In a related development, Palaniappan and Annadurai (1999) opined that when nutrients are made available to the crop-plants in required quantity and proportion, these may aid formation of substances such as amino acid**s**, sugars, enzymes, phenols, alkaloids etc. That influence pest activity. Nutrient sufficiency may provide a general form of resistance to biotic attack by maintaining a high level of inhibitory compounds in tissue or quick response to invasion by insect pest. Chino *et al.* (1987) reported that asparagine content of plant phloem sap was significantly lower under organic cultivation, thereby adversely affecting the feeding of Brown plant hopper on rice. Different nutrient sources used in this study reduced the incidence of *N. dilecta* and *P. uniforma* infestation at different rates. In this experiment poultry manure recorded higher severity of leaves damaged when compared with pig manure but not significantly different and with okra grown on unfertilized plots recording maximum infestation and severity of leaves damaged. The reason for the different levels of infestation and severity may be due to the difference in the available nutrients present in the manure sources. Potassium was abysmally low both in the experimental soil and in poultry and cattle manure used for soil amendment. This condition may have contributed to the increased susceptibility of the crops to the insect pests. Similar findings were also reported by Van Embden (1966). However, the increased abundance and severity of the insect pests, which was associated with high fruit numbers, should not be surprising. The high nitrogen supply probably ensures healthy compensatory plant growth after direct injury caused by the insect pests which enabled the plant withstands this high level of infestation.

5.1. CONCLUSION

Organic manure shows more promising effect to induce okra growth and tolerance to *P. uniforma* and *N. dilecta* infestation. Their effects exhibited through increasing okra vegetative growth, fruits yield and decreasing population/incidence and severity of *P. uniforma* and *N. dilecta.*

Pig manure recorded the lowest amount of infestation and severity in both planting seasons, it recorded a lower yield not significantly different compared to yield obtained from poultry manure. It could be concluded that both pig and poultry manure are best for controlling *P. uniforma* and *N. dilecta* infestation on okra as they both show greater tolerant and compensatory ability and thus recommended for the management and suppression of *P. uniforma* and *N. dilecta* population in the study area. Further study is required to ascertain the optimum manure level required for suppressing insect infestation on okra cultivation.

ACKNOWLEDGMENT

The author is grateful to Mr. Olotu Charles Olanrewaju, Department of Crop, Soil and Pest Management Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria for his tremendous assistance during the field work and data collection.

REFERENCES

Adesina, J. M. and L. A. Afolabi. 2014. Comparative bio efficacy of aqueous extracts of *Loncarpous cyanescens* and *Trema orientalis* against Flea beetle (*Podarica* spp.) (Coleoptera: Chrysomelidae) infestation and yield of okra. Intl. J. Hort. 4(2): 4-9.

Adesina, J. M. and D. K. Ileke. 2014. Insecticidal Efficacy of *Mitrocarpus villosus* and *Momordica charantia* Extracts for the Control of Flea Beetles Podagrica spp. Jacq. (Coleoptera: Chysomelidae) on Okra *Abelmoschus esculentus* (L.) Moench. Med. Plant Res. 4(1): 1-5.

Adilakshmi, A., D. M. Korat. and P. R. Vaishnau. 2007. Effect of organic and inorganic fertilizers on insect pests infesting okra. Karnataka J. Agric. Sci. 21(2): 287-289.

Akande, M. O. and J. A. Adediran. 2004. Effects of terralyt plus fertilizer on growth nutrients uptake and dry matter yield of two vegetable crops. Moor J. Agric. Res. 5: 12-107.

Akinrinde, E. A. and G. O. Obigbesan. 2000. Evaluation of the fertility status of selected soils for crop production in five ecological zones of Nigeria. Proc. 26th Annual Conf. Soil Sci. Soc. Nigeria. Ibadan. Nigeria. pp. 279-288.

Aluko, O. A., S. O. Olanipekun, A. Kareem. and O. N. Adeniyan. 2014. Effect of organic and inorganic fertilizer on the yield and nutrient composition of Jute mallow. Global J. Agric. Res. 2(3): 1-9.

Atijegbe, S. R., B. O. Nuga, N. E. S. Lale. and R. N. Osayi. 2014. Effect of organic and inorganic fertilizers on Okra (*Abelmoschus esculentus* L.) production and incidence of insect pests in the humid tropics. J. Agri. Vet. Sci. pp. 25-30.

Cardoso, M. O., A. P. Oliveira, W. E. Pereira. and A. P. Souza. 2009. Eggplant growth as affected by cattle manure and magnesium thermo phosphate in association cow urine. Horti. Brasileira. 27: 307-313.

Chino, M., H. Hayashi. and W. E. T. Fukumoto. 1987. Composition of rice phloem sap and its fluctuation. J. Plant Nutr. 10: 1651-1661.

Clementine, L., L. Dabiré-Binso, N. Malick, S. Ba-Koussao. and S. Antoine. 2009. Preliminary studies on incidence of insect pest on okra, *Abelmoschus esculentus* (L.) Moench in central Burkina Faso. Afr. J. Agri. Res. 4(12): 1488-1492.

Enujeke, E. C. 2013. Response of watermelon to five different rates of poultry manure in Asaba area of Delta state, Nigeria. J. Agri. Vet. Sci. 5(2): 45-50.

Ewulo, B. S. 2005. Effect of poultry and cattle manure on sandy clay loam soil. J. Anim. Vet. Sci. 4: 839-841.

Federal Ministry of Agricultural and Natural Resources (FMANR). 1996. Soil fertility investigation, Fertility ratings. Produced by the Federal Ministry of Agriculture. Lagos. Nigeria.

Huber, D. M. and R. D. Graham. 1989. The Role of nutrition in crop resistance and tolerance to disease. *In*: Mineral Nutrition of Crops Fundamental Mechanism and Implication, Rengel, Z. (Ed.). Food Product Press. New York. USA. pp: 169-226.

Ikpe, F. N. and J. M. Powel. 2002. Nutrient cycling practices and changes in soil properties in the crop-livestock farming systems of western Nigeria. Nutr. Cyc. Agro-Eco-syst. 62: 37-45.

International institute for Tropical Agriculture (IITA) 1979. Laboratory manual for soil and plant analysis. Manual series 7. IITA. Ibadan. Nigeria.

Luna, J. 1988. Influence of soil fertility practices on agricultural pests. *In*: P. Allen and Van Dusen (Eds.). Global perspectives in agroecology and sustainable agricultural systems. Proc. 60th Intl. Sci. Organic Agri. Move. Univ. California. Santa Cruz. pp. 589-600.

Magdoff, F. and H. Vanes. 2000. Building soils for better crops. Handbook Series No. 4. Beltsville. p. 230.

Merill, M. C. 1983. Bio-agriculture: A review of its history and philosophy. Biol. Agri. Hort. 1: 181-210.

Meyer, G. A. 2000. Interactive effects of soil fertility and herbivory on *Brassica nigra*. Oikos. 22: 433-441.

Naveed, A., A. A. Khan. and I. A. Khan. 2009. Generation mean analysis of water stress tolerance in okra. Pak. J. Bot. 41: 195-205.

Okonmah, L. U. 2012. Effects of various organic manures on the growth and yield of Maize in Asaba zone. Asian J. Sci. Tech. 4(11): 6-9.

Olaniyi J. O., W. B. Akanbi, O. A. Olaniran and O. T. Ilupeju. 2010. The effect of organo mineral and inorganic fertilizer on the growth, fruit yield quality and chemical composition of okra. J. Anim. Plant Sci. 9: 11354-1140.

Palaniappan, S. P. and K. Annadurai 1999. Organic farming: Theory and practice. Sci. Publ. Jodhpur. India.

Phelam, P. L., J. F. Mason. and B. R. Stinner. 1995. Soil fertility management and host preference by European corn, *Ostrinia nubilalis*, on *Zea mays*: A comparison of organic and conventional chemical farming. Agric. Eco-Syst. Environ. (56): 1-8.

Raikar, S. D., B. S. Vyakaranahal, D. P. Biradar. and J B. Sanagoudar. 2009. Effect of nutrient and pest management on seed yield and quality components in scented rice. Mugad. Karnataka J. Agri. Sci. 22: 61-67.

Ramesh, P., M. Singh. and A. Subba Rao 2005. Organic farming: Its relevance to the Indian context. Cur. Sci. 88(4): 561-568.

Rao, N. V. 1996. Research needs of non-pesticide approach in plant protection. Proc. National Workshop on Organic Farming for Sustainable Agri. 18-20 January. Hyderabad. India.

Rao, S. and R. Rajendran. 2003. Joint action potential of neem with other plant extracts against the leaf hopper *Amrasca devastance* (Distant) on okra. Pest Manage. Econ. Zool. 10: 131-136.

Santana-Gomez, S. M., C. R. Dias-Arieira, M. Roldi, T. S. Dadazio, P. M. Marini. and D. A. O. Barizao. 2013. Mineral nutrition control nematodes. Afr. J. Agric. Res. 8: 2413-2420.

Van-Embden, H. F. 1966. Studies on relations of insect and host plant. III. A comparison of the reproduction of *Brevicoryne brassicae* and *Myzus persicae* on brussels sprout plants supplied with different rates of nitrogen and potassium. Entomol. Exp. Appl. 9: 444-460.