Original Research Paper

PERFORMANCE OF OKRA (*Abelmoschus esculentus* (L) Moench*)* UNDER VARIOUS APPLICATION OF PESTICIDES AND FERTILIZERS IN OXIC PALEUSTALF

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ABSTRACT

This study was conducted to determine the performance of okra, (*Abelmoschus esculentus* (L) Moench) under various application of pesticides and fertilizer in Oxic Paleustalf.

A field experiment was carried out to examine the effect of the combination of varying levels of neem (100%, 75% and 50% concentration), cypermethrin (350mls and 250mls), poultry manure (6000kg and 8000kg) and NPK fertilizer (112kg and 83kg) on the growth, yield and yield component of okra. The experimental design was a randomized complete block design with three replicates.

The results show that the application of the various pesticides and fertilizer have significant effect $P< 0.05$ on the performance of okra (*Abelmoschus esculentus)*. The combined application of 100% neem, 350 mls/ha cypermethrin, 8000 kg/ha poultry manure and 112 kg/ha NPK fertilizer reduced pest population compared to the control plot.

The combination of 50% neem, 350 mls/ha cypermethrin, 6000 kg/ha poultry manure and 112 kg/ha NPK fertilizer produced the best yield in the numbers and weight of okra fruits.

It is concluded that the Combined application of pesticides and fertilizer resulted in the control of pest population and significantly $P< 0.05$ increased the soil fertility and yield of okra planted on Oxic Paleustalf.

Keyword: Pesticides, fertilizer, yield and yield components, and okra.

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INTRODUCTION

Okra {*Abelmoschus esculentus* (L) Moench} is one of the home garden vegetables popularly grown and consumed in the tropical countries (Greensill, 1976, Fayemi, 1999). It has a great demand because it forms an essential part of human diet. It is grown mainly for its young tender fruits. However, its immature leaves are sometimes utilized for soup making to thicken and add flavour to the soup (Fayemi, 1999).

Nevertheless, despite the great demand for okra due to its uses and importance, its production is being hampered by some major pests and diseases such as Fleabeetles (*Podarica species*); cotton stainer (*Dysdercus superstitus*); white fly (*Bermisia tabaci*); and green stink bug (*Nezera viridula*) among others (Libby, 1968, Benson, 2004). Observation at the National Horticultural Research Institute Farm revealed that the flea beetles are the most common and injurious insect pest of okra (Ogunlana *et al.,* 1982).

However, in order to combat the problems of pests and diseases which hinder the quality and optimum yield of okra, farmers have resulted to the use of pesticides as means of controlling the pests and their damaging effects. This in turn increases the yield of the crop and hence enhances the overall productivity. Various pesticides of both organic and synthetic origin have been widely adopted by the farmers in times past. Nonetheless, the synthetic pesticides are known to have caused more damage to the environment due to their undecomposed residuals which may be persistent and lead to adverse effect on non-target organisms and serious pollution of the ecosystem. They could also cause atmospheric pollution and health hazards to farmers. (Giller *et al.,* 1989).

Therefore, there arises the need to research into organic pesticides like Neem extracts, scent leaf extracts which are more environmental friendly, since they are biodegradable and less toxic to human. They are also readily available and cheap unlike the synthetic pesticides. Although researchers in times past have done few works on discovery of botanicals but little is known about the most effective botanicals and their recommended rates. Also, there is little or dearth information about possible integration of both the synthetic and organic pesticides in order to curb the damaging effects of pests and diseases. Hence the research work is aimed at proffering solutions to the problems stated.

Besides the pests challenges of okra, poor soil nutrients status constitute another set back for commercial optimum production of okra and other vegetables in Nigeria, (Kroll, 1997). The intensive cultivation of available land with little or no fertility

management has been one of the major factors contributing to the decline in soil nutrients vis-à-vis the conservation balances.

This eventually poses great difficulty to increased productivity to meet the food requirements of a rapidly growing population thereby leading to food insecurity (Senjobi, 2007).

In view of the above, mineral fertilizers and organic fertilizers (Ammonium sulphate, Urea, NPK 15:15:15, poultry manure, compost) have been widely used by farmers to supplement the soil nutrient deficiencies in order to increase the yield of grown vegetables. More so, with the increasing demand for food crops by the geometrically growing population in Nigeria, there exists need for adequate fertilization or manuring of the land for optimum growth and yield of planted crops.

Meanwhile, despite the fast nutrient releasing potential of mineral fertilizers which meet the immediate needs of crops, yet they are scarce and expensive coupled with their high pollution effects on the soil and its environments. Globally now, efforts have been made by researchers in finding possible shift from mineral fertilizers to organic fertilizers which are cheaper, more readily available to farmers and which could maintain soil physical and chemical properties without pollution effect.

Though several works have been done and a lot more in progress to discover the appropriate fertilizer for okra production very little is known about the integration of organic and mineral fertilizers in okra.

Hence this study aims at determining the most effective recommended rates of pesticides and appropriate fertilizers that will alleviate the incidence of okra pests, and to increase soil fertility and yield of okra.

The major objectives of this study are:

1. To determine the effect of pesticides and fertilizers on the performance and growth of okra.
2. To determine the appropriate pesticides and fertilizers for the optimal performance of okra and improved soil nutrients' status and
3. To come up with the critical level of pesticides and fertilizers required for remarkable production of okra.

MATERIALS AND METHODS

Description of the Study Area

The study area is located within the College of Agricultural Sciences of the Olabisi Onabanjo University, Ayetoro, Yewa North, Ogun State in Nigeria. Ayetoro is located on 35km Northwest of Abeokuta or. Latitude 7°12¹N and Longitude 3°0¹E.The study area is located in a subtropical region with an average annual rainfall of 1250mm and a mean temperature of 26^0C. The onset and end of rains in this area have been mainly governed by the position of Inter Tropical Convergence Zone (ITCZ). The Relative Humidity of Ayetoro is generally high.

The study area lies within the derived guinea savannah zone of Southwestern Nigeria. There were some evidences that this area was formally humid tropical forest with tall trees and green leaves throughout the year (Ayinde, 1983). However, man's daily interference has translated all the trees to an area colonized with grasses and savannah trees and shrubs.

The soil consists of a deeply weathered layer of sedimentary rocks consisting of false bedded sand stones which underlined the area. It lies within the ferralitic zone. Ferralitic soils are old deep highly weathered red soil (oxisols) of humid tropics, strongly leached, highly deficient in weatherable mineral resources. The clay contents are of the kaolinitic type with low water and nutrient holding capacity. The land was originally fallowed for a long time before its cultivated for this experimental research work.

Methodology of Investigation

The land area was cleared, ploughed and harrowed with a tractor. Composite surface soil samples were randomly collected for determination of physical and chemical properties before planting. The land area of about 23.5m x 23m was mapped out for the experiment. Seeds of Jokoso variety of okra was obtained and sown at a plant spacing of 60cm between rows and 30cm between individual plants with 3 stands per stand row and 3 rows per plot. The seeds were tested for viability before sowing.

The experimental design was a Randomized Complete Block Design (RCBD) with three (3) replicates. Each plot had a dimension of 1.2cm x 60cm, separated by 2m from each other. The synthetic insecticide was cypermethrin and plant extract was Neem plant extracts; the mineral fertilizer was NPK and poultry manure as the organic fertilizer. The factorial combination of the treatments is 3x2x2x2 and one control. Treatment commenced at about 4 weeks after germination. The spraying exercise was carried out at two weeks interval up to the flowering stage. The mineral fertilizer was applied at four

weeks after planting while poultry manure was applied two weeks before sowing. Insecticides were applied with the aid of calibrated hand sprayer.

The procedure for Neem leaf (*Azadirachta indica*) extraction was adopted from method of Omoloye *et al* (2002), the various weights of the leaves were soaked in 1 litre of water for 48 hours. Later, the extracts was filtered and applied immediately with hand sprayer.

The following data were collected through the period of the experiment which was a period of 60 – 80 days. Morphological properties such as: plant height, leaf area per plant, number of leaves per plant, number of damaged leaves per plant, pest population at time of visit per plant, number of fruits per plot, weight of fruit per plot were collected on weekly basis.

Soil samples were also collected after the final harvesting for chemical and physical analyses according to AVAC (1990). The data collected were subjected to analysis of variance (ANOVA) and means were separated by Duncan multiple range test $P < 0.05$.

RESULTS

The result on Table 1 shows that the pH range of the soil is 5.3 – 5.9. The C.E.C of the soil also ranges between 2.26 – 2.96. The percentage of sand has a higher value compared to the percentage clay and silt component of the soil.

The result on Table 2 shows that the pH of the soil is slightly acidic ranging from 5.3 – 5.75. There was a slight variation in the pH level after the experiment.

Comparing this with pH range of 5.4 – 5.9 in Table 1, there is a slight decrease in pH. There was also a significant increase in the nitrogen content of the soil after the experiment. An appreciable increase in the level of exchangeable cations was equally observed except in the concentration of sodium ion which reduced. The result also showed that there is an increase in the cation exchange capacity of the soil, organic matter content of the soil and organic carbon content of the soil. The percentage clay and silt increased while the percentage sand content decreased at the end of the experiment.

The result on Table 3 shows that the combination of varying levels of Neem, Cypermethrin, Poultry manure and NPK Fertilizer has significant effect $P < 0.05$ on the plant height of okra. The combination of 50% neem concentration, 0.025 mls cypermethrin, 400g poultry manure and 9 g N P K Fertilizer ($N_3C_2P_1Z_2$) has the tallest

plant height while the combination of 75% neem concentration, 0.018 mls cypermethrin, 400g poultry manure and 6g N P K Fertilizer ($N_2C_1P_1Z_1$) has the shortest plant height.

The result on Table 4 shows that there is a significant difference between the leaf area and the treatments ($P < 0.05$). There is no significant difference within the treatments. The combination of 100% neem concentration, 0.025 mls cypermethrin, 400g poultry manure and 9 g N P K Fertilizer ($N_1C_2P_1Z_2$) has the smallest leaf area while the combination of 100% neem concentration, 0.025 mls cypermethrin, 900 g poultry manure and 9 g N P K Fertilizer ($N_1C_2P_2Z_2$) has the largest leaf area.

The result on Table 5 shows that there is a significant difference between the number of leaves and the treatments ($P < 0.05$). There is no significant difference within the treatments. The combination of 100% neem concentration, 0.025 mls cypermethrin, 400g poultry manure and 6 g N P K Fertilizer ($N_1C_2P_1Z_1$) gave the highest number of leaves while the combination of 75% neem concentration, 0.018 mls cypermethrin, 600g poultry manure and 9 g N P K Fertilizer ($N_3C_1P_2Z_2$) gave the lowest number of leaves.

The result on Table 6 shows that there is a significant difference between the number of leaves and the treatments($P < 0.05$). There is no significant difference within the treatments. The combination of 100% neem concentration, 0.025 mls cypermethrin, 400g poultry manure and 6 g N P K Fertilizer ($N_1C_2P_1Z_1$) has the highest number of damaged leaves while the combination of 100% neem concentration, 0.018 mls cypermethrin, 600g poultry manure and 9 g N P K Fertilizer ($N_1C_1P_2Z_2$) has the lowest number of damaged leaves.

The result on Table 7 shows that there is a significant difference between the number of leaves and the treatments($P < 0.05$). There is no significant difference within the treatments. The control ($N_0C_0P_0Z_0$) has the highest pest population while the combination of 75% neem concentration, 0.018 mls cypermethrin, 400g poultry manure and 6 g N P K Fertilizer ($N_2C_1P_1Z_1$) and The combination of 100% neem concentration, 0.025 mls cypermethrin, 600g poultry manure and 6 g N P K Fertilizer ($N_1C_2P_2Z_1$) has the lowest pest population.

The result on Table 8 shows that there is a significant difference between the number of leaves and the treatments $P < 0.05$. There is no significant difference within the treatments. The combination of 75% neem concentration, 0.025 mls cypermethrin, 400g poultry manure and 9 g N P K Fertilizer ($N_2C_2P_1Z_2$) has the highest number of

fruits while the combination of 50% neem concentration, 0.018 mls cypermethrin, 600g poultry manure and 9 g N P K Fertilizer ($N_3C_1P_2Z_2$) has the lowest number of fruits.

The result on Table 9 shows that there is a significant difference between the weight of fruits and the treatments $P < 0.05$. There is no significant difference within the treatments. The combination of 75% neem concentration, 0.025 mls cypermethrin, 400g poultry manure and 9 g N P K Fertilizer ($N_2C_2P_1Z_2$) has the highest weight of fruits while The combination of 50% neem concentration, 0.018 mls cypermethrin, 600g poultry manure and 9 g N P K Fertilizer ($N_3C_1P_2Z_2$) has the smallest weight of fruits.

DISCUSSION

The application of various pesticides and fertilizers produced significant effect on the performance of okra when compared with the control treatment. All the parameters taken were positively influenced by the application of the pesticides and fertilizers. The plant height of okra increased in plants treated with the combination of 50% neem concentration, 350 mls/ha of cypermethrin, 6000 kg/ha of poultry manure and 112 kg/ha of NPK fertilizers were the tallest plants in the combined application. In the sole application of poultry manure, NPK fertilizer, neem and cypermethrin, poultry manure applied at the rate of 8000 ka/ha gave the shortest plant while the application of neem at 50 %concentration gave the tallest plant. This may be due to the presence of possible growth hormones in the appropriate amount in neem (Ogunlana, 1995). This difference in heights of plants being treated with the combination of neem, cypermethrin, poultry manure and NPK fertilizer may also be attributed to the availability of the plants' nutrients in absorbable forms and at the required time as supplied by the poultry manure and NPK fertilizers (Singh *et al* 2004).

Other growth parameters like the leaf area and number of leaves appreciably increased in most of the combined application of Neem, Cypermethrin, Poultry manure, NPK fertilizer than the control. This can also be due to the efficacy of the combination of the growth increasing characteristics of these pesticides and fertilizers. There was neither phytotoxicity nor loss of coloration in leaves of okra as against the observation of Cobbinah and Osa-Owusu (1988) when okra was sprayed with 10% and 20% methanolic extract of neem.

Though there was an a increase in the number of damaged leaves per time, the plants sprayed with 100 % neem, 250 mls/ha of cypermethrin, 8000 kg/ha of poultry

manure and 112 kg/ha of NPK fertilizers have the least numbers of damaged leaves. There was significant difference between the control and the treated plots in the number of leaves damaged. This could be attributed to efficacy of the combined treatment due to the complementary action of the pesticides applied.

The pest population was highest in the control plot. Application of cypermethrin at 350 mls/ha has the lowest pest population. This is due to the immediate killing of thick pests as it comes in contact with the okra leaves and its persistence. Application of 100 % neem, 350 mls/ha cypermethrin, 8000 kg/ha poultry manure and 112 kg /ha of NPK fertilizer also reduced pest population. Since this is more environmental friendly it can be used to control pest population of okra.

The yield of okra both in the number of fruits and weights increased in an appreciable pattern. 50% neem, 350 mls/ha cypermethrin, 6000 kg/ha poultry manure and 112 kg/ha of NPK fertilizer produced the highest fruits numbers and weights. This can be due to the optimum availability of the nutrients to the crops.

Adequate nutrients availability had been indicated to improve crop growth and yield parameter. For instance, it has been reported that, when N supply is not limiting, dry matter production, assimilate partitioning as well as organic compounds production (Protein) would not be disturbed. However, a shortage in any of the nutrient requirements cause pronounced effect in the physiological processes in the crops (Akanbi *et al* 2000). This explains the general higher performance of the crops resulting from the application of both poultry manure and NPK fertilizer.

There was an increase in the soil fertility at the end of the experiment. The soil acidity was reduced tending towards neutrality. There was also an increase in the level of available P in the soil. P is very essential in cellular processes being a component of RNA and DNA. It also aids cell division and fast growth and can be found mainly in large quantities in young plants. This gives the reason for higher values in morphological properties like leaf area, leaf number of okra plants treated with both poultry manure and NPK fertilizer.

The significant increase in cation exchange capacity (CEC) of the soil, exchangeable cations and increase in % clay and % silt after the experiment indicates that apart from supplying nutrients to the soil and plants, the soil amendments also improved the soil texture and stability (Akanbi, 2006).

In summary, viewing the yield and growth parameters, the crop treated with the combination of 50 % concentration Neem, 350 mls/ha cypermethrin,6000 kg/ha poultry manure and 112 kg/ha NPK fertilizer may produce the optimum yield of okra.

CONCLUSION AND RECOMMENDATION

Cultivation of okra has been hampered in recent times by pest and soil infertility. The use of synthetic pesticides has been discouraged by environmental scientists, hence farmers have resulted to low production of this crop. Combination of the organic pesticides and synthetic pesticide will help reduce the toxicity of the synthetic pesticide while still taking advantage of their fast action. Also, the integrated form of soil amendment will improve the soil structure and texture as conditioned by the organic amendment and supply nutrients rapidly to crops as observed in inorganic fertilizers.

I will recommend that more research work be carried out on the extracts of plants to be used as possible alternative to the synthetic pesticide. The critical level for neem and the other plant extracts for optimum yield of okra should be studied. The overall effect of this on the soil should also be critically studied.

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Table 1: Pre- Physical and Chemical Analysis of The Soil

		<----------Cmol/kg---------->													
Sample	pH	Na	k	Ca	Mg	H^+	CEC	Av.P	Zn	%	%	%	%	%	%
Description	(H_2O)	Cmol/kg	Cmol/kg	Cmol/kg	Cmol/kg			Mg/kg	Mg/kg	O.C	O.M	N	Sand	Clay	Silt
0-15cm A	0.56	0.24	0.96	0.88	0.11	2.75	5.80	6.90	4.90	0.79	1.36	0.079	81.00	10.90	09.10
15-30 cm A	0.48	0.19	1.08	0.90	0.13	2.78	5.40	4.60	6.00	0.63	1.08	0.063	70.00	21.00	09.00
0-15 cm B	0.63	0.26	0.92	0.82	0.10	2.73	5.90	7.20	6.10	0.91	1.57	0.091	78.40	10.00	11.60
15-30 cm B	0.43	0.16	0.90	0.80	0.14	2.43	5.50	5.00	7.40	0.68	1.17	0.068	69.60	22.10	08.30
0-15 cm C	0.60	0.25	1.10	0.90	0.13	2.93	5.60	8.10	6.10	0.89	1.53	0.089	73.00	14.00	13.00
15-30 cm C	0.43	0.16	0.83	0.73	0.15	2.30	5.30	5.30	8.20	0.70	1.20	0.070	70.00	18.00	12.00
0-15 cm D	0.56	0.22	0.89	0.80	0.14	2.61	5.50	6.80	5.90	0.76	1.31	0.076	80.00	09.00	11.00
15-30 cm D	0.49	0.18	0.76	0.70	0.13	2.26	5.40	5.20	8.10	0.63	1.08	0.063	70.10	20.00	09.00
0-15 cm E	0.59	0.28	0.99	0.89	0.13	2.46	5.60	7.20	6.10	0.81	1.39	0.081	78.10	10.00	11.90
15-30 cm E	0.46	0.20	0.89	0.78	0.13	2.46	5.40	6.00	5.20	0.78	1.34	0.078	70.00	21.00	09.00
0-15 cm F	0.63	0.22	1.08	0.91	0.12	2.96	5.70	6.90	5.80	0.76	1.31	0.076	76.00	11.90	12.10
15-30 cm F	0.58	0.15	0.89	0.76	0.13	2.51	5.40	4.80	7.00	0.77	1.20	0.070	66.10	25.00	8.90

Table 2: Post- Physical And Chemical Analysis Of The Soil

		<----------Cmol/kg---------->													
Sample	pH	Na	k	Ca	Mg	H^+	CEC	Av.P	Zn	%	%	%	%	%	%
Description	(H_2O)	Cmol/kg	Cmol/kg	Cmol/kg	Cmol/kg			Mg/kg	Mg/kg	O.C	O.M	N	Sand	Clay	Silt
00-15cm A	5.70	0.38	0.50	1.12	0.68	0.085	2.765	6.90	5.90	1.16	2.00	0.116	71.00	09.00	20.00
15-30cm A	5.50	0.43	0.56	1.17	1.02	0.095	3.275	7.10	6.90	0.93	1.60	0.093	72.00	07.00	21.00
00-15cm B	5.60	0.41	0.53	1.20	1.10	0.090	3.330	6.40	6.70	1.10	1.90	0.110	69.00	10.00	21.00
15-30cm B	5.70	0.45	0.57	1.37	1.14	0.100	3.630	7.50	8.70	0.80	1.38	0.080	73.00	07.00	20.00
00-15cm C	5.60	0.39	0.49	1.40	1.03	0.080	3.390	6.50	5.90	1.14	1.97	0.114	64.00	08.00	24.00
15-30cm C	5.40	0.35	0.53	1.44	1.13	0.098	3.548	7.80	6.90	0.69	1.19	0.069	68.00	10.00	26.00
0-15cm D	5.30	0.40	0.44	1.10	1.12	0.085	3.145	6.90	7.80	1.12	1.93	0.112	70.00	18.20	11.80
15-30cm D	5.60	0.43	0.58	1.14	1.27	0.105	3.525	8.20	8.90	0.60	1.03	0.060	75.00	13.50	11.50
0-15cm E	5.40	0.39	0.43	1.07	1.06	0.090	3.040	8.50	7.10	1.17	2.02	0.117	70.20	19.00	10.80
15-30cm E	5.60	0.34	0.53	1.28	1.17	0.095	3.415	9.50	10.2	0.66	1.14	0.066	76.10	15.00	08.90
0-15cm F	5.75	0.47	0.46	1.08	1.00	0.083	3.093	6.90	8.90	1.12	1.93	0.112	68.00	10.00	22.00
15-30cm F	5.50	0.51	0.49	1.19	1.14	0.100	3.430	7.10	7.60	0.63	1.09	0.063	72.00	07.00	21.00

Table 3: The influence of the application of the combination of varying levels of Neem, Cypermethrin, Poultry manure and NPK Fertilizer on the plant height of okra.

Treatment	Plant height
$N_1C_1P_1Z_1$	48.24^{a}
$N_2C_1P_1Z_1$	27.46^{hij}
$N_3C_1P_1Z_1$	38.67^{bcdef}
$N_1C_2P_1Z_1$	40.85^{abcde}
$N_2C_2P_1Z_1$	36.23^{cdefgh}
$N_3C_2P_1Z_1$	$34.78^{cdefghi}$
$N_1C_1P_2Z_1$	$33.89^{cdefghij}$
$N_2C_1P_2Z_1$	30.59^{fghij}
$N_3C_1P_2Z_1$	28.93^{ghij}
$N_1C_1P_1Z_2$	$35.23^{cdefghi}$
$N_2C_1P_1Z_2$	37.25^{bcdefg}
$N_3C_1P_1Z_2$	32.50^{efghij}
$N_1C_2P_2Z_1$	$33.06^{defghij}$
$N_2C_2P_2Z_1$	$35.31^{cdefghi}$
$N_3C_2P_2Z_1$	44.84^{ab}
$N_1C_2P_2Z_2$	41.81^{abcd}
$N_2C_2P_2Z_2$	$33.42^{defghij}$
$N_3C_2P_2Z_2$	$34.97^{cdefghi}$
$N_1C_1P_2Z_2$	31.10^{fghij}
$N_2C_1P_2Z_2$	45.30^{ab}
$N_3C_1P_2Z_2$	31.88^{efghij}
$N_1C_2P_1Z_2$	35.26^{j}
$N_2C_2P_1Z_2$	45.81^{ab}
$N_3C_2P_1Z_2$	48.81^{a}
$N_0C_0P_0Z_0$	36.07^{cdefgh}

Table 4: The influence of the application of the combination of varying levels of Neem, Cypermethrin, Poultry manure and NPK Fertilizer on the leaf area of okra

Treatment	Leaf area
$N_1C_1P_1Z_1$	350.28^{abcd}
$N_2C_1P_1Z_1$	199.56^{i}
$N_3C_1P_1Z_1$	367.66^{abcd}
$N_1C_2P_1Z_1$	384.52^{ab}
$N_2C_2P_1Z_1$	$311.79^{abcdefg}$
$N_3C_2P_1Z_1$	346.62^{abcde}
$N_1C_1P_2Z_1$	243.82^{defghi}
$N_2C_1P_2Z_1$	233.61^{efghi}
$N_3C_1P_2Z_1$	211.41^{fghi}
$N_1C_1P_1Z_2$	323.47^{abcdef}
$N_2C_1P_1Z_2$	366.29^{abc}
$N_3C_1P_1Z_2$	$297.93^{abcdefgh}$
$N_1C_2P_2Z_1$	$303.96^{abcdefg}$
$N_2C_2P_2Z_1$	$309.44^{abcdefg}$
$N_3C_2P_2Z_1$	337.32^{abcde}
$N_1C_2P_2Z_2$	405.32^{a}
$N_2C_2P_2Z_2$	$280.20^{bcedfgh}$
$N_3C_2P_2Z_2$	$301.33^{abcdefgh}$
$N_1C_1P_2Z_2$	243.79^{defghi}
$N_2C_1P_2Z_2$	403.55^{a}
$N_3C_1P_2Z_2$	$278.92^{bcdefghi}$
$N_1C_2P_1Z_2$	190.80^{hi}
$N_2C_2P_1Z_2$	347.22^{abcde}
$N_3C_2P_1Z_2$	384.42^{ab}
$N_0C_0P_0Z_0$	309.75^{abcdef}

Table 5: The influence of the application of the combination of varying levels of Neem, Cypermethrin, Poultry manure and NPK Fertilizer on the number of leaves of okra.

Treatment	Number of leaves
$N_1C_1P_1Z_1$	$10.33^{abcdefg}$
$N_2C_1P_1Z_1$	8.17^{ghijk}
$N_3C_1P_1Z_1$	10.42^{abcdef}
$N_1C_2P_1Z_1$	12.33^{a}
$N_2C_2P_1Z_1$	$9.33^{cdefghij}$
$N_3C_2P_1Z_1$	$9.33^{cdefghij}$
$N_1C_1P_2Z_1$	8.42^{fghijk}
$N_2C_1P_2Z_1$	7.92^{hijk}
$N_3C_1P_2Z_1$	10.42^{abcdef}
$N_1C_1P_1Z_2$	10.83^{abcde}
$N_2C_1P_1Z_2$	$10.08^{bcdefgh}$
$N_3C_1P_1Z_2$	$8.92^{efghijk}$
$N_1C_2P_2Z_1$	$9.50^{cdefghij}$
$N_2C_2P_2Z_1$	$9.40^{cdefghij}$
$N_3C_2P_2Z_1$	11.42^{abc}
$N_1C_2P_2Z_2$	$9.00^{efghijk}$
$N_2C_2P_2Z_2$	8.42^{fghijk}
$N_3C_2P_2Z_2$	7.92^{hijk}
$N_1C_1P_2Z_2$	11.33^{abcd}
$N_2C_1P_2Z_2$	7.75^{ijk}
$N_3C_1P_2Z_2$	7.08^{k}
$N_1C_2P_1Z_2$	10.75^{abcde}
$N_2C_2P_1Z_2$	11.67^{ab}
$N_3C_2P_1Z_2$	$9.92^{bcdefghi}$
$N_0C_0P_0Z_0$	9.08^{abcdef}

Table 6: The influence of the application of the combination of varying levels of Neem, Cypermethrin, Poultry manure and NPK Fertilizer on the number of damaged leaves of okra.

Treatment	Number of damaged leaves
$N_1C_1P_1Z_1$	9.17^{abcdef}
$N_2C_1P_1Z_1$	$7.25^{bcdefghi}$
$N_3C_1P_1Z_1$	$8.25^{abcdefghi}$
$N_1C_2P_1Z_1$	10.25^{a}
$N_2C_2P_1Z_1$	$7.42^{bcdefghi}$
$N_3C_2P_1Z_1$	$7.17^{cdefghi}$
$N_1C_1P_2Z_1$	$7.33^{bcdefghi}$
$N_2C_1P_2Z_1$	7.00^{defghi}
$N_3C_1P_2Z_1$	6.92^{efghi}
$N_1C_1P_1Z_2$	9.75^{ab}
$N_2C_1P_1Z_2$	9.17^{abcdef}
$N_3C_1P_1Z_2$	$8.83^{abcdefg}$
$N_1C_2P_2Z_1$	6.67^{fghi}
$N_2C_2P_2Z_1$	$7.25^{bcdefghi}$
$N_3C_2P_2Z_1$	$8.17^{abcdefghi}$
$N_1C_2P_2Z_2$	9.50^{abcd}
$N_2C_2P_2Z_2$	6.75^{fghi}
$N_3C_2P_2Z_2$	7.00^{defghi}
$N_1C_1P_2Z_2$	5.83^{i}
$N_2C_1P_2Z_2$	$8.83^{abcdefg}$
$N_3C_1P_2Z_2$	$7.17^{cdefghi}$
$N_1C_2P_1Z_2$	6.33^{ghi}
$N_2C_2P_1Z_2$	$8.25^{abcdefghi}$
$N_3C_2P_1Z_2$	9.42^{abcde}
$N_0C_0P_0Z_0$	9.58^{abc}

Table 7: The influence of the application of the combination of varying levels of Neem, Cypermethrin, Poultry manure and NPK Fertilizer on the pest population of okra.

Treatment	Pest population
$N_1C_1P_1Z_1$	4.58^{efghi}
$N_2C_1P_1Z_1$	1.67^{i}
$N_3C_1P_1Z_1$	7.00^{cdefg}
$N_1C_2P_1Z_1$	2.17^{hi}
$N_2C_2P_1Z_1$	3.00^{hi}
$N_3C_2P_1Z_1$	2.67^{hi}
$N_1C_1P_2Z_1$	3.17^{hi}
$N_2C_1P_2Z_1$	2.50^{hi}
$N_3C_1P_2Z_1$	3.83^{fghi}
$N_1C_1P_1Z_2$	4.92^{defghi}
$N_2C_1P_1Z_2$	5.00^{defghi}
$N_3C_1P_1Z_2$	5.50^{defgh}
$N_1C_2P_2Z_1$	1.67^{i}
$N_2C_2P_2Z_1$	2.08^{hi}
$N_3C_2P_2Z_1$	3.08^{hi}
$N_1C_2P_2Z_2$	4.00^{efghi}
$N_2C_2P_2Z_2$	2.08^{hi}
$N_3C_2P_2Z_2$	2.50^{hi}
$N_1C_1P_2Z_2$	2.58^{hi}
$N_2C_1P_2Z_2$	3.25^{hi}
$N_3C_1P_2Z_2$	5.75^{defgh}
$N_1C_2P_1Z_2$	3.00^{hi}
$N_2C_2P_1Z_2$	3.50^{ghi}
$N_3C_2P_1Z_2$	2.00^{hi}
$N_0C_0P_0Z_0$	13.67^{a}

Table 8: The influence of the application of the combination of varying levels of Neem, Cypermethrin, Poultry manure and NPK Fertilizer on the number of fruits of okra.

Treatment	Number of fruits
$N_1C_1P_1Z_1$	3.08^{abcd}
$N_2C_1P_1Z_1$	1.50^{bcd}
$N_3C_1P_1Z_1$	2.33^{bcd}
$N_1C_2P_1Z_1$	2.92^{abcd}
$N_2C_2P_1Z_1$	1.83^{bcd}
$N_3C_2P_1Z_1$	0.83^{cd}
$N_1C_1P_2Z_1$	1.42^{bcd}
$N_2C_1P_2Z_1$	1.33^{bcd}
$N_3C_1P_2Z_1$	2.50^{bcd}
$N_1C_1P_1Z_2$	1.83^{bcd}
$N_2C_1P_1Z_2$	1.92^{bcd}
$N_3C_1P_1Z_2$	1.42^{bcd}
$N_1C_2P_2Z_1$	0.58^{cd}
$N_2C_2P_2Z_1$	0.50^{d}
$N_3C_2P_2Z_1$	1.17^{bcd}
$N_1C_2P_2Z_2$	2.75^{bcd}
$N_2C_2P_2Z_2$	1.42^{bcd}
$N_3C_2P_2Z_2$	1.08^{bcd}
$N_1C_1P_2Z_2$	0.83^{cd}
$N_2C_1P_2Z_2$	3.42^{abc}
$N_3C_1P_2Z_2$	0.42^{d}
$N_1C_2P_1Z_2$	0.58^{cd}
$N_2C_2P_1Z_2$	5.33^{a}
$N_3C_2P_1Z_2$	3.75^{ab}
$N_0C_0P_0Z_0$	1.42^{b}

Table 9: The influence of the application of the combination of varying levels of Neem, Cypermethrin, Poultry manure and NPK Fertilizer on the weight of fruits of okra.

Treatment	Weight of fruit
$N_1C_1P_1Z_1$	12.88^{bc}
$N_2C_1P_1Z_1$	14.78^{bc}
$N_3C_1P_1Z_1$	19.48^{bc}
$N_1C_2P_1Z_1$	33.34^{bc}
$N_2C_2P_1Z_1$	24.40^{bc}
$N_3C_2P_1Z_1$	7.17^{c}
$N_1C_1P_2Z_1$	15.21^{bc}
$N_2C_1P_2Z_1$	12.27^{bc}
$N_3C_1P_2Z_1$	13.34^{bc}
$N_1C_1P_1Z_2$	18.91^{bc}
$N_2C_1P_1Z_2$	18.73^{bc}
$N_3C_1P_1Z_2$	16.48^{bc}
$N_1C_2P_2Z_1$	4.65^{c}
$N_2C_2P_2Z_1$	3.43^{c}
$N_3C_2P_2Z_1$	6.78^{c}
$N_1C_2P_2Z_2$	29.22^{bc}
$N_2C_2P_2Z_2$	9.98^{c}
$N_3C_2P_2Z_2$	11.61^{c}
$N_1C_1P_2Z_2$	7.32^{c}
$N_2C_1P_2Z_2$	32.59^{bc}
$N_3C_1P_2Z_2$	5.93^{c}
$N_1C_2P_1Z_2$	4.69^{c}
$N_2C_2P_1Z_2$	68.66^{a}
$N_3C_2P_1Z_2$	41.05^{b}
$N_0C_0P_0Z_0$	14.03^{bc}

KEY

$N_1C_1P_1Z_1$ _ Combination of 100% Neem concentration, 0.018 mls Cypermethrin, 400g Poultry manure and 6 g N P K Fertilizer

$N_2C_1P_1Z_1$ _ Combination of 75% Neem concentration, 0.018 mls Cypermethrin, 400g Poultry manure and 6 g N P K Fertilizer

$N_3C_1P_1Z_1$ _ Combination of 50% Neem concentration, 0.018 mls Cypermethrin, 400g Poultry manure and 6 g N P K Fertilizer

$N_1C_2P_1Z_1$ _ Combination of 100% Neem concentration, 0.025 mls cypermethrin, 400g Poultry manure and 6 g N P K Fertilizer

$N_2C_2P_1Z_1$ _ Combination of 75% Neem concentration, 0.025 mls Cypermethrin, 400g Poultry manure and 6 g N P K Fertilizer

$N_3C_2P_1Z_1$ _ Combination of 50% Neem concentration, 0.025 mls Cypermethrin, 400g Poultry manure and 6 g N P K Fertilizer

$N_1C_1P_2Z_1$ _ Combination of 100% Neem concentration, 0.018 mls Cypermethrin, 600g Poultry manure and 6 g N P K Fertilizer

$N_2C_1P_2Z_1$ _ Combination of 75% Neem concentration, 0.018 mls Cypermethrin, 600g Poultry manure and 6 g N P K Fertilizer

$N_3C_1P_2Z_1$ _ Combination of 50% Neem concentration, 0.018 mls Cypermethrin, 600g Poultry manure and 6 g N P K Fertilizer

$N_1C_1P_1Z_2$ _ Combination of 100% Neem concentration, 0.018 mls Cypermethrin, 400g Poultry manure and 9 g N P K Fertilizer

$N_2C_1P_1Z_2$ _ Combination of 75% Neem concentration, 0.018 mls Cypermethrin, 400g Poultry
manure and 9 g N P K Fertilizer

$N_3C_1P_1Z_2$ _ Combination of 50% Neem concentration, 0.018 mls Cypermethrin, 400g Poultry manure and 9 g N P K Fertilizer

$N_1C_2P_2Z_1$ _ Combination of 100% Neem concentration, 0.025 mls Cypermethrin, 600g Poultry manure and 6 g N P K Fertilizer

$N_2C_2P_2Z_1$ _ Combination of 75% Neem concentration, 0.025 mls Cypermethrin, 600g Poultry manure and 6 g N P K Fertilizer

$N_3C_2P_2Z_1$ _ Combination of 50% Neem concentration, 0.025 mls Cypermethrin, 600g Poultry manure and 6 g N P K Fertilizer

$N_1C_2P_2Z_2$ _ Combination of 100% Neem concentration, 0.025 mls Cypermethrin, 600g Poultry manure and 9 g N P K Fertilizer

$N_2C_2P_2Z_2$ _ combination of 75% neem concentration, 0.025 mls Cypermethrin, 600g Poultry manure and 9 g N P K Fertilizer

$N_3C_2P_2Z_2$ _ combination of 75% neem concentration, 0.025 mls Cypermethrin, 600g Poultry manure and 9 g N P K Fertilizer

$N_1C_1P_2Z_2$ _ Combination of 100% Neem concentration, 0.018 mls Cypermethrin, 600g Poultry manure and 9 g N P K Fertilizer

$N_2C_1P_2Z_2$ _ Combination of 75% Neem concentration, 0.018 mls cypermethrin, 600g Poultry manure and 9 g N P K Fertilizer

$N_3C_1P_2Z_2$ _ Combination of 50% Neem concentration, 0.018 mls Cypermethrin, 600g Poultry manure and 9 g N P K Fertilizer

$N_1C_2P_1Z_2$ _ Combination of 100% Neem concentration, 0.025 mls Cypermethrin, 400g Poultry manure and 9 g N P K Fertilizer

$N_2C_2P_1Z_2$ _ Combination of 75% Neem concentration, 0.025 mls Cypermethrin, 400g Poultry manure and 9 g N P K Fertilizer

$N_3C_2P_1Z_2$ _ Combination of 50% Neem concentration, 0.025 mls cypermethrin, 400g Poultry manure and 9 g N P K Fertilizer

$N_0C_0P_0Z_0$ _ Control