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GROWTH, YIELD AND DISEASE RESPONSE OF TWO OKRA (*Abelmoschus esculentus* L.) VARIETIES TO POULTRY MANURE RATES IN ADAZI-NNUKWU, SOUTHEAST NIGERIA

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Abstract

A field experiment was conducted in Adazi-Nnukwu, Anaocha Local Government Area of Anambra State from July to October, 2019. The research aimed at determining the effects of poultry manure rates and variety on growth, yield, fungal disease incidence and severity of two okra varieties in Adazi-Nnukwu. Three poultry manure rates of 4 t/ha, 8t/ha, and 12 t/ha were applied to two varieties of okra – Clemson spineless, and Otukwuru-Omia in a 2 x 3 factorial experiment laid out in randomized complete block design and replicated three times. The result showed significant effects of poultry manure rates on growth parameters. Tallest okra plants (65.69 cm) was obtained in Clemson spineless fertilized with 12 t/ha of poultry manure, while broadest leaf (415.00 cm), and highest number of leaves (12.59) were obtained in the local variety fertilized with 12 t/ha of poultry manure, at eight weeks after planting. Poultry manure rates and variety had significant ($P \leq 0.05$) effect on weight of fruits, fruit lengths, number of fruits per plant and yield per plot. Highest number of fruits (3.96) and highest fruit length (7.50 cm) were obtained in Clemson spineless. Highest fruit weight (14.34g) and highest yield (1.414 t/ha) were obtained in local variety fertilized with, 12 t/ha of poultry manure. There was no significant effects on disease incidence and severity. However, highest disease incidence (55.6%) was obtained in both Clemson spineless and local variety fertilized with 12 t/ha of poultry manure. Also, disease severity was highest (4.00) in Clemson spineless fertilized with 12 t/ha of poultry manure. The fungi isolated from the infected Okra leaves and fruits were *Botrydiplodia* spp and *Rhizopus* spp. Based on the findings of this investigation, it was recommended that farmers in the study area should cultivate the local variety (Otukwuru-Omia) in soil amended with 12 t/ha of poultry manure.

Keywords: Okra, poultry manure, yield, disease incidence, disease severity

Introduction

Okra (*Abelmoschus esculentus* L. Moench) also known as ladies' fingers, is an annual herbaceous vegetable cultivated throughout the tropical, sub-tropical and warm temperate regions of the world (National research council, 2006). It is cultivated throughout the tropical and warm temperate regions of the world for its green edible fibrous fruits and pods containing round, white seeds as well as for its ornamental value. It is considered one of the most versatile crops with multiple health benefits (Gemede et al., 2015).

Okra is an important vegetable crop widely grown primarily for its soft immature fruits or pods and the most important fruit vegetable crop before tomato and pepper in Nigeria (Babatunde et al., 2007). The pods contain a glutinous, sticky substance that is used to thicken soups and stews.The fruits are green to dark green sometimes yellow to red (Tripathi et al., 2011) and contain moderate levels of vitamins A and C. They are boiled or fried and eaten as vegetable. They can also be cut into pieces, dried and/or powdered and stored for use in soups during the dry season when fresh Okra fruits are scarce.

Despite its nutritional value, its optimum yield (2-3 t/ha) in the tropical countries is low partly because of continuous decline in soil fertility (Abdul-El-kader et al., 2010). Okra plant grows to a height of 3-6 feet or more with some local varieties reaching 12 feet with a stem base of up to 4 inches in diameter.

Propagation can be done by soaking seeds overnight in warm water before sowing to improve germination. Seed quality has been reported to affect yield in various Okra varieties (Thapa et al., 2012). The stems are woody and bear hairy and usually lobed leaves. Plants branch out only when they reach a height of 30-40cm. Branch thinning may be necessary to control dense growth of the plant. The flowers are large and up to 2 inches in diameter, mostly yellow in color and last only for a day in most varieties. Okra grows well in warm weather and should be planted in full sun.

The soil for growing Okra should be fertile, well drained and high in organic matter with a pH ranging from 6.0 to 6.5. Okra starts yielding about 60 days after planting and if the pods/fruits are not picked on time and allowed to mature on the plant, flowering and further production will be reduced. Okra is susceptible to several diseases, both in the field and in storage. Some varieties are highly susceptible to root decaying/root rot organisms while some are associated with both field and storage diseases. Organic matter in soil improves moisture and nutrients retention and soil physical properties (Zane, 2006). Adding compost to garden soil improves soil structures, increases the population of beneficial microbes reduces nutrients loss, boost pH and can suppress certain diseases. Animal manures (poultry manure) are an excellent source of organic matter to the soil and the utilization of organic manures in soil fertility management is an integral part of sustainable agriculture. However, incorporating organic matter before planting will produce good yields.

One of the limiting factors to consider for profitable production of Okra is damage by insect pests. In order to improve yield and maintain good quality, the pests and diseases of Okra must be managed. One of the effects of applying soil amendments, to the soil is an increase in leaf area. This is agronomically the most important result of fertilizer application because an increase in leaf area results in improved radiation intercepted by the crop and therefore higher rate of photosynthesis. Effect of rates of poultry manure application is of critical importance in crop production. When properly applied, manure can be valuable resource for crop production (Ajari et al., 2003).

To maximize the economic and fertilizer value of organic manures, their application should match the nutrients needs of the crops. According to Ewulo (2005) and Awodun (2007), poultry manure contains high amount of nutrients especially nitrogen that are easily taken up by plants for fast growth however, Quinton (2006) reported that manure application should be limited to amount needed to make a difference between crop needs and the existing soil fertility levels. Any manure application more or less will result into defect in production. There is scarcity of information on the rate of poultry manure application to vegetable crops which includes Okra despite the fact that the crop is an important and highly nutritive one, cultivated in home gardens as well as in mixed-cropping systems with the application of organic materials. There is need to determine the appropriate rate of poultry manure in order to boost the growth and yield of Okra. The objective of the study was to test the effect of poultry manure and varieties on growth, yield, disease incidence and severity of Okra plants in Adazi-Nnukwu, Anambra State.

Materials and Methods

Site description: The experiment was conducted from July to October, 2019 cropping season at Adazi-Nnukwu, Anaocha local government area, Anambra, Nigeria, to evaluate the effect of poultry manure rates on two varieties of Okra and the disease incidence and severity on the Okra plants. The study location was between latitude 6.10°N and longitude 7.01°E in South-Eastern Nigeria. The okra plant was grown under rain -fed farming. The site was previously cultivated to cocoyam, cassava and maize intercrops.

Treatments combinations and experimental design: Two varieties of Okra used were "Clemson spineless and "Otukwuru-Omia. Both are popular varieties grown by farmers and show good adaptation to the local environment. The treatments consisted of three rates of poultry manure (4 t/ha, 8 t/ha, and 12 t/ha) corresponding to 4.8, 6.4, and 14.4 kg/14m2 ground area combined with two varieties of Okra. The six treatment combinations were laid out in a randomized complete block design (RCBD) with three replications

Cultural practices: The experimental area (130.5 m2) which consisted of sandy-loam soil was cleared, tilled and ridged and divided into six plots. Each plot had an area of 14 m2. The plot consisted of three ridges in which twelve Okra plants per ridge were sown at a spacing of 40 cm × 90 cm, giving a total plant population of 36 Okra plants per plot. Okra seeds were planted at about 2-3 cm deep at a rate of two seeds per hole. The poultry manure was obtained from a nearby local farm. Manure was applied to the soil after land preparation at two weeks before Okra seeds were sown. Weeding was done using the native hoe as the need arose. The manual removal of weeds from the ground area was done at 2, 4, and 6 weeks after sowing. Subsequently, weeds found growing were uprooted by hand. Okra pods were harvested when the tip of the pod was observed to break easily when pressed with the fingertips. They were cut using a knife. Fruits were harvested at four days interval.

Media preparation and isolation: Potato dextrose agar was prepared by adding 10g of PDA powder to 250 ml of distilled water. It was stirred thoroughly to dissolve completely and was later sterilized by autoclaving for 30minutes and then poured into the sterilized petri dishes with tree drops lactic acid. Okra leaf samples showing infection symptom were cut out into small disks with sterilized razor blade. The infected portions were rinsed in distilled water and sterilized in 10% ethanol for 1 minute. The samples were later rinsed in two changes of distilled water to remove traces of alcohol. Each of the infected portions was then inoculated aseptically on each petri dish containing the potato dextrose agar. The inoculated plates were left for four days and then the emerging colonies were sub-cultured and stored properly for subsequent studies.

Identification of organism: Identification of isolated fungi was on the basis of morphological characteristic and spore formation of colonies which appeared on the plates. They were further identified by preparing slides. The slides used were temporarily prepared by placing one drop of water on the slide and a small portion of the pure culture collected with the aid of a sterile inoculating needle from the interface of the continuous growth and placed on the slide. This was then covered with the slide cover. Viewing of the sample culture was done with the aid of a compound microscope with magnification of x100 and identification was based on the morphological characteristics of mycelial growth and the fruiting bodies as described by Bernett and Hunter (1999).

Data collection: Seed germination was recorded regularly until completion of the process (8 days after sowing). At the end of germination study, the germination indices such as percent germination were recorded. Growth parameters were measured from the randomly selected plants and they include; plant heights (measured as the distance in cm from the soil surface to the tip of the apical bud), number of leaves per plant, leaf area (cm2) measured by length x breath multiplied by the standard correction factor, pod length, number of pods per plant, pod weight (measured (g) using weighing balance) and yield (tons ha-1).

Assessment of disease incidence and severity of the organisms: Assessment of disease incidence and severity was done on the experimental farm. Disease incidence was assessed by visual observation of the Okra plants that were sampled. The percentage disease incidence of Okra was determined according to the formula suggested by Snedecor and Cochran (1994) as follows;

$$Disease\ incidence = \frac{Number\ of\ diseased\ plants}{Total\ number\ of\ plants\ sampled}\ x\ 100$$

A five -point scale of 0-5 was used for the disease severity measurement as was used by (IRRI 2006) where;
0 = No infection
1 = 1 - 20% of plants infected
2 = 21 - 40% of plants infected
3 = 41 - 60% of plants infected
4 = 61 - 80% of plants infected
5 = 81 - 100% of plants infected

Statistical analysis: The data collected were subjected to analysis of variance (ANOVA) for randomized complete block design (RCBD) using Genstat7.3. Mean separation was done using Fisher's least significant difference (F-LSD) at 5% level of probability**.**

Results

Effect of varieties and poultry manure rate on some growth characteristics of Okra plants

Table 1 shows that there was no significant effect of variety on plant height of okra where the highest plant height (43.94cm) was obtained at 8 weeks after planting which was statistically the same with 43.16cm obtained from the local variety. At 2 weeks after planting, the plant height was statistically the same but Clemson spineless had a higher plant height (10.60cm) than the local variety (10.52cm). At 4 and 6 weeks after planting, the plant heights were also statistically the same but local variety had a higher plant height (16.83cm and 25.28cm respectively) while Clemson spineless at 4 and 6 weeks after planting had 16.48cm and 21.17cm respectively. Table 1 also shows that the different rates of poultry manure had significant effect on plant height of okra where the highest plant height (62.33cm) was obtained with the application of 12t/ha at 8weeks after planting followed by 48.31cm obtained with the application of 8 t/ha of poultry manure also at the 8th week after planting. The least plant height was attained at the 2nd week after planting with the application of 2 t/ha of poultry manure. Generally, it was observed that the higher the level of poultry manure application, the higher the plant heights for both varieties in the entire week interval except on the 6th week after planting where plant height depreciated with increase in poultry manure application. Plant height also increases with time. That is, there was continuous growth with time within the period observed.

Table 1: Effect of poultry manure rates and varieties on plant height of Okra plants

Treatments	2WAP	4WAP	6WAP	8WAP
Varieties				
Clemson spineless	10.60	16.48	21.17	43.94
Local	10.52	16.83	25.28	43.16
$LSD_{0.05}$	ns	ns	ns	ns
PM rates (t/ha)				
4	7.24	11.67	16.31	20.01
8	11.83	17.91	28.80	48.31
12	12.61	20.38	24.56	62.33
$LSD_{0.05}$	0.71	1.83	5.17	2.99
Interactions				
Clemson spineless x 4	7.39	11.86	16.46	20.19
Clemson spineless x 8	11.23	17.58	26.65	45.94
Clemson spineless x 12	13.18	20.02	20.40	65.69
Local x 4	7.09	11.49	16.17	19.83
Local x 8	12.42	18.25	30.95	50.67
Local x 12	12.04	20.74	28.78	58.98
$LSD_{0.05}$	0.999	ns	ns	ns

WAP =Weeks after planting, PM= Poultry manure, ns= Non-significance

Table 1, shows that there was no significant interaction effect of okra varieties and poultry manure rates on plant height of okra at 2 weeks after planting but there was significant effect on the same plant parameter at other week interval (4, 6, and 8 weeks after planting). The highest plant height (65.69cm) was obtained with the application of 12 t/ha of poultry manure together with Clemson spineless at 8 weeks after planting, followed by 58.98cm obtained with the application of 12 t/ha of poultry manure together with local variety also at the 8th week after planting. The least plant height (7.09cm) was obtained from the application of 4 t/ha of poultry manure together with local variety. The interaction effect also shows that the higher the poultry manure application, the higher the plant heights at some weeks interval because at 2 weeks after planting, increase in poultry manure application led to a depreciation of height in local variety from 12.42cm (8 t/ha) to 12.04cm (12 t/ha). This same trend was observed in Clemson spineless at 6 weeks after planting where the plant heights depreciated from 26.65cm (8 t/ha) to 20.40cm (12 t/ha), this was observed from Clemson spineless.

Table 2 also shows that there was no significant effect of variety on leaf area of okra at the 2nd and 4th weeks after planting but significant effect was observed at the 6th and 8th weeks after planting. The highest leaf area (264.00cm^2) was observed from local variety at 8 weeks after planting followed by the Clemson spineless with 205.00cm2 also at the 8th week after planting. The least leaf area (24 5cm^2) was obtained from Clemson spineless at 2weeks after planting while local variety had a highest leaf area of 31.2cm^2. At 4 weeks after planting, Clemson spineless leaves had a higher leaf area (96.5cm^2) than 95.8cm^2 obtained in local variety, but at 6 weeks after planting, local variety had a higher leaf area of 186.8cm^2 than 144.7cm2 obtained from Clemson spineless variety.

The application of poultry manure increased the leaf area of okra (Table 2). The table shows that there was significant effect of poultry manure on leaf area of okra at all week intervals. Highest leaf area per plant (365.00cm^2) was obtained when 12 t/ha of poultry manure was applied at 8weeks after planting. It was followed by leaf area of 252.00cm^2 also obtained at 8 weeks after planting with the application of 8t/ha of poultry manure. The least leaf area (15.6cm^2) was obtained at 2 weeks after planting from plants applied with 4 t/ha of poultry manure. At 4 weeks after planting, there was a gradual increase in leaf area at all levels of poultry manure application. The highest leaf area (165.90cm^2) at 4 weeks was with the application of 12t/ha of poultry manure with the lowest (92.10cm2) at 4t/ha of poultry manure. The same trend was observed at 6 weeks after planting where 12t/ha of poultry manure gave the highest leaf area (165.90cm2) and 4 t/ha gave the least leaf area (92.10cm2). Generally, it was observed that leaf area increased with increasing level of poultry manure application.

In Table 2, there was no significant interaction effect of okra varieties by poultry manure rates on leaf area of okra at bi- week intervals. Maximum leaf area (415.00cm^2) was attained with the application of 12 t/ha of poultry manure together with local variety, followed by 315.00cm^2 obtained from Clemson spineless at 12t/ha of poultry manure while the least leaf area (13.90cm^2) was obtained with the application of 4 t/ha of poultry manure together with Clemson spineless.

Table 2: Effect of poultry manure rates and varieties on leaf area (cm^2) of Okra plants

Treatments	2WAP	4WAP	6WAP	8WAP
Varieties				
Clemson spineless	24.5	96.5	144.7	205.00
Local	31.2	95.8	185.8	264.00
LSD $_{0.05}$	ns	ns	37.65	50.30
PM rates (t/ha)				
4	15.6	30.50	44.80	86.00
8	21.6	92.10	172.40	252.00
12	46.3	165.90	278.70	365.00
LSD $_{0.05}$	10.52	21.63	46.11	61.60
Interactions				
Clemson spineless x 4	13.90	32.40	42.30	79.00
Clemson spineless x 8	19.30	87.70	133.70	220.00
Clemson spineless x 12	40.20	169.40	258.20	315.00
Local x 4	17.20	28.50	47.20	93.00
Local x 8	23.90	96.50	211.10	284.00
Local x 12	52.40	162.40	299.30	415.00
LSD $_{0.05}$	ns	ns	ns	ns

WAP =Weeks after planting, PM= Poultry manure, ns= Non-significance

At 4 weeks after planting, Clemson spineless together with 12 t/ha of poultry manure gave the highest leaf area of 169.40cm2 followed by 162.40cm^2 obtained from local variety together with 12 t/ha of poultry manure. The least leaf area (28.50cm^2) at 4 weeks after planting was obtained from local variety together with 4t/ha of poultry manure. The reverse was the case at 6weeks after planting where the highest leaf area (299.30cm2) was obtained from local variety together with 12 t/ha of poultry manure followed by 258.20cm2 obtained from Clemson spineless with 12t/ha of poultry manure application. The least leaf area (42.30cm2) at 6 weeks after planting was obtained from Clemson spineless together with 4t/ha of poultry manure. The interaction effect also shows that there was a gradual increase of leaf area at all levels. Table 3 shows that there was no significant effect of variety on number of leaves of okra where a higher number of leaves (8.81) was observed at 8 weeks after planting with the use of local variety than the Clemson spineless with 4.15 which was obtained at 2 weeks after planting with the use of Clemson spineless variety. At 4 weeks after planting, local variety also gave a higher number of leaves (5.74) than the Clemson spineless with 5.67. The same trend was also observed at the 6th week after planting where local variety gave a higher number of leaves (6.56) than the Clemson spineless (6.37). It was observed that local variety gave a higher number of leaves at all week intervals compared to Clemson spineless.

Table 3 shows that the application of poultry manure led to increased number of leaves. Number of okra leaves was significantly influenced by different levels of poultry manure. Highest number of leaves (11.45) was recorded from the application of 12 t/ha of poultry manure at 8 weeks after planting, followed by 8.00 which was recorded on the 6th week after planting with the application of 12 t/ha of poultry manure, the least number of leaves (3.67) was recorded with the application of 4t/ha of poultry manure. At 4 weeks after planting, 12t/ha of poultry manure also gave the highest number of leaves (6.94), followed by 5.61 with the application of 8t/ha of poultry manure and the least (4.56) was observed on plant supplied with 4t/ha of poultry manure. It was observed that poultry manure application lead to an increase in number of leaves at all week intervals.

Table 3: Effect of poultry manure rates and varieties on number of leaves of Okra plants

Treatments	2WAP	4WAP	6WAP	8WAP
Varieties				
Clemson spineless	4.15	5.67	6.37	8.30
Local	4.44	5.74	6.56	8.81
LSD $_{0.05}$	ns	ns	ns	ns
PM rates (t/ha)				
4	3.67	4.56	4.89	6.50
8	4.55	5.61	6.50	7.72
12	4.67	6.94	8.00	11.45
LSD $_{0.05}$	0.68	0.79	0.73	1.14
Interactions				
Clemson spineless x 4	4.00	4.45	4.89	6.44
Clemson spineless x 8	4.00	5.78	6.44	8.11
Clemson spineless x 12	4.44	6.78	7.78	10.34
Local x 4	3.33	4.67	4.89	6.55
Local x 8	5.11	5.44	6.55	7.33
Local x 12	4.89	7.11	8.22	12.59
LSD $_{0.05}$	0.96	ns	ns	1.61

WAP =Weeks after planting, PM= Poultry manure, ns= Non-significance

Table 4: Effect of poultry manure rates and varieties on yield and yield parameters

Treatments	No. of branches	No. of fruits	Fruit length (cm)	Fresh Wt. of pod (g)	Fresh pod yield (g/stand)	Fresh pod yield (t/ha)
Varieties						
Clemson spineless	1.83	2.60	6.11	9.48	30.7	0.797
Local variety	1.88	2.00	4 45	8.28	25.2	0.643
LSD	NS	0.39	0.933	ns	ns	ns
Pm_ rates (t/ha)						
4	0.00	0.95	3.26	4.28	8.7	0.231
8	1.83	2.05	5.47	8.71	23.4	0.591
12	3.75	3.91	7.11	13.64	51.8	1.332
LSD	0.52	0.48	1.14	2.70	8.18	8.18
Interactions						
Clemson spineless x 4	0.00	0.89	3.35	3.06	6.9	0.180
Clemson spineless x 8	2.00	2.95	7.49	12.44	36.3	0.926
Clemson spineless x 12	3.50	3.96	7.50	12.94	48.9	1.260
Local x 4	0.00	1.00	3.17	5.52	10.5	0.283
Local x 8	1.67	1.14	3.46	4.98	10.4	0.257
Local x 12	4.00	3.86	6.72	14 34	54.8	1.414
LSD	NS	0.67	1.62	3.82	11.56	11.56

WAP= Weeks after planting, ns= Non-significance, PM=Poultry manure

In Table 3, there was significant interaction effect of varieties by poultry manure application on number of leaves of okra at 2 weeks after planting, but there was no significant interaction effect of okra varieties by poultry manure rates on number of leaves at the 4th and 6th weeks after planting. Also, at 8 weeks after planting, significant interaction effect of varieties by poultry manure was observed on the number of leaves of okra. The highest number of leaves (12.59) was obtained from plant applied with 12 t/ha of poultry manure at 8 weeks after planting together with local variety followed by 10.34 from plants also applied with 12 t/ha of poultry manure at 8 weeks after planting together with Clemson spineless. The least number of leaves (3.33) was attained at 2 weeks after planting with the application of 4t/ha together with local variety. It was followed by 4.00 obtained from the application of 4t/ha and 8 t/ha of poultry manure together with Clemson spineless at 2 weeks after planting.

At 4 weeks after planting, the highest number of leaves (7.11) was obtained from the interaction between local variety and 12t/ha of poultry manure followed by 6.78 obtained from the interaction between Clemson spineless and 12 t/ha of poultry manure. The same observation occurred at 6 weeks after planting where the highest number of leaves (8.22) was obtained from the interaction between local variety and 12 t/ha of poultry manure, followed by 7.78 obtained from the interaction between Clemson spineless and 12 t/ha of poultry manure. The least number of leaves (4.89) was obtained from the interaction between both Clemson spineless at 4t/ha and local variety at 4t/ha of poultry manure.

Effect of varieties and poultry manure rates on yield and yield parameters of Okra plants

Table 4 shows that there was significant effect of varieties on number of fruits, fruit length, but there was no significant effect on fresh weight of pod (g/pod), fresh weight of pod (g/stand) and number of branches. The highest number of fruits (2.60) was obtained from Clemson spineless with local variety producing 2.00. The same trend was observed in fruit length with Clemson spineless producing significantly higher fruit length (6.11cm) than local variety (4.45). Although fresh weight of pod (g/pod) were statistically the same, Clemson spineless gave a higher weight of pod (9.48g) compared to the local variety (8.28g). The same trend was observed in fresh weight of pod (g/stand) with Clemson spineless producing a higher weight (30.7g) than local variety (25.2g). in number of branches, local variety gave a higher number of branches (1.89) than Clemson spineless with 1.83.

Table 4 also shows that the different rates of poultry manure had significant effect number on fruits, fruit lengths, fresh weight of pod (g/pod), and fresh weight of pod (g/stand), no of branches. The highest number of fruits (3.91) was obtained from okra plant supplied with 12 t/ha of poultry manure followed by okra plants supplied with 8t/ha of poultry manure. The least number of fruits was obtained from okra plants supplied with 4 t/ha of poultry manure. This study observed that number of fruits increased with increasing rate of poultry manure application. The same trend was observed in fruit lengths where the maximum fruit length (7.11cm) was obtained with the application of 12 t/ha of poultry manure and the least fruit length obtained with the application of 4t/ha of poultry manure. The highest number of branches (3.75) was also obtained with the application of 12 t/ha of poultry manure and the least (0.00) obtained with the application of 4t/ha of poultry manure. The highest fresh weight of pod (13.64g) was also obtained with the application of 12t/ha of poultry manure. Generally, it was observed that the higher the levels of poultry manure application, the higher the yield and its parameters.

Table 4 also shows that there was significant interaction effect of okra varieties and poultry manure rates on number of fruits, fruits length, fresh weight of pod (g/pod) and fresh weight of pod (g/stand), but there was no significant interaction effect on number of branches. The highest number of fruits was obtained from Clemson spineless plants supplied with 12 t/ha of poultry manure. This was followed by local variety at the same poultry manure rate. The least number of fruits was obtained from plants supplied with 4t/ha of poultry manure x Clemson spineless. The highest fruit length (7.50cm) was obtained from Clemson spineless together with 12t/ha of poultry manure application, followed by 7.49cm also obtained in Clemson spineless at 8t/ha of poultry manure application. The least fruit length (3.17cm) was obtained in local variety x 4t/ha of poultry manure application. The highest weight of pod (54.8g/stand) was obtained in local variety by 12 t/ha of poultry manure interaction effect. Although the number of branches were statistically the same, the highest number of branches (4.00) was obtained from plants supplied with 12t/ha of poultry manure x local variety. The least number of branches was obtained from plants supplied with 4t/ha of poultry manure x Clemson spineless, the same observation was seen at the same rate by local variety.

Effects of varieties on disease incidence and severity of okra planted in Adazi-Nnukwu

Table 5 shows that there was no significant effect of varieties on disease incidence and severity of okra planted in Adazi-Nnukwu. A higher disease incidence level (51.9%) was observed from Clemson spineless variety than from local variety (44.4%). Also, a higher disease severity (3.11) was obtained from Clemson spineless compared to the local variety with 2.67 disease severity score.

Effect of poultry manure rates on disease incidence and severity of okra planted in Adazi-Nnukwu

Table 5 shows that there was significant difference with increasing application of poultry manure rates.

The highest disease incidence (61.1%) was obtained with the application of 12t/ha of poultry manure followed by 50.0% obtained with the application of 8t/ha of poultry manure. The least disease incidence (33.3%) was obtained with the application of 4t/ha of poultry manure. The same trend was observed with disease severity. The highest number of disease severity (3.67) was observed from plant supplied with 12t/ha of poultry manure and the least disease severity (2.00) from plant supplied with 4t/ha of poultry manure. Disease incidence and severity generally increased with the increasing application of poultry manure at all levels of application. The symptoms observed includes necrotic leaf spots and fruit wet rot with white fungal mycelia mass.

Table 5: Effect of poultry manure rates and varieties on disease incidence and severity

Treatments	Incidence (%)	Severity
Varieties		
Clemson spineless	51.9	3.11
Local variety	44.4	2.67
LSD	ns	ns
PM rates(t/ha)		
4	33.3	2.00
8	50.0	3.00
12	61.1	3.67
LSD	1.12	0.36
Interactions		
Clemson spineless x 4	33.3	2.00
Clemson spineless x 8	55.6	3.33
Clemson spineless x 12	66.7	4.00
Local x 4	33.3	2.00
Local x 8	44.4	2.67
Local x 12	55.6	3.33
LSD	ns	ns

ns= Non-significance, PM=Poultry manure

Interactions effect of varieties and poultry manure rates on disease incidence and severity

Table 5 shows that there was no significant interaction effect of varieties and poultry manure application on disease incidence and severity. The highest disease incidence (66.7%) was recorded with the application of 12t/ha of poultry manure together with Clemson spineless, followed by 55.6% with the application of 8t/ha of poultry manure together with Clemson spineless. The same incidence level was observed with local variety obtaining 55.6% together with 12t/ha. The highest number of disease severity (4.00) was attained with the application of 12t/ha of poultry manure together with Clemson spineless. Local variety and Clemson spineless gave the same severity level of 33.3 but at different rates (12t/ha and 8t/ha) of poultry manure application.

Isolation and identification of microorganisms associated with okra in the field

The result of Isolation and identification of microorganisms associated with okra plants in the field revealed that *Botrydiplodia* spp and *Rhizopus* spp present.

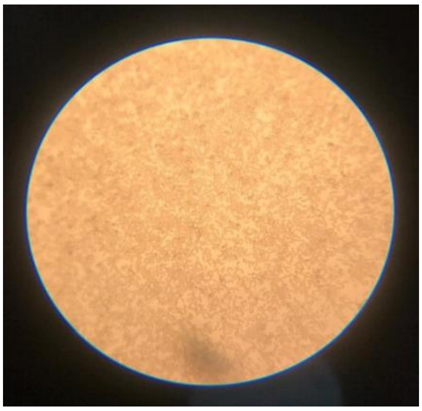

Plate 1: Micrograph of *Botrydiplodia* spp

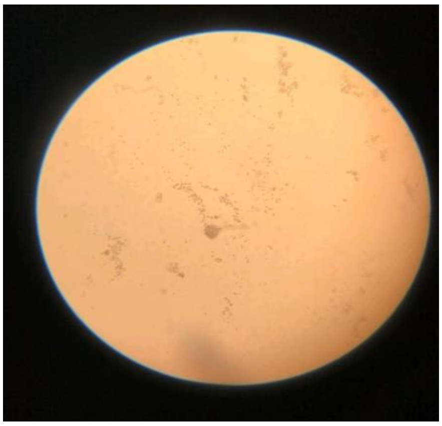

Plate 2: Micrograph of *Rhizopus* spp

Discussion

Effect of poultry manure rates and varieties, on some agronomic characteristics of two okra varieties grown in Adazi-Nnukwu

From the study, it was observed that the different rates of poultry manure had significant effect on plant height of okra. The significant increase in plant height with increase in poultry manure could be attributed to increased available nutrients supplied by the manure which are in available form for easy absorption by plant roots throughout the growth stage of the crop. Hence, there was a boost in the morphological growth of the plant. This is in agreement with the findings of Ewulo et al., (2008), and Iyagba et al., (2013) who also reported that plant height increases as the rate of poultry manure and fertilizer application increases. The result is also consistent with the findings of Ojeniyi e t al. (2007) who reported significant increase in plant height and yield as a result of poultry manure application.

The experiment also showed that the application of poultry manure increased number of leaves. Number of okra leaves was significantly influenced by different levels of poultry manure. The increase in number of leaves per plant lead to increase in plant photosynthetic rate which may ultimately lead to yield increase. This is in agreement with the findings of Nweke et al., (2013) who reported an increase in pepper leaves number due to increase in levels of poultry manure application.

Yield attributes

The increase in fresh pod weight of okra observed in this study could be attributed to easy solubilization effect of released plant nutrient leading to improved nutrient status and water holding capacity of the soil that resulted to increased yield. The result is in agreement with the findings of Premsekhar and Rajashree (2009) in okra (A. esculentus) where they reported that higher yield response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to the plants. The results also revealed that, application of different rates of poultry manure to okra led to significant increase in yield. This showed that okra plants were able to utilize the nutrients in the poultry manure for yield enhancement.

The yield increased with an increase in poultry manure rates suggest that poultry manure supplies nutrients which enhance vigorous growth which are important indices that culminate in increase in fruit yield. This observation was in agreement with Ogundiran (2013), who reported that as level of poultry manure application increases, number of pods produced by Okra also increases. The significant effect due to poultry manure application might also be due to easy and the gradual release of plant nutrients from poultry manure leading to improved nutrients status of the soil. It was observed that okra fruit lengths vary significantly influenced with increase in poultry manure application. Generally, fruit length varies significantly with variety as well as with increase in rate of poultry manure application. This result agrees with Onwu et al., (2014) who reported that increase in rate of application of poultry manure increases the length of Okra pods. Sharma (2004) observed that organic manure improves pod size and fruit yield when manure is correctly applied at the required amount. The observed improvement in yield of okra could be linked to the ability of the poultry manure to increase soil organic matter content and also the changing of chemical composition of the soil.

Effect of poultry manure rates and varieties on disease incidence and severity of two okra varieties in Adazi-Nnukwu

There was significant increase in disease incidence and severity on okra plants with increasing rates of poultry manure application. The observed increase in disease incidence and severity shows that higher poultry manure application increases susceptibility of plants to disease. The application of poultry manure did not prevent the occurrence of disease and severity at the three rates of application but the percentage incidence were varied at different percentage. From the results obtained, it was observed that increase in disease incidence and severity with poultry manure application increased susceptibility of plants to disease. The lowest occurrence of was obtained when 4t/ha of poultry manure was applied, while the highest incidence was obtained when 12 t/ha of poultry manure was applied. This corroborates with the findings of Ranjit and Surajit (2013) who reported in their work that late blight disease incidence of tomato increases with increased application of manure.

The result of isolation and identification of fungi organisms associated with okra plant in the field showed that *Botrydiplodia* spp and *Rhizopus* spp were implicated in which there were symptoms of brown irregular spots on leaves. This result agrees with Arinze (2005) and Iwuagwu et al.(2014) who reported that fungi diseases are among the serious diseases of cereal, legumes, tubers, vegetables and fruits and that the effects of the field infection extends to storehouses.

Conclusion

From this experiment it was observed that increasing rate of poultry manure application had significant effect on some growth parameters (plant height, leaf area, number of leaves) and yield performances (number of fruits and fruits length) of okra plant. The poultry manure at the rate of 12t/ha was found to affect the growth and yield of okra positively in the assessed parameters. It was also observed that increased poultry manure rate (12t/ha) led to increase in incidence of disease.

Recommendations

From the experiment, it could be recommended that farmers in Adazi Nnukwu should cultivate Otukwuru-Omia using 12t/ha of poultry manure even though the variety is highly susceptible to disease caused by *Botrydiplodia* spp and *Rhizopus* spp, but that did not eventually affect yield.

References

Abdul-El-kader AA, Shaaban SM, Abdul- ElFattan MS (2010). Effects of irrigation and organic compost on okra plants (Abelmoschu sesculentus I.) grown in sandy cancerous soil. Agricultural Biology Journal of North America. 1(3):225-231.

Ajari, O., Tsado, L.E.K., Oladiran, J.A. and Salako, E.A. (2003). Plant height and fruit yield of okra as affected by field application of fertilizer and organic matter in Bida, Nigeria. The Nigerian Agricultural Journal, 34: 74 – 80.

Arinze, A. E. (2005). Plant pathology and post-harvest food losses. Professorial inaugural lecture series. University of PortHarcourt, 98pp.

Awodun, M. A. (2007) Effect of Poultry Manure on the Growth, Yield and Nutrient Content of Fluted Pumpkin (Telfairia occidentalis (Hook). F). Asian Journal of Agricultural Research, 1:67-73.

Babatunde R. O., Omotesho O. A. and Sholotan O. S. (2007). Socio-economic characteristics and food security status of farming household in Kwara State, North-Central Nigeria. Pak. J. Nutr. 6 (1):49-58

Barnett, H.L. and Hunter, B.B. (1999) Illustrated Genera of Imperfect Fungi. Prentice Hall Inc., Upper Saddle River. Pp218.

Ewulo, B.S. (2005) Effect of Poultry and Cattle Manure on Sandy Clay Loam Soil. Journal of Animal and Veterinary Sciences. 4: 839-841.

Gemede HF, Ratta N, Haki GD, Woldegiorgis AZ, Beyene F (2015). Nutritional Quality and Health Benefits of Okra (Abelmoschusesculentus): A Review. Journal of Food Process Technology 6: 458. doi:10.4172/2157-7110.1000458

IRRI (2006). News from International Rice Research Institute. International Rice Research Institute. Philipines p 26.

Iwuagwu, C. C., Mbah, B. N. and Nwogboga, A.C (2014). Identification and control of mycopathogens associated with storage of five horticultural produce in evaporative coolant-vegetable basket. European Journal of Biotechnology and Bioscience 2 (2): 24-27

Iyagba, A. G., Onuegbu, B. A. and Ibe, A. E. (2013) Growth and yield response of okra (Abelmoschus esulentus (L.) Monech) to NPK fertilizer rates and weed interference in southeastern Nigeria. International Research Journal of Agricultural Science and soil Science, 3(9): 328- 335

National research council (NRC). (2006) Okra: Lost crops of Africa: vegetables. National Academics press. P2

Nweke, I. A., Ijearu, S. I. Igili, D. N. (2013) Effect of Different sources of Animal manure on the growth and yield of okra (Abelmoschus esulentus (L.) Monech) in Ustoxicdystropetat Enugu SouthEastern, Nigeria. International journal of Scientific and Technology Research, 2(3) 33-38.

Ogundiran, A. O. (2013). The effect of combined application of poultry manure and sawdust on the growth and yield of okra. Journal of Agricultural Science, 5(10): 7-11.

Ojeniyi, S.O. (2007). Effect of goat manure on soil nutrient and okra yield in a rain forest area of Nigeria. Applied Tropical Agriculture, 5: 20-23

Onwu, A.C., Abubakar, J.R. and Unah, P.O. (2014). Effect of poultry manure on growth, yield of okra and Soil properties in Makurdi, North Central Nigeria. International Journal of Agricultural and Food Sience

Premsekhar, M. and Rajashree, V. (2009). Influence of organic manure on growth, yield and quality of okra. American Eurasian Journal of Sustainable Agriculture, 3(1): 6

Quinton, I. (2006) Indigenous Spinach. Go Farming for the Farmers of Tomorrows, Pg. 20-21.

Ranjit C and Surajit K (2013) Influence of Organic Amendments and Inorganic Fertilizers on Late Blight Incidence and Yield of Tomato (Lycopersicon esculentum Mill.) International Journal of Geology, Agriculture and Environmental Sciences Vol 1 (1):35-38

Sharma A. R,(2004). Effect of different rate of application of organic manure, Journal of Agricultural science Cambridge; 1: 313-318.

Snedecor, G.W and Cochran, W.G. (1994). Statistical methods. 14th edition, Iowa State University, Ames.

Thapa, U., Rai, A. K., and Chakarborty, R.(2012). Growth and Yield of Okra Abelmoschus esculentus as Influenced by Seed Weight. The Bioscan 74: 711-714.

Tripathi, K.K., Govila, O.P., Warrier, R. and Ahuja, V. (2011). Biology of Abelmoschus esculentus L. Okra. Series of Crop Specific Biology Documents 35 p., Department of Biotechnology, Ministry of Science& Technology & Ministry of Environment and Forestry, Govt. of India.

Zane F.I. (2006). Residual effect of dairy cattle manure on plant growth and soil properties. Agronomy journal. 72: 123-130