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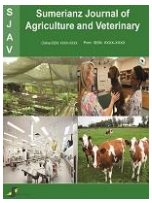

Original Article Open Access

Influence of Variety and Poultry Manure Rates on Growth, Yield, Incidence and Severity of Fusarium Wilt Disease on Three Pepper (*Capsicum annum*) Varieties

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Abstract

A field experiment was conducted to study the effect of different rates of poultry manure on growth, yield, incidence and severity of fusarium wilt on three varieties of pepper (*Capsicum annuum*). The research was carried out at the Crop Science and Horticulture research farm of the Faculty of Agriculture, Nnamdi Azikiwe University Awka, Anambra State-06º15'2''N,7º6'59''and 51m above sea level. The experiment lasted from June to August 2019 wet season planting. The pepper varieties used include: California wonder (green), Efia red and Nsukka yellow. The three pepper varieties received 0tons/ha, 8tons/ha and 16tons/ha of poultry manure. It was a 3 x 3 factorial experiment laid out in a Randomized Complete Block Design (RCBD) and replicated thrice. Variety influenced ($P<0.05$) plant height where the Nsukka yellow pepper gave the tallest plants (46.60cm) while the shortest was the green variety (27.0cm) at 8WAT.

Highest number of leaves were obtained in red variety (167.9) which was significantly different (P<0.05) from the other varieties. No significant difference was observed in the leaf area of the three varieties (P>0.05) at the second and fourth WAT though Nsukka yellow had the largest leaf area at 4WAT and, Efia red was largest at 6WAT. Poultry manure application influenced leaf area (P<0.05) at 2nd, 4th and 6WAT. Poultry manure at 16 tons/ha gave the largest leaf area at 2nd, 4th, 6th and 8WAT. There was a significant (P<0.05) varietal effect on incidence and severity of diseases where the green variety had the highest incidence and severity of wilt. Poultry manure also influenced incidence and severity of Fusarium wilt disease where highest incidence and severity was obtained at 0tons/ha. There was a significant interaction (P<0.05) effect of variety and poultry manure rates which was observed on plant height at 2nd,4th ,6th and 8WAT. Yellow x 8tons/ha gave the tallest plants at 8WAT. Effect poultry manure rates on the number of fruits, weight gain, fruit length, fruit diameter, number of locus and fruit girth were not significantly different (P>0.05), though the highest (5.70) number of fruits was obtained at 8ton/ha poultry manure application This was followed by 4.93 at 16ton/ha, while the least number of fruits was produced when 0ton/ha was applied Poultry manure at 8tons/ha also produced the highest pepper fruit weight with a mean value of (5.700g) though not statistically different from the other two varieties. It is therefore that farmers should adopt the application of 8tons/ha poultry manure, as this was most suitable in terms of yield and increase beyond this level may not lead to appreciable marginal increase in yield as observed in this investigation.

Keywords: Pepper varieties; Poultry manure; Yield; Disease incidence; severity and Fusarium wilt.

1. Introduction

Pepper (Capsicum anum) is annual or perennial herbs belonging to the family *Solanaceae* [1]. It is native to south and central America. Capsicum consists of approximately twenty-two wild species and five domesticated species but mainly five are domesticated. These are *Capsicum annum, C. baccacum, C. chinensis, C. pubescens and C. frutescens* [2]. Capsicum varies considerably especially in the shape of the fruit, color and size [3]. Inflorescence ranges from one to several flowers at one node [4]. Pedicel length varies significantly among cultivars and it ranges from 3 to 8cm [4]. The petals are usually white with five to seven stamen which vary in color. Greenish white color in C. frutescens were observed by Udoh, *et al.* [5] and they added that corolla color is one of the consistent features that separate one capsicum specie from another. Seeds within the fruit are cream colored and the fruit is generally referred to as a berry. Statistics on pepper production shows that it is widely distributed. Capsicum played a major role in the development of food in America. Estimates of world production of pepper by FAO statistics 2001 was at 21.3 million tons from a harvested area of 1.6 million hectares (ha) and an average yield of 13.4t/ha. Vietnam was reported to be the largest producer in the world with 10 million tons while Madagascar was estimated to be the highest producer in Africa with 715000 tons [6]. Ghana was ranked the 11th largest producer in the world and the second largest producer in Africa. Pepper is seen as the second most important fruit vegetable after tomatoes in the tropics [7]. It is a highly valued crop due to its numerous benefits. These benefits range from the nutritional, pharmaceutical and even industrial [8]. Numerous vitamins found in pepper that are not present in other food materials makes it very palatable in dishes. Capsicum are good sources of medicinal preparations because of the many phytochemicals found in them [8]. Pepper is also processed into various other products that are used in confectionaries [7], UGCE 2009. To effectively produce this crop, artificial supply of nutrients is needed. The use of poultry manure in the production of pepper have proven to yield good results [9]. To get good result from manure application, large amounts up to 10ton/ha are required depending on the nutrient status of the soil [9]. The ability of poultry manures to release nutrients gradually supports crops for a longer time [10]. Many diseases and other agents like climatic and environmental conditions militates against the growth and production of pepper [11]. Diseases that attack pepper can either be fungal e.g Alternaria leaf spot, Anthracnose, Cercospora leaf spot, Fusarium wilt etc. They also could be bacterial diseases like the bacteria soft rot that is caused by *Erwinia carotovora* [11], it could also be bacterial leaf spot that is caused by *Xanthomonas campestris* and many others. Other group of diseases are the viral diseases like the pepper mottle virus [11] which most times makes fruits from affected plants to be misshapen [11]. Beet curly top virus is another viral disease that affects pepper. Measures in the estimation of diseases that attack crop plants is highly dependent on the type of disease and the purpose of study [12]. Generally, two major ways used in measuring severity of plant diseases are the destructive sampling that involves sacrificing of the plant and secondly the use of visual estimates where descriptive scales are used [13, 14].

2. Materials and Methods

2.1. Experimental Site

The experiment was carried out at the teaching and research farm of crop science and horticulture in the Faculty of Agriculture, Nnamdi Azikiwe University Awka, Anambra state (06º15'2''N,7º6'59'', 51m above sea level) from June to August, to determine the effects of different rates of poultry manure on growth, yield, disease incidence and severity on three pepper varieties. The site has an average rainfall of 1810.3mm per anuum and a mean minimum and maximum temperature of 27ºC and 27.3ºC respectively and a relative humidity of 72.3% [15].

2.1.1. Materials Used in Both Field and Lab Experiments

The materials used in this experiment include: seeds of three pepper varieties-green, Red and yellow, poultry droppings, measuring tape, hoe, machete, weighing balance, wooden pegs, ropes, beakers, masking tape, spirit lamp, distilled water, petri dishes, PDA powder, Autoclave machine, electronic weighing balance, cotton wool, methylated spirit, slides and slide cover and a compound microscope.

2.1.2. Treatments, Experimental Design and Plot Size

The experiment was a 3x3 factorial experiment in a Randomized Complete Block Design (RCBD) and replicated three times. The treatments consisted of three pepper varieties (Nsukka yellow pepper, Efia red and the California Wonder) and the plant spacing was 50cm x 50cm which were combined to give nine treatment combinations, three poultry manure rates: 0, 8 and 16 tons/ha were used. The total land area used for this experiment was 8m x 22m ($176m^2$) while each plot size is 2m x 2m ($4m^2$) and intra-row and inter-row spacing of 0.5m was adopted. Each block measured 7m x 7m to give $49m^2$. The total number of plots were twenty-seven.

2.1.3. Seed Source and Description of Variety

The improved seed (California Wonder) was sourced from Premier Seeds Nigeria limited, while the Efia red were gotten from East-West Seed International Ltd. California Wonder is blocky shaped and has a primary color that is usually green, but may be yellow or purple. The secondary mature color is usually red, with 75 to 80 days from transplanting to maturity. It is a very hardy strong and vigorous plant with short nodes. The variety has a yield potential of up to 3 t/ha. The Nsukka yellow pepper was sourced from the local market at Ugwuoba, Enugu state.

2.1.4. Nursery Preparation and Management

The seeds were sown in well prepared nursery beds of 2 m x 1 m. Seeds were broadcasted. These were covered with thin layer of soil and dry mulch and then watered regularly until the seedlings emerged. The mulch material was removed and spread between the emerged seedlings. The seedlings were watered and weeded regularly until the time of transplanting at 4WAS.

2.1.5. Land Preparation Sand Fertilizer Application

The experimental sites were harrowed and later ridged 50cm between rows. Manure was incorporated as per treatment after land preparation two weeks to transplanting by splitting the ridge and the manure applied and thereafter buried.

2.1.6. Transplanting

The seedlings were transplanted at 4WAS in the morning by uprooting with a ball of earth. Transplanting was done on a plant spacing of 50cm x 50cm. Each of the plots had sixteen plants.

2.1.7. Weed Control

Weeds were controlled by manual hoe weeding at two weeks' interval, which kept the plots clean.

2.1.8. Harvesting

The green glossy matured fruits were harvested during the cool hours of the day by hand picking. Care was taken not to damage or severe the fruiting branches in the course of the harvest. The fruits were also placed directly into well labeled field baskets before weighing. Harvest was done three times at weekly interval

2.1.9. Data Collection

The data were collected on the following parameters, using the four middle plants to avoid border effect.

2.1.10. Growth Parameters

Observation and measurement of growth characters were done at intervals of two weeks beginning from 2 WAT and terminated at 8 WAT. Parameters measured include;

2.1.11. Plant Height (cm)

Heights of four randomly selected plants per plot were determined by measuring the height from the ground level to the main shoot apex of the plant using a meter rule, and the average thereafter recorded.

2.1.12. Number of Branches Per Plant

The number branches per plant were carefully counted from the four randomly selected plants and the average was determined and recorded.

2.1.13. Number of Leaves Per Plant

The number of leaves was counted per plant from the four plants and the average per plot was determined and recorded.

2.1.14. Leaf Area (cm^2)

This was done by first obtaining the leaf length and width using a meter rule to measure from the base of the leaf petiole to the apex for the length and also measuring the widest part of the leaf to get the width. The area was computed using the relation LA= 0.57 (L x W) [16].

2.1.15. Number of Flowers Per Plant

This was determined by counting the total number of flowers produced by each plant from the four plants at the 4^{th} and 6^{th} week and the average was obtained and recorded on per plot basis.

2.1.16. Number of Fruits Per Plant

The number of harvested fruits were counted at each sampling period and recorded. The total number of harvested fruits per plant thereafter was recorded.

2.1.17. Fruit Diameter

This was determined by measuring the diameter at the top broad end of four selected fruits using a Venier caliper and the average was recorded on per plot basis.

2.1.18. Fruit Length

This was determined by measuring the length of four randomly selected fruits from the proximal to the distal ends and the average was recorded as per treatment.

2.1.19. Fruit Yield (kg ha^{-1})

This was determined by weighing freshly harvested fruits from the net plots with a balance scale. The fresh fruit weights per net plot were added and taken as yield per plot and the yield/ha computed thereafter was recorded.

$$\text{Fruit yield (tons/ha)} = \frac{\text{Plot yield (kg)}}{\text{Plot area (m}^2\text{) x 10000m}^2}$$

2.1.20. Assessment of Disease Incidence and Severity of the Pathogens

Incidence and severity of diseases was accessed in the farm during the field stage at 6WAT. Disease incidence was accessed by visual observation of the diseased pepper plants in the sample. Percentage disease incidence of pepper plant was determined according to Snedechor and Cochran [17] as follows

$$\text{Disease incidence} = \frac{\text{Number of diseased plants}}{\text{Total number of plants sampled}} \times \frac{100}{1}$$

Severity of diseases on the other hand was accessed by recording the extent or degree of the disease in the infected pepper of the sampled plots in the field. A five-point scale of 0-5 was used [18] where:

0= No infection
1= 1-20% of plants infected
2= 21-40% 0f plants infected
3= 41-60% of plants infected
4= 61-80% of plants infected
5= 81-100% of plants infected.

2.1.21. Soil and Manure

Analysis: Soil samples were randomly collected with auger from depth of 0 -15 cm across the experimental site during 2019 dry season prior to transplanting. The soil samples were thoroughly mixed, air dried, and sieved using 2 mm mesh sieve and later analyzed for physicochemical properties.

The following analysis were conducted in the laboratory:

2.2. Soil Chemical Analysis

Saturated hydraulic conductivity (Ksat) was calculated using Darcy's equation as was outlined by Uloma, *et al.* [19].

Organic carbon was determined using Walkley and Black dichromate method as described by Nelson and Sommer [20]. This was corrected to soil organic matter by multiplying with a correction factor of 1.724.

Total nitrogen was determined using the Kjeldhal method as described by Bremner [21]. Soil P^H was determined using a P^H meter in a soil solution of 1:2:5.

Exchangeable Calcium, Magnesium, Sodium and Potassium were extracted with NH4OAc. Calcium and Magnesium were determined using Ethylene diaminetatra-acetic acid (EDTA) titration method while potassium and sodium were determined by flame photometer [22]. Manure samples were taken before applying to the soil and analyzed for NPK and 3 other elements Na, Mg and Ca (Table 1).

2.2.1. Laboratory Analysis of the Diseased Plant

The specimens were randomly collected from the different plant parts of the three varieties i.e. the leaves, the roots and the stem. These were packaged separately and taken to the pathology laboratory of Crop science and Horticulture of Nnamdi Azikiwe University Awka.

2.2.2. Sterilization

The working area was first surface sterilized using methylated spirit. The pepper specimen collected were washed in tap water, cut into sections with a sterilized blade and then surface sterilized in 10ml ethanol mixed with 90ml of distilled water for 5 minutes and then rinsed in a sterile distilled water.

2.2.3. Preparation of Culture Media

Ten grams of Potato Dextrose Agar (PDA) was weighed using an electronic scale and was carefully poured into a conical flask. 250ml distilled water was added and stirred properly, the flask was corked with a cotton wool wrapped in an aluminum foil. Water was added into the autoclave and the conical flask containing the PDA was placed inside it and then covered. This was heated at a temperature of 120^0C, for 20-25mins. The PDA was brought out and 5ml of it was dispensed into each of the 9cm petri dishes with two drops of lactic acid to prevent the growth of bacteria.

2.2.4. Incubation of the Infected Specimen

The infected specimen was picked with an inoculating loop and placed at the center of the petri dishes containing the PDA and then covered, masking tape was used to wrap it round and then labelled according to the date and the variety. While inoculating, the air around was sterilized by keeping the spirit lamp lighted. The inoculated media was checked on daily basis and growth was observed on the third day. A sub culture was carried out to obtain a pure culture which was taken for microscopic identification of the fungal pathogen.

2.2.5. Microscopic Identification of the Fungal Pathogen

Resulting pure cultures were used for the identification of the fungal pathogen, and this was done with the aid of a compound microscope. Slides were prepared by using a syringe to put a drop of water after which, the pure culture was teased on it and then covered with the slide cover. These were viewed under the microscope with a magnification of 100. The fungi were identified using illustrated pictures of the fungi by Barnet and Hunter (1999. Micrographs of identified pathogen were taken.

2.2.6. Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) using the procedure outlined by Steel and Torrie [23] in a Randomized Complete Block Design using GENSTAT (2007) statistical software package. Separation of treatment means for statistical significance was done using the least significant difference (LSD) at 5% probability level.

3. Results

Table-1. Physical and chemical properties of the soil samples taken at 0-15cm depth of the experimental site before transplanting

Physical	**Values**
Sand(%)	69.6
Silt(%)	22.0
Clay(%)	8.4
Textural class	Sandy-loam (SL)
Chemical	
$P^H(H_2O)$	5.14
Total N (%)	0.97
Organic carbon (%)	1.14
Organic matter (%)	1.98
Ca (Cmolkg-1)	2.27
Mg (Cmolkg-1)	1.33
K (Cmolkg-1)	0.25
Na (Cmolkg-1)	0.12
EA (Cmolkg-1)	1.63
ECEC (Cmolkg-1)	4.97
BS (%)	80.23
Available P (mgkg-1)	5.53

Source: Soil science laboratory, department of soil science and land resource management, Nnamdi azikiwe university, Awka.

Abbreviations: P-Phosphorus, N- Nitrogen, Ca- Calcium, Mg-Magnesium, K-Potassium, Na-Sodium, EA-Exchangeable acidity, ECEC-Effective cations exchange capacity, BS-Base saturation.

Table 2 shows that there was a significant effect ($P<0.05$) among the three varieties on plant height at 2WAT where the highest plant height (19.00cm) was obtained in yellow pepper followed by 15.50cm obtained in red pepper while the least (12.15cm) was obtained in green pepper. The same trend was also observed at both 4, 6 and 8WAT. Generally, yellow pepper had the highest plant height. The table also shows that variety had a significant effect ($P<0.05$) on the number of leaves among the three pepper varieties where the highest (177.6) number of leaves was obtained from the red pepper at 8WAT followed by 167.9 obtained in yellow pepper at 8WAT while the least (105.2) was obtained from green variety at 8WAT. From the result, varietal effect on the number of leaves in three varieties was significant in all the weeks. Highest number of leaves (16.72) was obtained in red pepper at 2WAT

followed by 15.81 in yellow pepper while the least (12.44) was obtained in green pepper. This trend was observed at 4WAT, 6Wat and 8WAT. Generally, red pepper had the highest number of leaves (Table 2).

Table 2 also shows that there was a significant varietal effect (P<0.05) on incidence and severity of diseases where the highest incidence (94.4%) of disease was obtained on green pepper, followed by 66.7% obtained on red pepper while the least (44.4%) obtained in yellow pepper. The same trend was also observed on the severity of diseases where the highest disease severity score 4.78 was obtained in green pepper followed by 3.67 obtained in red while the least was (2.78) which was obtained in yellow.

Table-2. Effect of variety and poultry manure on plant height, number of leaves, disease incidence and severity on pepper

	2WAT	4WAT	6WAT	8WAT	2WAT	4WAT	6WAT	8WAT	6WAT	6WAT
Green	12.15	15.36	21.99	29.10	12.44	21.10	75.50	105.2	94.40	4.780
Red	15.50	22.55	23.71	41.10	16.72	34.00	92.10	177.6	66.70	3.670
Yellow	19.02	24.42	30.44	46.60	15.81	31.40	68.80	167.9	44.40	2.780
$LSD_{0.05}$	2.724	3.134	4.918	07.03	3.034	09.34	18.55	47.90	18.07	0.723
PM rates(t/ha)										
0	14.46	18.94	26.11	39.50	09.50	24.20	62.60	139.6	77.80	4.110
8	16.13	21.70	25.22	38.10	17.47	27.50	80.60	155.6	61.10	3.440
16	16.07	22.19	24.82	39.20	18.00	34.70	93.20	155.6	66.70	3.670
$LSD_{0.05}$	NS	NS	NS	NS	3.034	NS	18.55	NS	NS	NS
	PLANT HEIGHT (cm)				NUMBER OF LEAVES				INCIDENCE AND SEVERITY	

WAT-Weeks after transplanting, PM- Poultry manure, NS- Not significant

Table 2 also showed the main effect of poultry manure rates on plant height, number of leaves and incidence and severity of diseases where a significant effect was only observed on the number of leaves. For plant height, there was no significant effect (P>0.05) of poultry manure. But the highest plant height was obtained at 0 ton/ha of poultry manure at 8WAT followed by 16tons/ha at 8WAT, while the least (14.46cm) plant height was obtained at 0tons/ha at 2WAT.

Table 2 also shows that at 2WAT, the highest plant height was obtained at 16ton/ha of poultry manure followed by (16.13cm) obtained in 8ton/ha at 2WAT while the least(14.46cm) was obtained in 0ton/ha at 2WAT. This trend was observed at 4WAT, 6WAT and 8WAT. For number of leaves, the highest number of leaves were obtained at 8 ton and 16ton/ha with values of number of leaves of 153.6 respectively. Generally, it was observed that the number of leaves increased with age where the highest number of leaves were obtained at 8WAT followed by the 6WAT while the least was obtained at 2WAT. At 6WAT, there was a significant effect (P<0.05) between the 0ton/ha and the 16ton/ha were the number of leaves were 62.60 and 93.20 respectively.

Table 2 also shows that there was no significant effect (P>0.05) of different rates of poultry manure on disease incidence and severity of different pepper varieties were the highest incidence (77.80%) was obtained in 0tons/ha at 6WAT followed by 66.70% obtained in 16tons/ha at 6WAT while the least (61.10%) was obtained in 8ton/ha at 6WAT. The same trend was also observed in disease severity were the highest disease severity score of 4.11 was observed in 0tons/ha at 6WAT, followed by 3.67 obtained in 16tons/ha at 6WAT while the least was 3.44 obtained in 8ton/ha at 6WAT.

3.1. Interaction Effects of Variety and Poultry Manure Rates on the Height of Pepper at 2,4,6 and 8WAT

Table 3 shows that there was a significant interaction effect (P<0.05) of variety and poultry manure rates on plant height at 2,4,6 and 8WAT were the highest (50.60cm) plant height was observed at 8WAT. At 2WAT, yellow x 8tons/ha gave the highest plant (19.69cm) followed by yellow x 16ton/ha (19.22cm) while the least (11.09cm). At 4WAT, the highest plant height (26.50cm) was obtained at red x 8tons/ha followed by 26.26cm at yellow x 16ton/ha while the least 13.83cm obtained at green x 8ton/ha. This trend was also observed at 6WAT when the highest (36.60cm) was obtained at yellow x 16ton/ha. Generally, the highest plant height was obtained from yellow pepper at various poultry manure levels.

Table-3. Interaction effect of variety and poultry manure rate on plant height at 2, 4, 6 and 8 weeks after transplanting

Variety	Pm rate	2WAT	4WAT	6WAT	8WAT
Green	0	12.54	15.92	23.93	29.80
	8	11.09	13.89	23.50	30.20
	16	12.81	17.77	18.53	27.30
Red	0	12.71	18.59	25.74	41.80
	8	17.61	26.50	27.08	41.90
	16	16.19	22.55	24.32	39.70
Yellow	0	18.14	22.32	28.64	46.80
	8	19.69	24.70	26.08	42.30
	16	19.22	26.26	36.60	50.60
$LSD_{0.05}$		4.72	5.43	8.518	12.17

WAT-Weeks after transplanting, PM- Poultry manure

Effect of Poultry Manure and Variety on the number of branches, leaf area and the stem girth of three Pepper varieties.

Table 4 shows that was a significant (P<0.05) effect of variety and poultry manure on the number of branches at week 4 and week 8 but no significant effect at week 2 and 6. The table shows that the highest number of branches occurred at 8WAT with a value of 5.36 obtained in red variety followed by 5.22 obtained in yellow pepper variety. The least number of branches was obtained in yellow pepper at 2WAT with number of branches 1.11. At 4WAT, red pepper had the highest number of branches (3.11) followed by 3.56 obtained in yellow pepper while the least was 1.74 obtained in green pepper. Red pepper also had the highest number of leaves at week six followed by 3.42 obtained in green pepper while the least was 3.31 obtained in yellow pepper. Generally, red pepper had the highest number of branches as could be seen at week 4,6 and 8.

For leaf area, there was a significant effect of variety and poultry manure on leaf area at week 6 and 8 but not in 2 and 4WAT. The largest leaf area (70.7cm2) was obtained at 8WAT in yellow pepper followed by 62.6cm2 seen at 8WAT in red pepper while the least leaf area (14.6m2) was obtained at 2WAT in red pepper (Table 3). The table also shows that at 4 WAT, yellow pepper gave the highest leaf area (19.5cm2) followed by red pepper which had leaf area of 16.80cm2 while the least was 15.10cm2 in green pepper. At 6WAT, red pepper had the largest leaf area (50.20cm2) followed by 41.5cm2 obtained in yellow pepper while the least (20.20cm2) obtained in green pepper. A leaf area produced in red pepper at 6WAT (50.2cm2) is significantly higher than that produced in green pepper (41.5 and 48.2cm2) respectively. Also the leaf area produced by yellow pepper at 6WAT is significantly higher than that produced in green pepper. Generally, green pepper had the least leaf area followed by red pepper while the highest was produced in yellow pepper.

Table-4. Effect of variety and poultry manure on the number of branches, leaf area and the stem girth

Variety	2WAT	4WAT	6WAT	8WAT	2WAT	4WAT	6WAT	8WAT	2WAT	4WAT	6WAT	8WAT
Green	02.32	01.74	3.417	4.190	15.03	15.10	28.20	30.40	3.759	4.718	5.370	6.930
Red	01.52	03.11	3.639	5.360	14.60	16.80	50.20	62.60	3.156	4.451	5.900	7.570
Yellow	01.11	02.56	3.306	5.220	16.10	19.50	41.50	70.70	2.993	4.605	5.280	7.660
$LSD_{0.05}$	NS	0.986	NS	0.613	NS	NS	07.64	13.43	0.4456	NS	0.503	0.638
PM rates												
0	0.550	02.09	3.250	4.780	11.63	14.10	30.50	48.40	3.112	3.853	4.740	7.140
8	01.66	02.37	3.167	4.890	15.66	16.60	41.00	55.20	3.348	4.916	5.720	7.580
16	2.73	02.94	3.944	5.110	18.45	20.80	48.40	60.00	3.448	5.068	6.080	7.580
$LSD_{0.05}$	NS	NS	0.411	NS	3.109	5.380	07.64	NS	NS	0.379	0.503	NS

WAT-Weeks after transplanting, PM- Poultry manure, NS- Not significant, LSD- Least significant difference

Table 4 also shows that variety had significant effect (P<0.05) on the stem girth in all the weeks observed but not at 4WAT. The highest stem girth (7.66mm) was obtained in yellow pepper at 8WAT followed by 7.57mm obtained in red pepper at 8WAT while the least stem girth (2.99mm) was obtained in yellow pepper at 2WAT. At 2WAT, the stem girth 3.76mm produced in green pepper is significantly higher than those produced in red and yellow pepper (3.16 and 2.99) respectively. Also, the stem girth produced in red pepper is significantly higher than that produced in yellow pepper. Comparatively, green pepper had larger stem girth than the other two pepper varieties.

Table 4 also shows poultry manure at different rates had no significant effect (P>0.05) on the number of branches at 2WAT, 4WAT and 8WAT except at 6WAT. It could be observed that poultry manure rates produced the highest number of branches (5.11) at 16tons/ha followed by 4.89 obtained in 8tons/ha but both are statistically different from 3.94 produced at 16ton/ha. It was observed also in that different poultry manure rates had significant effect on leaf area at week 2,4 and 6 but no significant effect at week 8. The result also shows that various poultry manure application had significant effect at 4 and 6WAT but not significant at 2 and 8WAT. The largest stem girth 7.58 was obtained at 8WAT in both 8 and 16tons/ha of poultry manure application respectively followed by 7.14 obtained at 8WAT in 0tons/ha. The least stem girth (3.11mm) was obtained at 2WAT in 0tons/ha poultry manure application. Also, it was observed that the stem girth was increasing poultry manure application.

4. 5: Interaction effect of variety and poultry manure on the leaf area of pepper.

Table 5 shows that there was a significant interaction effect (P<0.05) in all the weeks after transplanting. At 2WAT, the largest leaf area (20.52cm2) was observed from red x 16tons/ha which was followed by green x 16tons/ha 19.17cm2 while the least was at green x 0tons/ha 11.74cm2. At 4WAT, yellow x 16ton/ha gave the largest leaf area (21.50cm2) which was followed by red x 16tons/ha 20.80cm2 while the least leaf area was by green x 8tons/ha (12.20cm2). At 8WAT, the largest leaf area (84.0cm2) was from yellow x 16tons/ha which was followed by red x 8tons/ha 69.5cm2 while the least was from green x 0tons/ha. At 6WAT, largest leaf area was from red x 16tons/ha (59.2cm2) which was followed by red x 8tons/ha 54.60cm2 while the least was from green x 0tons/ha 22.50. Generally, the smallest leaf area was from green x 0tons/ha.

Table-5. Interaction effect of poultry manure and variety on the leaf area of pepper at 2, 4, 6 and 8 weeks after transplanting

Variety	Pm rate(ton/ha)	2WAT	4WAT	6WAT	8WAT
Green	0	11.74	13.10	22.50	26.30
	8	14.19	12.20	29.70	35.20
	16	19.17	20.10	32.40	29.70
Red	0	09.08	11.90	36.90	60.50
	8	14.22	17.70	54.60	60.90

	16	20.52	20.80	59.20	66.40
Yellow	0	14.06	17.20	32.10	58.50
	8	18.57	19.90	38.70	69.50
	16	15.68	21.50	53.70	84.00
$LSD_{0.05}$		5.39	9.32	12.23	23.26

WAT-Weeks after transplanting, PM- Poultry manure, NS- Not significant, LSD- Least significant difference

The table shows that there was no significant interaction effect (P>0.05) on the number of branches at 2WAT. The highest number of branches (2.33) was from Green x 16tons/ha which was followed by Red x 8tons/ha (2.14) while the least was from yellow x 0tons/ha (0.05). A significant interaction effect (P<0.05) was observed at 4,6 and 8WAT. At 4WAT, highest (3.83) number of branches was by red x 16tons/ha which was followed by Red x 8tons/ha (3.50) while the least was Red x 8tons/ha and yellow x 16tons/ha gave the highest number of branches with mean values of 5.67 respectively. The least number of branches was by green x 16tons/ha 4.08. Generally, Red x 16tons/ha gave the highest number of leaves.

Table-6. The Interaction effect of variety and poultry manure on the number of branches of pepper at 2,4,6 and 8 WAT

Variety	Pm rate	2WAT	4WAT	6WAT	8WAT
Green	0	0.950	01.53	3.333	4.330
	8	01.02	01.28	3.500	4.170
	16	02.33	02.42	3.417	4.080
Red	0	0.770	02.00	3.333	4.830
	8	02.14	03.50	3.333	5.670
	16	01.67	03.83	4.250	5.580
Yellow	0	0.050	02.75	3.083	5.170
	8	01.83	02.33	2.667	4.830
	16	01.54	02.58	4.167	5.670
$LSD_{0.05}$		NS	1.707	0.712	1.062

WAT-Weeks after transplanting, PM- Poultry manure, NS- Not significant, LSD- Least significant difference

The table shows that there was a significant interaction effect (P<0.05) of variety and poultry manure on incidence and severity of diseases. Highest incidence was observed from green x 0tons/ha and green x 8tons/ha with a mean value of (100%) respectively while the least was yellow x 8tons/ha (25.0%). The same trend was seen in disease severity whereby the highest disease severity score (5.00) was from green x 0tons/ha and green x 8tons/ha respectively while the least severity was from yellow x 8tons/ha (2.00).

Table-7. Interaction effect of variety and poultry manure on the incidence and severity of diseases on pepper plant at 6WAT

Pm rate x Variety	Pm rate(ton/ha)	Incidence (%)	Severity
Green	0	100.0	5.00
	8	100.0	5.00
	16	83.30	4.33
Red	0	83.30	4.33
	8	58.30	3.33
	16	58.30	3.33
Yellow	0	50.00	3.00
	8	25.00	2.00
	16	58.30	3.33
$LSD_{0.05}$		31.30	1.25

Table 8 shows that different variety of pepper had effect in all the yield components measured except 50% flowering and number of locus. It was observed that yellow pepper had the highest (44.20) 50% flowering followed by 43.00 obtained in red pepper while the least 39.8 was obtained in green pepper. This trend was also observed in number of fruits where yellow pepper had the highest (9.48) number of fruits followed by red pepper (4.74) while the least (1.26) was observed in green pepper. For fruit yield, yellow pepper produced significantly higher fruit yield than red pepper with fruit yield value of 2.4 and 0.92tons respectively. It was also observed that the fruit yield of 2.09 produced in red pepper is statistically the same with 2.40tons produced in yellow pepper. The result also shows that green pepper produced the longest fruits (6.23cm) which is statistically different from 4.26cm produced in red pepper but statistically similar with 4.58cm produced in yellow pepper.

The result in table 8 also shows that green pepper had significantly higher number of seeds (116.3) than 45.8 and 40.7 obtained in yellow and red respectively. Yellow pepper gave the second highest number of seeds while the least 40.7 was produced in red pepper. Table 8 also shows that the different poultry manure rates had no significant effect on yield and yield components of pepper except in 50% flowering and number of seeds. There was a significant effect (P<0.05) of poultry manure in 50% flowering were 8tons/ha gave the highest 50% flowering (50.10) followed by 42% flowering obtained in 0tons/ha manure application. This trend was also observed in number

of fruits per plant were 8tons/ha gave the highest (5.70) number of fruits followed by 4.93 obtained in 16tons/ha while the least (4.85) was obtained 0tons/ha.

Table-8. Effect of variety and poultry manure on yield and yield components of pepper

Variety	50% flowering (%)	No of Fruits	Yield (tons/ha)	Fruit length (cm)	Diameter(mm)	No of Locules	Fruit girth (mm)	No of seeds
Green	39.80	1.260	2.09	6.230	8.000	3.333	4.574	116.3
Red	43.00	4.740	0.92	4.260	3.860	3.074	1.326	40.7
Yellow	44.20	9.480	2.40	4.580	3.830	3.074	1.321	45.8
$LSD_{0.05}$	NS	1.962	0.48	0.717	0.704	NS	0.475	15.00
PM rate(ton/ha)								
0	42.00	4.850	1.75	5.170	5.050	3.074	2.287	59.20
8	50.10	5.700	1.97	4.750	5.370	3.185	2.372	83.70
16	34.40	4.930	1.69	5.150	5.260	3.185	2.562	59.90
$LSD_{0.05}$	5.610	NS	NS	NS	NS	NS	NS	15.00

*NS means not significant, pm- poultry manure, LSD- least significant difference

The result of Table 8 also shows that there was no significant effect of poultry manure on yield of fruit where the highest fruit yield was obtained in 8tons/ha with a value of (1.97tons/ha) foll8owed by 1.75tons obtained in 0tons/ha while the least (1.69tons) was obtained in 16tons/ha. For fruit length, 0tons/ha gave the longest fruit length (5.17cm) followed by 5.15 obtained in 16tons/ha while the least 4.75 cm was obtained in 8tons/ha. Table 8 as well shows that there was a significant effect of poultry manure the number of seeds. The highest number of seeds (83.7) was produced in 8tons/ha followed by 59.90 obtained in 16tons/ha while the least (50.20) was obtained in 0tons/ha.

Table 9 Interaction effects of variety and poultry manure rates on yield and yield parameters.

Table 9 shows that there was a significant interaction effect in all the yield components except the number of locus. For 50% flowering, the highest number of days to 50% flowering was at red x 8tons/ha (53.30) followed by Red x 16tons/ha 35.70 while the least was green x 16tons/ha which flowered earlier (27.30). Highest number of fruits was at yellow x 8tons/ha (10.67) which was followed by yellow x 0tons/ha (9.00) while the least was green x 0tons/ha (1.22). Yield was highest at yellow x 8tons/ha (2.73tons) followed by yellow x 0tons/ha (2.39tons) while the least was red x 0tons/ha (0.83tons). Highest fruit length was at green x 0tons/ha (6.52cm) which was followed by green x 16tons/ha 6.50cm while the least was red x 8tons/ha (4.0cm). Highest diameter was observed at Green x 16tons/ha (8.34mm) which was followed by green x 8tons/ha 7.84mm while the least was yellow x 16tons/ha (3.710mm). Highest number of seeds were observed from green x 8tons/ha (144.0) which was followed by green x 0tons/ha (103.0) while the least was from red x 16tons/ha (32.80).

Table-9. Interaction effect of variety and poultry manure rates on yield parameters

Variety	Pm rate (ton/ha)	50%F	NF	Yield	FL(cm)	D(mm)	NL	FG(mm)	No of seeds
Green	0	45.00	1.22	2.03	6.52	7.82	3.22	4.53	103.0
	8	47.00	1.33	2.23	5.68	7.84	3.33	4.31	144.0
	16	27.30	1.22	2.00	6.50	8.34	3.44	4.89	102.0
Red	0	40.00	4.33	0.83	4.33	3.87	3.00	1.22	36.80
	8	53.30	5.11	0.95	4.00	3.96	3.11	1.42	52.60
	16	35.70	4.78	0.98	4.46	3.74	3.11	1.33	32.80
Yellow	0	42.30	9.00	2.39	4.66	3.47	3.00	1.11	37.90
	8	50.00	10.67	2.73	4.58	4.31	3.11	1.39	54.60
	16	40.30	8.78	2.07	4.49	3.71	3.00	1.46	45.00
$LSD_{0.05}$		9.72	3.39	0.83	1.24	1.22	NS	0.82	25.90

NF- Number of fruits, F-flowering, FL- fruit length, D- Diameter, FG- Fruit girth, Pm- poultry manure

Generally, the green variety flowered earlier than the other two varieties and also had the highest number of seeds and fruit length while the yellow variety had the highest number of fruit and weight.

3.2. Isolation and Identification of Fungi Pathogens Associated with Pepper in the Field

The result of isolation and identification of pathogen associated with pepper plant shows that the organisms isolated and identified were *Aspergillus spp and Fusarium spp*.

Plate-1. Pure culture of *Aspergillus spp*

Plate-2. Micrograph of Aspergillus spp

Plate-3. Pure culture of *Fusarium solani*

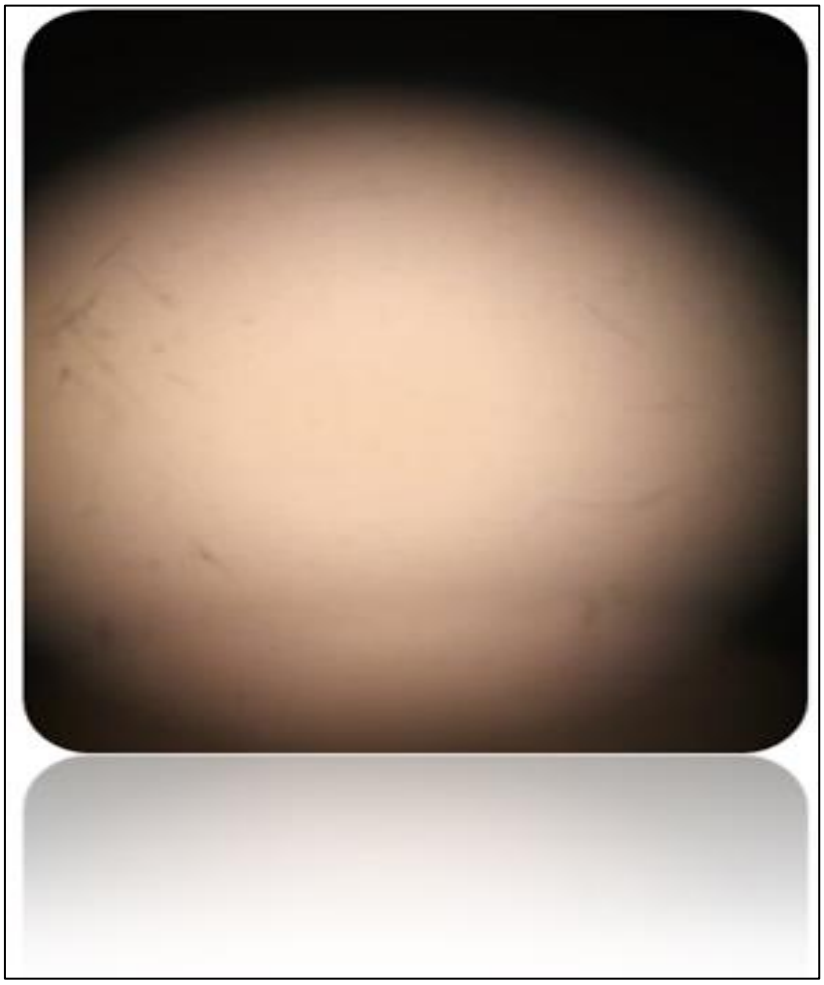

Plate-4. Micrograph of *fusarium solani*

4. Discussion

4.1. Effect of Variety and Poultry Manure Rates on Some Agronomic Characteristics of Pepper Varieties

The effect of variety and poultry manure rates on some agronomic characteristics of pepper showed that yellow pepper variety had the highest plant height. This is in line with the findings of Gebremedhen, *et al.* [24] who reported a varietal influence on the height of pepper in his work where he compared four pepper varieties – Mareko fana, Melka awaze, Melka shote and one local and concluded that mareko fana variety gave the highest plant height.

It was also discovered that some agronomic traits of pepper such as- the leaf area, number of leaves, stem girth, number of branches were increasing with increase in poultry manure application. This corroborates the findings of Adeola, *et al.* [25] who reported in his work that increasing poultry manure promoted vegetative mass, dry weight, plant height, rate of dry matter per leaf unit area, photosynthetic potential and consequently the yield of pepper.

4.2. Effect of Variety and Poultry Manure on Disease Incidence and Severity on Three Pepper Varieties

The effect of variety and poultry manure on disease incidence and severity showed that there was a significant effect of variety on disease incidence and severity where the highest incidence and severity (94.4%) was obtained in green pepper. This could be as a result of absence of an important secondary metabolite (Capsaicin) that has a pesticidal effect as seen in other pepper varieties. That could be the reason for high incidence of disease as observed in green pepper. This is similar to the findings of Deepaa, *et al.* [26], who reported that the lack of capsaicin in California wonder (green pepper) which led to high susceptibility of this variety to incidence of pest and diseases compared to other variety- (Tattasai Dan-Garko) used in his experiment.

The result also showed that there was no significant effect of different poultry manure rates on disease incidence and severity though, highest incidence was observed in 0tons/ha. This could have been as a result of low nutrient availability resulting from 0tons/ha application of poultry manure that led to less vigorous growth of the pepper plant culminating into low resistance to disease and pest observed in pepper varieties that received 0tons/ha application. This is in agreement with the findings of Echezona and Nganwuchu [10] who reported that incidence of pest and diseases is mediated by soil fertility, but disagrees with the findings of Iwuagwu, *et al.* [27], who reported that the higher the application of poultry the higher the disease incidence and severity in Cucumber production in Awka, Anambra State, Nigeria. It also agrees with the findings of Patriquin, *et al.* [28] who stated that pest and disease problems are indicative of soil fertility problems.

4.3. Effect of Poultry Manure and Variety on Yield and Yield Components.

The effect of variety had a significant effect on some of the yield components (No of fruits, weight, Fruit length, Fruit girth and number of seeds) while it was not significant on (50% flowering and the number of locus). The result also showed that the effect of variety and poultry manure application had a significant effect on fruit yield but there was a comparatively low yield values in this experiment. This could be as a result of the growth period which coincided with the peak of the rains with its attendant high humidity that favored the growth and proliferation of fungi pathogens attack as observed in this experiment. This consequently resulted to sparse plant population as a result of low survival of pepper plant after transplanting, abortion of flowers and abscission of fruits before maturity. This obviously was the reasons of the low yield obtained in this experiment. This is similar to the findings of Sarada, *et al.* [29] who reported in their investigation that high rainfall resulted to low productivity of chilli as a result of incidence and severity of diseases.

4.4. Isolation and Identification of Fungi Pathogens Associated with Three Pepper Varieties in the Field

The result of isolation and identification of fungi pathogens associated with the three pepper varieties used in this experiment showed that *Aspergillus spp* and *Fusarium solani* were isolated from infected pepper plant materials. This is similar to the findings of Adeola, *et al.* [25] who isolated six fungi pathogens from pepper plants based on the growth patterns, colour of mycelia and microscopic examinations of vegetative and reproductive structures with the aid of the microscope which were confirmed with the help of Mycological atlas of Roberts, *et al.* [11].

5. Conclusion

From this investigation, it was observed that variety and poultry manure had a significant effect on some of the growth and yield parameters -plant height, number of leaves, leaf area, number of fruits, weight and number of seeds. Yellow pepper had the best agronomic characteristics in terms of plant height and leaf area.

The results also showed that poultry manure at 8tons/ha gave the best agronomic traits in terms of yield and yield components. From the research, it was observed that green pepper had the highest disease incidence and severity while yellow pepper had the least incidence and severity.

The result also showed that the disease pathogens that caused the incidence and severity observed in the experiment were fungi pathogens- *Aspergillus spp* and *Fusarium solani.*

Recommendations

From this study, it is therefore recommended that farmers in this area of study should plant Nsukka yellow variety as compared to other varieties used in this experiment. This is because of its high yield, disease resistance and high survivability as obtained from this experiment. Nevertheless, the cultivation of this crop should be in a period of low humidity as it is susceptible to disease attack in periods of high humidity.

Farmers should also adopt the application of 8tons/ha poultry manure, as this is most suitable in terms of yield and increase beyond this level may not lead to appreciable marginal increase in yield as observed in this investigation.

Farmers should ensure to dress their seeds for planting with fungicides to prevent incidence of diseases and to ensure that planting materials are sourced from a certified outlet.

References

[1] Basu, S. K. and De, A. K., 2003. *Capsicum: historical andbotanical perspectives. In: De AK (ed) Capsicum:the genus Capsicum*. London: Taylor and Francis. pp. 1-16.

[2] Bosland, P. W. and Vatava, E. J., 2000. *Peppers, vegetables and spices capsicum*. Wallingford, UK: CABI Publishing. p. 204.

[3] Walsh, B. M. and Hoot, S. B., 2001. "Phylogenetic relationships of capsicum (solanaceae) using DNA sequences from two noncoding regions: The chloroplast atpb-rbcl spacer region and nuclear waxy introns." *International Journal of Plant Science*, vol. 162, pp. 1409-1418.

[4] Berke, T. G., 2000. "Hybrid seed production in capsicum. In hybrid seed production in vegetables, rationale and methods in selected species, a.S. Basra (ed.)." *Food Products Press*, vol. 135, pp. 49-67.

[5] Udoh, D. J., Ndon, B. A., Asuquo, P. E., and Ndaeyo, N. U., 2005. *Crop production techniques for the tropics*. Lagos: Concept Publications (Press Division). p. 464.

[6] FAOSTAT, 2016. "Crop production in africa. Retrieved 2018, august 18. Countries select all; regions africa + (total); elements area and production quantity; items red pepper; years-2010-2016."

[7] Alabi, D. A., 2006. "Effect of fertilizer phosphorus and poultry droppings treatments on growth and nutrient components of pepper (Capsicum annum L.)." *African Journal of Biotechnology*, vol. 5, pp. 671-677.

[8] Nadeem, M., Anjun, F. M., Khan, M. R., Saeed, M., and Riaz, A., 2011. "Antioxidant potential of bell pepper (capsicum annum l.)-a review." *Pakistan Journal of Food Science*, vol. 21, pp. 45-51.

[9] Adhikari, P., Khanal, A., and Subedi, R., 2016. "Effect of different sources of organic manure on growth and yield of sweet pepper." *Adv Plants Agric Res.*, vol. 3, pp. 158-161.

[10] Echezona, B. C. and Nganwuchu, O. G., 2006. "Poultry manure application and varietal effects of chilli pepper (*capsicum species*) on insect pests and diseases in a humid-tropical environment." *Journal of Agriculture, Food, Environment and Extension*, vol. 5, pp. 49-58.

[11] Roberts, P. D., Adkins, S., Pernezny, K., and Jones, J. B., 2004. "Diseases of pepper and their management." *Diseases of Fruits and Vegetables and Their Management*, vol. 2, pp. 333-387.

[12] Kenneth, G. P., Lindel, M. C., Wayne, T. O., and David, W. T., 2019. "The epidemiology of fusarium wilt of banana." *Frontiers in Plant Science*, vol. 10, p. 1395. Available: https://doi.org/10.3389/fpls.2019.01395

[13] Cambell, C. I. and Neher, D. A., 2016. *Estimating disease severity and incidence. Epidemiology management of root diseases*. Springer, Berlin, Heidelberg, pp. 117-147.

[14] Iwuagwu, C. C., Okeke, D. O., Onejeme, F. C., Iheaturu, D. E., Nwogbaga, A. C., and Salaudeen, M. T., 2019. "Effect of plant spacing on yield and disease assessment on two varieties of eggplant (solanum melongena l.) in awka." *East African Scholars Journal of Agriculture and Life Sciences*, vol. 2, pp. p281-288. Available: http://www.easpublisher.com/easjals/

[15] Uko, I., Anyanwu, S. C., Ndukwe, O. O., and Okonkwo, N. J., 2018. "Residual effect of pre-emergence herbicide application on weed emergence, growth and yield of cucumber (cucumis sativus.L)." *International journal of applied sciences and Engineering*, vol. 6, pp. 10-15.

[16] Yawei, W., Yifei, C., Xiangnan., Z., and Wenwen, G., 2021. "Research on measurement method of leaf length and width based on point cloud." *Agriculture*, vol. 11, pp. 1-13.

[17] Snedechor, G. W. and Cochran, W. G., 1994. "Statistical methods." *Journal of Education and Behavioural Statistics*, vol. 19, pp. 304-307.

[18] IRRI, 2006. *News from international rice research institute*. Philipines: International Rice Research Institute. p. 26.

[19] Uloma, A. R., Oyekachi, C. T., Torti, E. K., and Amos, U., 2013. "Infiltration characteristics of some selected schools in aba, Nigeria." *Archives of Applied Science Research*, vol. 5, pp. 11-15.

[20] Nelson, D. W. and Sommer, I. E., 1982. "Total carbon, organic carbon and organic matter. In: Page, A. L., Editor. Methods of soil analysis part II 2 nd Ed." *Agron Monogram*, vol. 9, pp. 539-579.

[21] Bremner, J. M., 1996. "Nitrogen-total. In: Sparks, D.L., Ed., Methods of Soil Analysis, Part 3, Soil Science Society of America, Madison." pp. 1085–1121.

[22] Udo, E. J. and Ogunwale, A. J., 1978. *Laboratory manual for the analysis of the soils plant and water samples*. Ibadan: Department of Agronomy, University of Ibadan. pp. 70-76.

[23] Steel, R. G. D. and Torrie, J. H., 1980. *Principles and procedures of statistics a biometrical approach*. New York: Mc- Graw-Hill Book Publishing Company.

[24] Gebremedhen, G., Yrgalem, T., Weldegerima, G., Kiros, Yohanes, G. H., and A., E., 2018. "Enhancing productivity of pepper (*Capsicum annuum* L.) by using improved varieties." *Journal of Agricultural science and Botany,* vol. 2, pp. 42-45.

[25] Adeola, R. G., Tijani-Eniola, H., and Makinde, E. A., 2011. "Ameliorate the effects of poultry manure and NPK fertilizer on the performance of pepper Relay cropped with two cassava varieties." *Global Journal Science Frontier Research,* vol. 11, pp. 6–12.

[26] Deepaa, N., Kaura, C., Singh, B., and Kapoor, H. C., 2006. "Antioxidant activity in some red sweet pepper cultivar." *Journal of Food Composition and Analysis,* vol. 19, pp. 572–578.

[27] Iwuagwu, C. C., Ugwu, F. C., Nwogbaga, A. C., Aguwa, U. O., Iheaturu, D. E., and Ejiofor, M. E., 2021. "Investigation on impacts of poultry manure application on yield, disease incidence and severity of cucumber (Cucumis. sativus l.) in Awka, Anambra State, Nigeria, Nigerian." *Journal of Botany,* vol. 34, pp. p13-22.

[28] Patriquin, D. G., Baines, D., and Abboud, A., 1995. *Diseases, pests and soil fertility. In. Soil management in sustainable agriculture, edited by hf cook and lee*. England: Wye College Press, Wye. pp. 161-174.

[29] Sarada, C., Ratnam, M., Naram, N. L., Venkata, R. C., Rajani, A., and Vijaya, L. T., 2015. "Chilli production and productivity in relation to seasonal weather conditions in guntur district of andhra pradesh." *International Journal of Pure and Applied Bioscience,* vol. 3, pp. 207-213.