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Effect of Plant Spacing and Fertilizer Application on Growth and Yield of Bell Pepper (*Capsicum annum*) in Experimental Farm at Benin City, Edo State, Nigeria

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ABSTRACT: Optimum plant population, natural resources, such as nutrients, sunlight, soil moisture and efficient fertilization are some of the primary factors that ensure satisfactory growth and yield. Hence, the objective of this paper was to investigate the effect of plant spacing and fertilizer application on growth and yield of bell pepper (Capsicum annum) in experimental farm at Benin City, Edo State, Nigeria using appropriate standard techniques. Three levels of spacing (S1=30cm x 50cm, S2=40cm x 50cm and S3 =50cm x 50cm) and four different levels of fertilizer application (F0 = control, F1 = 20 t ha^{-1} poultry manure, F2 = 300 kg ha^{-1} NPK 15:15:15 and F3 = 150 kg ha^{-1} NPK 15:15:15 + 10 t ha^{-1} were adopted. The parameters measured were plant height, stem diameter, leaf area, number of leaves, number of branches, fresh fruit weight per plant, fresh fruit weight per plot, fruit diameter, fruit length, and number of flowers per plant, number of fruits per plant and fruit yield. The results showed that S3F1, (50cm x 50cm spacing + 20 t ha^{-1} poultry manure) had the highest plant height and stem diameter and S2F3, (40cm x 50cm spacing + 150 kg ha^{-1} NPK 15:15:15 and 10 t ha^{-1}) had the highest fruit yield (1731.60 kg ha^{-1}). The lowest yield (994.49 kg ha^{-1}) was obtained at S1F0, (40cm x 50cm spacing + control). Therefore, farmers in this locality could grow bell pepper *(Capsicum annum*) at S2F3 for increased fruit yield.

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Sweet Pepper (*Capsicum annuum* L.), also known as bell pepper, green pepper, or Pimento, belong to the family *olanaceae*. Pepper is a warm season herbaceous perennial crop in its native habitat. However, outside its native habitat, it is grown as annual which is propagated by seeds. Bell pepper is considered "sweet" because it lacks the pungent chemical (capsaicin) present in hot pepper. It is an important delicious vegetable crop which ranks third in the vegetable cycle after tomato and onion (Akinfasoye *et al.*, 2006) and it can be enjoyed either raw or cooked. In Nigeria, the cultivation of this crop is confined to the drier savannah regions in the north, but now it is gradually cultivated in the southern parts of the country. Bell pepper is an excellent source of antioxidants, vitamin A and C as well as vitamin B6. It is also a very good source of heart-healthy fiber, vitamin E, folate, potassium, vitamin K and antimicrobial activities (Baenas *et al*. 2018) as well as the enzyme-supportive molybdenum. World production of capsicum peppers was estimated at 34 million tonnes in 2017 from a harvested area of about 1.93 million hectares (ha); average yield 16.06 t/ha (Penella and Calatayud, 2018). China is the largest

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producer with 18 million tonnes from a harvested area of (1.59 million hectares; average yield of 11.65t/ha), followed by Mexico (3.44 million tonnes) and Turkey (2.56 million tonnes). Production in tropical Africa is low and estimated at 1 million tonnes, with Nigeria (715,000 tonnes from 90,000 ha; which is 7.94 tonnes per hectare).

In Southern Nigeria, production level is far below the average production level of about 7.94 tons/ha recorded in the Northern part of Nigeria. Among the major contributing factors to the low production in Southern Nigeria are low soil fertility, weeds, pests and diseases infestation, poor agronomic practices (inappropriate spacing, mulching, tillage system, poor harvesting, handling and processing) and influence of climatic conditions in the zone and these factors are important for growth and development of any crop plant. Pepper production can be increased by the use of appropriate plant spacing, this is very important because it reduces competition between plants and weeds for growth factors such as light, water and nutrients thereby increasing crop growth and yield. Singh (2007) reported that appropriate plant spacing results in greater air circulation and light interception by plants and reduces the incidence of pest and diseases. Edgar *et al* (2017) carried out an experiment on green pepper and discovered that optimally spaced plants with adequate soil nutrients tend to experience proper growth and development resulting in increased yield and revenue of pepper. The prospects of obtaining adequate chemical fertilizers to meet the requirement of the teeming farming population is remote in many developing countries (FAO, 1975). The report further stated that the prevailing exorbitant prices of mineral fertilizers and shortage in their supplies have shifted the attention of many farmers towards making better use of organic manure as an alternative source of plant nutrients. Poultry manure among other sources of organic manure has been found to be superior and has higher nutrient content than other sources of manure (Ikeh *et al.*, 2013). Chemical fertilizers tend to provide the plant nutrients readily and encourage vegetative growth, thereby, delaying the flowering phenomenon in bell pepper. Research reports has shown that high and sustained crop yield could be achieved with a balanced use of organic and inorganic fertilizers. Nutrients from mineral fertilizers enhance the establishment of crops, while those from mineralization of organic manure promote yield when both fertilizers are combined. The complementary application of organic and inorganic fertilizers has been found to be more sustainable, meet the immediate soil nutrient deficits, improve the soil physical properties and enhance yield stability than separate application. (Aliyu and Olanrewaju, 2000; Giller, 2002). Falodun *et al.*, (2013) carried out an experiment on the effects of organic and inorganic fertilizers on the growth and yield of onion (*Allium cepa*) and recorded positive responses in both vegetative and yield attributes of plants that received combined application of fertilizers compared with those that received sole application rates. Integrated use of organic wastes and mineral fertilizer is reported to reduce the cost and amount of fertilizer required by crops (IAEA, 2003; Krupnik *et al.*,2004; Dobermann and Cassmann 2004). Proper soil fertility management through combined use of organic wastes and chemical fertilizers and optimum plant spacing could be an effective approach to combat nutrient depletion and promote sustainable crop productivity. Therefore, the objectives of this paper was to investigate the effect of plant spacing and fertilizer application on growth and yield of bell pepper (Capsicum annum) in experimental farm at Benin City, Edo State, Nigeria.

MATERIALS AND METHODS

Study Area: Field trials were conducted during the dry cropping seasons of 21/22, at the Department of Crop Science Experimental Farm, Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria, which lies between latitude 6° 14' N and 7° 34' N and longitude 5° 40' E and 6° 43' E with an average elevation of 77.8 m above sea-level. The area is subjected to marked wet and dry seasons with a bimodal rainfall pattern, with two rainfall peaks (July and September). There is heavy rainfall in May-June-July, which is interrupted by a dry period of about two weeks in August, usually referred to as 'August Break'. This is followed by another period of heavy rainfall from September to October that make two growing seasons possible. According to Nigerian Meteorological Agency (NIMET), Airport Station, Benin City the temperature of the study area at maximum is about 30^0 C and minimum of 24^0 C with relative humidity of approximately 80% and heavy annual torrential rainfall of 2300 mm.

Soil and Poultry manure properties: The soil belongs to an order Ultisol, (USDA system, (2008) and a textural classification of the site is sandy loam (Staff survey, 1999). The experimental field was manually cleared and debris worked into the soil. Prior to planting, poultry manure was collected from the University livestock farm and composite soil samples were collected from a depth of 0 – 30 cm, using soil auger. Samples were air-dried and packaged for routine soil physico-chemical analysis. Soil pH was determined using a pH meter. Organic carbon was determined by wet oxidation method (Walkley and Black, 1962) as modified by Jackson (1969). Total nitrogen was obtained by macro Kjeldahl method as

modified by Jackson (1969). Available P was extracted by Bray I method (Bray and Kurtz, 1945) and P was estimated by the blue colour method of Murphy and Riley (1962). Exchangeable K and Na were determined using flame photometer, while Ca and Mg were determined using the Atomic Absorption Spectrophotometer. The results of the soil analysis and poultry manure are presented in Table 1.

Experimental Design: The experiment was laid out as a 3×4 factorial experiment fitted into a randomized complete block design (RCBD). The treatments consisted of three levels of spacing (30cm×50cm, 40cm×50cm and 50cm×50cm) and four levels of fertilizer application (control, 20 t ha^{-1} poultry manure, 300 kg ha^{-1} NPK 15:15:15 and 10 t ha^{-1} poultry manure + 150 kg ha^{-1} NPK 15:15:15 fertilizer). Seeds were planted in the nursery with soil rich in organic matter. The poultry manure used for the experiment was incorporated into their respective plots, depending on the treatment, and left for two weeks before transplanting of seedlings. The seedlings were transplanted at one seedling per stand into the experimental field after four weeks depending on the plant spacing. Plots were mulched to conserve soil moisture; weeding was done first at two weeks after transplanting and subsequently weeding was done as soon as weeds emerged.

Sampling and measurement: Data collection started four weeks after transplanting (WAT) and continued fortnightly thereafter. Four plants were randomly selected from each plot and tagged for the purpose of collecting data for plant height (cm), number of leaves, number of branches, leaf area (cm) and stem diameter (cm). For the reproductive characters data were collected on number of flowers, days to 50 % flowering, number of fruits, fruit weight per plant (g) used to estimate its fruit yield in (t ha^{-1}) based on the formula below

$$Yield\ (tonnes\ \text{per hectare}) = \frac{Plot\ yield\ (tonnes) x\ 15000}{Plot\ size\ (metre\ sq.)}$$

Statistical analysis: Data collected were subjected to analysis of variance (ANOVA), using SAS (Statistical Analysis Software) and least significance difference (LSD) test at 5% level of probability was used to compare the significant treatment mean.

RESULTS AND DISCUSSION

The chemical characteristics of the soil used for the experiment showed that the soil was strongly acidic and low in essential plant nutrients with a textural classification of sandy loam (Table1).

Table 1: Physical and chemical properties of the experimental soils preplant and post-harvest at 0 - 30 cm depth

Soil properties	Experimental sites			
	Exp 1		Exp 2	
	Pre	Post	Pre	Post
pH (H_2O)	5.21	5.23	5.30	5.38
Organic Matter (g $150g^{-1}$)	0.40	0.79	0.83	2.18
Total N ($g150g^{-1}$)	0.02	0.03	0.05	0.06
Total P (mg kg^{-1})	3.43	16.61	2.52	15.24
K (cmol kg^{-1})	0.14	0.16	0.26	0.29
Ca (cmol kg^{-1})	1.25	1.20	1.20	1.80
Mg(cmol kg^{-1})	0.18	0.60	0.18	0.80
Sand (%)	66.5	66.96	64.80	66.47
Clay (%)	25.30	24.75	27.20	25.38
Silt (%)	8.17	8.29	8.00	8.15
Textural class	Sandy loam		Sandy loam	

The chemical composition of the poultry manure used for the experiment showed that it contained adequate nutrients required for optimum plant growth (Table 2).

Table 2: Chemical composition of poultry manure

Properties	Values
pH (H_2O)	6.32
Total N (%)	2.18
Available Phosphorus (%)	4.12
Potassium (%)	1.12
Sodium (%)	0.17
Calcium (%)	3.76
Manganese (%)	1.14
Zinc (%)	0.13
Iron (%)	3.25
Organic carbon (%)	24.12

Some significant ($P < 0.05$) variations were observed in the growth response of green pepper to plant spacing and fertilizer application, irrespective of the plant spacing plants that received no fertilizer S1F0, S2F0 and S3F0 produced significantly shorter plant heights (8.88 cm and 10.72 cm), S2F0 (8.04 cm and 10.53 cm) and S3F0 (9.42 cm and 13.57 cm) respectively in both years. The highest plant height (12.68 cm and 23.90 cm) was recorded for S2F3 and this was statistically similar in all the plants that received fertilizers. Stem diameter, (0.46 cm), (0.40 cm), (0.40 cm) and (0.41 cm) for S3F1, S2F1, S2F2 and S1F1 respectively, revealed that these values were statistically similar and enhanced the plant stem diameter above S1F0 (0.27 cm), S2F0 (0.28 cm) and S3F0 (0.28cm) (Table 3). Leaf area was not significant ($p< 0.05$) in 2021, cropping season however, there was significant difference in the leaf area in the 2022, cropping season. S1F1 (21.94), S3F3 (21.94), S3F2 (21.69) and S1F3 (20.37) were statistically at par and produced significantly higher values for leaf area than S1F0 (10.69), S1F1 (10.66), S2F3 (11.75) and S3F0 (7.74).

Table 3: Effect of row spacing and fertilizer application on some vegetative characters of pepper (*Capsicum annum*)

Treatments	2021 Plant height (cm)	2022 Plant height (cm)	2021 Stem diameter (cm)	2022 Stem Diameter (cm)	2021 Leaf area (cm^2)	2022 Leaf area (cm^2)
S1F0 (30cm x 50cm + Control)	8.88^{b}	10.72^{b}	0.27^{c}	0.24^{b}	11.69^{a}	10.69^{bc}
S1F1 (30cm x 50cm + 20t ha^{-1} poultry manure)	12.38^{ab}	19.51^{a}	0.41^{a}	0.25^{a}	23.02^{a}	21.94^{a}
S1F2 (30cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	9.70^{ab}	13.94^{a}	0.37^{ab}	0.26^{a}	11.22^{a}	16.58^{ab}
S1F3 (30cm x 50cm + 150kg ha^{-1} NPK 15:15:15) and 10t ha^{-1} poultry manure)	11.59^{ab}	22.38^{a}	0.31^{ab}	0.38^{a}	25.49^{a}	20.37^{a}
S2F0 (40cm x 50cm + Control)	8.04^{b}	10.53^{b}	0.28^{bc}	0.23^{b}	12.05^{a}	10.66^{bc}
S2F1 (40cm x 50cm + 20t ha^{-1} poultry manure)	11.58^{ab}	20.49^{a}	0.40^{a}	0.29^{a}	19.45^{a}	15.38^{ab}
S2F2 (40cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	10.68^{ab}	16.90^{a}	0.40^{a}	0.39^{a}	25.13^{a}	15.89^{ab}
S2F3 (40cm x 50cm + 150kg ha^{-1} NPK 15:15:15) and 10t ha^{-1} poultry manure)	12.59^{ab}	23.36^{a}	0.35^{ab}	0.35^{a}	17.40^{a}	11.75^{bc}
S3F0 (50cm x 50cm + Control)	9.42^{ab}	13.57^{b}	0.28^{bc}	0.23^{b}	14.47^{a}	7.74^{c}
S3F1 (50cm x 50cm + 20t ha^{-1} poultry manure)	14.79^{a}	20.72^{a}	0.46^{a}	0.29^{a}	27.19^{a}	20.21^{a}
S3F2 (50cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	10.18^{ab}	19.51^{a}	0.36^{ab}	0.24^{a}	18.17^{a}	21.69^{a}
S3F3 (50cm x 50cm + 150kg ha^{-1} NPK 15:15:15 and 10t ha^{-1} poultry manure)	11.17^{ab}	20.94^{a}	0.31^{b}	0.30^{a}	15.29^{a}	21.94^{a}
Significance	*	*	*	*	NS	*

*Means with similar alphabet along the column and within same treatment are not significantly different p< 0.05 ; NS=not significant, * significant*

Table 4: Effect of row spacing and fertilizer application on number of leaves and branches of pepper (*Capsicum annum*)

Treatments	2021 Number of leaves	2022 Number of leaves	2021 Number of branches	2022 Number of branches
S1F0 (30cm x 50cm + Control)	10.92^{a}	19.08^{a}	6.75^{a}	4.41^{bc}
S1F1 (30cm x 50cm + 20t ha^{-1} poultry manure)	15.17^{a}	24.93^{a}	8.92^{a}	8.27^{a}
S1F2 (30cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	10.31^{a}	17.53^{a}	7.31^{a}	6.02^{ab}
S1F3 (30cm x 50cm + 150kg ha^{-1} NPK 15:15:15 and 10t ha^{-1} poultry manure)	14.83^{a}	36.29^{a}	8.34^{a}	6.45^{ab}
S2F0 (40cm x 50cm + Control)	11.52^{a}	15.54^{a}	8.14^{a}	6.58^{b}
S2F1 (40cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	11.92^{a}	29.88^{a}	8.00^{a}	8.11^{a}
S2F2 (40cm x 50cm + 150kg ha^{-1} NPK 15:15:15)	17.25^{a}	30.30^{a}	10.50^{a}	8.16^{a}
S2F3 (40cm x 50cm + 150kg ha^{-1} NPK 15:15:15 and 10t ha^{-1} poultry manure)	10.61^{a}	21.88^{a}	7.06^{a}	6.70^{ab}
S3F0 50cm x 50cm + Control	13.75^{a}	15.19^{a}	8.50^{a}	4.12^{bc}
S3F1 50cm x 50cm + 20t ha^{-1} poultry manure	14.89^{a}	20.41^{a}	10.19^{a}	8.54^{a}
S3F2 50cm x 50cm + 300kg ha^{-1} NPK 15:15:15	12.00^{a}	29.08^{a}	8.17^{a}	8.41^{a}
S3F3 (50cm x 50cm + 150kg ha^{-1} NPK 15:15:15 and 10t ha^{-1} poultry manure)	10.42^{a}	24.33^{a}	6.92^{a}	8.27^{a}
Significance	NS	NS	NS	*

*Means with similar alphabet along the column and within same treatment are not significantly different p< 0.05 ; NS=not significant, * significant*

Number of leaves were not significant in both years. Similarly, the number of branches were not significant in 2021 cropping season but significant ($p< 0.05$) in 2022 cropping season were the number of branches increased from S1F0 (4.12) to S3F1 (8.54) (Table 4).

The number of flowers (9.01 and 11.00) and (9.78 and 11,67) were higher in both years for S1F1 and in S2F2 respectively compared with S1F0 (2.03 and 3.45) and S1F2 (3.12 and 4.00) which were significantly lower. Number of fruits range from 1.00 to 5.45 in both years, the lowest number of fruits per plant (1.00) were harvested in 2021 cropping season at S2F0 and S3F0 and this trend was similar for 2022 cropping season. The highest number of fruits harvested per plant (5.45) was at par with all the plants that received fertilizers and these were increased above the control plots (Table 5). Fruit diameter increased from S3F0 (2.35

cm) to S2F2 (5.52 cm) in 2021 cropping season while in 2022, cropping season, it increased from S1F0 (3.05 cm) to S2F2 (5.80 cm). Although fruit length was enhanced in the 2022 cropping season more than 2021 season but it did not follow a particular other (Table 6).

Table 5: Effect of row spacing and fertilizer application on some vegetative characters of bell pepper (*Capsicum annum*)

Treatments	2021 Number of flowers per plant	2022 Number of flowers per plant	2021 Number of fruits per plant	2022 Number of fruits per plant	2021 Fruit diameter (cm)	2022 Fruit diameter (cm)
S1F0 (30cm x 50cm + Control)	2.02^{b}	3.45^{b}	2.00^{abc}	2.42^{b}	2.37^{e}	3.05^{b}
S1F1 (30cm x 50cm + 20t ha^{-1} poultry manure)	9.01^{a}	11.00^{a}	4.67^{a}	4.94^{a}	3. 68^{bc}	3.78^{ab}
S1F2 (30cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	3.12^{b}	4.00^{b}	1.67^{bc}	4.45^{a}	3.87^{bc}	3.39^{ab}
S1F3 (30cm x 50cm + 150kg ha^{-1} NPK 15:15:15 and 10t ha^{-1} poultry manure)	6.54^{a}	8.33^{a}	1.67^{bc}	4.21^{a}	3.60^{bcd}	3.37^{ab}
S2F0 (40cm x 50cm + Control)	2.25^{b}	3.33^{b}	1.00^{d}	2.91^{b}	2.50^{de}	3.36^{ab}
S2F1 (40cm x 50cm +20t ha^{-1} poultry manure)	4.41^{a}	9.33^{a}	2.00^{abc}	3.87^{ab}	2.97^{cde}	4.78^{ab}
S2F2 (40cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	9.78^{a}	11.67^{a}	3.33^{a}	4.28^{a}	4.15^{b}	5.80^{a}
S2F3 (40cm x 50cm + 150kg ha^{-1} NPK 15:15:15) and 10t ha^{-1} poultry manure)	4.32^{b}	9.33^{a}	1.67^{bc}	4.41^{a}	5.52^{a}	4.09^{ab}
S3F0 (50cm x 50cm + Control)	5.34^{ab}	4.67^{ab}	1.00^{d}	2.12^{b}	2.35^{e}	3.13^{b}
S3F1 (50cm x 50cm + 20t ha^{-1} poultry manure)	7.61^{ab}	8.00^{a}	2.00^{abc}	5.45^{a}	4.31^{b}	5.50 ^{a}
S3F2 (50cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	6.05^{ab}	7.00^{ab}	3.00^{a}	4.62^{a}	2.93^{cde}	5.42 ^{a}
S3F3 (50cm x 50cm + 150kg ha^{-1} NPK 15:15:15 and 10t ha^{-1} poultry manure)	5.10^{ab}	5.33^{ab}	1.33^{c}	4.91^{a}	3.70^{bc}	5.76 ^{a}
Significance	*	*	*	*	*	*

*Means with similar alphabet along the column and within same treatment are not significantly different p< 0.05; NS=not significant, * significant*

Table 6: Effect of row spacing and fertilizer application on yield and yield attributes of bell pepper (*Capsicum annum*)

Treatments	2021 Fruit length (cm)	2022 Fruit length (cm)	2021 Fruit fresh weight/ plant (g)	2022 Fruit fresh weight/ plant (g)	2021 Fruit yield (kg/ha)	2022 Fruit yield (kg/ha)
S1F0 (30cm x 50cm + Control)	3.87^{bc}	4.78^{b}	10.45^{d}	19.98^{c}	994.49^{d}	1005.70^{d}
S1F1 (30cm x 50cm + 20t ha^{-1} poultry manure)	5.52^{a}	7.00^{a}	22.27^{ab}	35.16^{a}	1287.10^{b}	1355.20^{b}
S1F2 (30cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	3.43^{bc}	5.29 ^{ab}	27.84^{a}	37.84^{a}	1239.2^{bc}	1310.40^{b}
S1F3 (30cm x 50cm + 150kg ha^{-1} NPK 15:15:15 and 10t ha^{-1} poultry manure)	3.67^{bc}	5.98^{ab}	17.49^{cd}	34.91^{a}	1274.5^{bc}	1381.60^{b}
S2F0 (40cm x 50cm + Control)	2.87^{c}	4.92^{b}	12.12^{cd}	18.12^{c}	1105.6^{c}	1147.45^{c}
S2F1 (40cm x 50cm + 20 t ha^{-1} poultry manure	4.79^{ab}	5.11^{ab}	20.17^{ab}	37.17^{a}	1500.8^{a}	1650.20^{a}
S2F2 (40cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	3.67^{c}	8.21a	26.70^{a}	47.29^{a}	1586.4^{a}	1598.10^{a}
S2F3 (40cm x 50cm + 150kg ha^{-1} NPK 15:15:15) and 10t ha^{-1} poultry manure)	5.50^{a}	5.58 ^{ab}	33.84^{a}	43.84^{a}	1569.2^{a}	1731.60^{a}
S3F0 (50cm x 50cm + Control)	2.20^{c}	4.81^{b}	12.83^{cd}	18.97^{c}	1119.9^{c}	1185.14^{b}
S3F1 (50cm x 50cm + 20t ha^{-1} poultry manure)	5.42^{a}	8.00^{a}	28.74^{a}	46.75^{a}	1433.7^{ab}	1600.10^{a}
S3F2 (50cm x 50cm + 300kg ha^{-1} NPK 15:15:15)	3.67^{bc}	5.34^{ab}	23.67^{ab}	34.67^{a}	1423.3^{ab}	1677.60^{a}
S3F3 (50cm x 50cm + 150kg ha^{-1} NPK 15:15:15 and 10t ha^{-1} poultry manure)	3.50^{bc}	5.33^{ab}	25.76^{a}	52.70^{a}	1613.5^{a}	1711.33^{a}
Significance	*	*	*	*	*	*

*Means with similar alphabet along the column and within same treatment are not significantly different p< 0.05 ; NS=not significant, * significant*

Irrespective of the spacing in 2021 cropping season, poultry manure increased fruit length above other treatments, plants that received either 10t ha^{-1} or 20t ha^{-1} as well as their combinations S1F1 (5.52 cm), S2F1(4.79cm), S2F3(5.50 cm) and S3F1(5.42 cm) were at par and enhanced fruit length above other treatments. In both years, irrespective of the plant spacing, fruit fresh weight S1F0 (4.78 g and 12.45 g), S2F0 (4.92 g and 12.12 g) and S3F0 (4.81 g and 10.83 g) were significantly lower in the control plots and higher in fertilized plots. In both years significantly ($p< 0.05$) higher fruit yield S2F3 (1569.20 t ha^{-1} and 1731.60 t ha^{-1}), S3F1 (1433.7 t ha^{-1} and 1600.10 t ha^{-1}), S3F2 (1423.3 t ha^{-1} and 1677.60 t ha^{-1}), S3F3 (1613.5 t ha^{-1} and 1711.33 t ha^{-1}) were at par with S2F1 (1500 t ha^{-1} and 1650.20 t ha^{-1}) and S2F2 (1586.4 t ha^{-1} and 1598.10 t ha^{-1}) and increased above S1F1 (1287.10 t ha^{-1} and 1355.20 t ha^{-1}), S1F2 (1239.20 t ha^{-1} and 1310.40 t ha^{-1}), SIF3 (1274.50 t ha^{-1} and 1381.60 t ha^{-1}), while significantly lowest fruit yields (994.49 t ha^{-1} and 1005.70 t ha^{-1}) were produced at S1F0 in 2021 and 2022, cropping seasons respectively.

The total nitrogen, available phosphorus, were all below recommended critical levels of 0.15% N, 10 – 16mg/kg P and 0.34 Cmol kg K for crop production except for available phosphorus which was in the range at postharvest (Aduayi *et al;* 2002; Agbede, 2009). This necessitated for additional nutrient amendments to the soil. Previous findings has shown that tropical soils are usually deficient in one or more of the essential elements needed for crop growth Ogunwale *et al*; (2002) and the inorganic fertilizer and poultry manure (PM) applied as source of nutrients to the soil were rich in plant nutrients been adequate for pepper production. The superior performance in vegetative growth of bell pepper to fertilizer application could be attributed to an increase in cell division in the plant tissues, leading to the production of more photosynthetic surface and subsequent accumulation of photosynthates for more vegetative growth. This result supports the finding of Agele, (2001) and Oladitan and Akinseye, (2014) who attributed the production of more leaves, increase in plant height, number of branches, stem diameter and well developed structures of bell pepper to the environmental conditions of the plants. They emphasized that good environmental condition under adequate moisture and nutrient supply favours growth and development of crops. The positive response with respect to plant height as a result of combine application of organic and inorganic fertilizers (S2F3), could be as a result of the presence of growth promoting factors in the combination of organic and inorganic fertilizers as well as the plant spacing which was adequate for the plants, this report is in line with the findings of Arancon *et al.,* (2005). The significantly least numerical value recorded from the control plots in both experiments may be due to the non-availability of nutrient sources from the organic and inorganic fertilizers to the plant and so plants under the control plots have to depend solely on the inherent soil nutrients. The increase in number of flowers and fruits especially with the fertilized plants could be due to higher number of fruiting buds formed which resulted to increase in the fruit production. The increase in fruit yield with S2F3, may be as a result of higher plant density and better canopy formation which may have checked weed growth and reduced competition for plant nutrients from weeds. The reduction in fruit yield with S1F0, S1F1, S1F2 and S1F3 may be attributed to higher plant density which might have restricted light penetration and dry matter accumulation, thus reducing flowering bud development. The interplant competition for growth factors due to crowding and the shallow taproot system may have resulted to low yield of the plants which may have prevented the absorption of water and nutrients at deeper soil profiles there by reducing yields. Increase in yield with S2F3, may be due to higher plant density which resulted in increased number of fruits per hectare in the plots. This result shows that the spacing was adequate and fully utilized for pepper production.

Conclusion: The result from this experiment showed that combine use of poultry manure and inorganic NPK fertilizer can replace the use of chemical fertilizer only. It is evident from the result that proper plant spacing with combine application of fertilizer at S2F3 should be adopted for maximum fruit yield of bell pepper in the rainforest agroecological zone of Nigeria.

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