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Studies on Performance of "NsukkaAromatic Yellow Pepper" (*Capsicum annum* L.) under varying Population and Organomineral Fertilizer Regimes

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ABSTRACT

A field experiment was carried out during 2018 and 2019 planting seasons to evaluate the growth and yield of " Nsukka Yellow Pepper" as influenced by plant population density and rates of application of Organomineral fertilizer at the University of Ilorin Faculty of Agriculture Teaching and Research Farm vegetable field. The experiment was laid out in a split plot arrangement fitted into a Randomized Complete Block Design. The main plot comprised of three population densities (60,000 plants/ha, 50,000 plants/ha and 40,000 plants/ha) and four rates of Organomineral fertilizer (OMF): 0, 1, 2 and 3 t/ha as sub-plots. All treatments were replicated thrice. Data were collected on plant height, number of leaves and branches, stem girth, days to 50% flowering and 50% maturity, number of fruits, mean fruit weight and fruit yield. The data were analyzed using Genstat Statistical packages 17^{th} edition and significant means were separated using the Least Significant Difference at 5 % probability. Results from the study showed that plant population and organomineral fertilizer regimes had significant interactive effects on all parameters observed at $p< 0.05$. Number of leaves and branches; number of fruit, fruit weight/ plant and fruit yield/ha were highest at the lowest population which was not significantly different from 50,000 plant/ha. Days to 50% flowering and fruit maturity were highest at 50,000 plants/ha plus 3 t/ha OMF. The study concluded that the best plant population and organomineral fertilizer rate for cultivating "Nsukka Yellow Pepper" for optimum growth and yield are 50,000 plants/ha and 3 t/ha.

KEYWORDS: Pepper, Nutrient uptake, Plant density, Soil

1. INTRODUCTION

Pepper (*Capsicum annum L.)* belongs to the family Solanaceae a group of crops commonly referred to as perishables (Onwubuya *et al.,* 2009). It originated in the Mexico and Central American regions (Purseglove, 1981). It is the worlds' second most important vegetable after tomato (Yoon *et al.,* 1989). In the native habitats, pepper is grown as tender perennials, however, they are grown as annuals in many parts of the world. It is eaten raw in salads, cooked in various ways (Purseglove, 1991) or processed into canned, picked, frozen, fermented, dehydrated or extracted products (Bosland and Votava, 2000). It plays a vital role in the nutritional balance of the rural and urban dwellers by supplying vitamins and minerals in their diets (Leung *et al*., 1968). Pepper is an excellent source of natural antioxidants (carotenoids), Vitamins (A, C and E) and micronutrients (calcium and Iron) which are critically important in preventing/treating chronic and age-related diseases (Namiki, 1990). Pepper acts as a therapeutic agent for cancer, soothes gout, relieve cramps and improve complexion (Palevitch and Craker, 1996). It is grown primarily for its pungency due to high content of capsaicin that makes pepper an important ingredient in spice commodity in the world(Bosland and Votava, 2000).

Nigeria is one of the major pepper producing country in the world accounting for 452,673 metric tons annually, about 50% of Africa's production (FAOSTAT, 2009). Its consumption accounted for about 20% of Nigeria's average daily consumption per individual (Erinle, 1989). In Nigeria, it is regarded as the third most important vegetable after onions and tomato(Adetula and Olakojo, 2006). The varieties of pepper produced in Nigeria include; Bird peppers atawere (*C. frutescens*), red pepper "sombo" (*C. frutescens*), Atarado (*C. annum*), Tatase (*C. annum*) and also 'Nsukka aromatic yellow pepper' (*C. annum*) (Olufolaji and Denton, 2000;). 'Nsukka aromatic yellow pepper' (NY pepper), a variety of *C. annum*, is a popular crop in the eastern part of Nigeria (Adamu *et al.,*1994; Uguru, 1999) for its fruits which are characterized by unique aroma, hotness (due to the high capsaicin content), nutritional values, adaptability to the existing cropping systems and potentials for wealth creation (Abu and Uguru, 2005). Nsukka agricultural zone in the eastern part of Nigeria (Enugu state) is generally considered to be the home of NYPepper being its' centre of high production hence the name was so derived (Maga *et al.*,2012). Asogwa (2006) noted that the distinctive aroma of 'Nsukka yellow pepper' enhances its acceptability in the market and consequently attracts higher price than other pepper types in the local and urban markets. Ajayi and Eneje (1998) reported that the distinctive aroma of the cultivar makes it very much cherished in the diets of several homes and eateries. It was also observed that NY pepper is not widely cultivated in most states of Nigeria, probably due to the belief that it may not survive and the likelihood of losing its pungency, aroma and the yellow colour when planted outside Nsukka agricultural zone (Amakor, 1994;Uguru, 1999). However, it was reported to have been successfully cultivated in Kogi state, North central Nigeria within the same derived savanna ecology as Nsukka.

Currently, the domestic demand for peppers in Nigeria has been on the increase which has resulted in a decline in the quantity being exported to other countries (Erinle, 1989). Among major challenges of increase production are shortages of improved varieties, infestation and poor agronomic practices among local farmers that constitute the bulk of pepper producers in Nigeria. Hence, the need to urgently intensify the production of high quality pepper such as NY pepper in other areas within the guinea savanna zone of Nigeria.Peppers being an environment-dependent crop requires knowledge on the different ways of manipulating ambient environmental conditions to suit an improved production (Law-Ogbomo and Egharevba, 2009). Plant density is an important determinant of yield (Ekwu and Oporie, 2002) and yield was reported to increase per unit area with an increase in plant density up to a point then declines (Akintoye *et al*., 2009). Cultural methods such as crop intensification require knowledge of appropriate planting density that allows for healthy inter and intra plant competition for space, soil nutrients, light and water (Adani *et al*. 1998). Nasto *et al*.(2009) advocated for an increase in plant density of 'Bell Pepper' to improve fruit yield/hectare.

Pepper has been reported to be high nitrogen demanding crop for successful growth, high yield and fruit quality. Nigeria, like other tropical countries, is faced with inherent low soil fertility hence the need to enhance nutrient supply through the application of organic or inorganic fertilizers. Application of organic-based fertilizers such as Organomineral fertilizer has become more popular among vegetable farmers due to its low cost, availability and environmentally friendly nature for sustainable crop production (Okunlola *et al*., 2011; Olowoake, 2014). Organomineral fertilizer (OMF) which is a combination of organic manure (solid waste) and inorganic minerals (chemical nutrients) had been proposed for crop production (FAO, 2004). Application of recycled biosolid to agricultural land is relatively cheaper than other disposal practices such as incineration, landfill etc. which are generally considered unsustainable (Antille *et al*., 2013). Organomineral fertilizer is a new fertilizer product developed by blending granular inorganic fertilizer (of one or more macro nutrient) with organic fertilizer from residues of livestock production, sewage sludge and composted municipal solid waste. It is thus considered as a low-cost input technology aimed at improving the poor nutritional status of most tropical soils for sustainable crop production (Antilles *et al*., 2013). It has the advantage of releasing nutrients gradually into the soil in the form that can easily be absorbed by plants and can trigger the availability of soil microorganisms, which helps the decomposition processes of organic matter around the rhizosphere. These will enhance plant growth, better fruit yield and nutritional quality (Correa *et al*., 2016). An appropriate combination of plant density and fertilization are important practices that enhance fruit yield and quality of pepper. Therefore, this study aimed at evaluating the effect of different plant population density and varying rate of OMF on NYPepper production in Ilorin, southern guinea savannah, Nigeria.

2. MATERIALS AND METHODS

Field experiments were conducted at the Faculty of Agriculture Teaching and Research vegetable field, University of IIorin, IIorin (latitude 8º29'N longitude 4º35'E) North central Nigeria, during the rainy seasons of 2018 and 2019. The area is characterized by a bimodal rainfall pattern with peaks in June and September and dry spell between mid-July and August. The annual rainfall in Ilorin is between 1000-1240 mm and a mean temperature range of 19ºC-33ºC. It is also dominated by sandy loam soil with few scattered trees around.(Planning Monitoring and Evaluation Department, Kwara State Agriculture Development Project, llorin, Nigeria, 2016).

The study was set up as a split plot, laid out in a randomized complete block design (RCBD), whereby the main plot comprised of three plant populations which were; 60,000 (30 x 50cm), 50,000 (40 x 50cm) and 40,000 (50 x 50cm) plants/ha and four rates of organomineral fertilizer application in sub-plots ; 0 t/ha (control), 1t/ha, 2 t/ha and 3 t/ha. The total gross land area for the experiment (252 m^2) was ploughed, harrowed and made into raised beds of 2m x 2 m net plots. The field was divided into three main blocks partitionedto twelve subplots giving a total of thirty-six plots. Topsoil samples between 0-15 cm depths were taken randomly from the experimental site to form a composite, air dried, sieved and taken to the laboratory for the determination of some physical and chemical properties using standard laboratory procedures (AOAC, 1990): Particle size was determined by hydrometer method (Bouyoucos, 1962), pH was determined at 1:2.5 in water and KCl using pH meter, exchangeable acidity was determined using by titration using 1N KCl extract as described by Rhoades (1982), organic carbon was determined by dichromate oxidation, total nitrogen was determined by microkjedal wet oxidation, exchangeable bases {calcium (Ca^{2+}),magnesium (Mg^{2+}),potassium (K^+) and sodium (Na^+)}were extracted with 1N ammonium acetate; K^+ and Na^+ were determined by flame photometer while Mg^{2+} and Ca^{2+} were determined by AAS (Analyst 200 Perkin Elmer, Waltham, MA). Available phosphorus was determined by Bray P-1 method.

Organomineral fertilizer (Aleshinloye grade A) a commercial organic fertilizer product developed by Co-composting of decomposable organic solid waste from heap of wet organic matter at municipal dump site amended with $N:P_2O_5$ ratio. It was purchased from Aleshinloye fertilizer plant, Ibadan, Oyo State, Nigeria. Dry seeds of the aromatic 'Nsukka yellow pepper' obtained from the Enugu state nursery was established on good fertile soil, while healthy seedlings were transferred to the field at four weeks after sowing. Weeding was carried out manually at 3rd and 5th week after transplanting. Insect pest was controlled by the application of cypermethrin (1000EC) at 25ml/10 litres of water. Data were collected from five randomly selected plants from the inner rows on the following parameters: plant height, number of leaves, number of branches, days to 50% flowering, days to 50% maturity, number of fruits, fruit length, weight of fruits and fruit yield/ha. The data for 2018 and 2019 were subjected to analysis of variance separately using Genstat Statistical package 17th edition and significant means were separated using the Fisher's protected Least significant difference at 5 % level of significance.

3. RESULTS AND DISCUSSION

3.1. Pre-planting soil analyses

Results of physico-chemical properties of the experimental soil before planting in both years were presented in Table 1. The soil texture was described as sandy loam while soil pH inKClwas slightly acidic for both years which is good for vegetable production (Olaniyi and Ojetayo, 2010). However, a slight increase in acidity was observed in 2019 by 2.97% compared with 2018. This was probably due to an increase in exchangeable cations as nutrient storage capacity increased with the application of OMF. Mckenzie et al. (2004) reported that soil above pH 5 will maintain good exchangeable plant nutrient cations. Results on exchangeable bases of the soil indicated moderate Ca^{2+} , high Mg^{2+}, Na^+ and K^+ respectively. The total nitrogen and the phosphorus were very low while the organic matter was low in 2018 which indicated that the soil fertility status required an amendment to meet the appropriate nutrients requirements for the crop growth. Considerable increment was observed for nitrogen (3.4%), phosphorus (31.1%)and potassium (8.3%) in 2019 which suggested a positive effect of OMF application to soil of the study area.

3.2. Mean plant height of 'Nsukka Yellow pepper' as affected by plant population and OMF regimes

The plant height of NY pepper increased with increased age of plants from 4 to 6 weeks after transplanting (WAT) as shown in Table 2. The plant height was significantly affected ($p< 0.05$) by theplantpopulation differences at 4WAT in 2018, while no significant differences were observed thereafter. Similarly, population regime had no significant effect on plant height in 2019. The population of 60,000 plants / ha produced the tallest plants, while the 40,000 plants/ha produced the shortest plants at both years. This observation conforms with that of Adani et al. (1998) who reported that plant density has a significant effect on plant height as the plant tends to grow taller to compete for light. The result corroborated the findings of Abu and Uguru (2006) who reported a similar increment in plant height at a higher population of NY pepper.OMF regimes significantly affected plant height ($p < 0.05$) in both years except at 4WAT in 2018. The plant height increased with an increase in the rate of application of OMF for the two years. Application of 3 t/ha OMF (90kgN/ha) gave the best results while pepper under control treatment (0t/ha) had the least. Plant heights of NY pepper were significantly higher in 2019 than 2018 ($p<0.05$) which suggested that the

Table 1. Physical and chemical properties of experimental plot and Organomineral Fertilizer before planting

Physical properties	Soil values*		OMF
	2018	2019	
Clay(%)	6.60 ± 3.60	3.60±0.18	
Silt (%)	8.08 ± 0.40	14.40±0.72	
Sand (%)	85.22± 4.26	82.00±4.10	
Textural class (USDA)	Sandy Loam	Sandy loam	
Chemical properties			
pH (H_2O)	7.20±0.40	7.06±0.35	
pH (KCL)	6.40± 0.30	6.21±0.31	
Available P (mg/kg)	2.22±0.02	3.22±0.16	4.4±0.22
Available N (%)	0.28±0.03	0.29±0.02	5.1±0.25
Organic carbon (%)	0.77±0.04	0.89±0.04	
Organic matter (%)	1.34±0.07	1.53±0.08	
Exchangeable cations			
Ca^{2+} (Cmol/kg)	7.30±0.37	8.22±0.41	
Mg^{2+}(Cmol/kg)	3.42±0.17	3.35±0.17	
Na^{+} (Cmol/kg)	1.20±0.06	1.20±0.06	
K^{+} (Cmol/kg)	3.30±0.17	3.60±0.28	1.8±0.09
ExchangeableH^{+} (Cmol/kg)	0.31±0.02	1.23±0.06	

*values are means of two readings

Table 2. Main effect of planting density and organomineral fertilizer regimes on the plant height of Nsukka Yellow pepper

Planting density (P)plants/ha	Plant Height (cm) 2018			2019		
	4WAT	**5WAT**	**6WAT**	**4WAT**	**5WAT**	**6WAT**
60,000	17.02	18.68	22.35	26.80	32.42	39.03
50,000	15.37	18.01	21.27	22.23	24.83	34.08
40,000	14.34	16.75	21.70	21.71	32.47	32.47
Lsd (0.05)	2.28*	2.82ns	4.03ns	8.63ns	8.60ns	10.63ns
OMF Regime(R)(t/ha)						
0(control)	14.62a	16.93	21.71	20.08	23.75	29.78
1	16.03a	18.45	22.63	22.21	24.44	31.50
2	15.14a	16.10	18.44	24.81	28.82	38.23
3	16.51	19.77	24.31	27.13	31.94	41.27
Lsd (0.05)	2.82ns	3.08*	4.19*	6.37*	7.96*	10.28*
Lsd (0.05)PXR	*	*	*	*	*	*

LSD least significant difference at $p \leq 0.05$; WAT= Weeks After Transplanting, NS= Not significant *= Significant

cumulative effect of OMF application for both years had a positive effect on vegetative growth of the pepper. Interaction effect of population and OMF regimes was significant on the plant height of NY pepper (Table 3). In 2018, the combined population of 60,000 plants/ha and 3 t/ha gave the highest plant height which was not significantly different from 50,000 plants/ha and 3t/ha; while in 2019, the combined application of 50,000 plants/ha and 2 t/ha gave the highest plant height. This also indicated that the soil chemical properties were improved and thus available plant nutrients improved crop growth significantly.This corroborated the findings of Olaniyi and Ajibola (2008) who concluded that fertilizer rates had significant effects on plant height and other agronomic parameters studied.

Table 3. Interaction effect of planting density and organomineral fertilizer regimes on the plant height of Nsukka Yellow pepper

		Plant Height (cm)					
Planting Density(P) plants/ha	**OMF Regime(R) (t/ha)**	**2018**			**2019**		
		4WAT	**5WAT**	**6WAT**	**4WAT**	**5WAT**	**6WAT**
60,000	**0**	14.65	16.47	19.98	18.67	20.75	24.17
	1	16.90	19.22	19.65	20.17	22.22	34.33
	2	17.88	18.07	23.27	24.92	26.55	28.67
	3	18.66	20.95	26.50	24.83	28.17	40.17
50,000	**0**	14.10	16.47	17.65	19.83	20.92	27.67
	1	14.06	17.75	19.48	20.75	24.62	30.83
	2	15.62	17.37	21.77	35.42	43.05	49.53
	3	17.68	20.45	26.20	20.50	24.62	34.17
40,000	**0**	11.93	12.87	17.92	20.25	24.42	31.67
	1	15.11	17.15	21.92	23.92	30.75	37.50
	2	15.17	16.87	23.50	25.58	29.17	43.67
	3	15.20	19.63	23.47	27.45	31.67	39.17
LSD 0.05		*	*	*	*	*	*

LSD= least significant difference at p ≤0.05; WAT= Weeks After Transplanting, NS= Not significant *= significant

3.3. Mean number of leaves of 'Nsukka Yellow pepper' as affected by plant population and OMF regimes

The main effect of plant population and OMF regimes on the number of leaves/plant of NYP is shown in Table 4. The number of leaves /plant increased with increased age of plant and level of OMF. However, population regimes had no significant effect ($p< 0.05$) on the number of leaves for both years. Plants with the highest number of leaves were found in the lowest plant population (40,000 plants /ha). Application of different OMF regimes to NY pepper had significant treatment differences ($p < 0.05$) on the number of leaves of the pepper plant for the period of study in both years. The number of leaves was highest with plants on soil treated with 3t/ha OMF which was not significantly different from plants grown on soil treated with 2t/ha OMF for both years. Plants from the control treatment (0t/ha OMF) had the least number of leaves/plant indicating a positive effect of OMF on plants.This may be due to increased competition within higher plant population (for light, nutrient, space among others) as the plants grow older and thus impact on growth and leaf production.Effect of interaction between plant population and fertilizer regimes on the number of leaves of NY pepper was significant ($p<0.05$) for both years (Table 5). However, in 2018 mean number of leaves increased significantly at higher plant population (60,000 plants/ha) and highest OMF level (3 t/ha) during initial growth (4WAT) and by 6WAT plants, at lowest population (40,000plants/ha) and 3 t/ha OMF had the highest number of leaves/plant. By the following year in 2019, it was observed that plant population of 40, 000 and 2t/ha produced plants with the highest number of leaves/plant throughout the period of study which was not significantly different from 50,000plants/ha. This may be as a result of available nutrients for fewer plants and thus engaged in luxury consumption. This was similar to the observation of Olaniyi et al. (2010) who reported that Okra plants performed best on soil treated with 3 t/ha OMF.

3.4. Mean number of branches of 'Nsukka Yellow pepper' as affected by plant population and OMF regimes

Results obtained from the study showed that the number of branches /plant of NY pepper was not significantly ($p<0,05$) affected by the main effect of population regimes (Table 6) while the main effect of OMF regimes wassignificant ($p<0.05$).Control treatment (with zero application of OMF) had plants with the least number of branches/plant which was significantly different ($p<0.05$) from other levels of OMF application. The best performance was observed with the application of 2t/ha. OMF in 2018 and 3t/ha.OMFin 2019 which produced the highest number of branches/plant of NY pepper.Interaction effect of plant population and OMF regimes

Table 4. Main effect of planting density and Organomineral fertilizer regimes on number of leaves /plant of Nsukka Yellow Pepper

	Mean number of leaves					
Planting density(P)	**2018**			**2019**		
	4WAT	**5WAT**	**6WAT**	**4WAT**	**5WAT**	**6WAT**
60,000	14.5	27.4	47.6	36.6	70.5	95.8
50,000	14.0	26.9	51.3	28.8	52.9	99.6
40,000	13.2	25.4	59.4	42.4	72.3	135.3
$Lsd_{(0.05)}$	3.26ns	7.30ns	17.08ns	20.84ns	35.08ns	61.70ns
OMF Regimes(R) t/ha						
0 (control)	10.7	20.9	42.0	15.4	24.1	36.4
1	14.3	23.6	47.2	34.9	64.4	109.0
2	14.0	30.3	58.5	41.9	72.8	146.0
3	16.6	31.5	63.4	51.4	99.4	148.9
$Lsd_{(0.05)}$	3.19*	7.25*	18.66*	20.06*	40.50*	71.30*
$Lsd_{(0.05)}$ Px R	*	*	*	*	*	*

LSD= least significant difference at p ≤0.05; WAT= Weeks After Transplanting, NS= Not significant *= Significant

significantly affected the number of branches /plant of NY pepper (Table 6).The highest number of branches of NY pepperwas observed within 40,000 plants/ha population combined with the application of 2t/ha OMF while in 2019, 50,000 plants /ha. combined with 3t/ha OMF gave the highest value. This may be due to the higher plant vigour that resulted from the cumulative increase in the nutrient pool and increased nutrient uptake experienced that year.

Table 5. Interaction effect of planting density and Organomineral fertilizer regimes on number of leaves/plant of Nsukka Yellow Pepper

		Number of leaves / plant					
Planting density (P)	**OMF regime(R) t/ha**	**2018**			**2019**		
		4WAT	**5WAT**	**6WAT**	**4WAT**	**5WAT**	**6WAT**
60,000	**0**	10.1	20.8	32.7	16.5	27.3	28.3
	1	16.0	36.5	68.2	49.0	98.2	144.3
	2	13.5	20.5	37.3	35.5	74.0	101.3
	3	18.6	31.7	52.3	45.3	82.3	124.3
50,000	**0**	11.3	22.0	39.8	10.1	20.7	42.7
	1	11.7	24.2	50.3	30.7	56.8	84.3
	2	15.6	21.7	46.8	37.7	70.7	136.0
	3	17.6	33.8	68.3	36.8	63.3	120.0
40,000	**0**	10.8	27.8	53.5	19.7	24.3	38.3
	1	15.1	30.2	71.8	22.7	47.7	84.3
	2	13.1	20.7	57.5	52.7	73.8	209.3
	3	13.7	29.0	54.8	74.5	143.3	209.3
$Lsd_{(0.05)}$							
	P x R	5.67*	13.26*	33.77*	41.68*	70.15*	71.35*

LSD= least significant difference at p ≤0.05; WAT= Weeks After Transplanting, NS= Not significant *= Significant

Table 6. Interaction effects of planting density and organomineral fertilizer regimes on number of branches of Nsukka Yellow Pepper

Planting density (P)	OMF regime(R) t/ha	Number of Branches / plant			
		2018		2019	
		5WAT	6WAT	5WAT	6WAT
60,000	0	3.3	3.7	4.0	9.0
	1	7.3	12.3	5.5	15.3
	2	6.8	10.3	6.0	15.3
	3	7.5	12.2	10.5	17.2
50,000	0	2.3	7.3	5.2	16.3
	1	4.0	11.0	8.5	12.7
	2	6.7	15.3	7.8	25.3
	3	5.5	9.6	10.3	28.0
40,000	0	5.0	9.7	6.2	17.7
	1	7.8	11.0	8.2	21.0
	2	12.8	19.7	11.2	21.3
	3	6.3	12.0	7.7	17.0
$Lsd_{(0.05)}$	P	2.9ns	7.3ns	4.0ns	5.6ns
	R	3.0*	8.0*	4.6*	6.5*
	P x R	5.1*	14.1*	7.9*	11.2*

LSD= least significant difference at p ≤0.05; WAT= Weeks After Transplanting, ns= Not significant; *= Significant

3.5. Effect of plant population and OMF regimes on yield and yield parameters of Nsukka yellow pepper in 2018 and 2019

Effect of plant population and organomineral fertilizer regimes on yield and yield parameters of Nsukka Yellow Pepper in 2018 and 2019 were presented in Table 7 and 8 respectively. Interaction effect of plant population and OMF regimes significantly ($p<0.05$) affected most of the parameters evaluated for yield. The main effect of population on number of days to 50% flowering and days to 50% fruit maturity in NY pepper was found not to be significant ($p<0.05$). Also, OMF regimes alone had no significant effect on the two parameters. However, Interaction effect of plant population and OMF regimes affected flowering and fruit maturity significantly ($p<0.05$) in 2018. Early flowering (56.7 days) was observed in plants within 50,000 plants/ha on soil treated with 2t/ha OMF while longer days (69.7 days) were taken to reach 50% flowering at 60,000 plants/ha and 0t/ha OMF in 2018.

Days to maturity was significantly affected by the combined effect of plant population and OMF regimes at $p<0.05$. At the highest population of 60,000plants/ha, maturity was delayed and it took a longer period of time (110.7days) for 50% of fruits to reach maturity while plants in the lower population (50,000plants/ha) 50% fruit maturity was faster (75.0 days). The delay observed in flowering and fruit maturity particularly when there was no application of nutrient from OMF at highplant population confirmed the inadequacy of the native soil to support plant growth. The competition for space, water, nutrient and others were most severe at the highest population thus reducing the ability of the plants to carry out photosynthetic activities needed at the flowering stage (Amini, 2012). This result also indicated that appropriate planting population of crops alone cannot be considered without knowledge on the adequacy of soil nutrient to support plant growth. Nasto et al. (2009) reported that total fruit yield has an inverse relationship with plant density.

Main and Interaction effect of plant population and OMF regimes significantly ($p<0.05$) affected most of the parameters evaluated for yield in 2019. The only exception being mean fruit length which was not significantly affected by OMF regimes. Days to 50% flowering and days to 50% fruit maturity were shortest within the 40,000 plants/ha. Application of 0t/ha OMF on plants resulted in longer days to 50% flowering(70.7) and fruit maturity(100.7) by over 33% and 16% respectively.

Table 7. Interaction effect of planting density and organomineral fertilizer regimes on yield and yield parameters of Nsukka Yellow Pepper in 2018

Planting density (P)	OMF regime (R) t/ha	Days to 50% Flowering	Days to 50% fruit Maturity	Mean number of fruit/plant	Mean fruit length (cm)	Mean fruit weight /plant (g)	Yield (t/ha)
60,000	**0**	69.7	110.7	4.3	2.23	7.1	0.2
	1	65.7	89.7	9.4	3.97	33.2	0.6
	2	61.3	94.3	5.3	3.61	13.1	0.4
	3	63.3	95.3	5.9	3.28	15.3	0.4
50,000	**0**	65.7	90.3	10.9	4.11	47.8	0.7
	1	65.7	80.7	13.4	3.53	37.2	0.8
	2	56.7	75.0	16.7	3.90	35.1	0.8
	3	60.0	76.0	14.4	4.47	35.9	0.8
40,000	**0**	62.0	86.0	6.8	3.37	23.4	0.5
	1	64.3	84.0	9.7	3.91	23.6	0.5
	2	64.3	82.0	20.0	4.28	45.0	0.9
	3	63.0	81.3	29.3	4.62	82.2	2.6
Lsd$_{(0.05)}$	**P**	4.89ns	9.85ns	10.42ns	0.74*	25.59*	0.93n.s
	R	5.47ns	13.79ns	12.65ns	0.92ns	30.94ns	1.08ns
	P x R	10.10*	19.9*19.9	22.2*22.2	1.4*	1.4 52.1*	0.9*52.1 0.9

LSD= least significant difference at p ≤0.05; WAT= Weeks After Transplanting, NS= Not significant *= Significant

Table 8. Interaction effect of planting density and organomineral fertilizer regimes on yield and yield parameters of Nsukka Yellow Pepper in 2019

Planting density (P)	OMF regime (R) t/ha	Days to 50% Flowering	Days to 50% fruit Maturity	Mean number of fruit/plant	Mean fruit length (cm)	Mean fruit weight/plant (g)	Yield (t/ha)
60,000	**0**	68.7	94.7	50.6	3.73	158.4	4.8
	1	55.0	91.3	140.0	3.33	303.7	9.1
	2	50.3	84.7	165.7	3.31	385.5	11.6
	3	52.3	100.0	125.9	3.30	212.8	6.4
50,000	**0**	70.7	88.3	62.4	4.10	153.1	3.4
	1	55.3	96.7	83.7	4.33	189.4	4.3
	2	52.3	98.0	148.9	4.73	392.1	8.8
	3	55.3	99.3	187.9	4.67	438.7	9.9.
40,000	**0**	67.0	84.3	143.7	3.63	350.8	7.0
	1	49.3	91.3	331.8	4.37	384.2	7.7
	2	46.7	100.7	215.7	3.67	1137.0	22.7
	3	48.3	92.0	153.0	3.83	552.7.2	11.1
Lsd$_{(0.05)}$)	**P**	4.05*	5.98*	64.60*	0.72*	23.04*	4.95*
	R	4.67*	6.91*	74.60*	0.83ns	26.61*	5.72*
	P x R	8.90*	11.96*	129.20*	1.44*	460.80*	9.91*

LSD= least significant difference at p ≤0.05; WAT= Weeks After Transplanting, NS= Not significant *= Significant

Mean fruit length, number of fruits, fruit weight/plant and yield/ha were also affected significantly (p<0.05) by the combined effect of plant population and OMF regimes. Plants in 40,000plants/ha and 2t/ha showed the best performance for these parameters except fruit length which was highest at 50,000 plants/ha and 3t/ha OMF. The performance at the lowest population may be due to the high number of leaves and branches which implied wider leaf canopy. Higher photosynthetic efficiency could be achieved at a wider canopy due to improved light interception and consequently improved yield/ha (Aliyu et al. 1990). Abu and Odo (2017) also reported the highest number of fruits and fruit weight/plant for NY pepper at the lowest plant population at Nsukka. However, the yield /ha reported for NY pepper was in contrast with that observed in this study. This may due to differences in adaptation to environmental conditions. Nasto et al.

(2009) suggested that evaluation of adequate plant population of a location could help to maximise the yield (Aminifard et al. 2012).

4. CONCLUSION

The evaluation of growth and yield of "Nsukka Yellow Pepper" under different populations and organomineral regimes responded positively in terms of yield and other growth parameter measured in 2018 and 2019 cropping seasons.Most parameters evaluated on the soil of the experimental site and selected plants had higher values in 2019 than 2018. Growth parameters such as plant height, number of leaves, number of branches and yield parameters such as number of fruits, fruit length, number of days to 50% flowering and 50 % flowering, 50 % fruit maturity, fruit weight/plant and yield/ ha were positively impacted by population and OMF regimes in both years of observation. This was as a result of the residual effect of soil improvement for the 2018 cropping season enhanced by 2019 cropping season. Higher population of 60,000 plants/ha favoured higher increment in plant height for both years. The number of leaves and branches, number of fruit/plant,fruit length, fruit weight/plant and yield/ ha were highest at lowest population 40,000 plants/ha and 3t/ha OMF which were not significantly different from50,000 plant population and 3t/ha OMF in 2019. Early flowering and fruit maturity were observed at 50,000plants/ha and 3t/ha OMF. The study thus concluded that NY pepper could be grown sustainably in the southern guinea savanna under plant population of 50,000 plants / ha combined with 3tons. OMF.

5. CONFLICTS OF INTERESTS

There is no conflict of interest.

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الملخص العربى

دراسات حول اداء نبات "فلفل نسوكا الأصفر العطري" (الفليفلة السنوية .L) في ظل أنظمة كثافة نباتية متفاوتة و أسمدة عضوية معدنية

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تم إجراء تجربة حقلية خلال موسمي الزراعة ٢٠١٨ و ٢٠١٩ لتقييم نمو وإنتاجية "فلفل نسوكا الأصفر" متأثراً بالكثافة النباتية ومعدلات تطبيق السماد العضوي المعدني في كلية الزراعة بجامعة إيلورين بمزرعة التدريس والبحوث النباتيةالحقلية. تم تصميم التجربة بالقطع المنشقة في تصميم القطاعات العشوائية الكاملة (٣ مكررات). تتألف قطعة الأرض الرئيسية من ثلاثة كثافات نباتية (٦٠,٠٠٠ نبات / هكتار ،٥٠,٠٠٠ نبات / هكتار و ٤٠,٠٠٠ نبات / هكتار) وأربعة معدلات للأسمدة العضوية (OMF): ٠، ١ ، ٢ و ٣ طن / هكتار فى القطع الفرعية.

تم جمع البيانات عن طول النبات ، عدد الأوراق والافرع ، محيط الساق ، أيام التزهير حتى ٥٠٪ ونضوج ٥٠٪ ، عدد الثمار ، متوسط وزن الثمار ومحصول الثمار. تم تحليل البيانات باستخدام حزم إحصائية Genstat الإصدار السابع عشر وتم مقارنة المعاملات باستخدام أقل فرق معنوي باحتمال ٥٪. أظهرت نتائج الدراسة أن عدد النباتات وأنظمة السماد العضوي كان لها تأثيرات تفاعلية معنوية على جميع الصفات المدروسة عند p <٠,٠٥. اظهرت صفات عدد الأوراق والفروع و عدد الثمار ووزن الثمار/النبات ومحصول الثمار / هكتار أعلى قيم عند أدنى كثافة نباتية ولم تختلف معنوياعن٥٠٠٠٠ نبات / هكتار.

ظهرت اعلى قيم صفات عددالأيام حتى ٥٠٪ من الإزهار ونضج الثمار عند ٥٠٠٠٠ نبات / هكتار بالإضافة إلى ٣ طن / هكتار من OMF. خلصت الدراسة إلى أن أفضل كثافة نباتية ومعدل سماد عضوي لزراعة "فلفل نسوكا الأصفر" لتحقيق النمو الأمثل والمحصول هو ٥٠،٠٠٠ نبات / هكتار و ٣ طن / هكتار.