VOL. 12, NO. 4, APRIL 2017 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

RESPONSE OF DIFFERENT NPK FERTILIZER RATES ON THE GROWTH AND YIELD OF TWO LOCAL VARIETIES OF PEPPER (*Capsicum annuum* L.) IN OGOO FARM, WESTERN AREA, SIERRA LEONE

Salia M. Kanneh[1], Peter D. Musa[2], Michael K. Osei[3], Dan. D. Quee[1], Richard Akromah[4] and Musa Lahai[1]
[1]Sierra Leone Agricultural Research Institute, PMP 1313, Tower Hill, Freetown, Sierra Leone
[2]Njala University, Njala, Moyamba District, Southern Province, Sierra Leone
[3]CSIR-Crops Research Institute, Horticulture division, Kumasi, Ghana
[4]Department of Crops and Soil Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
E-Mail:saliamkanneh@yahoo.com

ABSTRACT

The overall objective of this study was to evaluate the effect of different rates of NPK on the growth and yield of two local pepper varieties. The trial was conducted at the Kabala Horticultural Crops Research Centre, Ogoo Farm, Freetown from November 2015 to February, 2016 cropping season. The experiment was laid out in a randomized complete block design with three replications using two varieties of local pepper (Small hot pepper and Gbengeh) grown in the Inland Valley Swamp. Almost all parameters measured showed significant differences for the two local pepper varieties with respect to different rates of fertilizer applied. However, small pepper at 4 weeks after transplanting had no significant difference for canopy spread and weight of nonmarketable fruit. For the gbengeh variety, T3 (120 Kg/ha) recorded the highest 100 fruit weight while in the small pepper T4 (150 Kg/ha) had the highest 100 fruit weight. The Control treatment had the least values for all measured parameters. The rate of fertilizer can influence growth and yield of pepper considerably. However, increasing the rate of fertilizer above 120 Kg/ha showed some negative effects on certain parameters. Best fertilizer regimes observed fall between 90 – 120 Kg/ha.

Keywords: pepper, fertilizer rates, growth, yield, nonmarketable, marketable.

INTRODUCTION

Pepper is the second most important vegetable after tomatoe and belongs to the Solanaceae family. Pepper encompasses about 30 species, but *Capsicum annuum* L. is the most cultivated species in both tropical and temperate zones (Grubben and El Tahir, 2004). According to FAOSTAT (2012), the average world's fresh chili and sweet pepper production in 2010 was 27.6 million tons, to which West Africa contributed 888 tons, 400 tons or 3.2% with Nigeria and Ghana ranked 8th as the biggest West African contributors respectively. The vast majority of West Africa's pepper is sold in local, regional and international markets. Pepper has economic, nutritional and medicinal values. It is an excellent source of natural colours and antioxidant compounds (Dagnoko *et al*., 2013; FAOSTAT, 2012). The dried fruit is used as a spice and seasoning (Dagnoko *et al*., 2013). They are consumed in large quantity daily by almost every household across Sierra Leone for their values. The crop constitutes a source of income for resource poor households (mostly women) in urban, peri-urban as well as the rural areas. This makes pepper a suitable candidate for use in poverty reduction programs targeting resource poor households, including women in developing countries

Pepper can be cultivated on varieties of soils but preferably sandy to loam soils with adequate organic manure. The crop requires an average temperature of 25-28^{0}C and 16 - 18^{0}C for day and night times respectively. Supply of adequate clean water to the root zone is critical (Madisa, 2006).

In the Urban and Peri-urban areas of Sierra Leone, vegetable production is the major agricultural activity and mostly undertaking by small-scale women farmers. The high costs of inputs, unavailability of high yielding varieties, inadequate research on pepper and other standard production practices results to poor yields, low quality produce and low returns.

Inevitably, the rapid increasing population unequivocally requires corresponding food supply especially vegetables. But vegetable growers in Sierra Leone are faced with numerous problems including inability to determine appropriate rate of fertilizer. Thus the aim of this finding is to evaluate different rates of NPK fertilizer to increase the productivity of local pepper adapted to the environment.

MATERIALS AND METHODS

The experiment was conducted at Kabala Horticultural Crops Research Centre (KHCRC) Site, Ogoo Farm (Latitude 7^0 10' North and longitudes 10^0 14' West), during minor cropping season (November 2015-February 2016) in an Inland Valley Swamp (IVS).

The experimental field is characterized by a monomodal rainfall pattern, with the rainy season extending from May to September with an average annual rainfall of 2000-3000 mm and temperature of 30-34 0C. The total rainfall and means sunshine recorded during the experiment was 331.0 mm and 31.1 h, respectively while maximum and minimum mean temperatures were however, 33.7 and 25.7EC, respectively. The soil is of dark alluvial.

The planting materials (small hot and gbengeh peppers) were collected from previous harvest and seeds were nursed on a 2m x 3m well prepared nursery bed supplied with adequate chicken manure. Insecticides (Delthametrine) at the rate of 250g/l and fungicides (Carbendazim) at the rate of 500g/l were used to control insects (white flies) and diseases. A week to transplanting, NPK 15:15:15 (80g) and urea (100g) was mixed in one full watering-can using clean water to do liquid feeding to strengthen vigorous growth of seedlings for field planting. Shade of the nursery was gradually removed to expose seedlings to field condition (hardening process); quantity of water and frequency of watering was reduced to alternate days during the last one week prior to field transplanting.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Flat beds measuring 6m x 1m ($6m^2$) with a 1m furrow between beds and 1.5m between replications were constructed. The four treatments of NPK fertilizer are indicated in Table-1.

Table-1. Experimental treatments.

Treatment	Fertilizer rate applied
Treatment T1	Control with no fertilizer application
Treatment T2	90 Kg/ha
Treatment T3	120 Kg/ha
Treatment T4	150 Kg/ha

Inter and intra row spacing of 60cm x 50cm with two rows per bed and one seedling per stand was transplanted 9th December, 2015. To enhance soil and applied nutrients availability, plants were watered using watering-can almost throughout the growing season and recommended cultural practices were employed as and when needed. Harvesting commenced on the 22^{nd} February, 2016 for three weeks with an interval of 3-4 days between harvests. The following data was recorded on five randomly selected tagged plants: plant height, stem girth, number of branches and canopy spread at 4, 8 and 10 weeks after transplanting (WAT), number of fruit set $plant^{-1}$, Number of fruit harvested $plant^{-1}$, Fresh fruit length $plant^{-1}$ (cm), Fresh fruit width $plant^{-1}$(cm), 100 fruit weight (g), Marketable fruit weight (g) and Nonmarketable fruit weight (g).

Data recorded were subjected to Analysis of Variance (ANOVA) using the Genstat (12th edition) Statistical package. The LSD at 5% was used to separate significant treatment means.

RESULTS AND DISCUSSIONS

Soil analysis of experimental site

The result of the soil properties analysis showed that the soil is a sandy loam, relatively acid (pH (H2O) = 6.65, low Organic carbon (g/kg^{-1} =1. 21), Total N (g/kg^{-1}= 0.51), moderate Organic matter (g/kg^{-1} =3.78) and Available P (mg/kg^{-1} =2.95) with the following exchangeable bases; Na2+ ($cmol/kg^{-1}$) = 0.67, K^+ ($cmol/kg^{-1}$) = 1.46, Ca^{2+} ($cmol/kg^{-1}$) = 3.19 and Mg^{2+} ($cmol/kg^{-1}$) = 1. 11. The soil showed that the soil fertility status is average FMANR, (1996). Thus, optimum crop growth and yield requires supplementary nutrients through soil amendment.

Vegetative parameters of small pepper

In Table-2, analysis of variance showed significant differences among mean values of vegetative parameters. The result showed that T4 treatment recorded significantly higher plant height (44.20 cm) at 4 WAT than the other treatments, while T1 had the lowest plant plant height (26.10 cm). Statistically, there was no significant difference between T4 and T3 treatments at 4 WAT. At 8 and 10 WAT, T3 recorded the tallest plant height (50.70 cm and 61.90 cm) respectively and was significantly ($P < 0.05$) taller than T1 treatment. This result agrees with the findings of Abd El-Aziz (2007), who reported significant increase in plant height, number of leaves, number of branches, root length, diameter of stem and leaf area of Pumpkin. Furthermore, the effects of stem girth in the T2 treatment was larger (6.75 cm) and significantly ($P < 0.05$) greater than the other treatments at 4 WAT, followed by T3 (6.62 cm). While T4 and T3 treatments recorded the largest stem girth (11.69 cm and 14.45 cm) at 8 and 10 WAT respectively and T1 had minimum stem girth at each sampling accasion. The finding is in accordance with Godia (2014) who reported that stem girth is one of the major sites for storage of food material from photosynthesis and can be influenced by nutrients in the soil. For number of branches $plant^{-1}$, T2 treatment produced the largest number of branches at 4, 8 and 10WAT than the other treatments, while T1 recorded the minimum number of branches at 4, 8 and 10WAT. The effects of T2 and T3 treatments were not significantly different for branch number at 4 WAT. The significant difference observed among the treatments with respect to number of branches per plant might be ascribed to the fact that fertilizers applied to the soil were readily available and in the best form for easy absorption by the plant roots increasing the morphological growth of the plant. The result is in agreement with the findings of Law-Ogbomo and Egharevba (2010) and Adebayo *et al*. (2009) who reported that number of branches associated with various soil amendments were at par and significantly different from control. Significant difference was observed among treatments for canopy spread; T2 recorded the widest canopy spread at 4 and 10WAT (21.27 cm and 62.20 cm) repectively followed by T3 (38.87cm) at 8 WAT, while T1 treatment had significantly lower canopy spread 4, 8 and 10 WAT than the other treatments. Inorganic fertilizer contains essential nutrient associated with high photosynthetic activities and thus promote roots and vegetative growths (John *et al*., 2004).

Table-2. Mean values of vegetative performance as affected by fertilizer application (Small pepper).

Characters												
Treatment (NPK Kg ha^{-1})	**Plant height** (cm)			**Stem girth** (cm)			**Number of branches plant^{-1}**			**Canopy spread plant^{1}**(cm^{-2})		
	4 WAT	8 WAT	10 WAT	4 WAT	8 WAT	10 WAT	4 WAT	8 WAT	10 WAT	4 WAT	8 WAT	10 WAT
T1	26.10	38.00	45.50	3.86	6.94	9.36	2.33	4.33	6.67	17.28	27.13	41.90
T2	31.00	43.00	57.40	6.75	11.35	14.41	3.67	6.67	9.33	21.27	34.64	62.20
T3	38.00	50.70	61.90	6.62	10.86	14.45	3.67	5.33	8.00	20.87	38.87	55.00
T4	44.20	49.20	58.20	6.32	11.69	13.89	3.33	5.33	8.33	18.88	37.99	49.10
Lsd p<0.05	7.02	7.86	7.66	1.62	4.31	2.49	1.20	1.91	2.42	5.23	5.18	7.41
CV (%)	10.10	8.70	6.90	13.80	21.10	9.60	18.50	17.70	15.00	13.40	7.50	7.10

Yield and yield components of small pepper

Mean values for number of fruit set plant^{-1}, number of fruit harvested plant^{-1}, fresh fruit length plant^{-1}, and fresh fruit width plant^{-1} of T3 treatment was significantly ($P < 0.05$) higher than the other treatments (Table-3). In addition, the number of fruit set plant^{-1}, number of fruit harvested plant^{-1}, fresh fruit length plant^{-1}, fresh fruit width plant^{-1} and nonmarketable fruit weight was 58.19%, 52.08%, 46.28%, 44.22%, and 86.79% respectively greater than T1 treatment. For 100 fruit weight and marketable fruit weight, T4 significantly recorded higher weights (167.40 and 139.60) respectively followed by T3 treatment (148.30g and 103.00g), while T1 recorded the least mean values of 100 fruit weight (83.00g) and marketable fruit weight (89.10g). The variation in the number of fruits set per plant, number of fruits harvested per plant, fruit weight among other yield components may be attributed to the differences in the rates of fertilizer to produce and retain high number of flowers that developed into fruits in addition to better genetic components, possibility of possession of higher stomata conductance, better partitioning of photosynthetic materials towards economic yield, and higher potential to transport photosynthetic materials within plants.

Table-3. Mean values of yield and yield components as affected by fertilizer application (Small pepper).

Characters							
Treatment (NPK Kg ha^{-1})	**Number of fruit set plant^{-1}**	**Number of fruit harvested plant^{-1}**	**Fresh fruit length plant^{-1}**(cm)	**Fresh fruit width plant^{-1}**(cm)	**100 fruit weight** (g)	**Marketable fruit weight** (g)	**Nonmarketable fruit weight** (g)
T1	93.70	67.70	4.21	5.36	83.00	89.10	26.30
T2	152.00	119.00	6.98	10.59	111.80	92.30	19.40
T3	161.00	130.00	9.10	12.12	148.30	103.00	30.30
T4	136.30	102.00	8.23	8.89	167.40	139.60	27.80
Lsd (p<0.05)	42.50	45.77	3.48	2.62	30.00	42.85	10.26
CV (%)	15.70	21.90	24.50	14.20	11.80	20.20	19.80

Vegetative parameters of Gbengeh pepper

Mean values for vegetative parameters of gbengeh; plant height, stem girth, number of branches and canopy spread, are presented in Table-4. With the exception of canopy spread at 4 and 8 weeks after transplanting (WAT), all other parameters showed significant differences with T1 treatment recording the least mean values across the parameters observed. There were significant differences among the rest of the treatments for plant height stem girth, number of branches and canopy spread at 10WAT. The tallest plant height was observed in T4 at 4, 8 and 10 WAT (32.20, 46.60 and 90.10cm) followed by T3 at 4, 8 and 10 WAT(30.36, 43.00 and 83.60cm) respectively. However, there were no significant differences between T3 and T4 for those characters. T1 recorded the shortest mean values (19.52, 27.50 and 43.00cm) respectively for plant height. This result is in conformity with Omotoso and Shittu (2007) and Awodun *et al*., (2007) who reported that NPK fertilizer significantly increase growth parameters of plant height, leaf area, number of leaves, yield and yield components in Okra and Pepper. The largest stem girth at 8 and 10WAT was recorded by T2 treatment (12.87 cm and 14.09 cm) followed by T4 (12.01 and 13.89cm) respectively. Additionally, T1 had the smallest stem girth (4.61, 7.68 and 10.06 cm) at 4, 8 and 10 WAT respectively. The observed differences in the stem girth among the rates of fertilizer applied could be perhaps attributed to effective uptake and efficient utilization of available nutrients for growth and development of the crop. The highest number of branches plant^{-1} at 4 and 10WAT was recorded by T4 (3.67 and 8.67) while the lowest (1.67, 3.00 and 4.33) were obtained by T1 respectively. This result conforms to the findings of Law-Ogbomo and Egharevba (2010) who reported that number of branches associated with various soil amendments were at par and significantly different from control treatment. At 4, 8 and 10WAT there were significant statistical variations among treatments for canopy spread; T3 (60.46 cm^{-2}) accounted for the widest canopy spread at 10 WAT and T1 recorded the closest (24.90, 34.20 and 42.65 cm^{-2}) at 4, 8 and 10 WAT, respectively.

Table-4. Mean values of vegetative performance as affected by fertilizer application (Small pepper).

	Characters											
Treatment (NPK Kg ha^{-1})	**Plant height** (cm)			**Stem girth** (cm)			**Number of branches plant^{-1}**			**Canopy spread plant^{1}**(cm^{-2})		
	4 WAT	**8 WAT**	**10 WAT**	**4 WAT**	**8 WAT**	**10 WAT**	**4 WAT**	**8 WAT**	**10 WAT**	**4 WAT**	**8 WAT**	**10 WAT**
T1	19.52	27.50	43.00	4.61	7.68	10.06	1.67	3.00	4.33	24.90	34.20	42.65
T2	23.68	40.40	79.10	5.82	12.87	14.09	2.67	4.67	8.00	33.90	44.20	56.84
T3	30.36	43.00	83.60	6.32	11.24	12.90	3.33	5.33	7.33	30.10	39.50	60.46
T4	32.20	46.60	90.10	5.54	12.01	13.89	3.67	5.33	8.67	30.30	43.40	55.83
Lsd (p<0.05)	3.80	9.43	15.05	1.20	2.73	1.50	1.29	1.88	2.13	9.38	10.22	5.84
CV (%)	7.20	12.00	10.20	10.80	12.50	5.90	22.80	20.60	15.10	15.70	12.70	5.40

Yield and yield components of gbengeh pepper

Mean values for yield and yield components of gbengeh; number of fruit set per plant, number of fruit harvested per plant, fresh fruit length per plant, fresh fruit width, 100 fruit weight, marketable fruit weight and nonmarketable fruit weight are presented in Table-5. With the exception of fresh fruit weight and nonmarketable fruit weight all other parameters showed significant differences with T1 treatment recording the least mean values across the aforementioned parameters. Also, significant differences were observed among treatments for number of fruit set plant^{-1}, number of fruit harvested plant^{-1}, fresh fruit length plant^{-1}, fresh fruit width and nonmarketable fruit weight. T2 produced the highest mean values of number of fruit set plant^{-1}, number of fruit harvested plant^{-1}, fresh fruit length plant^{-1}, fresh fruit width and nonmarketable fruit weight (140.00, 110.00, 5.49, 6.83 and 37.60) respectively while T1 recoded the least (66.30, 41.70, 3.99, 4.71 and 24.90) respectively. T3 had the highest values for 100 fruit weight (247.60 g) and marketable fruit weight (215.50 g) while T1 recorded the least mean values in the aforementioned parameters. The influence of nutrient sources on pepper fruit weight might be due to effect of K+ which is associated with fruit formation and quality of seed and fruits. This result is analogous to the findings of Costa and Campos (1990), Gardner *et al*. (1990) and Zaki *et al*. (1999) who ascribed the yield variances in crop cultivars to the stomata of its value and the differences in the allocation of photosynthetic material in economic performance.

Table-5. Mean values of yield and yield components as affected by fertilizer application (Small pepper).

	Characters						
Treatment (NPK Kg ha^{-1})	**Number of fruit set plant^{-1}**	**Number of fruit harvested plant^{-1}**	**Fresh fruit length plant^{-1}**(cm)	**Fresh fruit width plant^{-1}**(cm)	**100 fruit weight** (g)	**Marketable fruit weight** (g)	**Nonmarketable fruit weight** (g)
T1	66.30	41.70	3.99	4.71	204.30	179.40	24.90
T2	140.00	110.00	5.49	6.83	243.30	205.70	37.60
T3	139.00	100.70	5.24	6.38	247.60	215.50	32.10
T4	120.00	75.40	5.23	6.52	214.90	181.90	33.00
Lsd (p<0.05)	23.90	18.63	1.14	2.39	32.95	26.86	12.82
CV (%)	10.30	11.40	11.50	19.50	7.20	6.90	20.10

CONCLUSIONS

The rate of fertilizer can influence growth and yield of pepper considerably. This shows that fertilizers applied to the soil were readily available and in the best form for easy absorption by the plant roots, hence there was a boost in the morphological growth of the plant.However, increasing the rate of fertilizer application above 120 Kg/ha showed some negative effects such as reduction in Number of fruit set plant^{-1}, Number of fruit harvested plant^{-1}, fresh fruit length plant^{-1}, 100 fruit weight and Marketable fruit weight for gbengeh variety. While for small pepper, there was reduction in Number of fruit set plant^{-1}, Number of fruit harvested plant^{-1} and Fresh fruit width plant^{-1}. Thus best fertilizer regimes observed fall between 90 - 120 Kg/ha.

ACKNOWLEDGEMENTS

Authors gratefully acknowledge Sierra Leone Agricultural Research Institute (SLARI) for logistical support. Mr. Bob Josse and Mr. Solomon Bindi field technicians of the Kabala Horticultural Crops Research Centre (KHCRC) Site, Ogoo Farm are unreservedly acknowledge for their energetic participation for trial management, follow up and data collection.

REFERENCES

Abd El-Aziz N. G. 2007. Stimulatory effect of NPK fertilizer and benzyladenine on growth and chemical constituents ofCodiaeum variegatum L. plant. Am.-Eurasian J. Agric. Envi. Sci. 2: 711-719.

Adebayo A. G., Akintoye H. A., Ainu O. O., Olatunji M. T. and Shokalu A. O.2009. Assessment of Organicamendment on growth and flower yield of sunflower (Helianthus annus). In proceedings of the Horticultural Society ofNigeria 11-16 October 2009, Kano State, Nigeria. pp. 292-298.

Awodun M. A., Omonijo L.I. and Ojeniyi S. O. 2007. Effect of goat dung and NPK fertilizer on soil and leaf nutrientcontent, growth and yield of pepper. Int. J. Soil Sci. 2: 142-147.

Costa J. G. and Campos D. A. J. S. 1990. Maize cultivars recommended for the state of Acre. Counica deTecnicoUnidaded'Exeecuo de NumbitoEstand.(56): 1-4.

Dagnoko S., Yaro-Diarisso N., Sanogo P. N., Adetula O., Dolo-Nantoumé A., Gamby-TouréK., Traoré-Théra A.,Katilé S. and Diallo-Ba D. 2013. Overview of pepper (Capsicum spp.) breeding in West Africa. African Journal ofAgricultural Research. 8(13): 1108-1114.

FAOSTAT. 2012. Food and Agricultural Organization of the United Nations Statistical Database, Rome, Italy.

FMANR. 1996. Federal Ministry of Agricultural and Natural Resources, Soil fertility investigation (In 5 volumes);Fertility ratings. Produced by the Federal Ministry of Agriculture, Lagos, Nigeria.

Gardner F. P., McCloud D. E. and Valle R. 1990. Yield characteristics of ancient races of maize compared to a modernhybrid. Agron. J. 82: 864-868.

Godia A. K. G. 2014. Evaluation of some introduced fresh market tomato (*Solanum lycopersicum* L.) for geneticvariability and adaptability in Ghana using morphological and molecular markers. M.Sc. Thesis, Kwame NkrumahUniversity of Science and Technology, Kumasi, Ghana.

Grubben GJH, El Tahir IM. 2004. Capsicum annuum L. In: Grubben, GJH & OA Denton (eds.). PROTA 2:Vegetables/Légumes. [CD- Rom]. PROTA, Wageningen, the Netherlands.

John L. W., Farmer D. B., Samuel L. T. and Warner L. W. 2004. Soil fertility and fertilizers. In: An introduction toNutrient Management, Pearson Education, India.pp. 106-153.

Law-Ogbomo K. E. and Egharevba R. K. A. 2010. Nutrient uptake and productivity of sweet pepper (*Capsicum annum*)as influenced by soil amendments on an ultisol environment.Proceedings for the 28th Annual conference of Horticultural
Society of Nigeria:17-22.

Madisa M. M., Machacha D., Moamogwe M. and More K. 2006. Manual for vegetable production in Botswana. Prepared By The Horticultural Research Program.

Omotoso S. O. and Shittu O. S. 2007. Effect of NPK fertilizer rates and method of application on growth and yield ofokra (Abelmoschus esculentus (L.) Moench) at Ado-Ekiti Southwestern, Nigeria. Int. J. Agric. Res. 2: 614-619.

Zaki N. M., El-Gazzar M. M., El-Din K. M. G. and Ahmed M. A. 1999. Partition and migration of photosynthesis insome maize hybrids. Egypt. J. Applied Sci. 14: 117-139.