NIGERIAN JOURNAL OF CROP SCIENCE
Volume 9 N0 2 January 2024 pp 26 - 31
ISSN – 2350 -2487

INFLUENCE OF NITROGEN FERTILIZATION ONTHE PERFORMANCE OF HABANERO PEPPER (*Capsicum chinenses* L.) VARIETIES IN THE NIGERIAN SAVANNA

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ABSTRACT

A field experiments were conducted during the 2020 rainy season at the research farm of Institute for Agricultural Research (I.A.R) Farms, Ahmadu Bello University, Zaria. Located at Samaru in Northern Guinea and Kadawa in Sudan Savannas. The treatment consisted of factorial combinations of six rates of nitrogen (0, 30, 60, 90, 120, and 150 kgNha^{-1}) and three habanero pepper varieties (Safi, Jaune de Burkina, and Miango), arranged in a randomized complete block design with three replications. The crop exhibited positive response to N with application of 150 kgNha^{-1}recording highest value for both growth characters and yield. Application of N up to the maximum rate of 150kgha^{-1} significantly increased plant height, LAI, CGR, TDW, and yield per hectare. It was observed that variety Miango had higher value for plant height (30.67, 32.91 cm) followed by Safi (27.74, 28.68 cm) and Jaune de Burkina (26.47, 27.03cm) recorded the least in Samaru and Kadawa respectively. Also higher value for LAI (1.99, 2.34), total dry weight (146.19, 203.79), crop growth rates (5.99, 6.76) and fresh fruit yield (6324.41, 6896.13 kgha^{-1}) are recorded by Safi than for other varieties at Samaru and Kadawa respectively. The interaction of variety and nitrogen on plant height is significant with variety Miango producing taller plants when received 150 kgNha^{-1} at both locations whilevariety Jaune de Burkina was the shortest at the same N rate. Based on the result of this trial, it can be concluded that the use of 120 kgNha^{-1}and 150kgNha^{-1}and Safi variety resulted to maximum fruit yield of habanero pepper at Samaru and Kadawa respectively.

KeyWords: Habanero pepper *Capsicumchinense* L(Safi, Jaune de Burkina, and Miango), Nitrogen fertilizer

INTRODUCTION

Habanero pepper (*Capsicumchinense* L.) in one of the most important vegetables grown in Nigeria and other sub-humid and semi-arid tropics. After tomato and onion Habanero pepper is the third most important vegetable in Nigeria. Nigeria being the largest producer of crops in Africa account for 50% of the African production (Aliyu, 2001). Nutritionally, according to (Marin *et al.* 2004, and Gil-guerrero, 2006), habanero peppers are an excellent source of natural colours and antioxidant compounds, ascorbic acid, carotenoids, and phenolic compounds. It also contains vitamins A and C and it was reported that as hot pepper matures, the pro-vitamin A (B Carotene) and ascorbic acid increase. The intake of these compounds in foods is an important health protecting factor. Mediated intake of these compounds have been recognize to prevent some human diseases, including cancer and cardiovascular diseases, (Kaur and Kapoor, 2001; Sardas, 2003). This led to extensive

production of habanero pepper varieties in some countries for export markets. However, inspite of the important of pepper in Nigeria. Low yield were often obtained by farmers due to use of low yielding varieties, inadequate application of nutrients on soil that are already of low nutrients status, poor agronomic practices, improper row or planting arrangement, low soil fertility and other environmental factors such as the prevalence of fungal (blight) and bacterial as well as viral diseases (Fekudu and Dandena, 2006). The use of inorganic fertilizers has attracted attention in recent years in vegetables as a result of sustainable high yield and due to the fact that inorganic fertilizers alone can sustain the productivity of the soil under highly intensive cropping systems (Singh and Jain, 2004). The nutrient deficiency is one of the most important factors limiting habanero pepper yield particularly at early stages of the crops life cycle. The objective of the study is to determine the growth and yield response of three habanero pepper varieties under theclimatic condition of Samaru and Kadawa and also to determine the effect of nitrogen fertilizer rates on growth and yield of habanero pepper

MATERIALSANDMETHODS

A two location experiments were conducted during the 2020 rainy season at the research farm of Institute for Agricultural Research (I.A.R) Farms, Ahmadu Bello University, Zaria. Located at Samaru in Northern Guinea and Kadawa in Sudan Savannas. The treatment consisted of factorial combinations of six rates of nitrogen (0, 30, 60, 90, 120, and 150 $kgNha^{-1}$) and three habanero pepper varieties (Safi, Jaune de Burkina, and Miango), arranged in a randomized complete block design with three replications. Soil analysis was done in accordance with Black (1965). Three fine tilth nursery beds each measuring 1.5m x 2m were prepared for the purpose of raising seedlings of the three varieties of habanero pepper.Healthy and uniform sized seedling of the three varieties was transplanted into their respective plots at 25 cm intra row spacing in Samaru and Kadawa as per varietal treatment. This was carried out in the early morning hours after which the transplants were irrigated.There was no incident of pest and disease during the trials.Plant height, leaf area index, crop growth rate, total dry matter and fresh fruit yield per hectare.were recorded on plot basis. The data collected were analysed statistically in accordance with Snedecor and Cochran (1967). Significant different means were compared using Duncan Multiple Range Test (DMRT) (Duncan, 1965).

RESULTS

Table 1.Shows the effects of nitrogen fertilizer on the height of three habanero pepper varieties at 4, 8, 12 and 16 WAT in Samaru and Kadawa during the 2020 rainy season at both locations and sampling periods. The three varieties recorded significant variation in height with Miango variety as the tallest, followed by Safi, then Jaune de Burkina at all except at 16 WAT when the difference in height between Safi and Jaune de Burkina was not significant. Application of nitrogen significantly influenced the heights of the habanero pepper. Increase in nitrogen fertilizer up to $60kgNha^{-1}$ significantly increased the height of pepper. Further increase to $90kgNha^{-1}$ significantly increased the height of pepper at all except 16 WAT in Kadawa, where addition of N to $120kgNha^{-1}$ generally increased height. Beyond $120kgNha^{-1}$ height was increased at all except 16 WAT at Kadawa where the parameter remained significantly unaffected. There was a significant interaction of variety and nitrogen on the height of pepper only at 4 and 12 WAT at Samaru and 12 WAT at Kadawa.

The response of leaf area index (LAI) of three habanero pepper varieties to application of nitrogen fertilizer at 4, 8, 12 and 16 WAT in Samaru and Kadawa during the 2020 rainy season is shown in Table 2. At both locations and sampling periods, the three varieties recorded significant differences in LAI: Miango had the highest LAI, followed by Safi, then Jaune de Burkina. Application of nitrogen significantly influenced the leaf area index of pepper; it was observed that each addition of nitrogen fertilizer rate from 0 to 30 up to $150KgNha^{-1}$ led to corresponding increase in leaf area index of pepper at all the sampling periods in both locations. The variety x nitrogen interaction on LAI was not significant.The effect of treatments on crop growth rates (CGR) of habanero pepper varieties at Samaru and Kadawa during the 2030 rainy season is presented in Table 3. There were no significant differences in crop growth rates among the tested pepper varieties at 16 WAT in Kadawa, however at all the sampling period in Samaru and at 8 and 12 WAT in Kadawa Safi had highest value for CGR followed by Jaune de Burkina while the least CGR was produced by Miango. Application of nitrogen fertilizer significantly influenced crop growth rates of pepper in both location and sampling period, though the differences in CGR between 0 and $30kgNha^{-1}$ were not significant at 16 WAT and between 90 and $120kgNha^{-1}$ at 8 and 16 WAT at Samaru. The highest and the least values for CGR was by $150kgNha^{-1}$ and $0kgNha^{-1}$ respectively. The variety x nitrogen interaction on CGR was not significant.Table 4

shows the total dry weight (TDW) for three habanero pepper varieties and how it responded to application of nitrogen fertilizer at 4, 8, 12 and 16 WAT in Samaru and Kadawa during the 2020 rainy season. From the results obtained at both locations and sampling periods, the three varieties recorded a significant variation in TDW with Safi having higher value for total dry weight, followed by Jaune de Burkina, then Miango produced the least total dry weight. Application of nitrogen fertilizer significantly influenced total dry weight of habanero pepper. The result revealed that each increase in nitrogen rate significantly increased total dry weight. The highest total dry weight was recorded by 150kgNha^{-1} while the lowest was observed when no N was applied. Factor interaction on total dry weight at both locations and sampling periods was not significant.Table 5 present fresh fruit yield per hectare for the three habanero pepper varieties and its respond nitrogen fertilization at different harvest period and its summation in Samaru during 2020 rainy season. The three varieties recorded a significant variation in fresh fruit yield at both locations and harvesting periods. In either location Safi produced the highest fresh fruit yield followed by Jaune de Burkina then Miango which had the least. Application of N fertilizer significantly influenced fresh fruit yield. Increase in N rate from 0-30, 30-60, 60-90, 90-120, and 120-150kgNha^{-1} significantly increased fresh fruit yield of pepper, for each harvest period and location. There was no significant interaction of variety and nitrogen on fresh fruit weight of pepper.

Table 1: Effect of nitrogen rates on plant height of Habanero pepper varieties at Samaru and Kadaw during 2020 rainy season

	Plant Height (cm)							
	SAMARU (WAT)				KADAWA (WAT)			
Treatments	4	8	12	16	4	8	12	16
Variety(V)								
Miango	15.11a	23.47a	29.58a	30.67a	17.19a	24.41a	30.22a	32.91a
Safi	12.97b	20.82b	26.21b	27.74b	14.69b	21.93b	27.06b	28.62b
Jaune de Burkina	11.17c	19.48c	24.97c	26.47c	13.65c	20.56c	25.50c	27.03b
SE±	0.244	0.383	0.261	0.350	0.321	0.370	0.312	1.092
Nitrogen Fertilizer Rates (kgNha^{-1})								
0	9.47f	14.13f	20.37f	21.81f	10.59f	15.62f	21.32f	23.81d
30	11.14e	17.38e	23.70e	24.87e	12.47e	18.82e	24.27e	27.22c
60	12.81d	21.28d	26.11d	27.36d	14.36d	22.20d	27.00d	28.68b
90	14.04c	23.68c	28.27c	29.29c	16.48c	24.27c	28.78c	30.41b
120	15.01b	24.66b	30.15b	32.06b	17.87b	25.66b	30.73b	32.60a
150	16.07a	26.41a	32.93a	34.40a	19.29a	27.24a	33.78a	34.96a
SE±	0.043	0.106	0.051	0.354	0.073	0.091	0.071	1.092
Interactions								
V x N	**	NS	**	NS	NS	NS	**	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05level of probability using DMRT
NS=Not Significant

Table 2: Effect of nitrogen rates on leaf area index of Habanero pepper varieties at Samaru and Kadawa during 2020 rainy season

	Leaf Area Index							
	SAMARU (WAT)				KADAWA (WAT)			
Treatments	4	8	12	16	4	8	12	16
Variety (V)								
Miango	0.20a	0.67a	1.87a	2.35a	0.33a	0.84a	2.22a	2.89a
Safi	0.17b	0.54b	1.57b	1.99b	0.28b	0.71b	1.91b	2.37b
Jaune de Burkina	0.13c	0.41c	0.76c	0.91c	0.18c	0.49c	0.84c	1.10c
SE±	0.005	0.012	0.036	0.043	0.005	0.011	0.026	0.038
Nitrogen fertilizer rates (kgNha^{-1})								
0	0.0363f	0.1774f	0.4376f	0.6654f	0.0578f	0.2544f	0.5910f	0.8605f
30	0.0603e	0.2901e	0.6553e	0.9624e	0.0884e	0.3774e	0.8783e	0.2568e
60	0.1069d	0.4160d	1.0083d	1.3448d	0.1584d	0.5442d	1.2144d	1.2568d
90	0.1610c	0.5894c	1.4359c	1.7364c	0.2809c	0.7259c	1.6514c	2.0374c
120	0.2653b	0.8082b	2.1848b	2.6188b	0.4235b	0.9671b	2.3331b	2.8974b
150	0.3761a	0.9620a	2.6781a	3.1925a	0.5811a	1.2251a	3.2593a	4.0577a
SE±	0.005	0.012	0.036	0.043	0.005	0.011	0.026	0.038
Interactions								
V x N	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05level of probability using DMRT
NS=Not Significant

Table 3: Effect of nitrogen rates on total dry weight of Habanero pepper varieties at Samaru and Kadawa during 2020 rainy season

	Total Dry Weight (g)							
	SAMARU (WAT)				KADAWA (WAT)			
Treatments	4	8	12	16	4	8	12	16
Variety (V)								
Miango	20.98c	36.36c	86.31c	106.40c	25.73c	70.11c	135.51c	156.87c
Safi	25.22a	53.65a	123.03a	146.19a	31.18a	92.15a	181.50a	203.76a
Jaune de Burkina	23.08b	49.17b	112.31b	136.30b	27.73b	84.18b	135.51b	189.72b
SE±	0.384	1.292	1.000	1.502	1.291	0.860	1.834	1.942
Nitrogen fertilizer rates (kgNha^{-1})								
0	9.97f	25.26f	57.54f	77.01f	12.26f	38.30f	72.96f	90.99f
30	15.76e	35.20e	80.99e	102.51e	19.43e	55.23e	106.93e	127.23e
60	22.19d	44.01d	101.48d	120.11d	26.43d	78.17d	150.81d	176.32e
90	25.70c	51.74c	119.23c	140.48c	31.02c	95.23c	180.48c	204.79c
120	29.91b	56.87b	131.94b	154.76b	36.02b	104.17b	204.54b	227.96b
150	35.06a	62.28a	152.10a	182.87a	43.93a	121.80a	243.67a	273.41a
SE±	0.102	0.513	0.706	1.642	1.177	1.603	0.704	1.941
Interactions								
V x N	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05level of probability using DMRT
NS=Not Significant

Table 4: Effect of nitrogen rates on crop growth rates of Habanero pepper varieties at Samaru and Kadawa during the 2020 rainy season

	Crop Growth Rates (gm^{-1})					
	SAMARU (WAT)			KADAWA (WAT)		
Treatments	8	12	16	8	12	16
Variety (V)						
Miango	0.66c	0.96c	1.27c	0.71c	1.35c	3.01
Safi	1.23a	1.64a	2.19a	1.57a	2.74a	3.46
Jaune de Burkina	0.92b	1.24b	1.89b	1.03b	2.03b	3.21
SE±	0.193	0.230	0.361	0.534	0.674	0.601
Nitrogen fertilizer rates (kgNha^{-1})						
0	0.62e	1.23f	3.66d	0.76f	1.67f	4.01d
30	0.86d	1.45e	3.87d	0.95e	1.92e	4.18d
60	0.97d	1.87d	4.31bc	1.13d	2.13d	4.85c
90	1.21c	2.21c	4.39b	1.55c	2.53c	5.28b
120	1.71b	2.76b	4.64b	2.04b	3.14b	5.78b
150	2.36a	3.21a	5.69a	2.47a	4.09a	6.43a
SE±	0.191	0.233	0.370	0.533	0.672	0.602
Interactions						
V x N	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05level of probability using DMRT
NS=Not Significant

Table 5: Effect of nitrogen rates on fresh fruit yield **(**kg/ha**)** of Habanero pepper varieties at different harvest period at Samaru and during 2013 rainy season

	Fresh Fruits Yield at Different Harvest Period (kg/ha)						
	SAMARU (WAT)						
Treatments	1	2	3	4	5	6	Total
Variety (V)							
Miango	557.67c	627.41c	697.12c	787.75c	1000.30c	853.97c	4524.22c
Safi	779.59a	877.04a	974.49a	1101.17a	1398.39a	1193.75a	6324.43a
Jaune de Burkina	611.03b	687.41b	763.79b	863.08b	1096.03b	935.64b	4956.98b
SE±	15.575	17.526	19.477	21.993	27.945	23.854	126.816
Nitrogen fertilizer rates (kgNha^{-1})							
0	334.49f	376.30f	418.07f	472.46f	599.99f	512.18f	2713.49f
30	447.73e	474.07e	559.67e	632.48e	803.13e	685.60e	3602.63e
60	586.01d	622.22d	732.51d	827.73d	1051.16d	811.44d	4631.05d
90	691.36c	777.78c	864.20c	976,54c	1240.09c	897.33c	5447.30c
120	820.41b	922.96b	1025.51b	1138.88b	1471.61b	1058.64b	6457.96b
150	1018.10a	1143.70a	1270.79a	1435.99a	1823.57a	1556.71a	8247.86a
SE±	15.572	17.520	19.461	21.991	27.974	23.855	126.346
Interactions							
V x N	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05level of probability using DMRT
NS=Not Significant

DISCUSSIONS

The response exhibited by habanero pepper to nitrogen application as observed through increased plant height, total dry matter accumulation and higher value for leaf area index, and total dry weight in both location could be as a result of positive role of nitrogen in enhancing vegetative growth in plants, Nitrogen is an important constituent of chlorophyll, amino acid, and nucleic acid. The role N also play in meristematic tissue diffrenciation and photosynthetic processes might have contributed positively to the production of more assimilate which is another reason for the positive response of the pepper growth parameters to Nitrogen application. Osman *et al. (*1993), reported significant response of these growth parameters of habanero pepper to application of N. The significant response of these growth parameters to nitrogen application could be attributed to significant response of LAI and NAR which are known to play a greater role in assimilate production and assimilation by different plant parts there by leading to increased in growth and development of the aforementioned parameters. Khan *et al.* (2002), also reported that the increase in LAI as a result of N application had resulted in the increased number of fruits per plant at N rate between 90 and 120kgNha^{-1}and up to 150 kgNha^{-1}.The similarities in CGR among the N rate at 8, 16 WAT in Samaru and 16 WAT in Kadawa could be that the increase in N rate was inadequate enough to cause any significant variation in CGR. All of the growth parameter were maximized at 150kgNha^{-1}indicating the crops need for these important parameters is yet to be achieved. This agrees with Ray, R. B., Hidar, J. (2002). From the result of this experiment, the three pepper varieties exhibited differences in growth and yield characters. The vegetative growth represented by plant height, leaf area index, total dry matter, crop growth rate and fresh fruit yield. This difference among pepper varieties could be attributed to differences in environmental requirement, growth factors imposed by differences in genetic make-up of the variety. This result agree with that of JesusaCrisontomo*et al.* (2007) who reported the variation of two pepper variety in terms of plant height, number of leaves and fresh fruit yield in Florida. The greater vegetativeness of variety Miango in term of height per plant, could be to the larger assimilatory leaf surface which enable it to produce, assimilate and more vegetative growth. Unlike Miango, Safi partitioned higher amount dry matter for leaf and stem size and rather than for servicing larger number of leaves and branches. Similar difference in the performance of pepper varieties have been reported by Delegen, (2010). This further suggest that high yield in pepper is dependent on leaf and fruit size.

CONCLUSION

Based on the results obtained from the study, application of 150 kgNha^{-1} and 200 kgNha^{-1} resulted to maximum fruit yield of 11,541.07 kg/ha and 14,345.81 kg/ha for habanero pepper at Samaru and Kadawa respectively. While variety Safi consistent produced the highest fruit yield at both locations.

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