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The effect of organomineral and inorganic fertilizers on the growth, fruit yield and quality of pepper (*Capsicum frutescence*)

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1 SUMMARY

To determine the effect of organominerals and inorganic fertilizers application on the optimum yield and nutrient composition of pepper (*Capsicum frutescence*) so as to form an effective basis for selection of fertilizer and growth improvement strategy.

Pepper seedlings were subjected to two levels of nitrogen, phosphorus and potassium 15-15-15 fertilizer (NPK) (0 and 250 kg. ha^{-1}), , five levels of organomineral fertilizers (OMF) (0, 2, 3, 4 and 5 t. ha^{-1}) and their various combinations. These were assigned randomly into three replicates and arranged in a randomized complete block design fitted into a factorial experiment. Pepper growth, fruit yield and quality attributes were assessed and subjected to Analysis of Variance. The growth parameters such as plant height and number of leaves showed increasing response to all the treatments as the rates increased. Also the yield components increased as the rates increased from 0 to 4 t OMF ha^{-1} and thereafter a reduction in the yield was observed at 5 t. OMF ha^{-1}. The optimum yield of pepper was obtained from sole application of NPK at 250 kg NPK ha^{-1}. The combined application of 4 t. OMF and 125 kg. NPK ha^{-1} gave the highest fruit yield performance of pepper. The concentration of essential elements increased with treatment rates. These were significantly ($P \leq 0.05$) affected by the various treatments except for the effect of NPK on calcium (Ca) and magnesium (Mg). The study revealed that yield and nutritional quality of pepper fruit in the Guinea savannah of south western Nigeria could significantly ($P \leq 0.05$) be improved by the sole application of 4 t. OMF ha^{-1} and 250 kg NPK ha^{-1}, and by their combination at 4 t. OMF and 125 kg NPK ha^{-1}.

2 INTRODUCTION

Pepper (*Capsicum frutescence*) is an important fruit vegetable which belongs to the night shade family Solanaceae, and is related to egg plant, potato and tobacco. It was first domesticated in Mexico (Pickergill, 1971). Due to its importance and being the world second most important vegetable after tomatoes, it now commonly cultivated in all parts of the world. The bulk production of pepper is found in the Savanna zone and derived Savanna areas of the south western Nigeria. Pepper is grown in both wet and dry seasons but attracts a large profit during the dry season when the demand is often higher than of the limited supplies (Aiyelaagbe &Fawusi, 1986). In Southern Nigeria, four types of chilli pepper are recognised on the basis of fruit form namely, "Atarodo", "Sombo", "Tatase" and "Atawewe". Pepper has increased in popularity, value and importance over a long period, thus making it an indispensable part of the daily diet of millions of Nigerian. It is an important source of vitamin A and C, which protects the body against disease attack (Taylor, 1987). These vitamins in pepper help in maintenances of bones, tissues and blood and in the efficient

utilization of iron. Pepper is normally used as a spice in the preparation of soup and stew when cooked with tomatoes and onions. It can also be used as a condiment and extensively in flavouring of processed meat, colouring certain food preparation and also used for medicinal purposes (Chauhan, 1972).

The growing plant requires nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium(Ca), sodium (Na) and sulphur (Na) or soil fertility maintenance and crop production. These nutrients have specialized functions and should be supplied to plant at the right time and in right quantity. Pepper, like other crop produces well when it is adequately supplied with the essential nutrients through fertilization (Fagbayide, 1997). Nitrogen has the greatest effect on the average nutrients needed for optimum yield of capsicum. Capsicum is particularly responsive to nitrogen for plant growth while potassium is needed for good fruit quality (Bull, 1986). Generally, nutrient requirements of *Capsicum annum* and *Capsicum frutescence* are giving as 76kg N/ha, 48kg P_20_5/ha and 60kg K_20/ha (Anon, 1987, 1989; Usoroh, 1992).

Crop response to fertilizer is a function of the type of fertilizer applied (Ayodele and Olaniyan, 1982), soil fertility status and the type of preceding crops. The role of organic and inorganic fertilizer is to improve the yields and quality, and also for quick maturity of pepper. The use of organic manure cannot be over emphasized because of its usefulness in the improvement of physical conditions of soil and the nutrients it supplies for soil productivity. Apart from the role of organic manure as a store house for plant nutrient it acts as a major contributor to Cation exchange capacity and as a buffering agent against undesirable pH fluctuation (Ngeze, 1998). In Nigeria there is need for the ministry of Agriculture to adopt an aggressive policy of promoting complementary use of organic fertilizers to increase farmers yield. Therefore, this study was set up to determine the appropriate level of organomineral and inorganic fertilizers for optimum fruit yield and quality of pepper in the Guinea Savannah zone of south western Nigeria.

3 MATERIALS AND METHODS

Field experiments were conducted on a loamy soil of an alfisol during 2008 and 2009 cropping seasons, at the Teaching and Research Farm of Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria. Ogbomoso (Latitude 8^010^1N and Longitude 4^010^1E) is in the Guinea Savannah zone of the south-west Nigeria. The region has two rainy periods and had 1296mm to 1306mm of rainfall. The temperature regime is high with a high humidity of about 74^0C all year round except in January, when the dry wind blows from the north.Pre plant soil samples (0 - 15cm) were collected .The samples were taken randomly from 150 spots in the experimental site with an auger. Samples were bulked, air-dried, and ground to pass through a 2mm sieve. The soil samples were analyzed for physico and chemical properties as follows: Soil particle size was determined by Bouyoucos method (Bouyoucos, 1962). Soil pH in H_2O (1:1) was determined using the custom laboratory apparatus (IITA, 1982). Soil organic carbon was determined by Walkley black modified method (Black, 1965). Available phosphorus and total nitrogen were determined separately by Technicon A All method (Technicon, 1975), while exchangeable Ca, Mg, K, Na and effective C.E.C in soils by use of atomic absorption spectrophotometer (Tel and Hargerty, 1984).The *Capsicum frutescence* seeds were obtained from the department of Agronomy, LAUTECH, Ogbomoso, Nigeria. The nursery beds were prepared, the seeds were sown and watered regularly using a watering can and checked for seedling emergence which started on the 5^{th} day after sowing. The nursery plots were mulched to avoid poor germination and prevent excessive heat. Transplanting of pepper seedlings into their respective plots in the field took place four weeks after sowing (WAS) early in the morning after a heavy rainfall. On the field, the plot of land used was cleared and a total of thirty beds were made. These were divided into three blocks with each replicate containing 10 beds, and each

bed size was 1.0m by 1.2m. Each block was spaced at 1m apart to ease movement during cultural practices.

The soil was amended with 0, 2, 3, 4, 5 $t.ha^{-1}$ of organomineral (OMF) fertilizer, 250kg NPK and their various combinations. The factorial combination of the rates of organomineral and NPK resulted in 10 different treatment combinations distributed in randomized complete block design with three replicates. The OMF and NPK treatments were applied by ring banding method to the soil, two weeks after transplanting (WATP). Other cultural practices, such as watering, weeding and pest control by using neem extract were carried out on the plot as required. Data were collected on the growth parameters (number of leaves and plant height), number of flowers, number of fruits per plant, fruit weight per plant and fruit yield per hectare. The meter rulers was used for the measuring of the tomato plant height from base to the tip of the main shoots while the number of leaves were counted and recorded at 3 and 6 WATP. The numbers of flowers were counted and recorded at 50% flowering. The number of fruit per plant was counted while the fruit weight per plant and fruit yield per hectare were weighed and recorded at harvesting.

The proximate analysis of the fruits was also assessed. Fruit samples were collected from each treatment, and dried in an oven at 65^0C until a constant weight was obtained. The dried fruit samples were separately ground with a Wiley mill, and passed through a 0.5mm sieve for tissue analysis. Total P was determined by the Vanadomolybdate method. K and Ca were determined by flame photometry and Mg and were determined by atomic absorption spectrophotometer. Total N was analysed by the micro-Kjeldahl procedure as described by I.I.T.A (1982) and crude protein was obtained by multiplying the total N by a factor of 6.25. Concentrations of nutrient were expressed on the basis of percentage dry fruit material. All data collected were subjected to analysis of variance (ANOVA) using SAS-GLM procedure (SAS, 1989). The significance of the main factors and interaction effect were determined on the basis of the F-ratios. The differences between treatment means were evaluated using the least significant different at 5% level of probability.

4 RESULTS AND DISCUSSION

Pre cropping soil analysis determined showed that the soil contained total N, 0.14$gkg^{-1;}$ available P, 10.03$mgkg^{-1}$; and exchangeable bases of Ca, Mg and K, with values of 5.37, 4.32 and 2.01mol kg^{-1} respectively, and soil pH of 6.7 (Table 1).

Table 1: Results of the pre- cropping soil analysis of the experimental site.

Parameters	Value
PH (H_2O)	6.9
Total N (% 0)	1.10
P (ppm)	5.77
Exchangeable cat ion (cmolkg)	
Ca^{2+}	2.55
Mg^{2+}	1.12
K^+	0.24
Na^+	0.40
Physical characteristic	
Sand (%)	86.7
Slit (%)	9.2
Clay (%)	4.1
Textual class	Sand loamy

Although, the pH value was within the pH range 6 – 7 that is good for better performance of vegetables (Pureseglove, 1991)., most nutrient elements were below the critical range (Adeoye & Agboola,1985). These revealed that there is need for soil amendment in form of fertilizer application to improve the growth and yield of pepper. The influence of NPK and organomineral (OMF) fertilizers on selected growth parameters namely;

plant height and number of leaves are presented in Table 2 and 3, respectively.

Table 2: The plant height of pepper (*Capsicum frutescence)* as effected by organomineral and inorganic fertilizers.

Treatments	Weeks 2	After 4	Transplanting 6	8
0 (control)	6.4	7.8	47	50
2 OMF	9.3	8.3	32.7	50.5
3 OMF	8.1	9.6	57	52.5
4 OMF	8.1	12.1	94.3	53.3
5 OMF	6	6.5	25.7	21
NPK	8.2	9.5	36.2	59
2 OMF + NPK	6.4	10	39.4	21.3
3 OMF + NPK	8.4	8.9	51	36.5
4 OMF + NPK	8.3	8.7	70.2	54
5 OMF + NPK	9.9	10.6	66.9	23.5
LSD (0.05):				
OMF	NS	NS	NS	55.86
NPK	1.13	NS	NS	NS
OMF x NPK	NS	NS	NS	NS
CV%	18.65	18.65	60.09	46.47

OMF-Organomineral, NPK- Nitrogen, Phosphorus and Potassium fertilizer, CV- Coefficient of variation, LSD- Least significant different

Table 3: The effect of organomineral and inorganic fertilizer and their combination on the number of leaves of pepper. *Capsicum frutescence.*

Treatments	Weeks 2	after 4	Transplanting 6	8
0 (control)	4.5	4.6	8.4	10
2OMF	4.5	4.6	7.4	10.9
3 OMF	3.6	4.9	6.7	12.4
4 OMF	4.3	5.4	13.6	22.1
5 OMF	4	5.7	10.6	15.7
NPK	3.6	3.9	6.2	12.3
2OMF+NPK	4.1	4.8	5.5	13
3 OMF+NPK	4.2	4.3	8.6	13.1
4 OMF+NPK	4.7	5.4	10.8	18
5 OMF+NPK	5.8	5.9	10.7	16.4
LSD (0.05):				
OMF	NS	NS	NS	NS
NPK	NS	NS	NS	NS
OMF x NPK	NS	NS	6.94	NS
CV%	29.09	31.75	30.94	32.56

OMF-Organomineral, NPK- Nitrogen, Phosphorus and Potassium fertilizer, CV- Coefficient of variation, LSD- Least significant different

These growth parameters increased as the sampling occasions increased. The sole application of NPK and OMF and their various combinations improved the growth parameters of pepper. The plant height increased with increasing levels of organomineral fertilizer up to 4 t. OMF ha^{-1} , then thereafter declined at 5t. OMF ha^{-1} fertilizer application. Although, the highest number of leaves was recorded at 5t.OMF ha^{-1} there was no significant different ($P \leq 0.05$) between the values obtained at 4 t. and 5t.OMF ha^{-1} application rates. Likewise, the plant height and number of leaves also increased as the NPK rates increases with the highest value recorded at 250kg. NPK ha^{-1}. Combined application

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of OMF and NPK had significant effect on the growth parameters of pepper at 6th week after transplanting. The highest growth parameters were obtained at 4t.OMF by 125kg. NPK ha^{-1} combined fertilizer application. All the yield attributes under investigation were significantly ($P \leq 0.05$) influenced by the application of OMF, NPK and OMF by NPK effects (Table 4). The number of flowers, number of fruits, fresh fruit and dry fruit yields of pepper increased as the fertilizer treatments rates increased, with the highest values recorded at sole application of 4t.OMF and 250kg. NPK ha^{-1}. The combined application of NPK by OMF fertilizer improved the yield and yield components, with the highest values obtained at 3t.OMF by 125kg NPK ha^{-1}. The result of fruit (tissue) analysis of capsicum frutescence is presented in table 5.

TABLE 4: Yield and yield components of pepper (Capsicum frutescence) as effected by organomineral and inorganic fertilizers.

Treatments)	**No of flowers**	**No of fresh fruit**	**Weight of fresh fruit (kgha^{-1})**	**Weight of Dry fruit kgha^{-1}**
0 (Control)	5	22	27.3	115
2OMF	15	24.5	426	237
3OMF	17.3	37.5	482	262
4OMF	24	51.7	706	425
5OMF	13.8	35	415	230
NPK	19.8	46.7	559	328
2OMF + NPK	33.2	41	522	210
3OMF + NPK	55.3	57.7	756	484
4OMF + NPK	43.0	39.0	495	236
5OMF + NPK	12.5	29.7	350	164
LSD (0.05)				
OMF	0.77	0.76	4.21	3.19
NPK	0.49	0.48	2.66	2.02
OMF x NPK	0.38	0.37	11.19	6.44
CV%	6.25	1.51	0.66	0.91

OMF-Organomineral, NPK- Nitrogen, Phosphorus and Potassium fertilizer, CV- Coefficient of variation, LSD- Least significant different

TABLE 5: Mineral nutrient contents of pepper fruits as effected by organomineral and inorganic fertilizers.

Treatments	N	P	K	Ca	Mg
0 (Control)	2.09	0.15	2.96	0.08	0.22
2OMF	3.05	0.25	4.05	0.19	0.31
3OMF	2.11	0.18	2.99	0.10	0.25
4OMF	2.60	0.20	3.50	0.13	0.25
5OMF	2.85	0.24	3.98	0.17	0.29
NPK	2.75	0.19	3.62	0.16	0.30
2OMF + NPK	3.01	0.24	3.78	0.19	0.34
3OMF + NPK	3.16	0.29	4.16	0.22	0.35
4OMF + NPK	3.10	0.25	4.02	0.22	0.34
5OMF + NPK	2.95	0.21	3.15	0.18	0.29
LSD (0.05)					
OMF	0.15	0.03	0.21	0.01	0.02
NPK	0.15	NS	NS	0.01	0.9
OMF + NPK	0.02	0.03	0.21	0.0001	0.002
CV%	7.03	19.04	7.56	6.62	7.47

OMF-Organomineral, NPK- Nitrogen, Phosphorus and Potassium fertilizer, CV- Coefficient of variation, LSD- Least significant different

The fruit nutrient composition; N,P ,K, Ca and Mg were significantly influenced (P≤0.05) by the applied OMF rates. Although, the highest values were recorded from 5t.OMF ha^{-1}there are no significant differences between the values obtained at 4t. and 5t.OMF ha^{-1} . N, Ca and Mg contents were significantly improved by NPK fertilizer with the highest values obtained at 250 kg NPK ha^{-1}. The combined application of organo mineral and NPK fertilizers significantly influenced (P≤0.05) N, P, K, Ca and Mg contents of pepper fruits. The fruits nutrient contents increased with optimum values obtained at 3 t.OMF by 125kgNPK ha^{-1} combined fertilizer treatment.

The positive response and increased in growth parameters and yields of pepper with applied fertilizer treatments might be due to the low initial nutrient status in the used soils, which revealed the vital role played by the soil nutrient status in the crop production. Also, the response to OMF and NPK fertilizers probably shows that these fertilizers serve as sources of N, which is more than any other element appeared to control growth and yield potentialities in south western Nigeria studies soil (Sobulo et al, 1975, Olaniyi, 2006). The vigorous increase in height and leaf number to *capsicum frutescence* was due to the supply of nitrogen contained by the applied fertilizers; NPK and Organomineral fertilizers (Tisdale and Nelson, 1990; Akanbi *et al*, 2010). The increase in growth parameters and yield attributes from 0 to 4 t. OMF ha^{-1} and declined thereafter is in agreement with other researchers investigations (Akanbi *et al*., 2004; Olaniyi et al., 2005). The organomineral fertilizer, inorganic fertilizer and their combinations at different levels has shown a great influence on the growth parameters and yield and yield components of pepper. The better growth rate of capsicum frutescence has been observed in the sole application of different treatments and their combinations comparing to the control. The rate at which flowering occurred greatly influenced the amount of fruit produced per plant. The result obtained from various organomineral fertilizers alone prove to be a sound soil fertility management strategy (Lombin, *et al.,* 1991) by having growth and yield similar to that of the combined NPK and organomineral fertilizers.

The response of each fertilizer varied slightly but showed significant difference in the total fruit yield. In terms of effect of these treatments and their combinations, organomineral fertilizer at the rate of 4 tons OMF ha^{-1} favour the growth of capsicum whereas the combination of 4 tons OMF ha^{-1} and 125kgNPK ha^{-1} favours the yield of *capsicum frutescence* most. Therefore, combined application of 3 t. OMF and 125kg NPK ha^{-1} could be recommended for farmers as an economically fit fertilizer treatment for optimum pepper performance.

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