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Ameliorate the Effects of Poultry Manure and NPK Fertilizer on the Performance of Pepper Relay Cropped With Two Cassava Varieties

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Abstract - Farmers in Nigeria practice intercropping by relaying cassava (Manihot esculenta Crantz) into pepper (Capsicum annum L.). However, high cost of inorganic fertilizer had discouraged most farmers from applying fertilizer to their crops. The objective of this work was to evaluate the effects of NPK fertilizer and poultry manure on the performance of pepper relay cropped. A split-plot layout was adopted using four fertilizer levels: no fertilizer, 120N + 80P + 50K kg/ha, poultry manure (PM) 6,250 kg/ha and 50 % to 50 % mixture of NPK and PM. The cropping pattern, sole pepper, and two cassava cultivars relayed into pepper at 1 MAT were main plots while the fertilizer levels were the subplots. The experiments were replicated three times. Descriptive statistics and ANOVA were used to analyze the data of growth and yield parameters. Fertilizer application significantly ($P < 0.05$) affected all the characters investigated. The highest fruit yield of pepper (13.6 t/ha.) was obtained from the plots treated with 120N + 80P + 50K kg/ha. The highest cassava tuber yield (24.1 t/ha) was obtained from the plots treated with 6,250 kg PM/ha. The yield of pepper under different fertilizer application was in the order NPK > NPK + PM > PM. The yield (10.1 t/ha) of pepper obtained under 'Oko Iyawo' across the fertilizer treatments was 14.4 % greater than the yield (8.7 t/ha) obtained with TMS 30572. All the fertilizer treatments yielded more than the control in the following order: PM > ½ NPK + ½ PM >NPK alone respectively.

Keywords : *Manihot esculenta, cropping pattern, Capsicum annuum, relay intercrop, fertilizer application.*

AMELIORATE THE EFFECTS OF POULTRY MANURE AND NPK FERTILIZER ON THE PERFORMANCE OF PEPPER RELAY CROPPED WITH TWO CASSAVA VARIETIES

Strictly as per the compliance and regulations of :

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Abstract - Farmers in Nigeria practice intercropping by relaying cassava (*Manihot esculenta* Crantz) into pepper (*Capsicum annum* L.). However, high cost of inorganic fertilizer had discouraged most farmers from applying fertilizer to their crops. The objective of this work was to evaluate the effects of NPK fertilizer and poultry manure on the performance of pepper relay cropped. A split-plot layout was adopted using four fertilizer levels: no fertilizer, 120N + 80P + 50K kg/ha, poultry manure (PM) 6,250 kg/ha and 50 % to 50 % mixture of NPK and PM. The cropping pattern, sole pepper, and two cassava cultivars relayed into pepper at 1 MAT were main plots while the fertilizer levels were the subplots. The experiments were replicated three times. Descriptive statistics and ANOVA were used to analyze the data of growth and yield parameters. Fertilizer application significantly ($P < 0.05$) affected all the characters investigated. The highest fruit yield of pepper (13.6 t/ha.) was obtained from the plots treated with 120N + 80P + 50K kg/ha. The highest cassava tuber yield (24.1 t/ha) was obtained from the plots treated with 6,250 kg PM/ha. The yield of pepper under different fertilizer application was in the order NPK > NPK + PM > PM. The yield (10.1 t/ha) of pepper obtained under '*Oko Iyawo*' across the fertilizer treatments was 14.4 % greater than the yield (8.7 t/ha) obtained with TMS 30572. All the fertilizer treatments yielded more than the control in the following order: PM > ½ NPK + ½ PM >NPK alone respectively.

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I. Introduction

Pepper (*Capsicum annuum*) is a popular crop that is grown in most countries of the world and its production for spice and vegetables has increased by more than 21 % since 1994. According to FAO (1997), world production of peppers for 1996 was put at 14,068,000 metric tones. However, Asia is the largest producer, with China leading world with a production of 12,531,000 Mt. in 2005 (FAOSTAT, 2005). In pepper production, Nigeria was rated second in the world in 1979 (Yamaguchi, 1983).

However, production later declined and since the early 1980's, export has been minimal (Aliyu *et al.*, 1996). In 2005 Nigeria produced 720,000 Mt of pepper making her the largest producer of peppers in Africa and ranked 7th in the world (FAOSTAT, 2005). It is cultivated principally in southwestern and northern Nigeria between latitudes 10°N and 12°3N in the northern guinea savannah and Sudan savannah ecological zones (Erinle, 1988). *C. annuum* is one of the most popular cultivars grown by local farmers and the yield obtained ranges from 2.5 to 10.5 t/ha which is very low compared to 18 to 36 t/ha obtained in developed countries (Ado and Gupta, 1990).

Management of soil fertility in an intercropping system has a major influence on crop production. Several studies have revealed that intercropped mixtures extracted more nutrients from the soil than did single stands per unit area (Kassam and Stockinger, 1973; Dalal, 1974; Oelsligle *et al.*, 1976). High cost of nitrogen fertilizer has led to several research studies on the benefit of intercropping with legumes.

Cassava requires adequate fertilizer especially (K and N) for optimum growth and root yield (Amon and Adetunji, 1973; Obigbesan and Fayemi, 1976 and Sitti-busaya and Kurmarohita, 1978). The cultivation of cassava in traditional agriculture is without the use of any form of fertilizer. The use of adequate levels of nutrients by any crop is essential in order to increase its production and yield. Bosland and Votava (2000) reported that pepper required adequate amounts of major and minor nutrients to produce well. May *et al.* (1982) recorded the highest yield of 12.3t/ha from N and P application rates of 150 and 100 kg/ha respectively. Alabi (2006) found that P levels significantly increased pepper plant height, number of leaves and branches per plant and leaf area up to 125 kg P/ha level and concluded that poultry droppings increased the yield components of pepper more significantly than the phosphorous. The importance of integrated nutrient use in crop production in recent years cannot be over-emphasized in view of the high cost of chemical fertilizer to meet crop nutrient requirement. Complimentary use of organic manure and mineral fertilizers has proved to be a sound strategy to maintain soil fertility in many parts of the world (Lombin*et al.*, 1991*)*.Mello *et al.* (2000) recorded higher fruit weight and yield of pepper with 100 g poultry manure/hole + 100% NPK (130: 458: 262: kg N: $P_2 0_5$:$K_2 0$/ha) compared with treatments of 150 g peat compost/hole + 70 or 100% NPK; 100g wood chip

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compost (pine) per hole + 70 or 100 % NPK. Similarly, plant height and pepper fruit yield/ha increased with increasing levels of N with maximum yield recorded at 160 kg N/ha. Aliyu (2000) reported good establishment of pepper plants and superior yield with the application of various rates of organic manures supplemented with 50 kg N /ha.

II. Materials and Methods

Field trial on the ameliorate effects of NPK fertilizer and poultry manure on the performance of pepper relay cropped with two cassava varieties were conducted in Ogbomoso during 2001/2002 and 2002/2003 cropping seasons. Ogbomoso on Latitude 8° 01 N, Longitude 4° 06 E, about 310 m above sea level in the derived savanna belt of south-western Nigeria. The mean annual rainfall of the Experimental station was 1,062.18mm with high intensity over a period of seven months (April to October) (Table 1). The land used for the experiments had been previously cropped to staple food crops such as cassava, maize, yam guinea corn and grain. The soil is a ferric luvisol, locally classified under Iwo series (Murdoch *et al.*, 1970). Composite samples of the topsoil (0 – 15 cm depth) were taken from the site and analyzed for their physical and chemical properties before the commencement of the experiment in each year.

The experimental design for the trial was a split-plot fitted into a randomized complete block design with three replicates. The main plot was cropping pattern (i.e. sole pepper, *Oko Iyawo* + Pepper and TMS 30572 + Pepper. Both cassava varieties were relayed into pepper at one month after transplanting (MAT). The sub-plot was fertilizer at four levels namely:

i. No fertilizer,
ii. Inorganic fertilizer (alone), which was supplied in the form of urea, single super-phosphate and muriate of potash at 120 N + 80 P + 50 K kg/ha.
iii. Poultry manure (PM) at the rate of 6.3 t/ha.
iv. ½ NPK fertilizer (60 N + 40 P + 25 K kg/ha.) + ½ Poultry manure (3.15 t/ha.).

Each plot was 5 m x 4 m planted with cassava at 1 m x 1 m and pepper at 1 m x 0.5 m spacing. Plant population density was thus 10,000 per hectare for cassava and 20,000 plants per hectare for pepper. Two cassava clones the profusely-branching TMS 30572 from IITA, the local late-branching cultivar *Oko iyawo* and Pepper cultivar NHVI-B, released by the National Horticultural Research Institute (NIHORT) were used in the study.

Poultry manure was applied two weeks before transplanting. The rate of application was 6,250 kg. /ha in plots that received poultry manure alone and 3,125 kg/ha in plots that received poultry manure plus mineral fertilizers. The manure was spread uniformly on the respective plots and worked into the soil by light hoeing N, P and K were applied at the rate of 120 kg N. /ha, 80 kg P /ha and 50 kg K /ha respectively for inorganic fertilizer treatment and 60 kg N /ha, 40 kg P /ha and 25 kg K /ha in treatment with ½ poultry manure + ½ inorganic fertilizer treatment The fertilizers were applied in two equal split doses: two weeks after transplanting (WAT) of pepper and at fruit set (10 WAT).

Fifteen plants of each of the cassava varieties and pepper were randomly sampled from the net plot to record observations adopting the partial replacement procedure by Gomez and Gomez (1984). Days to 50 % flowering were also recorded. Number of days to first harvest was noted from sowing date to the time of picking the first fully ripe fruits of pepper. Ripe fruits of pepper were harvested at weekly intervals. Number of fruits per plant was obtained from randomly selected plants while the cumulative fresh weight of the total fruits picked from the net plot was recorded. Fruit length was obtained from 30 randomly picked fruits using transparent ruler. Fresh weight of cassava tubers per stand was taken from selected 10 plants. Total tuber yield from the net plot was recorded at maturity. All morphological characteristics, yield and yield components of pepper and cassava were subjected to statistical analysis using ANOVA based on the split plot design.

III. Results

Pepper plots treated with NPK and ½ NPK + ½ PM reduced number of days to 50 % flowering and days to reach first time of harvest which was significantly different ($P < 0.05$) from the control and PM alone treated plots across the cropping systems in two successive seasons (Table 2).

Application of fertilizers significantly increased the number of fruits per plant with sole pepper plot treated with NPK had the highest number of fruits per plant though not significantly different ($P > 0.05$) from the values recorded from pepper plots treated with NPK where *Oko Iyawo* was relayed into pepper (Table 3). Fresh fruit yields of pepper obtained from the plots treated with NPK alone were significantly ($P < 0.05$) higher than the yields obtained from the plots treated with ½ NPK + ½ PM and other treatments across the cropping systems. The yields of pepper under different fertilizer applications followed the trend of NPK > NPK + PM > PM. The highest fresh fruit yield of 13.6 t/ha. was recorded from the plot where *Oko Iyawo* was relayed into pepper under NPK alone treatment. However, the fresh fruit yield obtained from NPK treated plot where TMS 30572 was intercropped with pepper was significantly ($P < 0.05$) low compared to the yield obtained from the plot where *Oko iyawo* was relay cropped with pepper. (Table 4).

All the fertilizer treatments yielded more than the control in the following order: NPK alone, ½ NPK + ½ PM and PM alone. Averaged yield (10.1 t/ha) of pepper obtained under '*Oko Iyawo*' across the fertilizer treatments was 14.4 % greater than the average yield

(8.7 t/ha) obtained with TMS 30572. Similar trend was observed in the following cropping season (Table 4).

Yield of cassava as affected by different fertilizers in the intercrop is presented in table 5. Significant differences ($P < 0.05$) were recorded in the tuber yield in 2000/2001 across the treatments. In both seasons, cassava tuber yield recorded across the fertilizer treatments followed a similar trend of PM > ½ NPK + ½ PM >NPK. *Oko Iyawo* gave the highest tuber weight of 25.0 t/ha under PM, which was significantly ($P < 0.05$) higher than that obtained from the tuber weight of 22.2 t/ha produced by TMS 30572 under the PM alone. A similar occurrence was observed in 2001/2002 cropping season. Significant differences were observed in the yield of pepper obtained across the fertilizer treatments in the following season. The highest fresh fruit yield of 298.61 kg/ha was obtained from the cropping system where *Oko Iyawo* was relay cropped with pepper and treated with PM. However, the lowest yield of 98.3 kg/ha was recorded from the control. The fresh fruit yield of pepper obtained in the following season from all the cropping systems treated with fertilizer followed the order of PM > ½ NPK + ½ PM > NPK (Table 6).

IV. Discussion

The result of this study demonstrated that highest yields of pepper were obtained from the plots treated with NPK fertilizer compared to other fertilizer treatments and the control. A similar finding of 12.3 t/ha of pepper yield with the application of 150 kg/ha N and 100 kg/ha P had been reported by May *et al.*, 1982) while Aliyu *et al.*, (1996) reported predicted yields of pepper at high levels of 205 N kg/ha and 25 P kg/ha. Asiegbu and Oikeh (1995) reported the efficiency of NPK fertilizer in the supply of N, P and K to tomato plants in the short run than the organic manure.

The mixture of NPK and poultry manure produced fresh fruit yields greater than the application of poultry manure alone. The higher response of pepper to the mixture might be due to the differences in the availability of essential elements from inorganic and organic sources of fertilizer. This observation is in agreement with that of Okonkwo and Chibuzo (2000). Ayoola and Adeniyan (2006) also found that crops were lower under the application of poultry manure alone in comparison with NPK plus poultry manure or NPK alone in cassava/maize/melon mixture. Aliyu (2000) reported good establishment of pepper plants and superior yield with the application of poultry manure supplemented with inorganic fertilizer. However, Alabi (2006) reported that application of poultry droppings increased the growth and yield components of pepper significantly more than phosphorous fertilizer.

Highest yields of cassava were obtained from the application of poultry manure alone. A possible reason for this is that poultry manure ensured a season long supply of nutrients, which benefited cassava that stayed longer in the field due to its slow release of nutrients. Kumar *et al.* (1977) reported a good response of cassava to poultry manure and Hemeng *et al.* (1995) obtained highest yield of 10.2 t/ha when plantain was supplied with poultry manure as compared to 7.2 t/ha obtained in unfertilized controls. Application of poultry manure alone also gave the highest yield of pepper in the following cropping season when compared to other fertilizer treatments and the control. This implies that by the end of the first growing season, the manure had already decomposed which ensured release of nutrients for plant use.

The mixture of NPK and PM also gave better yields of both crops than the PM alone. This could be attributed to the complimentary roles of organic and inorganic fertilizers in improving crop yield. This observation agrees with that of Agboola and Odeyemi (1972), Agboola (1988) and Eneji *et al.* (1997). The combined yield of the intercrop under mixture of NPK and PM was about 1.5 greater than that of NPK alone. Similar finding was reported by McCollum (1983), in his work on multiple cropping systems and fertilizer application involving maize and rice followed by cassava and groundnut. The study also revealed that fertilizer treatments promoted early flowering and maturity of pepper compared to the control that took longer days to reach flowering stage and maturity. This might be due to availability of sufficient nutrients for the growth and development of the plants. Siti-Aishah-Hassan (1993) reported that doubling the application of N rate from 112 to 224 resulted in a 21 % increase in flower bud.

Table 2 : Growth attributes of pepper as affected by fertilizer in cassava +pepper intercrop

Treatments	Days to 50 % flowering		Days to maturity	
	2001	2002	2001	2002
Sole P 0 Fertilizer	88	88	146	146
P + C1 + 0 Fertilizer	88	89	146	145
P + C1 + NPK	76	75	133	132
P + C1 + NPK + PM	76	77	134	132
P + C1 + PM	86	86	144	140
P + C2 + 0 Fertilizer	88	87	147	146
P + C2 + NPK	76	76	135	133
P + C2 + NPK + PM	76	75	135	135
P + C2 +PM	86	87	144	144
LSD (0.05)	1.2	1.3	1.8	1.2

P = Pepper; C1 = *Oko Iyawo*; C2 = TMS 30572, PM = Poultry manure,

Table 3 : Yield attributes of pepper as affected by fertilizer in cassava + pepper intercrop

Treatments	Number of fruits/plant		Fruit length (cm)	
	2001	2002	2001	2002
P + C1 + 0 Fertilizer	23	22	8.2	8.6
P + C1 + NPK	76	74	9.2	9.5
P + C1 + NPK + PM	74	73	9.1	9.3
P + C1 + PM	67	66	8.3	8.6
P + C 2 + 0 Fertilizer	19	20	8.0	8.2
P + C2 + NPK	67	65	9.1	9.3
P + C2 + NPK + PM	64	62	8.7	9.2
P + C2 +PM	57	55	8.1	8.2
LSD (0.05)	3.3	3.6	1.09	1.17

P = Pepper; C1 = *Oko Iyawo*; C2 = TMS 30572, PM = Poultry manure,

Table 4 : Pepper yield as affected by fertilizer in cassava + pepper intercrop

Treatments	Fresh fruit yield, t/ha	
	2001	2002
P + C1 + 0 Fertilizer	4.2	4.4
P + C1 + NPK	13.4	13.6
P + C1 + NPK + PM	12.1	12.8
P + C1 + PM	10.7	10.2
P + C2 + 0 Fertilizer	3.3	3.4
P + C2 + NPK	11.8	12.6
P + C2 + NPK + PM	11.0	11.2
P + C2 +PM	8.5	8.3
LSD (0.05)	0.92	0.44

P = Pepper; C1 = *Oko Iyawo*; C2 = TMS 30572, PM = Poultry manure,

Table 5 : Cassava tuber yield as affected by fertilizer in cassava + pepper intercrop

Treatments	Tuber yield, t /ha	
	2001	2002
P + C1 + 0 Fertilizer	18.1	17.2
P + C1 + NPK	21.7	20.3
P + C1 + NPK + PM	22.9	21.2
P + C1 + PM	25.0	24.3
P + C2 + 0 Fertilizer	17.4	18.9
P + C2 + NPK	20.6	21.6
P + C2 + NPK + PM	21.8	23.0
P + C2 +PM	22.2	21.6
LSD1 (0.05)	1.12	0.44
LSD2 (0.05)	0.78	1.13

P = Pepper; C1 = *Oko Iyawo*; C2 = TMS 30572, PM = Poultry manure (alone)
LSD1 = LSD Fertilizer, LSD2 =LSD Variety

Table 6 : Residual harvest of pepper as affected by fertilizer in cassava + pepper intercrop in the following season

Treatments	Fresh fruit yield kg /ha	
	2001	2002
P + C1 + O Fertilizer	98.3	93.5
P + C1 + NPK	112.4	111.6
P + C1 + NPK + PM	189.5	193.7
P + C1 + PM	298.6	302.6
P + C2 + O Fertilizer	91.3	89.2
P + C2 + NPK	103.2	99.3
P +C2 + NPK + PM	142.3	137.2
P + C2 +PM	256.4	279.3
LSD (0.05)	0.92	0.44

P = Pepper; C1 = *Oko Iyawo*; C2 = TMS 30572, PM = Poultry manure

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