Current Agriculture Updates 9(3) 79-84(July, 2025)
www.currentagriculture.com

RESEARCH ARTICLE

Residual effects of organic and inorganic fertilizers previously applied to field grown sweet pepper on maize

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Manuscript received: June 12 ,2025; Decision on manuscript: June 30,2025; Manuscript accepted: July 15, 2025

Abstract

This experiment was carried out to evaluate the residual effects of organic and inorganic fertilizers previously applied to sweet pepper on the performance of maize. Residual effect of different manure rates (control (zero application), 5 t/ha of PM, 10 t/ha of PM, 300 kg/ha of NPK 15:15:15, 5 t/ha of PM + 200 kg/ha of NPK 15:15:15 and 10 t/ha of PM + 100 kg/ha of NPK 15:15:15) on the field. The results obtained suggested sufficient left over of manure/fertilizer which was enough to effectively support at least one more planting season on the same plot of land without any additional manure/ fertilizer but a different type of crop other than the first crop should be planted to avoid a buildup of disease/pathogen. Therefore using the same plot of land will optimize profit and reduce input costs (manure/fertilizer) as 10 t/ha of PM produced cob dry weight of 232.8 g significantly higher than control plot that produced 84.4 g of cob dry weight. Our findings suggest that sustainable agricultural system intensification may be feasible in the study location.

Keywords: Sweet pepper, maize, manure rates, residual effect, system intensification

Introduction

Maize (*Zea mays* L) belongs to the family of grass *gramineae* (Poaceae). It ranks third following wheat and rice in world production (FAO, 2003). Widely grown in the humid tropics and sub-Saharan Africa, the crop is a source of food and livelihood for millions of people (Agbato, 2003). It is consumed roasted, baked, fried, boiled or fermented in Nigeria. In developed countries, maize is a source of such industrial products as corn oil, syrup, corn flour, sugar, brewers' grit and alcohol (Dutt, 2005). As an energy supplement in livestock feed, maize is cherished by various species of animals, including poultry, cattle, pigs, goats and rabbits (DIPA, 2006). The numerous uses of maize notwithstanding, yield in Africa has continuously declined to as low as 1t/ha due to such factors as rapid reduction in soil fertility, and negligence of soil amendment materials (Olakojo *et al.*, 1998; DIPA, 2006) and extreme climatic condition and biotic/abiotic stresses are the major factors responsible for low yield potential of crop plants (Gayatonde *et al.*, (2021); Akpan and Dominic (2024), Akpan *et al.*, (2024 and 2025).

Residual effect of fertilizer is the responses to fertilizer after the first season of application (Rowell, 1994). Residual effect can vary from year to year under the influence of weather and factors other than the old fertilizer, making it difficult to infer the fertilizer residual as defined. The residual effects of increased nutrients and organic matter in soil following manure or compost application can contribute to the improvement of crop yield and soil properties and can last for several years (Ginting *et al.,* 2003). This fit into agricultural system intensification which is defined as an increase in agricultural production per unit inputs. It is a farming methodology that aims to increase the yield of crops while using fewer resources and reducing environmental impacts. In southeastern Nigeria, low fertility status of the soils has been advanced as a serious factor limiting crop yield. Maintenance of soil fertility has been recognized as a precondition for sustainable crop production and increase yield per unit area while organic manuring has been reported to play a vibrant role in this regard (Jablonska, 1990) as poultry manure a source of organic fertilizer with high nitrogen and organic matter contents capable of improving soil structure for sustainable and increased crop production (Dominic and Akpan, 2025). Therefore, the objectives of this study was to evaluate the growth and yield responses of maize to residual effect of different organic and inorganic fertilizer rates previously applied to sweet pepper.

Materials and methods

The experiment was carried out in the Department of Crop Science Experimental Farm, Faculty of Agriculture, University of Nigeria, Nsukka, Nigeria. Nsukka is located on latitude $6^{0}51^{1}$E, and longitude $7^{0}29^{1}$N of 475m above sea level, characterized by lowland humid condition with bimodal annual rainfall distribution that ranges from 1155mm to 1955mm, a mean annual temperature of 29^{0}C to 31^{0}C and relative humidity that ranges from 69% to 79% (Uguru *et al.,* 2011). OBA super 2 variety of maize was used to test the residual effect of six manure rates (control (zero application), 5 t/ha of PM, 10 t/ha of PM, 300kg/ha of NPK 15:15:15, 5t/ha of PM + 200kg/ha of NPK 15:15:15 and 10t/ha of PM + 100kg/ha of NPK 15:15:15) previously grown with Yalo wonder variety of sweet pepper in the field. Treatments were laid out in randomized complete block design (RCBD) with three replications. Each block contained six plots each measuring 1.5 m x 2.5 m, 1m and 0.5 m were used to demarcate between blocks and plots, respectively. Maize were planted at a spacing of 75 cm x 25 cm intra and inter rows. Data were collected on the following parameters of maize: percentage seedlings emergence, plant height, number of leaves, stem girth, leave area at interval of 3 weeks after planting (WAP), days to onset of tasselling, 50% tasselling, 100% tasselling, days to onset of silking, 50% silking, 100% silking, and plant dry weight components. Data collected were subjected to analysis of variance (ANOVA) following the procedure outline for randomized complete block design (RCBD) using GenStat Release 10.3DE Discovery Edition 4 (GenStat, 2010) software.

Results and discussion

Table 1 showed the residual effect of applied manure/fertilizer on maize growth in the field. There was significantly effect on plant height at 3 and 6 weeks after planting (WAP). Application of 10 t/ha of PM + 100 kg/ha of NPK had the highest plant height of 131.3 cm while the least was obtained in control plot (79.8 cm) at 6 WAP.

Though at 9 WAP, there was no significant difference, application of 5 t/ha of PM + 200 kg/ha of NPK produced the tallest plant (195.2 cm) while control plot produced the least (165.0 cm).The number of leaves per plant showed a significant effect at 3 and 9 WAP. At 3 WAP, application of 10 t/ha of PM had the highest number of leaves per plant (8.9) while the least was obtained in control plot (7.5). Also 9 WAP followed the same trend. Stem girth showed a significant effect at 6 and 9 WAP. Application of 10 t/ha of PM and 5 t/ha of PM had the biggest stem girth (8.4 cm) while the least was obtained in control plot (7.18 cm). Leaf area did not differ significantly, but application of 5 t/ha of PM + 200 kg/ha of NPK had the widest leaf area of 626.0 cm2 and the least was obtained in 300 kg/ha of NPK (599.0 cm^2). Residual effect is the responses of manure/fertilizer after the first season of application (Rowell, 1994). The residual effect of applied manure/fertilizer on plant height, number of leaves, stem girth and leaf area of maize plant showed that the applied manure/fertilizer was still very effective as the plot treated with 10 t/ha of PM +100 kg/ha of NPK was significantly higher than control plot. This relative increase in the growth by combined application of organic and inorganic fertilizer could be attributed to improvement in soil structure, mineral and water retention for plant use (Anyawu et al., 2001). This result is in harmony with Eghball (2000) who observed a significant increase in corn growth as influenced by residual effect of manure and compost application when compared to the check (control). Table 2 showed the residual effect of applied manure/fertilizer on seedlings emergence and reproductive traits of maize. Days to onset of tasselling was significant as control plot had the longest days (49.0 days) to onset of tasselling and the least was obtained in 10 t/ha of PM (39.7 days). Days to onset of silking was significantly influence by the residual manure/fertilizer rates as the longest days (49.7 days) was obtained in control plot and the shortest days to onset of silking was obtained in 10 t/ha of PM + 100 kg/ha of N P K (43.0 days). Days to 50 and 100 % silking were significant as the control plot had the longest days (56.7days) to 50 % silking and the least was obtained in 10 t/ha of PM (45.7 days). Also, days to 100 % silking followed the same trend. Significant difference observed in days to tasselling and silking revealed that the control plot (zero application) had the longest days to tasselling and silking. This could be as a result of insufficient nutrient availability to the plants in the control plot to support reproductive phase.

Table 1: Residual effect of manure/fertilizer rates after 3, 6 and 9 weeks after planting on the growth of maize

Manure/ fertilizer	Plant height (cm)			Number of leaves			Stem girth (cm)		Leaf area (cm^2)	
Rates	3	6	9	3	6	9	6	9	6	9
0t/ha	22.6	79.8	165.0	7.5	12.7	12.9	6.9	7.2	534.0	611.0
5t/ha	30.6	115.3	189.6	8.3	13.4	13.6	7.8	8.4	583.0	634.0
10t/ha	31.5	126.6	191.4	8.9	14.7	15.1	8.1	8.4	592.0	647.0
300kg NPK	26.0	98.5	176.2	8.2	13.3	14.0	7.4	7.9	467.0	599.0
5t/ha + 200NPK	28.9	119.7	195.2	8.4	12.4	13.9	7.9	8.1	626.0	645.0
10t/ha +100NPK	30.3	131.3	193.2	8.6	14.5	14.6	7.8	7.9	614.0	632.0
LSD (0.05)	5.2	21.9	ns	0.6	ns	1.1	0.7	0.6	ns	ns

Table 2: Residual effect of manure/ fertilizer rates on emergence and reproductive trait of maize

Manure/ fertilizer	Emergence (days) (%)				Onset of 50 (%)	Onset of 100 (%)		Onset of 50 (%)	Onset of 100 (%)
Rates	4	5	6	Tasselling	Tasselling		Silking	Silking	
0t/ha	66.7	75.0	93.8	49.0	54.7	61.0	49.7	56.7	64.0
5t/ha	87.5	91.7	91.7	43.0	51.7	57.3	46.3	49.3	54.3
10t/ha	81.2	95.8	95.8	39.7	50.7	55.0	45.7	45.7	52.0
300kg NPK	83.3	93.8	95.8	44.0	52.0	57.7	47.3	53.0	59.0
5t/ha+ 200NPK	81.2	83.3	87.5	40.7	52.0	55.7	46.0	48.0	53.7
10t/ha+100NPK	79.2	95.8	89.6	41.7	48.7	57.7	43.0	48.7	55.3
LSD $_{(0.05)}$	ns	ns	ns	4.6	ns	ns	3.7	4.4	6.6

Table 3 showed the residual effect of applied manure/fertilizer rates on dry weight and dry matter distribution pattern of the maize plant. There was no significant difference on these traits except on cob dry weight no husk as the application of 5 t/ha of PM + 200 kg/ha of NPK produced the highest cob dry weight no husk (229.8 g) and the lowest was obtained in control plot (145.9 g). 100 seeds weight was not significantly affected by the residual manure/fertilizer rates, but the application 5 t/ha of PM had the highest 100 seeds weight of 28.9 g and the least was obtained in 300 kg/ha of NPK (24.6 g). The leaves, stems and roots dry weight of maize showed no significant difference. Application of 10 t/ha of PM had the highest leaves dry weight (140.7 g) while the least was obtained in control plot (80.7 g). Dry matter distribution pattern of cob, leaves, stems and root was not significantly influenced by the treatments. Grain yield (100 seeds weight) did not differ significantly, but application of 10t/ha of PM had the highest 100 seeds weight when compared to control plot. Similar results have been reported by (Eghball *et al.,* 2004; Isitehale *et al.,* 2013). Whole plant total dry weight from manured/fertilized pots was significantly greater when compared to control plot. This result indicates a positive residual effect of applied manure/fertilizer on plant biomass; this suggested the possibility of successfully growing second crop to benefit from the residual nutrient. This is in agreement with (Eghball *et al.,* 2004) who observed a significantly greater biomass weight at tasselling as affected by residual effect of applied manure and compost when compared to the check.

In conclusion the studies revealed that there were significant differences in growth, yield and dry weight of maize plant components in response to the residual effect of applied of organic and inorganic fertilizer, indicating that maize could profitably be grown after sweet pepper without additional fertilizer inputs. It is suggestive that manure/fertilizer applied to a current crop of sweet pepper could be used to plant the next season crop; this will ensure full utilization of the applied manure/fertilizer and as such optimize profit and reduce input costs which the aim of agricultural system intensification. But to avoid a buildup of disease/pathogen a different type of crop other than the first crop should be planted

Table 3: Residual effect of manure/ fertilizer rates on dry weight (g) and dry matter distribution pattern

Manure/ Fertilizer rates	100Seed weight	Cob dry weight no husk	Leaves dry weight	Stem dry weight	Root dry weight	Dry matter distribution pattern (%)			
						Cob	Leaves	Stem	Root
0t/ha	24.7	145.9	80.7	313	74.5	24.49	13.1	50.7	11.7
5t/ha	28.9	215.0	114.5	458	134.6	23.39	12.4	49.7	14.5
10t/ha	26.6	224.9	140.7	520	144.1	22.89	13.7	49.6	13.8
300kg NPK	24.6	169.3	81.6	343	97.2	24.44	11.9	49.7	13.9
5t/ha+ 200NPK	27.4	229.8	108.3	511	120	23.97	11.1	52.4	12.6
10t/ha+100NPK	27.9	224.9	115	540	144.1	22.04	11.2	52.7	14.0
LSD $_{(0.05)}$	ns	42.15	ns	ns	ns	ns	ns	ns	ns

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