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Effect of Municipal Solid Waste and Fertilizer on Growth and Productivity Indices of Maize and Groundnut Intercrop in Asaba Delta State, Nigeria

[1]Chukwukelu, Ifeanyi Samuel; [2]Okwu, Goodluck Charles; [1]Anene, Ndubisi Kelvin; & [1]Ohanu, Victor, Chibueze

Department of Agricultural Education, Federal College of Education (Technical), Asaba Delta State, Nigeria. [2]Department of Agricultural Education, National Productivity Centre Abuja, Nigeria.

samuel.chukwukelu@fcetasaba.edu.ng

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Abstract

Field experiment was carried out in the Teaching and research Farm of Federal College of Education (Technical) Asaba during the 2023 cropping seasons. The objective of the study was to determine the Effect of Municipal Solid Waste and NPK Fertilizer on Growth and Productivity Indices of Maize and Groundnut Inter-crop. The experimental design was 6 x 3 factorial arranged in randomized complete block design (RCBD). The two factors studied were nutrient sources and cropping system. The six nutrient sources applied were 0 control, 100% MSWC, 100% NPK, 50%MSWC+50% NPK, 75% MSWC+25% NPK and 25% MSWC+ 75% NPK, while cropping system used were sole maize, sole groundnut and maize/groundnut inter-crop. 100% municipal solid waste was applied at the rate of 3.24kg/plot while 100% NPK was 324g/plot. The following data were collected plant height, inter-crop productivity of maize and groundnut were derived from the following indices: land equivalent ratio, relative crowding coefficient and aggressivity index. Data collected were analyzed using Genstat (3) Discovery edition package for statistical analysis of variance

(ANOVA). Separation of treatment means were carried out using Fisher's Least significant Difference (F – LSD). Vegetative growth increased with the application of 75% MSWC+25%NPK. . Early planting season performed better than late planting season. It was recommended that farmers should combine MSW and NPK fertilizer than sole application of NPK for increased yield and less pollution of the environment. The study established that application of 75%MSW +25%NPK has the potential of increasing growth and productivity of maize and groundnut.

Introduction

Maize botanically known as *Zea mays* is an important cereal crop that is believed to have originated in Mexico and Central America (Uguru, 2011). Maize is one of the major cereal crop grown by farmer all over Nigeria, due to its high demand as a staple food for human's, feed for animals and industrial raw material. Maize is made up of seven edible varieties namely dent maize, flint maize, sweet corn, flour or soft maize, waxy maize, popcorn and pod corn (Okonmah and Eruotor, 2012). The crop can adapt easily to a wide range of environment (Solaimalai et. al., 2021). Despite the adaptability nature of maize, there is still low production of this major crop in Nigeria. Some of the factors that have contributed to low production of maize are decline in soil fertility, under-utilization of soil boosting materials like organic fertilizers and inadequate practice of cropping system like inter-cropping legumes with maize (Dania, et. al., 2014), (DIPA, 2006). Groundnut is a leguminous crop botanically known as (*Arachis hypogaea. L*). it is also a popular cereal crop grown for its edible seed which serves many purposes as food for human beings, animal feed and raw material for industries. Groundnut is a wonderful crop that has the ability to attract atmospheric nitrogen from the sun through its root nodules and fixed it to the soil. This ability to fix nitrogen to soil is a great gain to crops like maize when inter-cropped with groundnut (Dania, *et. al*., 2014). However, productivity level of groundnut can be limited by availability of land, labour, fund, availability of appropriate fertilizer dosage, disease infection, post-harvest challenges, poor storage among others.

To increase the productivity of maize and groundnut, soil fertility is a major factor that must be placed on a high premium. Fertility of soil for cultivation of maize and groundnut can be boosted through application of municipal solid waste, inter-cropping of maize and groundnut and combine application of municipal solid waste and inorganic fertilizer (Chukwukelu, 2019). Municipal solid waste (MSW) are non-hazardous waste from households, markets, street sweeping that can decompose (Cristina, 2013). These waste can be composted and applied solely or combined with inorganic fertilizer to boost the productivity of maize and groundnut. According to Chukwukelu (2019) combined application of MSW and NPK fertilizer increased the productivity of maize and groundnut. Inter-cropping is growing of two or more crops simultaneously on the same field (Sangakkara *et. al.*, 2003). This type of cropping system help farmers with limited land to efficiently utilize the available land, inter-cropping legumes with crops like maize also helps to increase maize productivity. However, inter-cropping always lead to excessive removal of nutrient from the soil. Most farmer in a bite to amend the soil nutrient tends to adapt sole application of inorganic fertilizer. This practice is not the best for crops, the environment and human beings. Hence, the purpose of this research is to identify the effect of municipal solid waste and NPK fertilizer on the growth and productivity indices of maize and groundnut inter-crop. Specifically, the study has aim to:

1. Determine the effect of municipal solid waste on plant height of maize and groundnut.
2. Ascertain the effect of municipal solid waste and NPK fertilizer inter-cropping of maize and groundnut.
3. Determine the effect of municipal solid waste and NPK fertilizer productivity indices of maize and groundnut inter-crop.

Materials and Methods

Field experiment was carried out in the teaching and research farm of Federal College of Education (Technical) Asaba, Delta State Nigeria. Municipal solid waste were gathered from students hostels and market close to the school. These waste were sorted out and left to decompose for 60 days, 100% MSW was applied at the rate of 3.24kg/plot while 100% NPK fertilizer was applied at the rate of

324g/plot. NPK 15:15:15 fertilizer was used for the experiment. Land area of 1300m^2 was used. The land was demarcated into blocks and plots, each plot measured 5.4m x 3m and there were 18 plots within each block. Plant spacing of 90cm x 30cm was used for both sole and inter-crop. Two planting was carried, the first planting was done in the last week of April, 2023 while the second planting was in the second week of August 2023. The experimental design used was a 6 x 3 factorial in randomized complete block design (RCBD). The factors were nutrient sources at six levels (M_1.control, N_2 100% MSW + 25% NPK, 25% MSW + 75% NPK) and cropping system (sole maize, sole groundnut and maize + groundnut inter-crop). Data were collected on plant height and leave area for growth. While data for productivity indices were land equivalent ratio (LER), which is used to quantify the land use efficiency of inter-cropping system. Relative crowding coefficient (k), which is the measure of relative dominance of one component crop over the other in inter-cropping. Aggressivity Index (A) which is the measure of how much the relative yield in species 'a' is greater than that of species 'b'. Data collected were analyzed using Genstat (3) discovery edition package for statistical analysis. Separation of treatment means were carried out using fishers' least significant differences (F-LSD) (Obi, 2002). While test of significance was done at 5% probability level.

Results

Result in table 1 showed that cropping system and treatments had significant (P< 0. 05) effects on maize height at 4WAP. Application 75% MSW+ 25%NPK gave statistically higher plant height when compared with other treatments. At 6WAP treatments of NPK and MSW and cropping systems had significant (P<0.05) effect on maize height and application of 75%MSW+25%NPK had the tallest plants which were significantly (P< 0.05) teller than other treatments. Inter-cropping system had significantly (P< 0.05) increased plant height of maize when compared with sole cropping this was as a result of nitrogen fixed by groundnut nodules. Nutrients applied and cropping system had significant effect on plant height at 8WAP.Combination of Municipal Solid Waste at 75% + 25%NPK was significantly (P< 0.05) higher when compared to other treatments. Sole cropping significantly had higher plant height than inter-cropping system. Table 2 revealed

that at 4WAP application of 75% MSW+ 25% NPK at 4WAP was statistically higher than other treatments applied at plant height. Cropping system and nutrient combinations had significant (P< 0.05) effect on maize height at 4WAP. Inter-cropping of maize with groundnut was significant (P< 0.05) in plant height when compared to sole cropping. At 6WAP 75%MSW+ 25%NPK significantly influence plant height (P< 0.05) of crops at both sole and inter-cropping. Cropping system and nutrient combination had significant (P< 0.05) effect on plant height. Inter-cropping system had significantly (P< 0.05) higher plant height when compared with sole crop. At 8WAP 75% MSW +25%NPK had a significantly higher (P< 0.05) plant height than other nutrient. Cropping system and treatment produced a significant (P< 0.05) effect on plant height. At 8WAP inter-cropping system gave a significantly (P< 0.05) higher plant height than sole crop. At 10WAP sole cropping had a significant (p<0.05) higher plant height. Cropping system and treatment combination had a significant effect (P< 0.05) on plant height. Application of 50% MSW+25%NPK significantly (p< 0.05) had a higher plant height more than other treatment, N x CS is significant. Result presented in table 3 showed that at 4WAP 100% MSW had significantly (p<0.05) higher plant when compared with other treatments. Cropping system, MSW and NPK had significant (P<0.05) effect on plant height. At 6WAP cropping system and nutrient had a significant (P<0.05) effect on maize height. Application of MSW at 100% was significantly higher than when compared with other nutrient. Application of MSW at 100% significantly (P< 0.05) influenced groundnut. Nutrient applied and cropping system had significant effect on plant height at 8WAP. At 10WAP, inter-cropping significantly influenced groundnut height when compared with sole cropping. Application of MSW at 100% had statistically highest plant height when compared with other nutrients. Cropping system and MSW and NPK had significant (P<0.05), effect on plant height. Nutrient x cropping system had no significant effect at 10WAP. Table 4 revealed that application of NPK, MSW and cropping system showed significant (P<0.05) effect on the height of groundnut at 4WAP Application of 100% MSW at 4WAP produced significantly (P<0.05) taller plant compared with other treatments. Also sole cropping system significantly (P<0.05) increased plant height. At 6WAP, application of 100% MSW significantly (P<0.05) increased plant height of groundnut more than other

nutrients sources. Sole cropping system produced statistically taller plants then inter-cropping system. Application of MSW and NPK and cropping system significantly (P<0.05) enhanced plant height. The application of 100% MSW had a significant (P<0.05) over other treatments. Sole cropping produced taller groundnut than inter-cropping system at 10WAP. Application of MSW at 100% had a significant (P<0.05) effect on plant height more than other treatments. At 10WAP cropping system and nutrients combination had a significant effect (P<0.05) on groundnut height. N x CS was significant at 4WA. Result in table 5 showed that nutrient sources had significant (P<0.05) effect on RCC from the product value of groundnut. First planting had significantly (P<0.05) higher RCC than second planting due to consistent rain fall during the period. Application of MSW at 100% gave the highest RCC then other nutrient sources, nutrient combination had significant (P<0.05) effect on LER. Among the nutrient, the highest LER was recorded in MSW at 100% for first planting and 75% MSW+ 25% NPK for second planting. The highest LER value was obtained in first planting. Maize significantly (P<0.05) dominated groundnut with the application of the following nutrients 100%MSW, 100%NPK and 50%MSW+50%NPK, while groundnut had significant (P<0.05) dominance over maize with the following nutrients 0 control, 75%MSW+25%NPK and 25%MSW+75%NPK in the first planting. Second planting shows that groundnut significantly (p<0.05) dominated with the application of 25% MEW + 75% NPK and 0 control, while maize had significant (p<0.05) dominance over groundnut with the application of 100% MSW, 50% MSW + 50% MSW and 75% MSW + 25% NPK.

Discussion

Plant height, was increased with increases application of MSW at 100% and combination of 75% MSW + 25% NPK and 50%MSW+50%NPK, performed better than sole application of NPK and the control at both planting seasons. This shows that vegetative growth was improved with increased in MSW rate, Onwudiwe (2014) made similar observation on Maize. Combination of 75%MSW+25% NPK and 50% MSW+50%NPK increased the soil Nitrogen status and gave rise to increased vegetative growth. This agreed with Ghaly and Alkoaik

(2010), who observed that the application 50% NPK+50%MSW will increase maize yield..

Considering the economic implication of cultivating sole maize it was observed that inter-cropping maize and groundnut had a lot of positive effect on maize productivity indices through effective utilization of resources. This is in agreement with the reports of Thayamini *et al*., (2010) and *Shrikishnah, et al*, (2008), which stated that inter-cropping provides higher or additional income to the farmer since more than one crops can be planted on the same land at the same time.

Conclusion

The result showed that plant height increased with the increased application of MSW and combination of MSW and NPK. Application of NPK and MSW performed better than sole application of NPK. Combined application 75% MSW and 25%NPK fertilizer gave better productivity than sole application of NPK.

Recommendations

1. It is recommended that farmers should combine 75% MSW and 25%NPK fertilizer than sole application of NPK for increased yield and less pollution of the soil and environment.
2. Inter-cropping maize and groundnut should be encouraged for increased maize productivity and effective utilization of available land resources.

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Table 1: Effect of Municipal Solid Waste (MSW) and NPK Fertilizer on plant heights of Maize (cm) during first planting

Nutrient	4WAP			6WAP			8WAP			10WAP		
	Sole	**Intercro**	**mea**	**Sole**	**Intercro**	**mea**	**Sole**	**Intercro**	**Mean**	**Sole**	**Intercro**	**Mean**
0 control	26.5	56.3	41.4^{d}	130.7	107.7	119.2^{d}	163.7	121.5	142.6^{c}	172.3	129.4	150.9^{d}
100% MSW	73.3	65.7	69.5^{a}	166.3	160.0	163.2	221.3	169.9	195.6^{a}	224.4	190.4	207.4^{b}
100% NPK	49.0	58.0	53.5^{c}	133.3	131.7	132.5	171.6	156.8	164.2^{b}	178.4	164.1	171.3^{d}
50% MSW + 50% NPK	59.7	61.0	60.4^{b}	138.0	155.7	146.9	180.2	168.9	174.6^{b}	186.9	190.4	188.7^{c}
75% MSW + 25% NPK	79.3	80.2	79.8^{a}	172.0	170.3	171.2^{a}	221.3	189.2	205.3	224.4	195.4	209.9
25% MSW + 75% NPK	56.7	60.0	58.4^{b}	133.2	152.7	143.0	173.5	180.3	176.9^{b}	178.8	189.9	184.4^{c}
Mean	57.32	63.55^{a}		145.58	146.33^{a}		186.7	164.4^{b}		192.37	176.76^{b}	
CS LSD (0.05)	1.958			1.659			8.23			1.337		
N LSD (0.05)	3.392			3.393			14.26			2.316		
N x CS (0.05)	4.796*			4.799*			20.16*			3.275*		

N – Nutrients, CS – Cropping System, N- significant at 5% level of probability
Means with the same letter are not significantly different at 5% level of probability

Table 2: Effect of Municipal Solid Waste (MSW) and NPK Fertilizer on plant height of Maize during second planting

Nutrient	4WAP			6WAP			8WAP			10WAP		
	Sole	**Intercrop**	**Mean**	**Sole**	**Intercrop**	**Mean**	**Sole**	**Intercrop**	**Mean**	**Sole**	**Intercrop**	**Mean**
0 control	40.0	48.0	44.0^{e}	90.0	83.3	86.7^{f}	124.0	124.3	124.2^{e}	96.3	93.0	94.7^{e}
100% MSW	65.7	53.7	59.7^{b}	154.7	124.0	139.4^{c}	92.9	103.3	98.1^{f}	112.4	120.5	116.5^{d}
100% NPK	50.1	48.3	49.2^{d}	115.3	98.2	106.8^{d}	152.0	149.7	150.9^{c}	124.5	107.3	115.9^{d}
50% MSW + 50% NPK	58.7	51.5	55.1^{c}	145.7	148.3	147.0^{b}	199.2	118.5	158.9^{b}	116.7	142.3	129.5^{b}
75% MSW + 25% NPK	98.9	58.3	78.6^{a}	98.6	103.2	100.9^{e}	139.2	157.4	148.3^{d}	121.6	114.3	118.0^{c}
25% MSW + 75% NPK	67.0	51.0	59.0^{b}	157.4	156.4	156.9^{a}	130.0	239.6	184.8^{a}	150.9	125.7	138.3^{a}
Mean	63.4^{a}	51.8^{b}		203.7^{a}	149.4^{b}		147.0^{a}	195.0^{b}		151.8^{b}	231.8^{a}	
CS LSD (0.05)	1.47			2.546			1.88			1.153		
N LSD (0.05)	2.46			2.523			1.153			1.998		
N x Cs (0.05)	3.61*			3.40*			3.568*			2.825*		

N – Nutrients, CS – Cropping System, N- significant at 5% level of probability.
Means with the same letter are not significantly different at 5% level of probability

Table 3: Effects of Municipal Solid Waste and NPK Fertilizer on plant height of Groundnut for first planting

Nutrient	4WAP			6WAP			8WAP			10WAP		
	Sole	**Intercrop**	**Mean**	**Sole**	**Intercrop**	**Mean**	**Sole**	**Intercrop**	**Mean**	**Sole**	**Intercrop**	**Mean**
0 control	17.5	26.1	21.8^{c}	23.7	27.7	25.7^{c}	26.7	29.4	28.1^{d}	29.2	30.4	39.8^{a}
100% MSW	27.5	27.7	27.6^{a}	32.6	36.3	34.5^{a}	34.6	39.2	36.9^{a}	37.9	40.5	39.2^{a}

100% NPK	20.7	26.5	23.6[b]	27.9	29.3	28.6[b]	28.3	35.3	31.8[c]	30.3	36.1	33.2[c]
50% MSW + 50% NPK	26.9	26.8	26.9[a]	31.3	27.3	29.3[b]	35.4	28.1	31.8[c]	35.1	36.7	35.9[b]
75% MSW + 25% NPK	26.8	27.3	27.1[a]	34.3	36.0	35.2[a]	35.7	39.1	37.4[a]	36.8	39.9	38.4[a]
25% MSW + 75% NPK	26.1	26.0	26.1[a]	30.0	32.3	26.7[b]	30.0	35.3	32.7[b]	36.0	35.7	35.9[b]
Mean	26.7[a]	26.7[a]		29.9[b]	31.9[a]		32.4[b]	34.4[a]		34.20[b]	36.6[a]	
CSLSD (0.05)	0.85			1.06			0.970			1.963		
N LSD (0.05)	1.47			1.83			1.680			3.400		
N x Cs (0.05)	5.26*			2.25[NS]			2.41[NS]			2.47[NS]		

N – Nutrients, CS – Cropping System. N- significant at 5% level of probability.

Means with the same letter are not significantly different at 5% level of probability

Table4: Effect of Municipal Solid Waste and NPK Fertilizer on plant height of groundnut for second planting

Nutrient	4WAP			6WAP			8WAP			10WAP		
	Sole	**Intercrop**	**Mean**	**Sole**	**Intercrop**	**Mean**	**Sole**	**Intercrop**	**Mean**	**Sole**	**Intercrop**	**Mean**
0 control	17.0	20.0	18.5[b]	22.3	22.7	22.5[e]	25.6	23.3	24.5[e]	26.7	23.6	25.2[f]
100% MSW	27.0	21.0	24.0[a]	32.0	31.7	30.5[a]	34.7	35.1	34.9[a]	36.6	36.0	36.3[a]
100% NPK	18.0	19.0	18.5[b]	25.3	23.3	24.3[d]	27.8	24.9	26.4[d]	29.9	26.4	28.2[c]
50% MSW + 50% NPK	24.0	20.0	22.0[a]	29.7	28.3	29.0[b]	30.0	32.6	31.3[b]	31.3	33.3	32.3[c]
75% MSW + 25% NPK	27.0	20.0	23.5[a]	30.7	29.3	30.0[a]	32.7	32.7	32.7[b]	34.7	34.9	34.8[b]
25% MSW + 75% NPK	18.0	19.0	18.5[b]	25.3	26.3	25.8[c]	26.4	29.1	27.8[c]	30.8	30.6	30.7[d]
Mean	22.0[a]	20.0[a]		27.5[a]	26.9[b]		29.7[a]	29.5[a]		31.6[a]	30.8[a]	
CS LSD (0.05)	2.15			0.92			0.98			1.01		

N LSD (0.05)	3.72	1.59	1.70	1.75
N x CS (0.05)	5.26*	2.25^{NS}	2.41^{NS}	2.47^{NS}

N – Nutrients, CS – Cropping System,N-significant at 5% level of probability.

Means with the same letter are not significantly different at 5% level of probability.

Table 5: Effect of Municipal Solid Waste (MSW) and NPK Fertilizer on the Relative Crowding Coefficient, Land Equivalent Ratio LER, and Aggressive Index (AI) on Maize and Groundnut inter-crop during first and second planting

Nutrient	LER		RCC				AI			
			Maize		Groundnut					
	First Cropping	First Cropping	First Planting	Second Planting	First Planting	Second Planting	First Cropping		Second Cropping	
							Maize	Groundnut	Maize	Groundnut
0 control	1.94	1.63	1.5	1.4	4.1	1.4	-0.05	0.05	-011	-011
100% MSW	1.81	1.81	4.1	2.8	10.7	5.2	0.04	-0.04	0.02	-0.02
100% NPK	2.11	2.11	3.4	1.9	4.9	1.8	0.03	-0.03	-0.13	0.13
50% MSW + 50% NPK	2.04	2.04	1.9	1.4	10.3	3.4	0.01	-0.01	0.07	-0.07
75% MSW + 25% NPK	1.57	1.57	2.5	4.5	5.5	2.1	-0.08	0.08	0.03	-0.03
25% MSW + 75% NPK	2.08	2.08	1.8	2.4	5.2	1.7	-0.04	0.04	-0.13	0.13
Mean			2.52	2.39	6.22	2.72				
NLSD (0.05)			2.66	2.36	5.72	2.96				