PRELIMINARY STUDIES ON EFFECTS OF MAIZE/FOOD LEGUME INTERCROPPING SYSTEMS ON WEED CONTROL AND SOIL NUTRIENT STATUS UNDER REDUCED INORGANIC FERTILIZATION IN AN ULTISOL

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ABSTRACT

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Effects of maize/food legume intercropping systems on weed control and soil nutrient status under reduced inorganic fertilization were assessed at the Teaching and Research Farm of Federal University of Technology, Owerri. The experiment was a 4x3 factorial laid out in a randomized complete block design with three replications. The treatments were three crop mixtures (maize + cowpea, maize + groundnut, maize + soybean, and sole maize) and three NPK (20-10-10) fertilizer rates: 400 kg ha^{-1} (zero percent reduction), 200 kg ha^{-1} (50 percent reduction) and 100 kg ha^{-1} (75 percent reduction). Results showed a general increase in soil nitrogen, organic matter and potassium contents after harvest. Sole maize produced the highest dry weed biomass (48.40 gm^{-2}) at 6 weeks after sowing while maize/cowpea produced the least (30.30 gm^{-2}). Fertilizer rates had no effect on weed biomass. Crop mixture x fertilizer interaction was significant with suppression of weeds greater at lower fertilizer rate (100 kg ha^{-1}). Maize/groundnut fertilized with 200 kg ha^{-1} of NPK produced the highest number of groundnut nodules (221.70). Pod yield was higher in maize/cowpea and maize/groundnut than in maize/soybean mixture. Higher pod yield from legumes fertilized with 200 kg ha^{-1} over those fertilized with 400 kg ha^{-1} NPK suggests that heavy application of fertilizer to legumes could reduce their ability to nodulate and possible yield reduction.

Keywords*: Maize, food legumes, intercropping, weed, fertilization, soil nutrient.*

INTRODUCTION

The tropical ultisol is known to be deficient in major nutrients necessary for optimum crop growth and yield performance. Therefore, to get high yields, fertilizer containing these elements must be applied to satisfy crop needs (Lammers, 1989). The use of inorganic fertilizer alone has been reported not to be helpful under intensive agriculture in the tropical ultisols because it aggravates soil degradation (Sharma and Mittra, 1991). Also, worrisome is the fact that under the characteristically intense rainfall and rapid mineralization common in tropical ultisol, the organic matter level falls drastically, and consequently, there is rapid loss of nutrients especially the cations through leaching, and this lowers the pH and subsequently low crop yield. In addition, weeds constitute a major limiting factor in food production in Nigeria (Fadayomi, 1979). According to Lavabre (1991), the average crop losses due to weeds are estimated at 20% but may be as high as 50% or over 80% with certain food crops. Remison (1978) reported 80% reduction in maize yield due to weed infestation.

Intercropping, the practice of growing two or more crops in proximity to promote interaction between them can be used to address some of these problems (Ibeawuchi, 2007; Udoh and Ndaeyo, 2000). Growing maize and legumes in mixture offers a good crop relationship because their respective growth habits complement one another. The food legume may enrich the soil with nitrogen, provide live mulch, suppress weed and provide physical barrier to the maize. The legume/ rhizobial symbiosis provides farmers with an inexpensive and environmentally sound source of N. Therefore this study was conducted to determine the effect of maize/food legumes crop mixture on soil nutrient status as well as ascertain the efficacy of maize/food legume intercropping systems in weed control.

MATERIALS AND METHODS

Field experiment was carried out at the Teaching and Research Farm of the Federal University of Technology, Owerri during the late planting season (August to December) of 2013. Owerri is located between latitude 5° 20´ N - 5° 27´ N and longitude 7° 02´ E – 7° 07´ E. The vegetation of the area is generally rainforest (Nwaogu *et al.*, 2004). The area has a bimodal pattern of rainfall with peaks at July and September. The mean annual rainfall is 2,500 mm with minimum and maximum temperatures of 20 °C and 32 °C respectively. The soil is predominantly ultisols. The utisols are strongly acidic, coarse textures, highly leached upland soils (Eshett, 1993).

The experiment was a 4 x 3 factorial laid out in a randomized complete block design with three replications. The size of the individual plot was 4m x 2m (8 m^2), the size of each block was 60m x 2m (120 m^2). The plots were separated by each other by 1m alley while the blocks were separated from each other by 2m alley. The total size of the experimental area was 60m x 13m. The treatments consisted of three crop mixtures (maize + cowpea, maize + groundnut, maize + soybean, and sole maize) and three NPK 20-10-10 fertilizer rates: 400 kg ha^{-1} (zero percent reduction), 200 kg ha^{-1} (50 percent reduction) and 100 kg ha^{-1} (75% reduction). This followed 50 and 75% reduction of the standard recommendation (400kg ha^{-1}) for maize production in the area. Maize (*Zea mays* L.)

variety, Oba super 2, cowpea (*Vigna unguiculata* L. Walp) variety, IT 2246, soybeans (*Glycine max* L. Merr*)* variety, TG x 536 – 021, and groundnut (*Arachis hypogeal)* variety, Maculu red sourced from National Seed Service Substation, Umudike, Abia State were used for the study. The experimental site was cleared manually with machete and the debris was packed. The site was lined out and tilled manually with a spade. Three seeds of maize were sown per stand at a spacing of 1m x 30cm using row intercropping pattern. Three seeds of each legume were sown per hill at a spacing of 1m x 15cm. Seedlings were later thinned to one per stand at 7 days after sowing and thus giving the total plant population of 33, 333.33 and 66, 666.67 plants per hectare for maize and legume respectively. Each fertilizer rate was split applied in two equal applications with half the dose applied at 2 and 5 weeks after sowing (WAS) using band placement method. Weeding was done using a native hoe at 6 and 13 WAS

Data collection and analysis

The effects of the treatment were evaluated by measuring growth and yield parameters. Soil samples were collected at 0-30cm depth from different locations on the plot using soil auger, and analyzed for some physico-chemical properties before and after the field experiment. The effect of the treatments was evaluated by measuring growth and yield parameters. For the assessment of these parameters, 4 tagged crops were used from the net plot in each plot of various treatments and the measurement of growth character was done on those plants in situ at bi-weekly intervals starting from 4 WAS. Weeds collected were sundried and weighed using a weighing balance. Data collected were subjected to analysis of variance and F test used to determine significant treatments and their interactions effects. Treatment means were compared using the Fishers Least Significant Difference (FLSD) at 5% probability (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Weed biomass

Sole maize produced the highest dry weed biomass (48.40 gm^{-2}) at 6weeks after sowing(Table 1) followed by maize/soybeans (41.30 gm^{-2}), while maize/cowpea produced the least (30.30 gm^{-2}). The same trend was observed at 13 weeks after sowing. Fertilizer rates had no effect on the weed biomass. However, crop mixture x fertilizer interaction was significant (Table1) with suppression of weeds greater at lower fertilizer rate (100 kg ha^{-1}). The result suggests that cowpea and groundnut are more effective in weed suppression and thus capable of reducing the cost of weed control. The higher weed biomass produced at 6 weeks after sowing as against 13 weeks after sowing could be attributed to the fact that the crops at 6 WAS had not established enough canopies to effectively suppress the weeds. The poor weed suppression by sole maize could be as a result of low plant population per unit area of land. This result is in line with Okigbo (1978) and, Moody (1977) who reported that most crop combinations suppressed weed growth by providing an early ground cover due to high plant population and fast growing component crop. FAO (1988) also reported that denser plant population usually found in crop mixtures may also help control weeds. The results also are in consonance with Hart (1975) findings that suppression of weed is often higher with low fertility than with high fertility soil.

Nodulation and pod yield of legumes

Maize/Groundnut mixture produced the highest number of nodules (164.43) followed by Maize/Cowpea (154.33) whereas Maize/soybean produced the least (121.67) (Table 1). However, maize/groundnut fertilized with 200 kg ha^{-1} of NPK produced the highest number of groundnut nodules (221.70) followed by maize/cowpea fertilized with 200 kg ha^{-1} with 177.00 cowpea nodules. The least nodule (106.30) was produced by soybean with 100kg ha^{-1} NPK. Pod yield was higher in maize/cowpea and maize/groundnut than in maize/soybean mixture. Higher pod yield from legumes fertilized with 200 kg ha^{-1} over those fertilized with 400kg ha^{-1} NPK suggests that heavy application of fertilizer to legumes could reduce their ability to nodulate and possible yield reduction. Low pod yield of legumes recorded could be attributed to the low light intensity and high relative humidity that inhibited great photosynthetic activities which would have resulted in higher formation of assimilates. Nitrogen fixation by these legumes can provide significant inputs which enter the soil organic pool and are released to companion or subsequent crops in the cropping system. The result is in line with NRC (1983) which reported that the amount of nitrogen fixed in rhizobium-leguminous plant association varies with the bacteria and legumes as well as with environmental factors.

Soil physico-chemical properties

The soil physico-chemical properties before planting (Table 2) indicated that the soil was sandy loam with medium acidic, low organic matter content, potassium and nitrogen but high in phosphorus content. This confirms an earlier work by Ohiri (1992) that soils in Rivers, Abia, Akwa Ibom and Imo States of South eastern Nigeria are in group H, characterized by low pH, low organic carbon and low exchangeable cations. At the end of the field experiment, soil nitrogen and organic matter contents increased in maize/legume and maize/groundnut plots. The biodegradation of the biomass left after crop harvest must have contributed to the nutrient increase in the soil. The general increase in soil nitrogen and organic matter in cowpea and groundnut fertilized with 200kg ha^{-1} NPK suggests that cowpea and groundnut nodulate and fix nitrogen proficiently when compared to soybean. This is in line with O'Harra *et al.* (1988) report that the level of availability of mineral nutrients in the soil may seriously affect nodulation and or nitrogen fixation, thus the optional performance at 200kg ha^{-1} of NPK fertilizer.

CONCLUSION

There was a general increase in soil nitrogen, organic carbon and potassium contents at the end of the experiment in most of the maize/legume mixtures, indicating the sustainability of soil fertility by maize/food legume intercropping. Maize/food legumes mixture was effective in controlling weeds compared with sole maize treatment.

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Table 1: Effects of Crop Mixtures and Inorganic Fertilizer rates (kg ha^{-1}) on dry weed biomass, number of nodules, and pod yield

	Dry Weed Biomass (g m^{-2})															
	6 weeks after sowing				13 weeks after sowing				Number of nodules per plant legumes				Pod yield of legumes (kg)			
Mixtures	100.00	200.00	400.00	Mean	100.00	200.00	400.00	Mean	100.00	200.00	400.00	Mean	100	200	400	Mean
Maize/Cowpea	19.60	29.50	42.00	30.30	17.90	24.50	28.03	23.48	125.30	177.00	160.70	154.33	0.26	0.35	0.30	0.30
Maize/Groundnut	31.30	32.00	27.70	30.40	31.47	33.70	24.30	29.82	119.30	221.70	152.30	164.43	0.20	0.41	0.23	0.28
Maize/Maize	49.40	51.60	44.30	48.40	42.97	36.17	36.53	38.56	-	-	-	-	-	-	-	-
Maize/Soybean	34.50	39.20	50.10	41.30	38.70	29.13	36.73	31.52	106.30	135.00	123.70	121.67	0.07	0.07	0.08	0.07
Mean	33.70	38.10	41.00		30.26	30.87	31.40		117.00	177.90	145.60		0.17	0.28	0.20	
LSD $_{0.05}$ mixture		10.29				5.18				28.87				0.69		
LSD $_{0.05}$ fertilizer		Ns*				Ns*				28.87				0.69		
LSD $_{0.05}$ mixture x fertilizer		17.82				8.98				50.01				0.12		

Table 2: Physico-chemical properties of the experimental soil (0 - 30 cm) before and after the experiment

	Sand	Silt	Clay	OM	N	BS	Av. P	K	Mg	Ca	Na	CEC	pH
	----------------	------%------				----------------	mg kg^{-1}	------------	------cmol kg^{-1}------			------------	
Pre planting soil Analysis	77.86	13.28	8.86	1.29	0.23	63.35	11.76	0.10	1.10	0.64	0.32	4.73	5.20
Post-harvest soil Analysis													
100kg ha^{-1}													
Maize/Cowpea				2.01	0.25	44.30	9.58	0.15	0.47	0.45	0.21	3.50	5.00
Maize/Groundnut				2.10	0.24	44.50	8.76	0.23	0.46	0.45	0.22	3.55	5.00
Maize/Soybean				1.93	0.23	42.20	8.34	0.20	0.47	0.43	0.20	3.25	4.70
Sole Maize				1.01	0.20	41.50	10.12	0.14	0.45	0.42	0.20	2.98	4.50
200 kg ha^{-1}													
Maize/Cowpea				2.09	0.35	49.70	10.78	0.37	0.54	0.66	0.34	3.80	5.10
Maize/Groundnut				2.19	0.35	49.80	10.78	0.38	0.58	0.53	0.29	3.87	5.26
Maize/Soybean				2.02	0.27	48.52	8.34	0.29	0.53	0.52	0.27	3.54	5.10
Sole Maize				1.12	0.21	45.60	10.98	0.00	0.52	0.50	0.20	3.26	4.50
400 kg ha^{-1}													
Maize/Cowpea				2.01	0.24	55.20	11.00	0.32	0.55	0.54	0.29	3.95	4.98
Maize/Groundnut				2.01	0.25	55.25	12.32	0.34	0.58	0.56	0.34	3.90	4.98
Maize/Soybean				1.95	0.22	49.70	10.12	0.25	0.53	0.51	0.27	3.74	4.62
Sole Maize				1.22	0.21	47.20	10.78	0.11	0.48	0.50	0.20	3.50	4.94