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Performance of Maize Crop (*Zea mays l.*) under Selected Rotation Systems in Makurdi, Benue State, Nigeria.

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ABSTRACT

In the middle belt of Nigeria and in particular in Makurdi, farmers use very high amount of fertilizer due to the sandy nature of their soil which is fragile with low activity kaolinite clays, low effective cation exchange capacity (CEC) and low fertility. Crops produced under this condition may have high chemical residue which is injurious to human health. Therefore producing crops that are environmentally acceptable, economically viable and sustainable is needed. The use of legumes could be an alternative means to improving soil quality and consequently yield. There was need therefore to evaluate the abilities of the various food legume species to improve soil fertility and yield. Field experiments were conducted in 2006 and 2007 at the Teaching and Research Farm of the University of Agriculture, Makurdi, Nigeria to examine the effect of different rotations on the performance of maize crop (*Zea mays* L.). Treatments comprised of farmers varieties of four food legumes in the region, namely pigeon pea (*Cajanus cajan L. Millsp*,) soybean (*Glycine max* L.Merr) bambara nut (*Vigna subterranean* L.Vedcourt) and cowpea (*Vigna unguiculata* (L.) Walp) and two fallows. The trial was laid out in a Randomized Complete Block Design (RCBD) replicated three times. In 2006, food legumes were planted with two plots left under fallow. In 2007 maize crop was introduced into plots previously planted with food legumes and also in plots that were left to fallow in 2006. NPK fertilizer NPK 20: 10: 10 was applied at the rate of 450Kg/ha in one of the fallowed plot, while the other fallowed plot was left without fertilizer as control. The results showed that soil N level during the mid season varied from 13.1 KgN/ha-15.90 KgN/ha depending on the legume species. There was no significant difference with the soil N on the fallow. At harvest, the amount of soil N was observed to be highest in bambara nut and cowpea plots as 7.0 N Kg/ha. The food legumes reduced the acidity of the soil from 5.8 to 7.0 and the Cation Exchange Capacity (CEC) of the soil increased from 6.0 to 12.5Cmolkg^{-1}. Among the food legumes planted in 2006, cowpea gave the highest grain yield (6.6 t/ha) while pigeon pea had the lowest (3.73 t/ha). However, the growth and grain yield of maize obtained from legume plots in 2007 showed significant differences at 5% probability.

Keywords: Food legumes, Maize yield, Crop rotation, Soil fertility, Nitrogen fixaion

INTRODUCTION

The tropical areas in general and the Guinea savanna agro-ecological zones of Nigeria in particular are characterized by fragile soils with low activity kaolinite clays, low effective cation exchange capacity (CEC) and low fertility resulting from high susceptibility to soil degradation (Akamigbo, 1988). Tropical sandy soils which Makurdi soils belong have a wide range of limiting factors for agricultural use, and these include nutrient deficiencies, low water storage and poor physical attributes. Low nutrient levels are common on sandy soils. Crops grown on these soils commonly express multiple nutrients disorders, which limit their productivity. (CEC/IFPREB, 1999).

Maize (*Zea mays* L.) has significantly replaced traditional crops such as sorghum and millet in the farming systems of West and Central Africa. It is important especially in the Sub Humid Savanna (SHS), where it is one of the two major crops covering about 40% of the area under agricultural production (Smith *et al.*, 1992). In Nigeria, maize has gained prominence in the Savanna as the most important cereal (Lagoke *et al.*, 2002). One important characteristic of maize is its high and relative rapid nutrient requirement (Lagoke *et al.*, 2002). The soils, for example, must supply about 50-60% kg N (usually nitrate) and 30 kg P per hectare in plant available form for each ton of grains produced (Weber, 1998). Most often, those requirements are not met because farmers do not apply the required amount of inorganic fertilizer due to high cost and its unavailability at required times.

However, Olaniyan *et al.* (2000) recommended the use of leguminous crops as an alternative in farming systems. These leguminous crops form soil organic matter which functions as the principal source of nutrients to soil. Its decline affects not only crop yield but also the physical and chemical properties of the soil, because these characteristics are highly correlated with organic matter. Agbola (1974) also reported that the newly opened up soil at time of cultivation has plant nutrients at its peak but declines with continuous cultivation.

The use of and dependence on external inputs such as inorganic fertilizers as sole soil restorative measure is not only unsustainable but have problems associated with environmental friendliness, high cost, scarcity, lateness in supply and acquisition (Akamigbo, 1988). There is need to find ways of reducing inorganic fertilizers and yet maintain an acceptable yield. The use of low external input and environmentally sound practice which involved the systematic integration of food legumes into the cropping systems is alternatively proposed.

Legumes however, offer alternative sources of N, aid in soil erosion control, have potential for improvement of surface and "ground water quality, improve soil quality and also increase yield. The integration of food legumes in the cropping system could serve as soil management practices to maintain long term soil fertility. There is need to evaluate the abilities of the various food legume species for soil fertility and improved yield.

Therefore, the main objective of this study was to evaluate the potential of using food legumes to improve soil fertility and consequently maize yield without additional inorganic fertilizer application.

MATERIALS AND METHODS

The field experiment was conducted in two cropping seasons at the Teaching and Research Farm of the University of Agriculture Makurdi, Benue state. Makurdi is in the southern Guinea Savanna agro-ecological zone of Nigeria with Latitude 7^0, 44N and longitude 8^0, 35E and 94m above sea level. Makurdi has a sandy and alluvial type of soil with an average rainfall of 100mm per annum. The cropping history of the experimental site showed that in 2003 cropping season, the site was planted with cassava which was harvested in 2004 and had been left fallow with weeds for 2 years. The current study commenced in 2006 cropping season. The food legumes used in this study, were selected based on their level of adaptability to Makurdi area and these were: Pigeon pea {*Cajanus cajan* (L.) Millsp} - farmers variety; Bambara groundnut {*Vigna subterranean* (L.) Vedcourt} -farmers variety; Cowpea {*Vigna unguculata* (L.) Walsp }- farmers variety; Soybean { *Glycine max* (L.) Merr }- TGX1448-2E a determinate and medium maturing variety, developed at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Maize { *Zea mays* (L.)} - DMRESR-Y (Yellow maize) an early maturing variety resistant to Downy mildew and streak virus disease, developed at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria.

The land was manually cleared after which ridges were demarcated in 5m lengths and spaced 0.75cm apart using the West African hoe. A plot was made up of four rows (ridges) in a Randomized Complete Block Design (RCBD) replicated three times. Treatments include pigeon pea rotation, soybean rotation, bambara groundnut rotation, cowpea rotation, fallow rotation without fertilizer and fallow rotation with NPK fertilizer at the rate of 450Kg/ha. In 2006 cropping season, six treatments were planted using Randomized Complete Block Design replicated three times. The plot size was 4 rows each of 5m long and 1m wide with the distance 75cm between rows. In the first cropping season (2006), four food legumes (Pigeon pea, Soybean, Bambara and Cowpea) seeds were treated with Fernasan D and were planted June 25, 2006. Soybean was later thinned to give within row spacing of 2 stands/0.05m that making a total of 266,667 stands/ ha, Pigeon pea was thinned to 2 stands/0.5m to give approximately 53,333stands/ha; Bambara was thinned to 2 stands/0.5m to give approximately 53,333stands/ha; Cowpea was also thinned to 2 stands/0.5m to give approximately 53,333stands/ha. In 2007 cropping season, maize crop was introduced into fallow plots and plots previously planted with the food legumes. NPK fertilizer at the rate of 90kgN/ha, 45Kg P_2 0_5/ha and 45Kg $K0_2$/ha was added to one of the fallowed plots as a treatment. Three maize seeds treated with Fernasan D and was later thinned to 2 stands/0.5m to give approximately 53,333stands/ha being full recommended population density. Two hoe - weeding was done at three and six weeks after planting to control weeds in 2006 and 2007 cropping seasons. Insects pests were controlled using Attacke (Lambacyhalothrin 2.5 EC) at the rate of one litre per hectare especially on cowpea plots for the control of cowpea pod borers and pod sucking bugs. This was repeated four times at fortnightly intervals. At first flower opening, pigeon pea plants were sprayed with Perfekthion (dimethoate) at 6 ml/L of water (equivalent to 0.24g active ingredient L) for the control of pigeon pea pod borers and pod sucking bugs. Grain yield of food legumes and the maize in 2007 were determined from the two center rows of each plot. Soybean and bambara nut were harvested in the first week of November, 2006 respectively. Harvesting of cowpea started mid October by hand picking and ended 1st week of November 2006. Pigeon pea was harvested in first week of February, 2007. Grain yields for both legume crops and maize were obtained from the experimental plot in kilograms, but later converted to tonnes per hectare (t/ha)

Soil samples were collected three times: prior to the planting of the various food legume crops, at flowering stage and at the end of the season for laboratory analysis. The soil samples were analyzed for soil acidity, particle size distribution, total nitrogen, Cation Exchange Capacity, organic matter, available P, exchangeable cations and aluminum (Black, 1965)

Plant heights for both legumes and maize were measured fortnightly after emergence using a meter rule from the soil surface to the flag leaf. Six leaves per plant from six plants in a plot were used to calculate the leaf area. The leaf area of food legumes were obtained by carefully tracing the outlines of the leaves on metric graph paper using the techniques described by Obasi (1989). This procedure involved measuring the length and the width of the terminal leaflet of each leaf on the metric graph paper from which their rectangular areas were calculated by multiplying with the ratio 0.71 to obtain the correct leaf area. The maize leaf area was determined non-destructive using the method described by Wahua (1985) using the linear equation. Leaf area = 0.75 (L x W), where L is the length and W is the maximum width of leaf. Number of nodules per plant of each food legumes crop was estimated. At 50% flowering, two plants from the border row of each plot were examined for nodules. The soil round the two plants was loosened with the aid of garden fork to a depth of about 50 cm and the plants were uprooted carefully. The roots of each plant were washed carefully under a running tap. The nodules were then detached with the aid of a sharp knife into a petridish and then counted. Nodules per plant was estimated by dividing the total number of nodules obtained for both plants by two. Roots of two plants were carefully uprooted and were washed under running tap and their flesh weight was measured using analytical sensitive weighing balance. The weight per plant was estimated by dividing the total weight obtained for both plants by two. The roots of the two plants from each plot were oven dried to constant weight to estimate the dry weight (g). Other parameters observed were biomass, fresh and dry weights (g), number of primary branches at flowering, number of leaves per plant at flowering, number of primary branches at harvest, number of pods/plant, pod length/plot (cm), number of grains/pod, 100 grain weight and total grain yield (g).

Parameters taken on the maize crop were percentage emergence, days to 50% tasselling and silking and stand counts after thinning and at harvest. From the two center rows of each plot, six plants were selected at random for ear height which was measured from base of the plant to the node bearing the topmost ear. Six cobs were randomly selected per plot were used for data on mean cob diameter,mean cob weight and mean cob length, mean number of kennel rows and mean seeds per cob. Percentage survival was taken as the ratio of stand count at maturity to that at thinning. Grain yields as 100 seed weight and total grain yield were measured using analytical sensitive balance.

Analysis of Variance (ANOVA) was used to analyze data collected and were significant, means were separated using Fishers Least Significant Difference (F LSD) at $P<0.05$ as described by Obi (1986).

RESULTS AND DISCUSSION

Almost all the chemical properties of the soil used at the beginning of the experiment in 2006 were below the level required for optimum maize growth and yield (Table 1). Total soil nitrogen at the experimental site before the commencement of the research was low (6.4 and 7.0 kg N/ha), which is below the critical soil N range (10.0-15.0 kg N/ha) reported by Agboola and Fayemi (1972). The rapid increase in the soil total N content from 7.0 to 16.0 kg/ha at the flowering stages of the legumes (Table 1) could be attributed to the fixation of atmospheric N by the food legumes and this agree with the studies of Asibuo and Osei-Bonsu (1999) who reported that legumes fixed more N at the flowering than at phenological stages. This result was also similar to the findings by Heichel (1987) indicated that, the ability of legumes to fix atmospheric N which adds external N to the crop-soil ecosystem is a distinct benefit of legume culture. The drastic reduction in the soil N (-23 to -54%) after the various food legumes had been harvested could result from the fact that most legumes still utilize the N fixed (Voss and Shrader,1984; and Hesterman *et. Al.*,1986). Although soybean grown in rotation with corn (*Zea mays*) enhances corn production, studies with N - Isotopes indicate that after harvest of the soybean seed, soybeans contribute little to total soil N (Heichel, 1987). Available P in the soil range from 4.66-9.04 mg/kg in 2006. This was less than optimum 15 mg/kg for crop growth reported by Agboola and Fayemi, (1972). These finding agrees with that of Hoshikawa (1991) who reported that phosphorus is usually the most deficient nutrient (after N) in soils of the semi-arid tropics, including Alfisols and Vertisols. The increase in available P at flowering which brought a corresponding increase in soil N similar to the findings of Heichel in 1987could be that since high soil P encouraged the rhizobium activity, it enhanced N fixation by the food legumes .The decline in available P after the food legumes were harvested could be attributed to the fact that symbiotic nitrogen fixation increase plant demand for P and the most common nutritional disorders in legumes are related to P deficiency (Munns and Mosse, 1980).

Legume rotations recorded higher CEC values than the fallow rotations (Table 2). This may be attributed to the effect of the food legume which lead to accumulation of organic matter content with more exchangeable sites resulted in higher CEC. Cation exchange capacity was highest in the cowpea rotation and least on soybean rotation. These could be as a result of the higher biomass weight recorded which might have led to organic matter build up in the soil since organic matter accounts for more than 80% of the CEC (Agboola and Fagbenro,1985). This means that the higher the organic matter, the higher the CEC of the soil as reported by Lal and Kang (1982). Organic matter has been noted to improve the buffering capacity of the soil due to their high calcium and magnesium content, which have liming effects. Hence amelioration of the soil organic matter also affects the physical and chemical condition of the soil through the formation of soil humus (Hulugalle and Kang, 1990). This also agrees with the studies reported by White (1987) that, organic matter can make a substantial contribution to the CEC of the soil, and hence the retention of exchangeable cations. Potassium was found to be between 0.20 and 0.51Cmol/kg (Table2) which are marginally adequate for crop growth as cited by London,(1984).

Table 1: Influence of Selected Fallow Practices on Total N, P and K Status in Soil, Makurdi, 2006

S/N	Food Legume	Total N (Kg/ha)				Available P (Pmm=mg/kg)				K+ Cmol/kg $^{-1}$			
		1st	2nd	3rd	% Increase/decrease over initial value	1st	2nd	3rd	% Increase/decrease over initial value	1st	2nd	3rd	% increase over initial value
1.	Pigeon Pea	7.60	14.00	5.30	-30	8.46	12.46	7.00	-17	0.29	0.33	0.15	-48.3
2.	Soybean	7.60	15.90	3.50	-54	7.59	12.27	8.75	15.3	0.31	0.55	0.20	-35.5
3.	Bambara	6.40	15.90	7.00	9.4	9.04	10.25	14.00	54.9	0.51	0.90	0.24	-52.9
4.	Cowpea	7.00	13.10	7.00	0.0	5.83	11.09	8.75	50.1	0.20	0.50	0.22	10
5.	Grass fallow	7.00	15.90	5.30	-24	4.66	6.14	7.88	69.1	0.48	0.66	0.13	-72.9
6	Grass fallow	7.0	15.65	5.28	-23	4.64	6.15	7.87	67.8	0.47	0.66	0.13	-72.9

Table 2: Influence of some rotation practice on soil acidity, organic matter and CEC status in the soil, Makurdi, 2006

S/No	Food Legume	pH			Organic matter (%)			Cation Exchange capacity Cmol/kg $^{-1}$		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1.	Pigeon Pea	5.90	5.63	6.30	0.99	1.47	0.79	6.00	7.30	10.06
2.	Soybean	6.33	5.83	6.70	1.10	1.12	0.72	7.33	9.67	9.80
3.	Bambara	6.20	6.20	7.00	1.20	1.27	0.82	9.03	9.20	11.40
4.	Cowpea	5.87	5.43	6.30	0.88	1.04	0.89	7.60	7.90	12.50
5.	Grass fallow	6.67	5.55	6.60	0.92	1.28	1.01	7.40	7.47	11.70
6	Grass fallow	6.57	5.55	6.50	0.92	1.26	1.04	7.38	7.46	11.60

Key: 1st = Beginning of cropping season
2nd = At flowering stage 3rd = End of cropping season

The poor nodulation and low nodule biomass weight observed among the legumes might also have resulted from decreased photosynthate supply to nodules from the under-nourished food legume crops. The larger number of nodules produced by cowpea (78.8) over and above those of the other food legumes and its comparatively low nodule biomass dry weight (0.24g). while pigeon pea which produced less number of nodules (11.8) but rather gave the highest dry weight 0.43g (Table 3). This result agrees with the findings of Ogoke *et al.* (2006), who reported that with increasing number of nodules in cowpea, nodules became smaller in size, with increasing weight loss presumably because of competition for photosynthate. Although there was no correlation in the current study between root weight and available P, Adu-Gyamfi, *et al.* (1989) reported that root weight was correlated with P absorption amount, indicating that, P uptake was dependent on the size of the root. This may be the reason why pigeon pea had the highest root weight and also had lower available P after the legumes were harvested it could be that it absorbed more P from the soils.

The maize leaf area and plant height which showed significant difference through out the study period indicated that the food legume treatments affected the build up of soil nutrient elements than the legume- free control. The maize plant height and leaf area were highest and largest respectively on fallow rotation with fertilizer application followed by those after the food legumes rotation and least by fallow rotation without fertilizer (Table 4 and 5). This showed that, the nutrient build up in the soil from organic matter in legumes had effect on the subsequent maize crop. This finding agree with that of Lal and Kang (1982) which says, improvement recorded in CEC which is responsible for making nutrients available for plant use. The fact that the leaf area of the maize crop from all the treatments increased progressively up to 6WAP and then decline could indicate the critical nutrient requirement age of maize crop. This agrees with the studies of Kling and Edmeades (1997) who reported that, nutrients should be applied to the maize crop before 6WAP; otherwise, the nutrients added would not affect its vegetative performance. Maize height increased steadily up to 10 WAP by which time all vegetative characters of maize might have attained their maximum value 9Table 5).

The significant effect of rotating maize with some food legumes (Pigeon pea, Soybean, Bambara nut and Cowpea) with respect to days to 50% teaseling, days to 50% silking could be attributed to the nutrient build up in legume plots. The fertilizer plot which might have hastened the maize crop to tassel and silk earlier than control. This finding corroborated Wahua (1985) who stated that lacks of nutrients are likely cause of delay in growth. Numbers of ears per plot, number of ears per plant, cob diameter, cob length, number of seeds per cob, 100 seeds weight, shelling percentage, grain yield per hectare were significantly lower in unfertilized plots (Table 6). This could be that, there were no sufficient nutrients to enhance the performance of the maize crop under it.

The maize grain yield from the food legume plots increased by 38-126% while the grain yield from fertilizer plot increased by 214% . This increase in maize grain yield recorded on plots previously planted with food legumes agreed with studies of Asibuo and Osei-Bonsu in 1999 indicated that leguminous crop can improve the nitrogen status of the soil and reduce N fertilizer requirement of the succeeding non-leguminous crop. Codjia, (1996) reported that *Mucuna pruriens* and *Mucuna cochinchinensis* increased maize grain yield by 98% without inorganic fertilizer application. Heichel (1987) suggested that the grain yield increase could be as a result of the effect the various food legume on N availability and yield of the following maize in rotation. It also agrees with the findings of Mukurubia (1985) who reported that, the use of food legumes as a component in the system significantly improved the yield of the cereal component. He further reported that , in Zimbabwe, the yield of maize was greater after bambara groundnut than after groundnut. However, in the current study it was observed that among the food legumes tested, maize after pigeon pea gave the highest yield (5.1t/ha) followed by the yield after soybean (4.3t/ha) while bambaranut gave the lowest (3.0t/ha).

The amount of N observed in the soil after the food legumes were harvested was low, These could be attributed to the findings of Heichel (1987) which stated that, some legumes often result in a net deficit in the soil because more N is removed in the harvest grain than is biologically fixed N undoubtedly, the rotation effect is a factor. The decrease in 100 seed weight of maize from the control plot might have been due to lack of nutrient.

Table 3: Means of agronomic parameters of legumes in legume-maize rotation systems in Makurdi, Nigeria in 2006 cropping season

Legumes	No. of Nodules/plant at flowering	Nodules fresh wt/plant at flowering	Nodules dry weight/plant at flowing (g)	Root fresh wt/plant	Root dry wt/plant	No. of primary root/plant at flowering	No. of primary branches/plant at flowering	No. of leaves/plant at flowering	Above ground fresh biomass wt/plant at flowering (g)	Above ground dry biomass wt/ plant at flowering (g)	No. of pods/plant	Pod length/plot (cm)	No. of grain/pod	100 seed wt/plot	Total grain wt/plot t/ha
Pigeon pea	11.8	0.93	0.43	30.87	7.87	11.0	13.57	175	348.0	49.0	350.0	5.53	8.33	10.60	3.73
Soybean	47.8	0.47	0.20	6.20	1.13	13.8	4.77	90	37.0	8.0	26.0	5.47	15.37	11.30	4.63
Bambara	11.3	0.23	0.02	4.77	0.93	7.2	13.43	350	189.0	29.0	53.0	3.10	2.13	84.72	5.70
Cowpea	78.8	1.00	0.24	4.57	6.13	16.0	6.90	306	819.0	285.0	60.0	12.60	12.57	18.93	6.63
C.V.%	63.1	46.1	73.7	11.9	42.6	33.8	28.6	16.6	50.1	94.6	43.7	9.60	20.20	5.7	27.60
FLSD (0.05)	**47.26**	**0.61NS**	**0.33 NS**	**2.76**	**3.42**	**8.11 NS**	**5.33**	**76.2**	**349.0**	**174.5**	**87.3**	**1.27**	**3.87**	**3.57**	**2.15 NS**

Key: C.V. = Coefficient of Variation

FLSD = Fisher Least Significant Difference

NS = Not Significant

Table 4: Influence of legume crops on mean leaf area per plant maize variety Dmesr-Y grown in the various rotations in Makurdi, 2007

Treatment (Rotations)	Plant Height (cm)					
	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
PP Fb Maize	24.8	149.9	426.6	414.2	406.5	406.1
SB Fb Maize	25.7	265.0	494.8	518.3	505.8	503.3
BB Fb Maize	30.1	191.2	368.3	324.7	315.4	309.9
CP	37.5	253.2	474.8	468.8	465.6	462.7
FF	36.5	260.6	498.8	527.9	529.4	524.5
FO	37.4	231.9	397.1	279.3	289.0	279.6
C.V.%	14.3	8.3	5.6	7.9	9.8	9.3
FLSD (0.05)	**8.31**	**33.82**	**44.9**	**60.33**	**74.35**	**70.04**

Key:
PP Fb Maize = Pigeon Pea Followed by maize
SB Fb maize = Soybean followed by maize
BBV Fb maize = Bambaranut followed by maize
CP Fb maize = Cowpea followed by maize
FF = Fallow followed by maize supplemented with fertilizer
FO = Fallow followed by maize without fertile

Table 5: Influence of legume crops on mean plant height of maize variety DMESR-Y grown in the various rotations in Makurdi, 2007

Treatment (Rotations)	Plant Height (cm)					
	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
PP Fb Maize	20.73	42.17	89.5	132.37	168.1	166.3
SB Fb Maize	19.30	56.87	104.7	147.83	161.9	161.5
BB Fb Maize	16.27	54.37	90.5	126.17	138.4	138.3
CP Fb Maize	20.47	59.93	111.7	149.27	157.2	156.7
FF	19.37	59.23	102.3	174.9	176.2	173.8
FO	15.59	56.73	90.1	121.37	138.5	129.9
C.V.%	11.9	6.5	6.5	2.7	4.7	5.1
FLSD (0.05)	**NS**	**6.53**	**11.66**	**6.94**	**13.92**	**13.56**

Key:
PP Fb Maize = Pigeon Pea Followed by maize SB Fb maize = Soybean followed by maize
BB Fb maize = Bambaranut followed by maize CP Fb maize = Cowpea followed by maize
FF = Fallow followed by maize supplemented with fertilizer
FO = Fallow followed by maize without fertilizer

Table 6: Means of agronomic parameters of maize grown in different rotations in Makurdi (2007).

Treatment	Emergence (%)	Days to 50% Tasseling (No)	Days to 50% silking (No)	Ear height (cm)	No of Ears/plant	No of Kennel rows/cob	Maize ear length (cm)	Cob diameter (cm)	Cob weight/ plot (kg) (kg)	Cob seeds (No)	Plant count at thinning (No)	Plant count at harvest (No)	Plant survival (%)	Shelling percentage (%)	100 seeds/plot (g)	Grain weight (t/ha)
PP FB Maize	79.60	51.00	53.67	59.00	1.67	14.67	13.67	3.70	6.17	534.0	41.33	39.33	96.00	83.3	22.40	5.13
SB FB Maize	78.80	50.67	53.67	59.57	1.73	14.67	13.83	3.60	5.73	481.7	42.67	41.67	97.69	76.0	22.93	4.33
BB FB Maize	75.80	50.00	57.00	51.53	1.37	12.67	10.67	3.43	4.10	2288.3	40.1	38.33	95.67	73.77	21.43	3.03
CP FB Maize	80.30	50.00	53.33	64.93	1.90	14.33	14.00	3.67	5.33	537.3	40.67	537.3	40.33	6.5	22.93	4.07
FF	80.30	50.00	51.00	65.33	1.90	14.00	15.90	4.0	8.83	655.3	40.33	39.67	98.33	80.0	23.73	7.03
FO	74.20	53.33	56.67	50.45	1.17	12.33	10.83	3.40	3.73	230.3	40.33	66.67	92.67	65.3	20.23	2.27
C.V.%	6.80	0.90	0.90	6.00	13.1	4.10	5.8	3.9	17.0	3.30	3.60	4.10	3.10	6.9	3.10	14.1
FLSD (0.05)	NS	0.89	0.92	7.09	0.39	1.03	1.40	0.26	1.75	26.60	NS	NS	NS	9.56	1.26	1.11

<u>Key</u>:

PP Fb Maize	=	Pigeon Pea Followed by maize
SB Fb maize	=	Soybean followed by maize
BBV Fb maize	=	Bambaranut followed by maize
CP Fb maize	=	Cowpea followed by maize
FF	=	Fallow followed by maize supplemented with fertilizer
FO	=	Fallow followed by maize without fertilizer

CONCLUSION

The results of the current study on the performance of maize crop under crop rotation system with some selected food legumes in Makurdi showed that, food legumes integrated with the cropping system improved the physical and chemical properties of the soils in question. Although there was no textural change in the soil, there was improvement in the percentage clay content of the soil, improved soil pH, organic matter content, CEC. Although the food legumes did not improved much soil N, there is an indication that in the absence of synthetic chemical fertilizers, the food legumes could be used to improve soil properties to improve yield production of maize crop.

The study further indicated that among the food legumes in the rotation systems, cowpea gave the highest grain yield (6.6 t/ha) and pigeon pea gave lowest in 2006.

The food legumes in rotations enhanced both the vegetative and grain yield of the subsequent maize crop in legume based rotation (Tables 5 and 6). Grain yield and other yield parameters of maize under food legume-maize rotation differ significantly. Among the food legumes rotation, maize after pigeon pea rotation gave highest grain yield (5.13 t/ha) followed by the one from soybean rotation (4.33t/ha) while the least was bambara rotation (3.5t/ha).

It is recommended that, since the use of food legumes rotation fits appropriately into farmers' preference and aspiration with respect to increased output, minimal or no risk, cowpea could be utilized in legume- maize rotation.

Research on the use of this food legumes technology for crop production is advocated in different agro-ecological zones of Nigeria.

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