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POTENTIALS OF COVERCROPS FOR SUSTAINABLE SHORT FALLOW REPLACEMENT IN LOW-INPUT SYSTEMS OF MAIZE PRODUCTION IN THE HUMID TROPICS

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ABSTRACT

A field experiment was conducted from 1999 to 2003, in which the growth of eleven green manure covercrops were studied for biomass production at Umudike, in the humid tropics of south eastern Nigeria. The covercrops were turned into the soil as green manures after three years of fallow and compared with grass cover and NPK fertilizer for production of two maize varieties. Treatments comprised *Chamacrista rotundifolia, Pueraria phaseoloides, Aeschynomene histrix, Centrosema pascuorum, Centrosema brasilianum, Stylosanthes capitata, Mucuna pruriens, Mucuna deeringiana, Mucuna veracruz, Crotolaria ochroleuca, Lablab purpureus*, natural grass cover and NPK fertilizer. Maize (Zea mays L.) varieties consisted of FARZ-23-Y and TZBR Eldana $2C_3$-W. All possible combination of the maize varieties and the manure treatment were laid out in a randomized complete block design with three replications. *Mucuna deeringiana* and *Mucuna veracruz* gave the significantly highest biomass 3 months after planting in the establishment year. However, *Aeschynomene histrix* produced the significantly highest biomass 3 years after planting. *Mucuna pruiens, Crotolaria ochroleuca and Lablab purpureus* did not persist in competition with the native vegetation. *Aeschynomene histrix* fallow produced significantly higher maize dry matter yield than *Centrosema pascuorum, Centrosema brasilianum, Lablab purpureus* and grass cover but not other treatments. Average grain yields ranged from 1260.4kg/ha in *Mucuna pruriens* to 2399.4kg/ha in *Aeschynomene histrix* fallow in 2002 and from 640.7kg/ha in *Lablab purpureus* to 1428.2kg/ha in *Stylosanthes capitata* fallow in 2003. In 2002, grain yields obtained with *Aeschynomene histrix* improved fallow were statistically similar to those obtained with *Chamaecrista rotundifolia, Centrosema brasilianum* and NPK fertilizer treatment, but significantly lower in other cover crop fallows. There were generally no statistically significant effects of variety and its interaction with cover crops on maize crop growth and yields.

KEYWORDS: Cover crops, short fallow, maize, humid tropics.

INTRODUCTION

Traditional farming in Nigeria and other countries of the humid tropics mainly involves shifting cultivation or bush fallowing. Agricultural production in such low-input systems relies partly on nutrient cycling and the maintenance of soil fertility through biological processes (Hauser and Kang, 1993). Maintaining adequate levels of soil organic matter is an important factor in the long-term productivity of the system (Bohlool, 1989). However, increased food requirements for expanding human populations in the tropics have put the farming system under great pressure, leading to reduced fallow periods of less than three or four years and more intensive cultivation of farmland (Chikoye et al, 2002).

Cropping intensification reduces the soil organic matter (Agboola, 1994), with an associated decline in soil nitrogen and increasing weed intensification (Nye and Greenland, 1960). Although, high crop yields can be obtained with judicious application of inorganic fertilizer, the use of high chemical inputs can not be sustained; not only because they are expensive for the resource-poor farmer, but also because of constraints in supply and pollution risks. The use of green manure covercrops for soil fertility regeneration has been shown to be among the most promising technologies to reverse the challenges of land impoverishment for the rural poor (Tarawali, 1999). The crops can be efficient sources of nitrogen and improve soil physical and biological properties (Carsky et al.., 1998)

The potentials of *Mucuna pruriens* as a green manure crop in southeastern Nigerian have been documented (Okpara and Njoku, 2002), but a major problem associated with the use of the species is its poor capacity to persist and survive the dry season after the establishment year (Olaniyan et al.., 2000). The investment made to establish and manage some covercrops may, therefore, be more than the benefit from reduced weed pressure and increased soil nitrogen (Manyong et al.., 1999). However, the use of covercrop species with good capacity to persist and regenerate soil fertility within a short fallow period could enhance the profitability of the system. Short duration fallow system with suitable species improve yield and halt soil quality decline (Thor Smestad et al.., 2002). This paper, therefore, assesses biomass production of eleven covercrops and evaluates their uses as fallow species in comparison with natural fallow (grass cover) and inorganic fertilizer for production of maize in southeastern Nigeria.

MATERIALS AND METHODS

Field experiments were conducted between 1999 and 2003 on the National Root Crops Research Institute (NRCRI) farm at Umudike, southeastern Nigeria. Umudike is situated at latitude 5^0 29^{1}N, Longitude 7^{0}33^{1}E and at 122m above sea level. The soil is a 'low activity clay' classified as an ultisol (Eke-Okoro et al, 1999). Annual rainfalls for Umudike in 1999, 2000, 2001, 2002 and 2003 were 2601.3, 1680.3, 2010.0, 2351.4 and 2237.4mm, respectively.

The experiments were laid out as 2 x 13 factorial in randomized complete block design (RCBD) with three replications. Treatments comprised all combinations of two varieties of maize and thirteen manure sources. The two varieties of maize were FARZ 23 and TZBR Eldana $2C_3$. The manure sources were *Chamacrista rotundifolia, Pueraria phaseoloides, Aeschynomene histrix, Centrosema brasilianum, Stylosanthes capitata, Mucuna deeringiana, Mucuna pruriens, Crotolaria ochroleuca, Lablab purpureus,*

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Table 1: Dry matter (kg/ha) of eleven legume covercrops at 1 and 3 years after planting (YAP)

Covercrop	Time of harvest (YAP)	
	1	3
Chamacrista rotundifolia	912.3	1393.9
Pueraria phaseoloides	2732.0	1138.9
Aeschynomene histrix	847.0	4096.8
Centrosema pascuorum	1956.6	201.3
Centrosema brasilianum	2501.9	275.6
Stylosanthes capitata	2657.1	1259.5
Mucuna deeringiana	4448.8	117.0
Mucuna veracruz	4269.3	138.1
Mucuna pruriens	3032.1	
Crotolaria achroleuca	3038.9	
Lablab purpureus	706.6	
LSD (0.05)	1386.4	773.1

Table 2: Effect of three-year covercrop fallow on soil pH and organic matter in 2000, 2001 and 2002.

	Soil pH (water)			% OM		
Covercrop	2000	2001	2002	2000	2001	2002
Chamacrista rotundifolia	4.7	4.8	4.5	1.49	1.54	1.64
Pueraria phaseoloides	4.3	4.6	4.5	1.36	1.64	1.49
Aeschynomene histrix	4.5	4.9	4.5	1.38	1.82	1.91
Centrosema pascuorum	4.5	4.8	4.6	1.47	1.83	1.75
Centrosema brasilianum	4.4	4.7	4.5	1.43	1.59	1.66
Stylosanthes capitata	4.4	4.9	4.4	1.26	1.25	1.67
Mucuna deeringiana	4.5	4.8	4.5	1.41	1.39	1.55
Mucuna veracruz	4.5	4.7	4.7	1.49	1.67	1.71
Mucuna pruriens	4.4	4.8	4.4	1.48	1.43	1.46
Crotolaria ochroleuca	4.4	4.7	4.6	1.83	1.69	1.74
Lablab purpureus	4.4	4.7	4.3	1.46	1.5	1.74
Grass cover/weed	4.5	4.8	4.4	1.34	1.75	1.83
LSD $_{(0.05)}$	NS	NS	NS	0.25	0.37	NS

natural fallow (dominated by *Panicum maximum*) and natural fallow plus inorganic fertilizer (NPK) applied as 100kgN (urea), 40 Kg P_2O_5 (single super phosphate) and 40 Kg K_2O (muriate of potash) per hectare. The NPK rate is recommended for maize in Nigeria (NFC, 1988). The fertilizer was applied to maize 2 weeks after planting (WAP) on 10 June, 2002 only. Each plot measured 5 x 3m (15m^2).

Land used for establishment of the covercrop fallow plots was slashed on 30 July, ploughed in on 2 August and harrowed in on 4 August, 1999. The small- seeded legumes were broadcast in appropriate plots at a seed rate of 15kg/ha (Leonard, 1986) while the large-seeded Mucuna species and *Lablab purpureus* were sown at 1 x 0.25m spacing (Olaniyan et al, 2000) on 5 August, 1999. The legume plots were weeded at 4 WAP. The plots were sampled for biomass production using a quadrat at 1 (3 months after planting- MAP) and 3 years after planting (YAP). Composite soil samples from three locations per plot were obtained to a depth of 20 cm in 2000, 2001 and 2 weeks after incorporation of the organic materials in 2002 and used to determine treatment effects on soil pH and organic matter. After three years, the plots (fallow vegetation) were ploughed in and used for the green manure covercrop trials in 2002 and 2003. In the first year of cropping with maize, the fallow vegetation was slashed on 30 April, ploughed in on 19 May and harrowed in on 23 May, 2002. Ridges were made 1m apart on 25 May, 2002. In the second year of cropping, the same land was slashed on 4 June, ploughed in on 16 June, harrowed in on 17 June and ridges made on 23, 2003.

Seeds of the maize varieties were hand sown in the appropriate plots 10 days after incorporation of the organic materials at three seeds per hole on 29 May, 2002 and 8 days after incorporation of the organic materials on 24 June, 2003. The plants were spaced at 1m x 0. 5m along the crest of ridges and thinned to two seedlings per stand two weeks after planting (WAP). Supply at vacant stands was done 2 WAP and a plant population of 40,000 plants/ha was maintained. Fencing with black polythene sheets and bamboos to a height of 50cm was done to protect the maize plants against rodent (*Thryonomys swinderianus* and *Xerus erythropus*) on 30 May, 2002 and 26 June, 2003. Hoe weeding was done at 4 WAP while the plants were protected against stemborers with furadan at 3kg/ha at 2 WAP.

Soil pH was measured in 1: 2.5 soil: water ratio. Organic carbon was determined by Nelson and Sommers (1982) method. The organic carbon was converted to organic matter (O.M) by multiplying by 1.724. Records were taken on plant height (cm), leaf area index and shoot dry matter (g/plant) at 8 WAP in 2002. Data on number of grains per cob, 100 grain weight (g) and grain yield (kg/ha) were taken at full maturity in 2002 and 2003. Analysis of variance of the data was done as outlined for a randomized complete block design (Gomez and Gomez, 1984).

RESULTS

Above ground biomass production of the covercrops ranged from 706.6kg/ha in *Lablab purpureus* to 4448.8kg/ha in *Mucuna deeringiana* at 3 MAP in the first year, and from 117.0kg/ha in *Mucuna deeringiana* to 4096.8kg/ha in *Aeschynomene histrix* at 3 YAP (Table 1). In the establishment year, *Mucuna deeringiana* had significantly higher above ground biomass than the other covercrops except *Mucuna veracruz*. However, at 3 YAP, the biomass of *Aeschynomene histrix* was significantly higher than that obtained with *Chamacrista rotundifolia, Pueraria phaseolodies* and *Stylosanthes capitata*, which also gave markedly higher dry matter than *Centrosema pascuorum, Centrosema brasilianum, Mucuna veracruz* and *Mucuna deeringiana. Mucuna pruriens*, Crotolaria ochroleuca and Lablab *purpureus* at 3 YAP, did not persist (had zero drymatter) in competition with the volunteer biomass regrowth.

Soil pH was not significantly affected by the covercrop treatments but significant differences in soil organic matter occurred among the covercop fallows in 2000 and 2001 (Table 2). Soil organic matter in 2000 was higher in Crotolaria ochroleuca than other covercrop fallows. In 2001, however, soil organic matter was higher in *Centrosema pascuorum* and *Aeschynomene histrix* than in *Stylosanthes capitata, Mucuna deeringiana* and *Mucuna pruriens* fallows. There was a general decline in soil pH in all covercrop fallows except *Mucuna veracruz* while soil organic matter increased in all treatments except *Pueraria phaseoloides* and *Centrosema pascuorum* fallows at 2 weeks after incorporation of the plant materials and one week after maize planting in 2002.

Table 3: Effect of three-year covercrop fallow on the growth of two varieties of maize

Covercrop	Plant height (cm)			Leaf area index			Shoot dry matter (g/plant)		
	FARZ 23	TZBR	Mean	FARZ 23	TZBR	Mean	FARZ 23	TZBR	Mean
Chamacrista rotundifolia	112.1	109.5	110.8	1.9	1.8	1.9	48.3	39.8	44 1
Pueraria phaseoloides	99.5	107.0	103.3	1.7	1.6	1.7	33.4	46.7	40.1
Aeschynomene histrix	138.0	124.0	131.0	2.6	1.9	2.3	77.6	46.9	62.3
Centrosema pascuorum	103.8	103.3	103.6	1.0	1.1	1.1	18.6	17.3	18.0
Centrosema brasilianum	107.9	116.3	112.1	1.5	1.9	1.7	28.4	40.4	34.4
Stylosanthes capitata	112.7	108.4	110.6	1.8	1.5	1.7	32.3	42.6	37.5
Mucuna deeringiana	110.8	100.4	105.6	1.7	1.6	1.7	40.8	43.6	41.7
Mucuna veracruz	120.0	113.9	117.0	1.8	2.0	1.9	36.0	43.7	39.9
Mucuna pruriens	115.7	116.1	115.9	1.2	1.7	1.5	30.6	42.7	36.7
Crotolaria ochroleuca	112.9	99.3	106.1	1.8	1.9	1.9	46.0	31.1	38.6
Lablab purpureus	129.7	102.9	116.3	1.5	1.3	1.4	24.1	23.6	23.9
NPK	142.4	158.2	150.3	2.7	2.4	2.6	68.5	52.8	60.7
Grass cover/weed (Natural fallow)	112.2	114.7	113.5	1.6	1.5	1.6	27.9	24.4	26.2
Mean	116.7	113.4		1.8	1.7		39.4	38.0	

		Plant height	Leaf area index	Shoot dry matter
$LSD_{(0.05)}$ for covercrop (C) means	=	16.3	0.7	25.8
$LSD_{(0.05)}$ for variety (V) means	=	NS	NS	NS
$LSD_{(0.05)}$ for C x V means	=	NS	NS	NS

Table 4: Effect of three-year covercrop fallow on number of grains/cob in two varieties of maize in 2002 and 2003

Covercrop	Number of grains per cob					
	2002			2003		
	FARZ 23	TZBR	Mean	FARZ 23	TZBR	Mean
Chamacrista rotundifolia	261.6	257.7	259.7	207.8	260.9	234.4
Pueraria phaseoloides	255.3	221.2	238.3	150.3	150.0	150.2
Aeschynomene histrix	304.1	346.8	325.5	197.7	174.3	186.0
Centrosema pascuorum	343.3	299.2	271.3	232.5	206.7	219.6
Centrosema brasilianum	292.6	259.5	276.1	186.6	188.7	187.7
Stylosanthes capitata	265.7	231.8	248.8	228.8	251.9	240.4
Mucuna deeringiana	234.9	260.3	247.6	160.1	198.0	179.1
Mucuna veracruz	234.9	284.2	259.6	156.2	166.5	161.4
Mucuna pruriens	217.7	173.2	195.5	189.7	181.2	185.5
Crotolaria ochroleuca	226.3	262.0	244.2	176.4	222.8	199.6
Lablab purpureus	340.6	288.7	264.7	143.1	95.2	119.2
NPK	279.3	339.4	309.4	188.5	157.8	173.2
Grass cover/weed (Natural fallow)	228.6	226.7	227.7	129.3	174.6	152.0
Mean	252.7	265.4		180.5	186.8	

		2002	2003
$LSD_{(0.05)}$ for covercrop (C) means	=	70.8	63.4
$LSD_{(0.05)}$ for variety (V) means	=	NS	NS
$LSD_{(0.05)}$ for C x V means	=	NS	NS

NPK fertilizer gave significantly taller maize plants than the covercrop treatments (Table 3). However, leaf area index and dry matter of maize obtained with NPK fertilizer and *Aeschynomene histrix* fallow were similar but significantly higher than those of other cover crops especially *Centrosema pascuorum*, Lablab *purpureus* and natural grass cover. There were no significant effects of maize variety and its interaction with the cover crops or NPK fertilizer on the growth parameters.

Aeschynomene histrix fallow gave significantly higher number of grains per cob than other treatments except *Chamacrista rotundifolia, Centrosema brasilianum, Mucuna veracruz, Lablab purpureus* and NPK fertilizer in 2002 (Table 4). In 2003, however, *Stylosanthes capitata* produced more grains per cob than *Pueraria phaseoloides, Mucuna veracuz, Lablab purpureus*, natural grass cover and NPK fertilizer. Maize variety and its interaction with the covercrop fallows did not significantly affect the number of grains harvested per cob.

The weight of 100-seeds in 2002 was significantly higher in *Crotolaria ochroleuca, Aeschynomene histrix* and *Chamacrista rotundifolia* than in *Centrosema pascuorum, Lablab purpureus* and NPK but not other treatments (Table 5). On average, maize variety FARZ 23 gave significantly higher seed weight than TZBR Eldana $2C_3$. Combination of covercrop fallow and maize variety did not produce significant interation effects on seed weight in both the years.

In 2002, maize grain yields obtained with *Aeschynomene histrix* were statistically similar with the yield values in *Centrosema brasilianum, Chamacrista rotundifolia* and NPK fertilizer but significantly higher than those of other covercrop fallows (Table 6). The order of performance among the high yielders was *Aeschynomene* histrix > *Centrosema* brasilianum > NPK ≥ *Chamacrista rotundifolia.* In the second year of cropping in 2003, however, statistical significance was not established for the covercrops, although grain yields seemed higher in *Centrosema pascuorum* and *Sylosanthes capitata* than other fallows. Maize variety and its interaction with the covercrop fallows or NPK fertilizer did not significantly influence grain yields in both years.

DISCUSSION

The greater biomass production by *Aeschynomene histrix* and *Chamacrista rotundifolia* in the third growing season may in part be due to their growth habits which conferred good capacity to persist and compete with the native vegetation. For example, the culm of *Aeschynomene histrix* branched profusely and produced a more compact canopy which shaded and reduced volunteer biomass regrowth while *Chamacrista rotundifolia* formed a good ground cover as a result of its decumbent growth habit and shade tolerance in the presence of volunteer regrowth. Furthermore, regeneration from seeds or vegetative parts after the dry season, expressed in the production of new leaves, was also high in *Aeschynomene histrix* and *Chamacrista rotundifolia.*

Among the covercrops, *Mucuna pruriens, Crotolaria ochroleuca* and *Lablab purpureus* did not persist (zero drymatter) in competition with the native vegetation at 3 YAP. Olaniyan et al. (2000) also found no traces of survival of *Mucuna pruriens* after the dry season in southern guinea savanna of Nigeria. Furthermore, the superior biomass production of *Mucuna veracruz* compared to *Mucuna prunens* confirms an earlier report by Chikoye and Ekeleme (1999).

The decline in soil pH 2 weeks after incorporation of the fallow vegetation and one week after maize planting in 2002, was probably due to leaching following land preparation and crop removal. With high rainfall in May (436.3 mm) and June (240.1 mm), as was the case in this experiment, nutrient losses due to leaching would be high. Leaching of nitrogen and basic cations has been reported for loam soils under similar rainfall conditions (Cuningham, 1962; Igbokwe, 1980; Ibedu et al., 1988), leaving a preponderance of hydrogen ions

Table 5: Effect of three-year covercrop fallow on 100-grains weight in two varieties of maize in 2002 and 2003

	Number of grains per cob					
	2002			2003		
Covercrop	FARZ 23	TZBR	Mean	FARZ 23	TZBR	Mean
Chamacrista rotundifolia	19.0	17.8	18.4	13.4	11.4	12.4
Pueraria phaseoloides	17.8	15.2	16.5	12.0	9.8	10.9
Aeschynomene histrix	19.6	17.1	18.4	13.1	11.2	12.2
Centrosema pascuorum	16.5	14.5	15.5	15.4	13.3	14.4
Centrosema brasilianum	18.8	16.7	17.8	13.4	10.8	12.1
Stylosanthes capitata	20.1	15.7	17.9	13.9	13.7	13.8
Mucuna deeringiana	18.1	17.1	17.6	14.6	12.1	13.4
Mucuna veracruz	18.1	16.7	17.4	16.3	11.9	14.1
Mucuna pruriens	17.6	14.2	16.9	16.1	11.7	13.9
Crotolaria ochroleuca	17.5	19.5	18.5	15.0	13.9	14.5
Lablab purpureus	16.3	14.2	15.3	14.7	10.4	12.6
NPK	15.4	15.6	15.5	18.5	11.6	15.1
Grass cover/weed (Natural fallow)	20.1	15.6	17.9	13.4	11.4	12.4
Mean	18.1	16.1		14.6	11.8	

		2002	2003
$LSD_{(0.05)}$ for covercrop (C) means	=	2.5	NS
$LSD_{(0.05)}$ for variety (V) means	=	1.0	NS
$LSD_{(0.05)}$ for C x V means	=	NS	NS

Table 6: Effect of three-year covercrop fallow on grain yield (kg/ha) of two varieties of maize in 2002 and 2003

	Grain yield (kg/ha)					
	2002			2003		
Covercrop	FARZ 23	TZBR	Mean	FARZ 23	TZBR	Mean
Chamacrista rotundifolia	1967.1	1775.5	1871.3	1111.2	1202.0	1156.6
Pueraria phaseoloides	1868.6	1390.7	1629.7	716.8	577.7	647.3
Aeschynomene histrix	2404.5	2394.3	2399.4	1016.6	784.7	900.7
Centrosema pascuorum	1654.7	1748.5	1701.6	1434.0	1100.0	1267.0
Centrosema brasilianum	2153.7	1761.8	1957.8	1005.3	811.4	908.4
Stylosanthes capitata	2118.0	1477.2	1779.6	1269.8	1428.2	1349.0
Mucuna deeringiana	1720.9	1765.8	1743.4	778.4	1041.9	910.2
Mucuna veracruz	1720.9	1896.9	1808.9	1088.8	792.5	940.7
Mucuna pruriens	1534.7	986.1	1260.4	1247.9	848.5	1048.2
Crotolaria ochroleuca	1631.9	1944.5	1788.2	1079.7	1254.9	1167.3
Lablab purpureus	1649.8	1645.0	1647.4	869.1	412.2	640.7
NPK	1771.8	2120.8	1946.3	1313.8	705.9	1009.9
Grass cover/weed (Natural fallow)	1816.6	1420.2	1618.4	696.4	1023.1	859.8
Mean	1847.2	1717.5		1048.3	921.8	

		2002	2003
$LSD_{(0.05)}$ for covercrop (C) means	=	2.5	NS
$LSD_{(0.05)}$ for variety (V) means	=	1.0	NS
$LSD_{(0.05)}$ for C x V means	=	NS	NS

on the absorption complex.

The significant variation in the efficiency of the covercrops in the first year of cropping after three years fallow, showed that the good performance of *Aeschynomeme histrix* fallow could be attributed to the species" high organic matter contribution and profuse branching as well as compact canopy growth habit which rendered it more effective for soil conservation. Peters et al. (1994), working in a subhumid environment of Nigeria, also found *Aeschynomene histrix* the most promising accession in terms of high dry matter yield in the second growing season, good drought tolerance, ability to compete with the native vegetation and high nutritive value. Unlike *Mucuna pruriens* that requires annual replanting to give high grain yields (Okpara and Njoku, 2002), *Aeschynomene histrix, Chamacrista rotundifolia* and *Centrosema brasilianum did not require replanting to give high maize yields.*

In the first year of cropping, the legume covercrops, especially, *Aeschynomene histrix* and *Centrosema brasilianum* had no disadvantage in improving maize grain yield compared to NKP fertilizer. This indicates the potentials of short duration fallow under these covercrop species for sustaining soil productivity in the humid tropics. Powell (1986) had noted that decomposed manure is well mineralized and that its application has the advantage of ameliorating soils productivity by increasing soil pH, organic carbon, total nitrogen, exchangeable phosphorus and maintaining the C:N ratio and the cation exchange capacity (CEC) of soils. Besides the manurial benefits, green manures improve the physical characteristics of the soil and slowly release organic nutrients, especially nitrogen and phosphorus (Powell, 1984, Bationo and Mokwunye, 1991), which could have benefited the plants over the growing period (Mpairwe et al., 2002).

In the second year of cropping, statistical significance for grain yield was not established and high yield were not sustained, probably due to the inability of the persistent covercrops to replenish enough nutrients and the delay in maize plating. With delay in maize planting in the second season, the activities of stem borers were high and loss of nutrients due to leaching might have occurred. Severe crop damage and yield losses in late maize due to stem borer attack have been reported by workers in Nigeria (Bosque – Perez and Mereck, 1990; Guonou et al., 1994; Ngwuta et al., 2001).

Grain yields did not differ among the varieties due mainly to the trade-off that existed between the yield components. For example, grain weight was higher in FARZ 23 while number of grains per cobs tended to be more in TZBR Eldana $2C_3$, on average. Maize variety FARZ 23 was found to be superior to other varieties in a previous work (Okpara and Njoku, 2002).

CONCLUSION

Short duration fallows (3 years) with *Aeschynomene histrix* was more effective at replenishing soil organic matter, and hence soil fertility than other covercrops in the first year of cropping. *Aeschynomene histrix* out produced other covercrops 3 YAP and was the most suitable green manure covercrop for short fallow replacement in the humid tropics of south eastern Nigeria. This was true not only in terms of organic matter contribution, but also because the erect, profuse branching and compact canopy growth habit rendered it more effective for soil conservation. Maize growth and grain yield were greater with *Aeschynomene histrix* fallow than other treatments except NPK fertilizer, Centrosema *brasilianum* and *Chamacrista rotundifolia.* Among the high yielders, the trend of performance was *Aeschynomene histrix*> *Centrosema brasilianum*> NPK>*Chamacrista rotundifolia.*

REFERENCES

Agboola, A., 1994. A recipe for continuous arable production in the forest zone of western Nigeria. In: Sanchez, P. A and Van Houten, H. (eds). Alternatives to slash-and-burn Agriculture. Int. Soc. Soil Sci. and Mex. Soc. Soil Sci. INEGICAN, Mexico, pp. 107.120.

Bationo, A. and Mokwunye, A. U., 1991. Role of manures and crop residue in alleviating soil fertility constraints to crop production: With special reference to the Sahelian and Sudanian zones of West Africa. Fertilizer Research 29: 117 – 125.

Bohlool, B. B., 1989. Pretace. In: Coleman, D. C., Oades, J. M and Uchara, G. (eds). Dynamics of Organic matter in Tropical Ecosystems. Proc. Conference, Hawaii, Oct 1988 Hawai, USA, NIFTAL.

Boaque-Perez, N. A . and Mareck, J. H., 1990. Distribution and species Composition of Lepidopterous maize borers in Southern Nigeria. Bulletin of Entomomlogical Research, 80: 363-368.

Carsky, R. J, Tarawali, S, Becker, M, Chikoye, D, Tian, G. and Sanginga, N., 1998. Mucuna herbaceous cover legumes with potential for multiple uses. RCMD Research Monograph No. 25, IITA, Ibadan. Nigeria.

Chikoye, D. and Ekeleme, F., 1999. Response of *Imperata cylindrica* to smothering by different Mucuna accessions. Proceedings of Workshop organized by IITA and CIEPCA, 26-29 Oct. 1999. Cotonou, Benin.

Chikoye, D., Manyong, V. M., Carsky, R. J. Ekeleme, F., Gbehounou, G, and Ahanchede, A., 2002. Response of spear grass (*Imperata cylindrica*) to covercrops integrated with hand weeding and chemical control in maize and cassava. Crop Protection 21: 145 – 156.

Cunningham, R. K., 1962. Mineral nitrogen in tropical forest soils. Journal of Agric. Science Cambridge 59: 257 – 262.

Eke-Okoro, O. N., Ikeorgu, J. E. G. and Okorocha, E. O. A. 1999. Comparative evaluation of five legume species for soil fertility improvement, weed suppression and component crop yield in cassava/legume intercrops. African Journal of Root and Tuber crops. 3: 54 – 57.

Gomez, K. A. and Gomez, A. A., 1984. Statistical Procedures for Agricultural research. John Willey & Sons, New York. Pp 89 – 107.

Gounou, S., Schulthess, F., Shanower, T.; Harmmond, W. N. O., Braima, H., Cudjoe, A. R., Adjakloe, R.; Antwi, K. K., and Olaleye, I., 1994. Stem borer and ear borers of maize in Nigeria. Plant Health Management Research Monograph No.4. International Institute of Tropical Agriculture, Ibadan, Nigeria, pp 25.

Hauser, S. and Kang, B. T., 1993. Nutrient dynamic, maize yield and soil organic matter in alley cropping with *Laeucaena leucephala*. In: Soil organic matter dynamics and Sustainability of Tropical Agriculture.

Mulongoy, k. and Merck, R. (eds) 1993. IITA/K. U. Leuven, A. Wiley – Sayee Co-publication, PP 215 – 216.

Ibedu, M. A., Unamma, R. P. A. and Udealor, a. 1988. Soil management strategies in relation to farming systems development in the southeastern agricultural zone of Nigeria Proceedings of the National Farming Systems Research Network Workshop held in Jos, Plateau State, Nigeria, May 10 – 13, 1988, pp 342 – 358.

Igbokwe, M. C., 1980. Nitrogen requirement of corn in a newly cleared loamy sand soil at Uyo, Nigeria: The effect of fertilizer and materials in: Nitrogen Cycling in West African Ecosystems (Ed. Rosswall, T.) 275 – 283.

Leonard, D., 1986. Soils, Crops and Fertilizer Use – Fields Manual for Development Workers. Peace corps Information Collection and Exchange, Washington DC USA.

Manyong, V. M., Houndekon, V. A., Sanginga, P. C., Vissoh, P. and Honlonkon, A. N., 1999. Mucuna fallow diffusion in southern Benin. IITA, Ibadan, Nigeria. PP 21.

Mpairwe, D. R., Sabiiti, E. N. Umunna, N. N., Tegegne, A. and Osuji, P., 2002. Effect of intercropping cereal crops with forage legumes and source of nutrients on cereal grain yield and fodder dry matter yields. African Crop Science Journal 10: 81 – 97.

Nelson, D. W. and Sommers, L. E., 1982. Total carbon, organic carbon and organic matter. In: A. L. Page Ed). Methods of soil Analysis, Part 2, 2nd Ed. Agronomy Monograph. 9 ASA and SSSA, Madison, WI; PP 559 – 579.

NFC (National Fertilizer Centre), 1988. Annual Report 1987/88. Ibadan, Nigeria

Ngwuta, A. A., Ajala, S. O., Obi, I. U. and Ene-obong, E. E., 2001. Potential sources of resistance to maize stem borers in local maize populations of southeastern Nigeria. African Crop Science Conference Proceedings 5: 23 – 28.

Nye, P. H. and Greenland, D. J., 1960. The soil under shifting cultivation. Tech. Comm. No. 51, Common Wealth Bureau of Soil. Farmharm Royal Bucks, England. PP 156.

Okpara, D. A and Njoku, J. C., 2002. Growth and yield responses of maize to duration of mucuna fallow in a tropical ultisol. Biological Agriculture and Horticulture 20: 1 – 9.

Olaniyan, G. O., Umar, A. and Ayorinde, S. O., 2000. Effects of leguminous covercrops on maize yield in the southern guinea savanna zone of Nigeria. Nigeria Journal of soil Science, 12:45 – 50.

Peter, M., Tarawali, S. A. and Alkamper, J., 1994. Evaluation of tropical pasture legumes for fodder banks in subhumid Nigeria. 2 *Accessions of Aeschynomene histrix, Centrosema acutifolium, C. Pascuorum, Stylosanthes guinensis and S. hamata.* Tropical Grasslands 28: 74 – 79.

Powell, J. M., 1984. Assessment of dry matter yield from grain yield in the West African Savanna zone. Journal of Agricultural Science (Camb.) 103: 695 – 698.

Powell, J. M., 1986. Manure for cropping: A case study from central Nigeria. Experimental Agriculture 22: 15 – 24.

Tarawali, S. A., 1999. An Approch for the evaluation of herbaceous legumes with multiple benefits. In: Covercrops for Natural Resources Management in Wet African. Proceedings of Workshop organized by IITA CIECA at Cotonou, Benin, 26 – 29 Oct., 1999.

Thor Smestad, B., Tiessen, H. and Buresh, R. J., 2002. Short fallows of *Tithonia diversifolia* and *Crotolaria grahamina* for soil fertility improvement in Western Kenya. Agroforestry Systems , 55: 181 – 194.