Tropical and Subtropical Agroecosystems

POTENTIAL OF COVER CROPS FOR SHORT FALLOW REPLACEMENT IN LOW-INPUT SYSTEMS OF MAIZE PRODUCTION IN THE HUMID TROPICS

[POTENCIAL DE LOS CULTIVOS DE COBERTURA COMO REEMPLAZO DEL BARBECHO CORTO EN SISTEMAS DE BAJOS INSUMOS PARA PRODUCCIÓN DE MAÍZ EN LOS TRÓPICOS HÚMEDOS]

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SUMMARY

A field experiment was conducted from 1999 to 2003, in which the growth of eleven green manure cover crops were studied for biomass production at Umudike, in the humid tropics of south eastern Nigeria. The cover crops 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 *Chamaecrista rotundifolia, Pueraria phaseoloides, Aeschynomene histrix, Centrosema pascuorum*, *C. brasilianum, Stylosanthes capitata, Mucuna pruriens, M. deeringiana, M. veracruz, Crotolaria ochroleuca, Lablab purpureus,* natural grass cover and NPK fertilizer. Maize (*Zea mays* L.) varieties consisted of FARZ-23-Y obtained from National Seed Service, Umudike and TZBR Eldana 2C3 - W from IITA, Ibadan, Nigeria. All possible combinations of the maize varieties and the manure treatments were studied. *M. deeringiana* and *M. veracruz* gave the significantly highest biomass 3 months after planting in the establishment year. However, *A. histrix* produced the highest biomass 3 years after planting. *M. pruriens*, *C. ochroleuca* and *L. purpureus* did not persist in competition with the native vegetation. *A. histrix* fallow produced higher maize dry matter than *C. pascuorum, C. brasilianum*, *L. purpureus* and grass cover but not other treatments. Average grain yields ranged from 1260.4kg/ha after *M. pruriens* to 2399.4 kg/ha after *A. histrix* fallow in 2002 and from 640.7kg/ha after *L. purpureus* to 1428.2kg/ha after *S. capitata* fallow in 2003. In 2002, grain yields obtained after *A. histrix* improved fallow were statistically similar to those obtained after *C. rotundifolia, C. brasilianum* and NPK fertilizer treatments, but significantly lower in other covercrop fallows. There were generally no statistically significant effects of variety and its interaction with covercrops on maize crop growth and yields.

Key words: Green manure, biomass, maize yield.

RESUMEN

Se evaluó el crecimiento y la producción de biomasa de once cultivos de cobertura en Umudike, Nigeria, de 1999 a 2003. Los cultivos fueron incorporados al suelo como abono verde despues de tres años de barbecho y se contrastó con el empleo de gramíneas de cobertura y el el uso de fertilizante (NPK) para la producción de dos variedades de maíz. Los tratamientos fueron; *Chamaecrista rotundifolia, Pueraria phaseoloides, Aeschynomene histrix, Centrosema pascuorum*, *C. brasilianum, Stylosanthes capitata, Mucuna pruriens, M. deeringiana, M. veracruz, Crotolaria ochroleuca, Lablab purpureus,* cobertura de graminea nativa y la fertilización con NPK. Las variedades de Maiz (*Zea mays* L.) empleadas fueron FARZ-23-Y obtenida del "Servicio Nacional de Semillas" de Nigeria y la variedad TZBR Eldana 2C3-W obtenida del IITA, Ibadan, Nigeria. Todas las combinaciones posibles entre las variedades de maíz y los tratamientos de abono fueron estudiados en un diseño de bloques al azar con tres replicas por tratamiento. *M. deeringiana* y *M. veracruz* produjeron la mayor cantidad de biomasa a los tres de establecimiento. Sin embargo, *A. histrix* produjó la mayor cantidad de biomasa a los tres años de establecimiento. *M. pruriens, C. ochroleuca* y *L. purpureus* no persistieron debido a la competencia con la vegetación nativa. La producción de maíz obtenida en el barbecho de *A. histrix* fue mayor que la obtenida con *C. pascuorum, C. brasilianum, L. purpureus* y el pasto nativo, pero no fue mayor a los otros tratamientos. La producción promedio de maíz varió de 1260.4kg/ha después del barbecho con *M. pruriens* a 2399.4 kg/ha con *A. histrix* en 2002 y de 640.7kg/ha con *L. purpureus* a 1428.2kg/ha con *S. capitata* en 2003. En 2002, la producción de maíz con *A. histrix* fue similar a la obtenida con *C. rotundifolia, C. brasilianum* y NPK. En general no se encontró efecto de variedad de maíz o una interacción con los cultivos de cobertura.

Palabras clave: Abono verde, biomasa, producción de maíz

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 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 fertilizers, 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. However, the use of green manure cover crops 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 Nigeria have been documented (Okpara and Njoku, 2002), but a major problem associated with the use of the species is its poor capacity to persist after the establishment year (Olaniyan *et al.*, 2000). The investment made to establish and manage some cover crops may, therefore, be more than the benefit from reduced weed pressure and increased soil nitrogen (Manyong et al., 1999). However, the use of cover crop 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 systems with suitable species improve yields 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 and inorganic fertilizer for production of maize in southeastern Nigeria.

MATERIALS AND METHODS

Field experiments were conducted between 1999 to 2003 on the National Root Crops Research Institute (NRCRI) Farm at Umudike, southeastern Nigeria. Umudike is situated at Latitude 50 291N, Longitude 70331E and at 122m above sea level. The soil is a "Low activity clay" classified as an Ultisol. 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 with three replications. Treatments comprised all combinations of two varieties of maize and thirteen manure/cover crop sources. The two varieties of maize were FARZ 23 and TZBR Eldana 2C3. The manure sources were *Chamacrista rotundifolia, Pueraria phaseoloides, Aeschynomene histrix, Centrosema pascuorum, C. brasilianum, Stylosanthes capitata, Mucuna deeringiana, M. veracruz, M. pruriens, Crotolaria ochroleuca, Lablab purpureus*, natural fallow (dominated by *Panicum maximum*) and natural fallow plus inorganic fertilizer (NPK) applied as 100 kgN (urea), 40 kg P205 (single super phosphate) and 40 kg K20 (muriate of potash) per hectare. The NPK rate is the 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 (15m2).

Land used for establishment of the cover crop 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 15 kg/ha (Leonard, 1986) while the large-seeded *Mucuna* species and *L. purpureus* were sown at 1 x 0.25 m spacing and at one seed per hill (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 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 cover crop 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 non 17 June and ridges made on 23 June, 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 3 kg/ha at 2 WAP.

Soil pH was measured in 1:2.5 soil:water ratio. Organic matter (O.M) content of the soil was determined by the wet oxidation method of Walkley and Black (1934). 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

Data on initial soil properties showed the experimental site to be sandy clay loam (Table 1). The soil was low in nitrogen and organic mater and was acidic. Above ground biomass production of the cover crops ranged from 706.6 kg/ha in *L. purpureus* to 4448.8 kg/ha in *M. deeringiana* at 3 MAP in the first year, and from 117.0 kg/ha in *M. deeringiana* to 4096.8 kg/ha in *A. histrix* at 3 YAP (Table 2). In the establishment year, *M. deeringiana* had significantly higher above ground biomass than the other covercrops except *M. veracruz*. However, at 3 YAP, the biomass of *A. histrix* was significantly higher than that obtained with *C. rotundifolia, P. phaseoloides* and *S. capitata*, which also gave markedly higher dry matter than *C. pascuorum, C. brasilianum, M. veracruz* and *M. deeringiana*. *M. pruriens, C. ochroleuca* and *L. purpureus* at 3 YAP, did not persist (had zero drymatter) in competition with the volunteer biomass regrowth.

Table 1. Initial soil properties of the experimental site in 1999.

a.	Soil physical characteristics	
	Sandy (%)	66.0
	Clay (%)	29.0
	Silt (%)	5.0
	Texture class	Sandy clay loam
b.	Soil chemical characteristics	
	Total N (%)	0.057
	Total P (PPm)	24.00
	0M (%)	1.36
	pH (H_20)	5.10

Table 2. Dry matter (kg/ha) of eleven legume cover crops at 1 and 3 years after planting.

	Time of harvest	
Cover crop	1*	3
Chamacrista rotundifolia	912.3	1393.9
Pueraria phaseoloides	2732	1138.9
Aeschynomene histrix	847	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
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

* 3 months after planting

Soil pH was not significantly affected by the cover crop treatments but significant differences in soil organic matter occurred among the cover crop fallows in 2000 and 2001 (Table 3). Soil organic matter in 2000 was higher in *C. ochroleuca* than other cover crop fallows. In 2001, however, soil organic matter was higher in *C. pascuorum* and *A histrix* than in *S. capitata, M. deeringiana* and *M. pruriens* fallows. There was a general decline in soil pH in all cover crop fallows except *M. veracruz* while soil organic matter increased in all treatments except *P. phaseoloides* and *C. pascuorum* fallows at 2 weeks after incorporation of the plant materials and one week after maize planting in 2002.

NPK fertilizer gave significantly taller maize plants than the cover crop treatments (Table 4). However, leaf area index and dry matter of maize obtained with NPK fertilizer and *A. histrix* fallow were similar but significantly higher than those of other cover crops, especially *C. pascuorum*, *L. purpureus* and natural grass cover. There were no significant effects of maize variety and its interaction with the cover crops or NPK fertililzer on the growth parameters.

A. histrix fallow gave significantly higher (236) number of grains per cob than other treatments (196 to 249) except *C. rotundifolia, C. pascuorum, C. brasilianum, M. veracruz, L. purpureus* and NPK fertilizer in 2002 (Table 5). In 2003, however, *S. capitata* produced more grains per cob than *P. phaseoloides, M. veracruz, L. purpureus*, natural grass cover and NPK fertilizer. Maize variety and its interaction with the cover crop fallows did not significantly affect the number of grains harvested per cob.

Table 3. Effect of three-year cover crop fallow on soil pH and organic matter.

Cover crop	Soil pH (water)			% OM		
	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
Natural fallow (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

Table 4. Effect of three-year cover crop fallow on the growth of two varieties of maize.

Cover crop	Plant height (cm)		Mean	Leaf area index		Mean	Shoot dry matter (g/plant)		Mean
	FARZ23	TZBR		FARZ23	TZBR		FARZ 23	TZBR	
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
Natural (Grass cover/weed)	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 cover crop (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

The weight of 100-seeds in 2002 was significantly higher in *C. ochroleuca*, *A. histrix* and *C. rotundifolia* than in *C. pascuorum, L. purpureus* and NPK but not other treatments (Table 6). On average, maize variety FARZ 23 gave significantly higher seed weight than TZBR Eldana 2C3. Combination of cover crop fallow and maize variety did not produce significant interaction effects on seed weight in both the years.

In 2002, maize grain yields obtained with *A. histrix* were statistically similar with the yield values of *C. brasilianum, C. rotundifolia* and NPK fertilizer but significantly higher than those of other cover crop fallows (Table 7). In the second year of cropping in 2003, however, statistical significance was not established for the cover crops, although grain yields seemed higher in *C. pascuorum* and *S. capitata* than other fallows. Maize variety and its interaction with the cover crop fallows or NPK fertilizer did not significantly influence grain yields in both years.

Table 5. Effect of three-year cover crop fallow on number of grains/cob in two varieties of maize in 2002 and 2003.

	Number of grains per cob					
	2002			2003		
Cover crop	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	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 cover crop (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

Table 6. Effect of three-year cover crop fallow on 100-grains weight in two varieties of maize in 2002 and 2003.

	Number of grains per cob					
	2002			2003		
Cover crop	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
Natural fallow (Grass	20.1	15.6	17.9	13.4	11.4	12.4
cover/weed)	18.1	16.1		14.6	11.8	
Mean						

		2002	2003
LSD$_{(0.05)}$ for cover crop (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

DISCUSSION

The greater biomass production by *A. histrix* and *C. 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 culms of *A. histrix* branched profusely and produced a more compact canopy which shaded and reduced volunteer biomass regrowth while *C. 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 *A. histrix* and *C. rotundifolia.*

Table 7: Effect of three-year cover crop fallow on grain yield (kg/ha) of two varieties of maize in 2002 and 2003.

	Grain yield (kg/ha)					
	2002			2003		
Cover crop	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
Natural fallow (Grass cover/weed)	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 cover crop (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

Among the cover crops, *M. pruriens, C. ochroleuca* and *L. purpureus* did not persist (zero dry matter) in competition with the native vegetation at 3 YAP. Olaniyan et al. (2000) also found no traces of survival of *M. pruriens* after the dry season in southern guinea savanna of Nigeria. Furthermore, the superior biomass production of *M. veracruz* compared to *M. pruriens* 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 (Cunningham, 1962; Igbokwe, 1980; Ibedu *et al.*, 1988), leaving a preponderance of hydrogen ions on the absorption complex.

The significant variation in the efficiency of the cover crops in the first year of cropping after three years fallow showed that the good performance of *A. histrix* fallow could be attributed to the species' high organic matter contribution or nitrogen biomass which rendered it more effective for soil conservation. Peters et al.(1994), working in a subhumid environment of Nigeria, also found *A. 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 *M. pruriens* that requires annual replanting to give high grain yields (Okpara and Njoku, 2002), *A. histrix*, *C. rotundifolia* and *C. brasilianum* did not require replanting to give high maize yields.

In the first year of cropping, the legume cover crops, especially *A. histrix* and *C. brasilianum* had no disadvantage in improving maize grain yield compared to NPK fertilizer. This indicates the potentials of short duration fallow under these cover crop 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 soil 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. Ikeorgu *et al*. (2005) in a similar soil as was the case in the present experiment, reported higher nitrogen content of the soil in *A. histrix* and *C. rotundifolia* fallows compared with natural fallow. In addition, 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 yields were not sustained, probably due to the inability of the persistent cover crops to replenish enough nutrients and the delay in maize planting. 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 various 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 2C3, 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 cover crops in the first year of cropping. *A. histrix* out produced other cover crops 3 YAP and was the most suitable green manure cover crop 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 *A. histrix* fallow than other treatments except NPK fertilizer, *C. brasilianum* and *C. rotundifolia*. Among the high yielders, the trend of performance was *A. histrix* > *C. brasilianum* > NPK > *C. rotundifolia*.

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