Journal of Animal & Plant Sciences, 2009. Vol. 4, Issue 2: 320 - 328.
Publication date: 15 September 2009, http://www.biosciences.elewa.org/JAPS; **ISSN 2071 - 7024**

Effects of *Mucuna* biomass and N-fertilizer on *Striga hermonthica* Del. Benth. infestation in maize (*Zea mays* L.)

[redacted]

[redacted]

Key words
Mucuna biomass, *Mucuna* incorporation, N-fertilizer, *Striga hermonthica*

1 SUMMARY

Two *Mucuna* biomass management practices were evaluated, with and without inorganic N-fertilizer to determine the effect on *Striga* emergence and maize grain yield. The *Mucuna* biomass amended the soil particle size composition/distribution by reducing sand particles and increasing clay and silt. The pH decreased while total N, available P and cation exchange capacity increased by 50, 36 and 11%, respectively. Combining *Mucuna* biomass with N-fertilizer increased maize grain yield by 353% and 55% over *Mucuna* free and *Mucuna* unincorporated (leaving the biomass on soil surface), respectively. Significant ($P \leq 0.05$) responses to 60 – 90 kg N/ha were observed with increased maize grain yield from 1060 to 1187 kg/ha. The highest numbers of *Striga* stands (7/m^2) emerged in plots that had neither Mucuna nor fertilizer. These findings show that farmers can improve soil fertility; reduce *Striga* density and increase maize grain yield by incorporating *Mucuna* biomass with low rates of inorganic N-fertilizer.

2 INTRODUCTION

Declining soil fertility contributes to increased *Striga* infestation, and the presence of this weed has been used by farmers as an indicator of reducing soil fertility (Mbwaga, 2002). The essential element for reversing *Striga* infestation of cereal crops is nitrogen (N), which increases crop yield and reduces *Striga* attack by increasing crop tolerance. The mechanisms by which high levels of N suppress *Striga* include the reduction in stimulant exudation from host roots (Taye Teferedegn, 1973; Sherif & Parker, 1988; Raju *et al.,* 1990; Cechin & Press, 1993), direct damage to *Striga* seeds and seedlings in the soil (Pesch & Pieterse, 1982; Pieterse, 1991), alteration of host root : shoot balance (Gworgwor & Weber, 1991), reduced osmotic pressure in the parasite relative to the host (Gworgwor & Weber, 1991), presumably reducing the flux of water and nutrients from host to parasite and increased shading of the weed by the crop (Hess & Ejeta, 1987). N-Fertilizer has been reported to delay *Striga* emergence, promote high maize growth and shoot dry matter production and reduce *Striga* damage in the Guinea Savanna ecological zone of Nigeria (Kureh *et al.,* 2003; Sule *et al.*, 2008)

In spite of its efficacy in suppressing *Striga*, the use of N fertilizers by farmers is low mostly due to high cost. Incorporation of green manure cover crops as a low-input technology (GMCC) in traditional cropping systems reduces germination of *Striga* seeds (Pesch & Pieterse, 1982; Olaniyan *et al.,* 1991) and produces large quantities of residual biomass for soil improvement and weed suppression, and could therefore be a reasonable alternative to inorganic fertilizers.

Mucuna has been the most researched GMCC in the tropics (Buckles, 1995). It grows well in diverse environments, usually producing the highest biomass among green manure/cover crops tested (Lathwell, 1990; Lobo Burle *et al.,* 1992; Carsky *et al*., 1998, 2001). In Kenya, Mureithi *et al.* (2000a) ranked *Mucuna* as the best GMCC based on farmers' perception due to its high biomass production thus making plenty available for incorporation into the soil, rapid establishment of ground cover for effective control of soil erosion and weeds, its alternative uses particularly as human food and livestock feed, and the softness of its stems, which makes them easy to chop prior to incorporation.

Incorporation of GMCC promotes greater yields of maize (Mureithi *et al.,* 2003), presumably due to increased N supply to the soil and reduced loss of N by volatilization (Hudgens, 2000). Returns to labour are higher with incorporation *Mucuna* biomass than with mulching, even though higher labour is required for incorporation (Muller-Samann & Kotschi, 1994; Hudgens, 2000). The additional labour required for incorporation can be minimised, especially if done together with land preparation (Mureithi *et al.,* 2000b).

The incorporation of GMCC in the moist savanna agro ecological zone is justified because during the dry season substantial above-ground biomass losses may occur due to bush fires, strong winds, termites, roaming village animals, or transhumance herds of cattle (Schulz *et al*., 2001). In the northern Guinea Savanna of Nigeria, above-ground residue of *Mucuna* disappears at a rate of approximately 1 t/ha/ month during the dry season (Carsky *et al*., 1998).

Integrated nutrient management (INM) emphasizes judicious use of inorganic and organic sources of nutrients to maintain ecologically and economically viable farming systems (Franzluebbers *et al.,* 1998). The combined use of the two sources of nutrients can be a sustainable way of maintaining the soil nutrient base to improve crop productivity in smallholder farms (Smaling *et al.,* 1992; Smaling & Braun, 1996; Kullaya *et al.,* 1998). In this study *Mucuna* biomass was combined with N-fertilizer to evaluate their effects on soil fertility and the suppression of *Striga* in maize.

3 MATERIALS AND METHODS

3.1 Experimental site: The trials were conducted in 2005 and 2006 on land under fallow, which was naturally infested with *Striga hermonthica*, at the Experimental Station of the University of Agriculture, Makurdi (7°41'N, 08°37'N, and 94 m above sea level). The area is located in the Sub-humid savanna (SHS) ecological zone. Total rainfall received from May to October at the site was 1247 mm in 2005 and 1401 mm in 2006. The soil type is sandy loam. Soil samples were taken before and after planting *Mucuna* and analyzed for changes in physical and chemical properties. The mean values of the particle size distribution, pH, organic matter (OM), total Nitrogen (N), available Phosphorus (P), exchangeable cations and cations exchange capacity (CEC) were used to calculate percentage changes as follows:

$$\% \text{ change} = \frac{(Mu \text{ or } Mi) - (Mo)}{Mo} \times \frac{100}{1},$$

Where,

Mo = No *Mucuna;* Mu = *Mucuna* unincorporated; Mi = *Mucuna* incorporated

3.2 Collection of *Mucuna* and maize: Seeds of *Mucuna cochinchinensis* were obtained from the International Institute of Tropical Agriculture (II TA), Ibadan, Nigeria, while those of an open pollinated, *Striga* susceptible maize variety, TZESR-W, were obtained from the National Cereal Research Institute (NCRI), Yandev sub-station, in Benue State, Nigeria.

3.3 Experimental design: In 2005 the treatments, which comprised two *Mucuna* biomass management practices viz: *Mucuna* unincorporated and *Mucuna* incorporated, and a fertilizer free treatment with no *Mucuna* as control, were arranged in a randomized complete block (RCB) design with four replications, in plots measuring 5 m x 4 m. In early April, the vegetation was slashed with a machete and then ploughed and harrowed in May. *Mucuna* seeds were soaked in warm water to improve germination (Chee & Chiu, 1997) and treated with Apron Plus (Metalaxyl) to protect them from pests. Three seeds were planted per hill at 100 cm x 25 cm in early May, when rain stabilized and later thinned to one seedling to give 40,000 plants ha^{-1}. Each plot was weeded twice at 2 and 4 weeks after planting (WAP) to enable *Mucuna* seedlings to develop and establish under weed free conditions (Versteeg & Koudokpon, 1990). *Mucuna* was removed from all the plots at 8 WAP in late June and new ridges were constructed with the biomass either incorporated or not incorporated according to treatments. Maize was planted in early July and weeded twice manually.

In 2006 the treatments comprised three *Mucuna* biomass management practices viz: *Mucuna* unincorporated, *Mucuna* incorporated and No *Mucuna*, which were combined with three fertilizer rates of 0, 30, 60, and 90 kgN/ha derived from Urea 46%N. The trial was laid out in a split-plot design in randomized complete block (RCB) with four replicates with *Mucuna* treatments in the main plot (20 m x 4 m) and N rates in the subplot (5 m x 4 m).

The seeds of *M. cochinchinensis* were treated and planted as in 2005. All plots were again cleared at 8 WAP *Mucuna* in early June. Fresh ridges were formed; *Mucuna* biomass was incorporated or removed as appropriate. Maize was planted and fertilizer was applied at 3 WAP. The plots were weeded twice at 3 and 6 WAP and all visible *Striga* stands were not removed.

3.4 Data collection and analysis: Maize plant height was assessed at 3, 6 and 9 weeks after planting, by measuring plant height from ground level to the last formed leaf. Maize cob height was taken as the distance between the ground level and the first cob formed on the maize stand. Maize cob number was assessed by harvesting all cobs from a 2m x 2m in the middle of each plot. The cobs were sun-dried and their weight obtained by measuring with a beam balance. The cobs obtained from the net plot were shelled and weighed to obtain grain yield. Shelling percentage (SP) was calculated using the formula

$$SP = \frac{\text{Grain weight}}{\text{Cob weight}} \times \frac{100}{1}$$

Three batches of 100 sun-dried maize seeds were weighed and the mean weight was multiplied by 10 to get the 1000 seed weight.

Emerged *Striga* plants were also counted at 6 and 9 WAP. Soil samples were taken before planting *Mucuna* and just before application of fertilizer.

The data were analysed using GenStat Release 7.2 DE (LAT, 2007). Means were separated using F-LSD at 5% level of probability. Only the results of soil analysis, agronomic yields of maize and *Striga* emergence have been presented in this report.

4 RESULTS

The physical and chemical properties of the soil were affected by *Mucuna* biomass when compared with soils not planted with the cover crop (Table 1). Particle size distribution was altered with a 3% decrease in sand where the cover crop was not incorporated after planting and 4% where it was incorporated. The decrease in sand led to increases in clay and silt particles. The pH decreased by 5% after incorporating *Mucuna*, while the organic matter increased tenfold without incorporation and 38% after incorporation. The total N was increased by 50% in *Mucuna*-incorporated soils. Incorporating *Mucuna* into the soil increased available P by 36%, and the exchangeable cations, with substantial increase in K (250%). The CEC of the soil also increased by 11% where *Mucuna* was incorporated.

Grain yield and shelling percentage differed significantly ($P \leq 0.05$) between the *Mucuna* treatments and the *Mucuna* free plots in 2005 (Table 2). In 2006, incorporation of *Mucuna* biomass in combination with N significantly increased maize grains by 353% and 55%, respectively over *Mucuna* free and *Mucuna* unincorporated treatments. A clear significant response to 60-90 kgN/ha was observed with increase in maize grain yield from 1060 to 1187 kg/ha. However, increasing N rates above 60 kg N/ha was uneconomical. There were highly significant ($P \leq 0.01$) interactions between *Mucuna* biomass and N rate for grain yield and shelling percentage (Table 2). Increasing N rates in combination with the incorporation of *Mucuna* biomass increased maize grain yield and shelling percentage significantly (Tables 3 and 4).

The highest numbers of *Striga* stands emerged in *Mucuna* free plots at 6 and 12 WAP in both years compared to plots in which *Mucuna* biomass (M) was incorporated in combination with N fertilizer (Table

Journal of Animal & Plant Sciences, 2009. Vol. 4, Issue 2: 320 - 328.
Publication date: 15 September 2009, http://www.biosciences.elewa.org/JAPS; ISSN 2071 - 7024

5). Increasing N rates suppressed *Striga* emergence. However, the M x N interaction was not significant.

Table 1: Changes[1] in physical and chemical properties of the soil grown with *Mucuna* in Makurdi, Nigeria. (Mean of 2005 and 2006)

Treatment[2]	Particle Size Distribution (%)			pH	Organic matter %	Total N %	Available P (ppm)	Exchangeable cations (Cmol/kg)				CEC (*Cmol/kg*)
	Clay	***Silt***	***Sand***					Ca	Mg	K	Na	
Mo	10	12	78	6.0	0.87	0.12	6.4	2.4	1.7	0.26	0.1	8.5
Mu	11	14	76	5.8	0.96	0.15	7.6	2.7	1.9	0.5	0.12	8.9
	10	*17*	*-3*	*-3*	*10*	*25*	*19*	*13*	*12*	*92*	*20*	*5*
Mi	12	14	75	5.7	1.2	0.18	8.7	2.9	2.1	0.91	0.13	9.4
	20	*17*	*-4*	*-5*	*38*	*50*	*36*	*21*	*24*	*250*	*30*	*11*

1=Percentage changes calculated as in Materials and Methods and are presented in italics
2=Treatments: Mo, No *Mucuna;* Mu, *Mucuna* unincorporated; Mi, *Mucuna* incorporated; CEC = Cation Exchange Capacity

Table 2: Effects of *Mucuna* biomass and N-fertilizer on agronomic yields of maize in experimental years 2005 and 2006

Treatment	2005			2006		
	Grain yield (kg/ha)	**Shelling (%)**	**1000 seed weight (g)**	**Grain yield (kg/ha) (g)**	**Shelling (%)**	**1000 seed weight**
***Mucuna* biomass (M):**						
No *Mucuna*	250	42	186.8	348	53	180.8
Mucuna unincorporated	860	59	190.3	1018	64	190.1
Mucuna incorporated	873	61	194.8	1578	79	195.9
F-LSD (P ≤ 0.05)	473	10	NS[1]	128	7.1	3.4
CV (%)	21.2	7.8	2.1	4.8	2.1	0.4
N Levels (kg/ha)(N):						
0	-	-	-	803	56	187.5
30	-	-	-	875	58	187.5
60	-	-	-	1060	70	189.7
90	-	-	-	1187	76	191.1
F-LSD (P ≤ 0.05)	-	-	-	87	7	NS
CV (%)	-	-	-	7.5	6.3	1.0
MxN	-	-	-	**2	**	NS

1 = Not significantly different P ≤ 0.05; 2**= Significant at P ≤ 0.01

Table 3: Interaction of *Mucuna* biomass and N-fertilizer on maize grain yield in year 2006 at Makurdi

Treatment	Nitrogen Level (kg/ha)			
	0	**30**	**60**	**90**
No *Mucuna*	205	212	387	587
Mucuna unincorporated	902	997	1,045	1,127
Mucuna incorporated	998	1,518	1,748	1,847

LSD (P≤0.01): 164 = for comparing means of interaction of *Mucuna* biomass management and N-levels; 142 = for comparing means with same *Mucuna* biomass management. CV = 10
WAP = Weeks after planting

Table 4: Interaction of *Mucuna* biomass and N-fertilizer on shelling percentage in year 2006 at Makurdi.

Treatment	Nitrogen Level (kg/ha)			
	0	**30**	**60**	**90**
No *Mucuna*	34.0	35.7	64.7	76.7
Mucuna unincorporated	58.0	63.0	64.7	65.7
Mucuna incorporated	67.7	81.0	82.7	86.2

LSD ($P \leq 0.01$): 11.5 = for comparing means of interaction of *Mucuna* biomass management and N-levels; 12.1= for comparing means with same *Mucuna* biomass management. CV = 12.1; WAP = Weeks after planting.

5 DISCUSSION

The study showed that *Mucuna cochinchinensis* improved the soil aggregate stability, reduced soil acidity, increased the OM and the total N as well as the available P, the exchangeable cations, and the CEC. The finding on improvement of P availability by *Mucuna* corroborates Vanlauwe *et al.* (2002) and Avav *et al.* (2008). P flux through the microbial biomass is faster in organic soils, and more P would bind in the microbial biomass (Oberson *et al.,* 1996; Oehl *et al.,* 2001). Evidently, nutrients in the organic systems are less dissolved in the soil solution, and microbial transformation process may contribute to plants' P supply.

Although *Mucuna* without N addition increased maize grain yield significantly in 2005, it was lower compared to the yield obtained by combining *Mucuna* with the lowest N rate in 2006. It is unlikely that inorganic N addition can be completely excluded if the ultimate goal is to increase maize production without further deterioration of the soil resource base (Vanlauwe *et al.*, 2002). Vissoh *et al.* (1998) demonstrated a declining trend over time in the productivity of maize-based systems when *Mucuna* was the only source of soil improvement in the traditional farming system. Shave *et al.* (2008), however, reported higher maize grain yield in an all-season *Mucuna*-maize N-free rotation compared to conventional fertilizer treatment. The duration of growth of *Mucuna* on the field could play a role in increasing soil fertility and maize yield. The longer the growth period the better the performance of *Mucuna*.

Incorporation of *Mucuna* biomass increased maize grain yield as previously reported (Mureithi *et al.,* 2003), presumably due to increased N supply to the soil and reduced loss of N through volatilization (Hudgens, 2000).

The low grain yields obtained in this study could be due to late planting (mid May to June) when much rainfall had been lost. The optimum planting date for maize in the southern Guinea Savanna is from late April to mid May, after which crop yields decline after the start of the rains (Iken & Amusa, 2004; Angula *et al.*, 2008).

The suppression of *Striga* emergence by both the biomass of sole *Mucuna* and *Mucuna* x N combination in this study could be attributed to the ability of the cover crop to fix N which inhibits germination of the parasitic plant (Pesch & Pieterse, 1982; Olaniyan *et al.,* 1991).

The results of this study indicate that *Mucuna* biomass can greatly reduce the need for inorganic N in addition to its ability to suppress *Striga* emergence. The recommended rate of N-fertilizer in the study area is 90-120 kg N/ha (Vanlauwe *et al.,* 2002). Consequently, *M. cochinchinensis*, which produces high biomass with rapid canopy establishment (Mureithi *et al.*, 2000a, Avav *et. al.,* 2008), is recommended to farmers for incorporation in combination with a reduced N rate of 60 – 90 kg N/ha for maize production in this and ecologically similar zones of the tropics.

Table 5: Effects of *Mucuna* biomass and N-fertilizer on *Striga* emergence in 2005 and 2006 at Makurdi

Treatment	2005 *Striga* stand count (No/m²)		2006 *Striga* stand count (No./m²)	
	6WAP[1]	12WAP	6WAP	12WAP
***Mucuna* biomass (M):**				
No *Mucuna*	4.5	7.0	3.6	3.8
Mucuna unincorporated	3.3	5.5	2.8	3.0
Mucuna incorporated	2.5	3.8	2.7	2.8
F-LSD ($P \leq 0.05$)	0.5	0.3	0.9	0.8
CV (%)	14.6	27.7	10.7	16.8
N rate (kg/ha)(N):				
0	-	-	3.5	3.8
30	-	-	3.5	3.6
60	-	-	3.0	3.4
90	-	-	2.3	2.9
F-LSD ($P \leq 0.05$)	-	-	0.7	NS
CV (%)	-	-	15.7	13.2
MxN	-	-	NS[2]	NS

1= Weeks after planting; 2 = Not significantly different $P \leq 0.05$

6 REFERENCES

Angula, Z.O., Avav, T. & Ekefan, E.J., 2008. Farmers' evaluation of maize hybrids and planting date for *Striga* management in Tarka Local Government Area of Benue State, Nigeria. *Nigerian Journal of Weed Science* 21: 12-22.

Avav, T. Shave, .PA. & Hilakaan, P.H., 2008. Growth of *Mucuna* accessions under fallow and their influence on soil and weeds in a sub-humid savanna environment. *Journal of Applied Biosciences* 10: 442-448.

Buckles, D., 1995. Velvet bean: A 'new' plant with a history. *Economic Botany* 49 (1):13-25.

Carsky, R.J., Becker, M. & Hauser, S., 2001. *Mucuna* cover crop fallow systems: Potentials and limitations. In: Tian, G., Ishiada, F. & Keatinge, D. (Eds.) Sustaining soil fertility in West Africa. *SSSA Special Publication* 58. Soil Science Society of America and American Society of Agronomy, Madison, WL, USA. Pp. 111-135.

Carsky, R.J., Tarawali, S.A., Becker, M., Chikoye, D., Tian, G. & Sanginga, N., 1998. *Mucuna*: An herbaceous cover legume with potential for multiple uses. *Resource and Crop Management Monograph* No 25. IITA, Ibadan, Nigeria.

Cechin, I. & Press, M.C., 1993. Nitrogen relations of the Sorghum – *Striga hermonthica* host-parasite association: germination, attachment and early growth. *New Phytologist* 124: 681-687.

Chee, K. H. & Chiu, S.B., 1997. Viability test of leguminous cover crop seeds. *Planter (Malaysia)* 73:581-582.

Franzluebbers, K., Hossner, L.R. & Juo, A.S.R., 1998. Integrated nutrient management for sustained crop production in sub-Saharan Africa: A review. Soil Management CRSP. Trop soils/TAMU. *Technical Bulletin 98-03*. Department of Soil Science and Crop Sciences, Texas A & M University. 50pp.

Gworgwor, N.A. & Weber, H.C., 1991. Effect of N-application on sorghum growth, *Striga* infestation and osmotic pressure of the parasite in relation to the host. *Journal of Plant Physiology* 139:194-198.

Hess, D.E. & Ejeta, G., 1987. Effect of cultural treatments on infestation of *Striga hermonthica* (Del.) Benth (Scrophurariaceae). In: Weaver, H.C.& Forstreuter, W. (Eds.) *Proceedings of 4th International Symposium on Parasitic Flowering Plants,* Marburg, Germany. 1987. Philips-Universitat, Marburg. Pp. 367-375.

Hudgens, R. E., 2000. Sustaining soil fertility in Africa: the potential for legume green manures.

Soil technologies for sustainable smallholder farming systems in East Africa. *Proceedings of the 25th Conference of the Soil Science Society of East Africa.* Nanyuki, Kenya. Pp. 63-78.

Iken, J.E. & Amusa, N.A., 2004. Maize Research and Production in Nigeria. *African Journal of Biotechnology* 3 (6): 302 – 307.

Kullaya, I.K., Kilisara, M. & Aune, J.B., 1998. The Potential of Morejea (*Crotalaria ochroleuca)* as green manure in maize production in the Kilimanjaro region of Tanzania. *Soil Use Management* 14:117-118.

Kureh, I., Chikoye, D., Schulz, S., Emechebe, A.M., Hussaini, A.M. & Ellis-Jones, J., 2002. Reduction of *Striga hermonthica* parasitism on maize using host-plant resistance, N-fertilization and rotation with legume trap crops. *Paper presented at the 30th Annual Conference of Weed Science Society of Nigeria.* 3-7 Nov. 2002, Benin, Nigeria.

L.A.T., 2007. Lawes Agricultural Trust (Rothamsted Experimental Station). GenStat Discovery Edition. http:// www.discovery genstat. co. uk.

Lathwell, D.J., 1990. Legume green manure: principles for management based on recent research. *Trap Soils Technical Bulletin.* Pp. 90 – 91. Soil Management collaborative research support programme, Raleigh, North Carolina.

Lobo Burle, M., Suhet, A.R., Pereira, J., Reseek, D.V.S., Peres, R.R., Cravo, M.S., Bowen, W., Bouldin, D.R. & Lathwell, D.J., 1992. Legume green manures: Their dry season survival and the effect on succeeding maize crop. *Soil Management CRSP Bulletin,* Pp. 92-94. Soil Management Collaborative Research Support Programme, Raleigh, North Carolina.

Mbwaga, A.M., 2002. Strategies for transfer of *Striga* control technologies to African farmers: A case study for Tanzania. In: *Proceedings of 4th General workshop of Pan-African Striga Control Network (PASCON), Bamako, Mali.* 28th Oct-1st Nov. 1996 pp. 38-41

Muller-Samann, K.M. & Kotschi, J., 1994. Sustaining growth: Soil fertility management in tropical smallholdings. ICT; GTZ, Transl: Christine Ernsting and Simon Chaterj Margraf, Weikersheim, Germany. 486pp.

Mureithi, J.G., Gachene, C.K.K & Ojiem, J., 2003. The role of green manure legumes in smallholders farming systems in Kenya. In: Eilitta, M., Miunga, R., Mureithi, J.G., Sandoval-Castro, C. & Szabo, N. (Eds.) *Proceedings of a Workshop Organized by KARI and CIEPCA-IITA, Mombassa,* Kenya, Sept. 23-26, 2002. Pp 57-70.

Mureithi, J.G., Mwaura, P. & Kamande, T., 2000a. Introduction of green manure legumes to smallholders in Gatanga Division, Thika District. *Legume Research Network Project Newsletter,* 3.

Mureithi, J.G., Mwaura, P. & Nekasa, C., 2000b. The role of green manure legumes in smallholders farms in Gatanga, Central Kenya. *Proceedings of 2nd Scientific Conference of Soil Management and Legume Research Network Projects.* 26-30 June 2000. Kenya Agricultural Research Institute. Pp. 153-164.

Oberson, A., Besson, J.N., Maire, N. & Sticher, H., 1996. *Biol. Fertile. Soils* 21: 138.

Oehl, F., Oberson, A., Tagmann, H.U., Besson, J.N., Dubois, D., Mader, P., Roth, H.R. & Frossard, E., 2001. Phosphorus budget and phosphorus availability in soils under organic and conventional farming. *Nutrient Cycling in Agroecosystems* 62: 25-35.

Olaniyan, G.O., Ogunremi, L.T. & Iwo, A., 1990. Highlights of research activities in search for *Striga* control of the National Cereal Research Institute (Badegi, Nigeria). In: Towards an integrated control of *Striga* in Africa. *Proceedings of 1st Pan African Striga Control Network (PASCON) General Workshop.* 11-14 March 1990. Ibadan, Nigeria. Pp. 35-42.

Pesch, C. & Pieterse, A.H., 1982. Inhibition of germination in *Striga* by means of Urea. *Experimentia* 38: pp.559-560.

Pieterse, A.H., 1991. The effect of nitrogen fertilizers on the germination of seeds of *Striga hermonthica* and *Orobanche crenata*. In: Wegmann, K. & Musselman, L.J. (Eds.). Progress in Orobanche Research. *Proceedings of International Workshop on Orobanche Research, Obermarchtal* 1989. Eberhard-Karls-Universitat, Tubingen. Pp. 115-124.

Raju, P.S., Osman, M.A., Osman, P. & Peacok, J.M., 1990. Effect of N, P and K on *Striga asiatica* (L.) Kuntze seed germination and infestation of sorghum. *Weed Research* 30: 139-144.

Schulz, S., Carsky, R.J. & Tarawali, S.A., 2001. Herbaceous legumes: The panacea for West African soil fertility problems? Sustaining soil fertility in West Africa. *SSSA Special Publication* 58:179-196.

Shave, P.H., Avav, T., Kalu, B.A. & Ekefan, E.J., 2008. Reducing *Striga hermonthica* (Del.) Benth incidence in maize (*Zea mays* L) using *Mucuna* –

maize rotation. *Journal of Applied Biosciences* 11: 584-593.

Sheriff, A.M. & Parker, C., 1988. Effect of nitrogen and organic matter on *Sorghum bicolor* Moench and *Striga hermonthica* Benth. *Ethiopian Journal of Agricultural Science* 8: 19-35.

Smaling, E.M.A. & Braun, A.R., 1996. Soil fertility research in sub-Saharan Africa: New dimension, new challenges, *Communications in Soil Science and Plant Analysis* 27:365-386.

Smaling, E.M.A., Nandwa, S.M., Prestele, H., Roetter, R. & Muchena, F.N., 1992. Yield response of maize to fertilizers and manure under different agro-ecological conditions in Kenya. *Agricultural Ecosystems and Environment* 41:241-252.

Sule, T.T., Avav, T., Kalu, B.A. & Adagba, M.A., 2008. Evaluation of host tolerance, legume trap crops and fertilizer application for management of *Striga hermonthica* in Sub-humid Savanna of Nigeria. *In*: Odey, M.O., Ghehe, N.T. & Avav, T. (Eds.). *Agriculture and the Environment*: *Socio-Economic Dynamics in 21st Century Nigeria*. (In Press).

Taye, T., 1973. Stimulation of *Striga hermonthica* germination with sorghum root exudates. Master of Technology thesis, Brunel University, Uxbridge U.K. 33pp.

Vanlauwe, B., Aihou, K., Iwuafor, E.N.O., Houngnandan, P., Diels, J., Manyong, V.M. & Sanginga, N., 2002. Recent development of maize-based systems: the role of legumes in N and P nutrition of maize in the moist savanna zone of West Africa. In: Carsky, R.J., Eteka, A.C., Keatinge, J.D.H. & Manyong, V.M. (Eds.). Cover crops for Natural Resource Management in West Africa. *Proceedings of a Workshop Organized by IITA* and CEIPCA, 26-29 October 1999, Cotonou, Benin. Pp. 3-13.

Versteeg, M.V. & Koudokpon, V., 1990. *Mucuna* helps control *Imperata* in southern Benin. West African Farming Systems of Northern Guinea Savanna: Resource and Crop Management. *Research Monograph Network Bulletin* 7:7-8.

Vissoh, P., Manyong, V.M., Carsky, R.J., Osei-Bonsu, P. & Galiba, M., 1998. Experiences with *Mucuna* in West Africa. In: Buckles, D., Eteka, A., Osiname, O., Galiba, M. & Galiano, G. (Eds.). *Cover Crops in West Africa: Contributing to Sustainable Agriculture.* International Development Research Centre, Ottawa, Canada. Pp. 1-31.

Journal of Animal & Plant Sciences, 2009. Vol. 4, Issue 2: 320 - 328.
Publication date: 15 September 2009, [*http://www.biosciences.elewa.org/JAPS*](http://www.biosciences.elewa.org/JAPS); **ISSN 2071 - 7024**

Table 6: Effect of *Mucuna* biomass and N-fertilizer on maize grain yield and gross revenue (N) [1]

Treatment	Grain yield (kg/ha)	[2]Crop Value (N/ha)	[3]Cost of *Mucuna* (M) (N/ha)	[4]Cost of Fertilizer (F) (N/ha)	Total cost of Mu+F (N/ha)	Net benefit (N/ha)	Margin over No Mu + No F (N/ha)	% Increase	B:C ratio
N fertilizer (kgN/ha)									
0									
30	205	10,250	-	-	-	10,250	-	-	-
60	212	10,600	-	3,261	3,261	7,339	-2,911	-28.4	3.25
90	387	19,350	-	6,522	6,522	12,828	2,578	25.2	2.99
	587	29,350	-	9,783	9,783	19,567	9,317	90.9	3.00
***Mucuna* unincorporated (Mu)**									
Mu + 0 kg N/ha									
Mu + 30 kg N/ha	902	45,100	8,000	-	8,000	37,100	26,850	262	5.64
Mu + 60 kg N/ha	997	49,850	8,000	3,261	11,261	38,589	28,339	276	4.43
Mu + 90 kg N/ha	1045	52,250	8,000	6,522	14,522	37,729	27,479	268	3.60
	1127	56,350	8,000	9,783	17,783	38,587	28,337	276	3,17
Mucuna incorporated (Mi)									
Mi + 0 kg N/ha									
Mi + 30 kg N/ha	998	49,900	10,500	-	10,500	39,400	29,150	284	4.75
Mi + 60 kg N/ha	1518	75,900	10,500	3,261	13,761	62,139	51,889	506	5.52
Mi + 90 kg N/ha	1748	87,400	10,500	6,522	17,022	70,378	60,128	587	5.13
	1847	92,350	10,500	9,783	20,283	72,067	61,817	603	4.55