Nigerian Journal of Ecology (2005) 7: 16-22.

ISSN: 1116-753X

Carry-Over Effects Of Different Cropping Patterns On Secondary *Striga* Infestation And Sorghum Performance.

Felix O. Ikie[1*], Sola Ogunyemi,[2] Steffen Schulz[3], Alphonse M.Emechebe[3] and Adeniyi O.Togun[2]

[1]Department of Agronomy, Delta State University, Asaba Campus, Asaba, Nigeria.
[2]Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria.
[3]International Institute of Tropical Agriculture, P.M.B. 5320, Ibadan, Nigeria.
*Correspondence: f_ikie@yahoo.com

(Accepted 4 July 2005)

ABSTRACT: Soil samples from plots with different cropping history were evaluated to determine their effect on secondary *Striga* infestation. The experiment was laid out in a split plot design with 13 treatments, organised into four sets consisting of 3 treatments of similar cropping practices and replicated four times. A fourth treatment, common to all sets, was soil prior to cultivation (T0). The soils were kept in three litre pots, infested with 3000 germinable seeds /pot of *S.hermonthica* seeds from the test locations. Data taken were, emerged *Striga hermonthica* on sorghum on weekly basis, maximum emerged *Striga* per pot and sorghum stover weight. Statistical analysis was done on set-basis. Data were subjected to analysis of variance using the General Linear Model of SAS, subsequent mean separation was by Duncan multiple range test.

Results showed that soils after amendments, and after legume rotation alone had significantly ($P \leq 0.05$) higher maximum emerged *Striga* than soil prior to cultivation. From 4 - 6 weeks after planting (WAP) the sorghum, all treatments had significantly higher emerged *Striga* than soils after poultry amendments. From 8 – 12 WAP, all treatments had significantly ($P \leq 0.05$) higher *Striga* emergence than soils prior to cultivation irrespective of the crop used in rotation. Results indicate that the carry-over effect of one season cropping along with soil amendment with either poultry manure or urea stimulated secondary *Striga* germination. Results also suggest that continued legume rotation over a period of time coupled with soil amendments could increase soil fertility to reduce *Striga* incidence.

Keywords: Cropping patterns, legume rotation, soil amendments, Sorghum *Striga*,.

INTRODUCTION

Striga parasitism on cereals is one of the serious constraints to cereal production in sub- saharan Africa. The Food and Agricultural Organisation (FAO) estimated an annual loss due to *Striga* spp. parasitism to be approximately US$7 billion which is detrimental to the lives of over 100 million African people (M'boob, 1986) The use of legume as a trap crop for *Striga hermonthica* control has been suggested by several authors (Parkinson *et al.*, 1988). Soybean preceding maize crop has been shown to reduce *Striga* seedbank in the soil depending on the variety and duration of rotation (Talleyrand *et al.*, 1994.; Ariga, 1996; Berner *et al.* 1996a; Berner *et al.*,1996b). Legume rotation operates through two major mechanisms: (1) suicidal germination of *Striga hermonthica* seeds in the soil, and (2) soil suppressiveness. Suppressive soils are defined as those soils in which disease development is suppressed even though the pathogen is introduced in the presence of a susceptible host (Baker and Cook, 1994). Natural biotic suppressiveness is widespread in Nigeria, including soils from *Striga hermonthica* infested areas (Berner *et al.*, 1996a). Rotation cropping with a selected legume a year, has been shown to be effective in *Striga hermonthica* control (Berner *et al.*, 1996a). Eplee and Norris (1990) also reported 90% reduction in *S .asiatica* using cotton in a single season. However, reports by Ramaiah (1981), Robinson and Dowler (1966) show that at least three years of rotation are likely to be needed for benefits in *Striga* control. Good soil management practices involving the use of crop residues and organic manure have been reported effective control measure against *Striga* (Hosmani, 1978; Chidley and Drennan, 1987). Vogt *et al.*(1991) observed that *Striga* infestation decreased with increasing organic matter of the soil and that organic matter content seemed to be the most important factor which preserved the soil fertility. Since soil microbial biomass flourishes better in a medium rich in organic matter, organic or inorganic soil amendments

Table 1: Cropping history of plots where soil samples (treatments) were collected for experimentation Table

S/N	Treatment code	Cropping history 1999	Cropping history 2000
1	T1PM	Soybean(TGX 1448-2E)	100KgN/ha Poultry manure + Sorghum
2	T1UR	Soybean(TGX 1448-2E)	100KgN/ha Urea + Sorghum
3	T1	Soybean(TGX 1448-2E)	
4	T2PM	Cowpea (IT90K-277-2)	100KgN/ha Poultry manure + Sorghum
5	T2UR	Cowpea (IT90K-277-2)	100KgN/ha Urea + Sorghum
6	T2	Cowpea (IT90K-277-2)	
7	T3PM	Sorghum (Mokwa local)	100KgN/ha Poultry manure + Sorghum
8	T3UR	Sorghum (Mokwa local)	100KgN/ha Urea + Sorghum
9	T3	Sorghum (Mokwa local)	
10	T4PM	Fallow	100KgN/ha Poultry manure +Sorghum
11	T4UR	Fallow	100KgN/ha Urea + Sorghum
12	T4	Fallow	
13	T0	Pre-cultivation soil.	

PM – Poultry Manure amendment UR – Urea fertilizer amendment

may increase soil suppressiveness to *Striga hermonthica* and also improve soil conditions to increase yield of subsequent cereal .

This study investigated the effect of soils after different rotational cropping and. soil amendments on secondary *Striga* infestation. Thus, the carry - over effect of a particular cropping pattern on secondary *Striga* infestation was assessed.

MATERIALS AND METHODS

Soil samples were collected prior to cultivation, after first year cropping, and at the end of the season of the second year (Table 1) to evaluate their effect on secondary *Striga* infestation. The experiment was laid out in a split plot design with 13 treatments replicated four (4) times with location as main plots. Treatments were organised into four sets consisting of 3 treatments of similar cropping practices. A fourth treatment that was common to all the four sets was soil prior to cultivation (T0) and this served as the control. Soils prior to cultivation in 1999, along with soil taken from the four treatment plots of 1999, and soil collected early and at the end of year 2000 cropping season were stored prior to use in a cold room at temperature of 10^{0}C. The soils were kept in three litre pots. All pots were infested with *S. hermonthica* seeds from the test locations at the rate of 3000 germinable seeds/pot. Infestation was effected by removing half of the soil content in each pot and mixing thoroughly with the estimated and weighed *S. hermonthica* seeds. Data taken were on, emerged *Striga hermonthica* on sorghum on weekly basis, maximum emerged *Striga* per pot and sorghum stover weight. Samples were taken from soils used for experimentation replicated three times and subjected to chemical analysis in the IITA Ibadan soil analytical laboratory.

Statistical analysis was done on set-basis. Data were subjected to analysis of variance using the General Linear Model of SAS (SAS 1999), subsequent mean separation was by Duncan multiple range test.

RESULTS

Chemical analysis of soils revealed that soils amended with poultry manure had significantly ($P \leq 0.05$) higher P (Phosphorus) than all other treatment soils. No significant differences were observed between the different sets of treatment with respect to nitrogen and potassium (Table 2). Location effect was not significant ($P > 0.05$) and result is presented across location. Soil after soybean cultivar TGX 1448-2E rotation (T1), after poultry amended TGX 1448-2E rotation (T1PM) and after urea amended TGX 1448-2E rotation (T1UR) compared to pre-cultivation soil (T0) on maximum *Striga* emergence. It showed that T1PM, had significantly ($P \leq 0.05$) higher *Striga* emergence (3.88) than T0 (2.75), but this was not significantly different from T1 and T1UR (Fig. 1). Striga emergence from the different treatment combinations varied with time. At 4WAP, all treatments had significantly ($P \leq 0.05$) higher *Striga* emergence than T1PM. At 6 & 8WAP, T1PM was not different from the other treatments but T1UR had significantly higher ($P \leq 0.05$) *Striga* emergence than T0 but from 10WAP to 12WAP, T1PM and TIUR had significantly ($P \leq 0.05$) higher *Striga* emergence than T0 (Fig. 8). With regards to soil from poultry amended IT90K-277-2 early cropping rotation (T2PM) had significantly higher ($P \leq 0.05$) Striga emergence (4.29) than T0 (2.75) , and urea amended IT90K-277-2 early cropping rotation T2UR (3.01) (Fig. 2).

Table 2. Macro-nutrients composition of experimental soills

SOIL	N %	P mg/kg	K cmol/kg
T1PM	0.033	72.44	0.10
T1UR	0.031	11.63	0.10
T1	0.028	11.23	0.10
T0	0.028	11.76	0.13
$LSD_{0.05}$	NS	16.73	NS
T2PM	0.033	56.20	0.10
T2UR	0.031	11.76	0.10
T2	0.029	10.13	0.10
T0	0.029	11.76	0.13
$LSD_{0.05}$	NS	20.79	NS
T3PM	0.033	54.20	0.10
T3UR	0.029	16.80	0.10
T3	0.027	17.23	0.10
T0	0.029	11.77	0.13
$LSD_{0.05}$	NS	38.33	NS
T4PM	0.029	67.20	0.10
T4UR	0.023	14.33	0.13
T4	0.023	15.16	0.10
T0	0.029	11.76	0.13
$LSD_{0.05}$	NS	20.91	NS

T0 =Pre-cultivation soil;
T1 = Soil after soybean cv TGX1448-2E rotation,T1PM = T1+ Poultry amendment, T1UR = T1+ urea amendment
T2 = Soil after cowpea cv IT90K-277-2 rotation, T2PM = T2 + Poultry manure amendment, T2UR = T2 + urea amendment
T3 = Soil after sorghum cropping, T3PM = T3 +Poultry manure amendment, T3UR = T3 + urea amendment.
T4 = Soil after fallow, T4PM = T4 + Poultry amendment,T4UR = T4 + urea amendment;

At 6 & 8 WAP, T2 had significantly ($P \leq 0.05$) higher *Striga* emergence than all other treatments but from 10WAP to 12WAP T1PM had significantly ($P \leq 0.05$) higher *Striga* emergence than all other treatments (Fig. 9). In sorghum cropped plots, soil from poultry amended continuous sorghum cultivar 'Mokwa local' cropping (T3PM) supported significantly ($P \leq 0.05$) higher *Striga* emergence (4.17) than T0 (2.75), but emergence in this soil did not differ from T3, and T3UR (Fig.3). At 4WAP sorghum cropped soil, urea amended sorghum soil and precultivation soil had significantly ($P \leq 0.05$) higher *Striga* emergence than T3PM. At 8WAP however , T3PM had significantly ($P \leq 0.05$) higher *Striga* emergence than T0, but the former was not different from all other treatments. From 10WAP to 12WAP, T3PM consistently had significantly higher *Striga* emergence than T0 (Fig. 10)

In fallow soil from poultry amended plot (T4PM) had significantly ($P \leq 0.05$) higher *Striga* emergence (3.80) than T0 (2.75), but was not different from T4, and T4UR (Fig.4). At 6WAP, T4UR & T4 had significantly ($P \leq 0.05$) higher *Striga* emergence than T4PM and T0, but from 10WAP, T4PM consistently had significantly higher *Striga* emergence than T0, however, the former was not different all the other treatments (Fig. 11). Soil after soybean cultivar TGX 1448-2E rotation (T1) and after poultry amended TGX 1448-2E rotation (T1PM) and after urea amended TGX 1448-2E rotation (T1UR) compared to pre- cultivation soil (T0) on stover weight showed that T0 had significantly ($P \leq 0.05$) higher stover weight (10.96g/pot) than T1 (5.77g/pot) and T1UR (5.14g/pot) but not different from T1PM (8.32g/pot) (Fig.5). Soil after fallow (T4) and after poultry amended fallow (T4PM) and after urea amended fallow (T4UR) compared to pre- cultivation soil (T0) on stover weight showed that T0 had significantly ($P \leq 0.05$) higher stover weight (10.96g/pot) than T4PM (6.01g/pot),T4 (4.79g/pot), and T4UR (5.55g/pot) but the latter were not different from each other (Fig. 6).

Soil after continuous sorghum cultivar 'Mokwa local' cropping (T3) and after poultry amended continuous sorghum cultivar 'Mokwa local' cropping (T3PM) and after urea amended continuous sorghum cultivar 'Mokwa local' cropping (T3UR) compared to pre- cultivation soil (T0) showed that T0 had significantly ($P \leq 0.05$) higher stover weight than T3PM, T3UR, and T3 but the latter were not different from each other (Fig. 7). A similar result was observed with soils after cowpea cultivar IT90K-277-2 early cropping rotation (T2), after poultry amended IT90K-277-2 early cropping rotation (T2PM), after urea amended IT90K-277-2 early cropping rotation (T2UR) compared to pre- cultivation soil (T0).

Discussion

The stimulation in *Striga* seed germination observed with poultry manure amended treatments over soil prior to cultivation, may be due to the enhancement of activities of ethylene producing bacteria which possibly stimulated *Striga* to germinate in the presence of the susceptible host. Goodlass and Smith (1978a.,1978b.) observed that there exist a close correlation between microbial ethylene production and organic matter content in soils.

The trend across periods of observation where poultry manure amended soils irrespective of the rotational crop significantly had lower *Striga* emergence relative to all other treatments at the early periods after sorghum planting and the dramatic turn with poultry manure amended treatment having significantly higher *Striga*

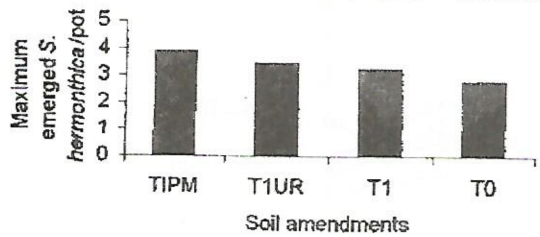

Figure 1. Effects of soil after soybean and soil amendments on maximum emerged *Striga*

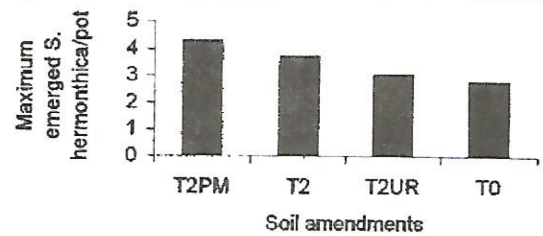

Figure 2. Effects of soils after cowpea and soil amendments on maximum emerged Striga.

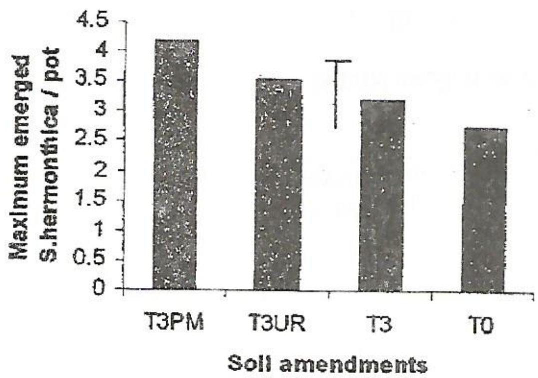

Figure 3. Effects of soil after *Sorghum* and soil amendments on maximum emerged Striga

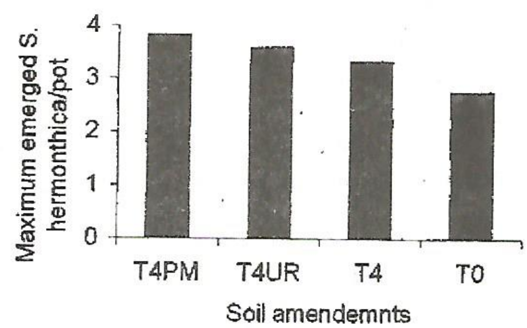

Figure 4. Effects of soils after fallow and soil amendments on maxomum emerged Striga

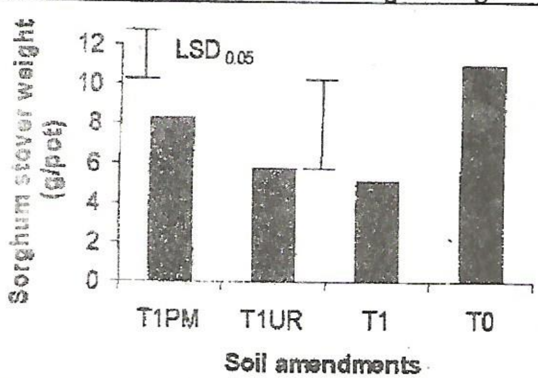

Figure 5. Effects of soil after soybean and soil amendments on Sorghum stover weight

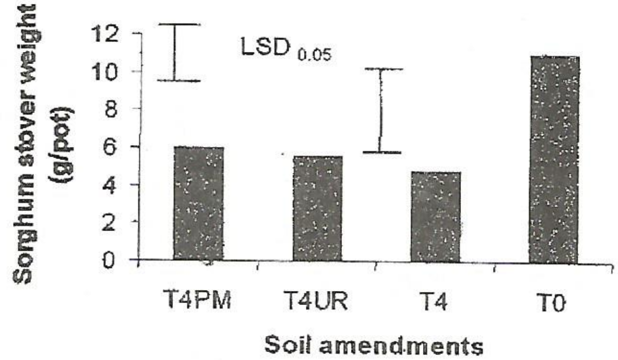

Figure 6. Effects of soil after fallow and soil amendments on Sorghum stover weight

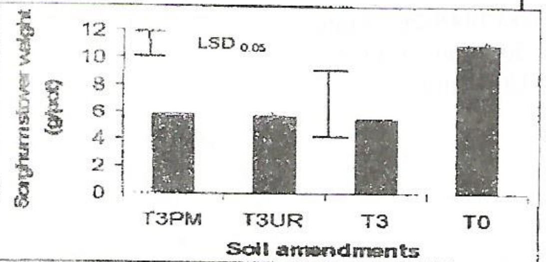

Figure 7. Effects of soil after sorghum and soil amendments on Sorghum stover weight

T0 = Precultivation soil;
T1 = Soil after soybean cv TGX1448-2E rotation
T2 = Soil after cowpea cv IT90K-277-2 rotation
T3 = Soil after sorghum cropping
T4 = Soil after fallow
PM = Poultry amendment,
UR = Urea amendment

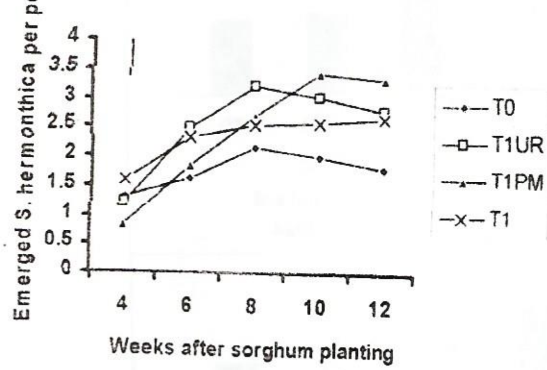

Figure 8. Effects of soil after soybean and soil amendments on emerged *Striga* across periods of observation

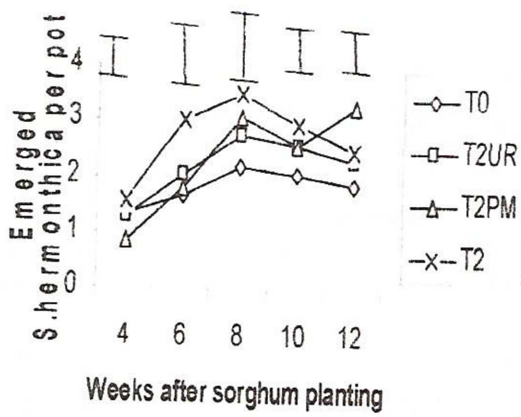

Figure 9. Effects of soil after cowpea and soil amendments on emerged *Striga* across periods of observation

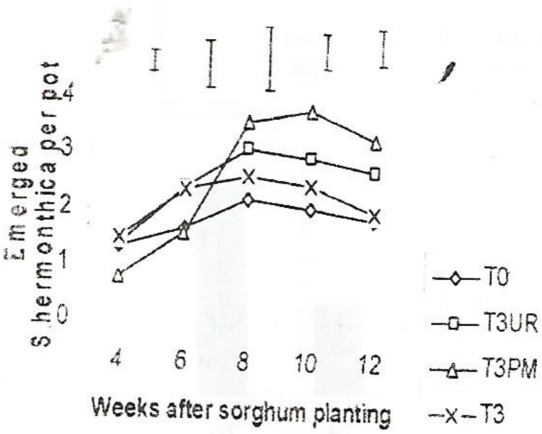

Figure 10. Effects of soil after sorghum and soil amendments on emerged *Striga* across periods of observation

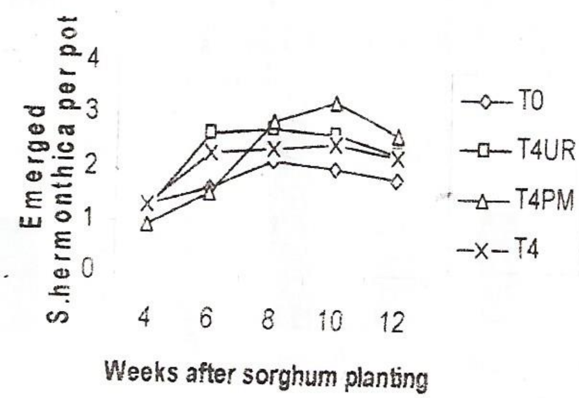

Figure 11. Effects of soil after fallow and soil amendments on emerged Striga across periods of observation

T0 = Precultivation soil; T1 = Soil after soybean cv TGX1448-2E rotation
T2 = Soil after cowpea cv IT90K-277-2 rotation T3 = Soil after sorghum cropping
T4 = Soil after fallow PM = Poultry amendment, UR = Urea amendment

emergence than soil prior to cultivation but sometimes not different from urea amended soils from later periods after sorghum planting, may be connected with the slow release of N by poultry manure and the enhancement of ethylene producing bacteria associated with soil with organic manure. The ethylene possibly stimulating *Striga* seed germination in the presence of sorghum (a susceptible host) and thus increasing *Striga* emergence. Goodlass and Smith (1978a; 1978b) observed that there exists a close correlation between microbial ethylene production and organic matter content in soils. Since ethylene is able to induce *Striga* germination, ethylene produced by micro-organisms could contribute to germination of *Striga* seeds more-so in the presence of a susceptible host (sorghum). Kranz (1997) reported ethylene-emission of soils from compound fields much higher than bush fields with regards to the soils of northern Ghana. Saunders (1933) had found that manured sorghum plots had 40% more *Striga* plants above ground than unmanured plots. Sherif and Parker (1986) also found a stimulatory effect of poultry manure on *Striga* emergence.

The significantly higher stover weight with precultivation soil over soil amended with poultry manure may be due to the stimulatory effect of poultry manure on *Striga* emergence and hence higher parasitism and consequent lower stover weight. Pre-cultivation soil had significantly higher stover weight than soils after legume rotation, and after urea amendment. This may be due to the absence of suicidal factor of the trap crop, which could not be carried over to current *Striga* seeds infestation, leaving only the fertility factor which was minimal but possibly enhanced *Striga* germination hence higher parasitism and lower stover weight. However, the case of urea amended soil may be due to the residual effect of added N from the previous season which again was minimal. Pieterse and Verkleij (1991) observed that in very infertile soils, N- fertilizers may stimulate *Striga* infestation.

The significant difference between treatments may be as a result of the high P content of the poultry manure introduced as amendment. However the significant difference with P and K may not have any effect on the results obtained with the treatments. Raju *et al.*, (1990) found that K promoted stimulant activity only in the absence of N; the presence or absence of P in the growth medium did not affect *Striga* seed germination probably due to the inability of this element to interfere with the production or the activity of the stimulating substance from the host plant.

This study indicates that the carry–over effect of one season legume rotational cropping and either additional poultry amendment or urea amendment is stimulatory to secondary *Striga* seed germination and suggests continued rotation of the legume and additional soil amendment and cereal cropping over a considerable length of time to improve the soil fertility status and reduce *Striga* incidence.

References

Ariga, E. (1996). Bioassay of germination stimulants of *Striga hermonthica* . University of Nairobi. Ph. D Thesis. 129p.

Baker, K.F. and Cook, R. J. (1994) Biological control of plant pathogens. W. H. Freeman, San Francisco. 433pp.

Berner, D. K; M. O Alabi; U. di Umba and F. O.Ikie (1996a). Proposed integrated control programme for *Striga hermonthica* in Africa. In: Advances in parasitic plant research.

Berner, D. K; R. Carsky ; K. Dashiell; J. Kling and V. Manyong (1996b). A land management based approach to integrated *Striga hermonthica* control in Subsaharan Africa. Outlook on Agriculture. Vol. 25 No. 3: 157- 164.

Chidley, V. L. and D. S. Drennan. (1987). *In vitro* culture of *Striga asiatica* (L.) Kunze (Scrophuliaraceáe) pp 829-831. In Weber, H. C. and W. Forstreuter. Editors: Parasitic Flowering Plants. Proceedings of the Fourth International Symposium on Parasitic Flowering plants. Marburg: Phillipps-University.

Eplee, R.E and Norris, R.S (1990). Soil sampling collection equipment and equipment to separate seeds from the soil. In: Sand, P.F., Eplee, R.E and Westbrooks, R.G (eds) Witchweed Research and Control in the United States. Weed Science Soceity of America, Champaign,pp136 –140

Goodlass, G. and K.A. Smith (1978a): Effect of pH,organic matter content and nitrate on the evolution of ethylene from soils. Soil Biology and Biochemistry 10: 193-199

Goodlass, G. and K.A. Smith (1978b). Effect of organic amendments o evolution of ethylene and other hydrocarbons from soils. Soil Biology and Biochemistry 10: 201-205.

Hosmani, M. M. (1978) *Striga* (A Noxious Root Parasitic Weed), University of Agricultural Science, Dharwar, India, p 165.

Kranz,.B (1997) Cited in Kroschel. J (1998) PLITS 1998/16 (2) 137-158.

M'boob, S. S. (1986). A regional programme for West and Central Africa. Pp 190-194. In Proceedings of the FAO/OAU All African consultation on *Striga* control. 20-24 October 1986, Maroua, Cameroun.

Parkinson, V., Kim, S.k., Efron, Y., Bello, L., and Dashiel, K. (1988). Potential of trap crops as a cultural measure of *Striga* control in Africa. FAO Bulletin No 96.

Pieterse, A.H., and A.C. Verkleij (1991) Effect of soil conditions on *Striga* development - a review p 329 - 339 In: J.K . Ransom *et al.*, (ed). Proc. International Symposium. Parasitic Weeds, 5th Nairobi, 24-30 June 1991. CIMMYT, Nairobi, Kenya.

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

Ramaiah, K.V.(1981). *Striga* resistance breeding. Pages D1-19 In: Annual report 1981. Ouagadougou, Burkina Faso. ICRISAT/Upper Volta Cooperative Programme, ICRISAT.

Robinson, E.L and Dowler, C.C (1966) Cited In: Parker, C and C.R. Riches (1993). Parasitic weeds of the World: Biology and control. CAB International.Wallingford, U. K. 332p.

SAS Institute(1999) SAS / STAT User,s Guide, version 8, SAS Institute, Inc., Carey NC, USA.

Saunders, A.R. (1933). Studies in Phanerogamic parasitism with particular reference to Striga lutea Lour. Science Bulletin. Department of Agriculture (South Africa) 128: 1-56.

Sherif, A. M and C. Parker (1986). Effect of N source and organic matter on Sorghum bicolor L. Moench and Striga hermonthica Benth. Ethiopian Journal of Agricultural Science 8 (19):19-35.

Tallyrand, H.; T. Ngoumou Ngai; J. Edseb; A. Ebete and W. Kashala. (1994). Differential response of maize and sorghum to *Striga* incidence after several trap crops in *Striga* infested alfisol of the lowland savanna of North Cameroun. In: Improving *Striga* management in Africa. S. T. O. Lagoke ; R. Hoevers; S. S. M'boob; and R. Traboulsi (Eds). Proceedings of the second general workshop of the Pan Africa *Striga* Network. Pp 64- 73. FAO PASCON, Accra Ghana.

Vogt, W., Sauerborn, J and Honisch M. (1991) *Striga hermonthica*, Distribution and Infestation in Ghana and Togo on Grain crops. Proceedings of fifth International Symposium of Parasitic Weeds, June 24th - 30th. Nairobi, Kenya. pp. 372- 377.

Nigerian Journal of Ecology ISSN: 1116-753X

Volume 6, 2004

Contents

Volume 7, 2005

Typeset and designed by Richman Production, Ibadan, Nigeria.
Produced for the Publisher by FOP Press, Eleyele, Ibadan, Nigeria 08059409821