ISSN - 2277 - 2755

Journal of
Agricultural Science
and Environment

EVALUATION OF OPEN POLLINATED MAIZE VARIETIES FOR RESISTANCE/TOLERANCE TO *Striga hermonthica* Del. Benth AT MOKWA SOUTHERN GUINEA SAVANNAH OF NIGERIA

K.M. ISAH [1]., S.T.O. LAGOKE[2]., B.B. PHILIP[3] I.A. ADENIJI[4] AND O.A. BABALOLA[2]

[1]Department of Pest Management Technology, Niger State College of Agriculture, Mokwa, Nigeria.
[2]Department of Plant Physiology and Crop Production
[3]Department of Agricultural Economics and Rural Development
[4]IFSERAR (2, 3 and 4), University of Agriculture, Abeokuta, Nigeria.
[1]**Corresponding author:** matthewmokwa@yahoo.com **Tel:** +2348038180987

ABSTRACT

Three trials were conducted on the College of Agriculture experimental field which was highly and uniformly infested by *Striga* at Mokwa (latitude 09° 18'N and longitude 05° 04'E) in the Southern Guinea Savanna agro- ecological zone of Nigeria during 2004, 2005 and 2006 wet seasons. The study was conducted to evaluate fifteen maize genotypes consisting of eleven improved, open- pollinated *Striga* tolerant varieties, a susceptible 8338-1 and tolerant hybrids 9022-13, an improved recommended open pollinated variety and a local selection (Mokwa Dzurugi) for their reaction to *Striga hermonthica*. The treatments were laid out in a randomized complete block design and replicated four times. Among the varieties tested, TZL Comp.1Syn Y-1F2, Cam, 1 STR – 1 and hybrid 9022-13 consistently resulted in significantly lower *Striga* emergence and crop syndrome reaction to *Striga* parasitism compared to all the other varieties including STR genotypes in 2004 and 2005 and of very low values of the parameters in 2006. The varieties also gave higher grain yield comparable to most of tolerant varieties evaluated. Under *Striga* infestation, maize grain yields of var. TZL Comp. 1 Syn Y-1F2 were 2.94, 3.04 and 2.93 times than those of the recommended TZB- STR (1015kg/ha, 989kg/ha and 993kg/ha) in 2004, 2005 and 2006, respectively. The corresponding values for the other promising variety, Cam- 1STR-1 were 2.93, 3.05 and 2.89 times higher than TZB STR in 2004, 2005 and 2006 respectively. The local selection, Mokwa Dzurugi also exhibited good performance with respect to *Striga* and maize parameters and could therefore be used in the breeding programme for *Striga* resistance.

Keywords: Open pollinated maize varieties, *Striga hermonthica*

INTRODUCTION

The rapid increase in maize cultivation has aggravated the problem of parasitic weed, *Striga* on maize crop in the savannas (Lagoke *et al*., 1994). Under heavy infestation, maize is more vulnerable to *Striga* parasitism than upland rice, sorghum and millet with high losses in excess of 90% (Efron *et al*., 1989; Adagba *et al*., 2005).

Some of the major constraints therefore to maize production in West and Central Africa and particularly in the Nigerian Savannas have been reported to be nitrogen deficiency and *S. hermonthica* parasitism (Berner *et al*., 1995). Yield losses may reach 100% on heavily infested fields hence causing farmers to abandon their fields in search of less infested areas (Doggett, 1984; Lagoke *et al*., 1991). In Nigeria, *Striga* has been reported to cause between 10 to 100% maize grain yield loss, depending on the incidence, level of infestation and distribution of the parasitic weed, the crop variety, location and cultural practices in use (Lagoke *et al*., 2002). Even when tolerant varieties were evaluated, *Striga* infestation caused between 17.2 to 77.4 % reduction in maize grain yield (Lagoke *et al*., 1999).

Some of the methods commonly used for *Striga* control include hand weeding, post-emergence application of herbicides, use of trap crops or other non- hosts in rotation or intercrop with host crops, host plant resistance, and in-organic and organic fertilizers (Lagoke *et al*., 2002).

The use of host crop resistance as a component of integrated *Striga* management is more likely to be adopted by the resource poor farmers (Kim, 1991; Debrah, 1994) in preference to measures requiring substantial cash outlays. Resistant varieties developed for *Striga* control have often broken down with time (Kim and Adetimirin, 1997; Ramaiah, 1984). This is as a result of build up of more virulent *Striga* populations, especially under continuous cropping as well as the development of new strains through cross fertilization (Musselmann, 1987). Recent studies have confirmed the existence of biotypes with respect to location ecotypes and host crop sources "haustotypes" (Koyama, 2000; Adagba, 2000; Botanga *et al.,* 2002; Adagba et al., 2003; Isah, 2008). This calls for the need for a continuous evaluation of varieties for resistance/tolerance to *Striga* parasitism. Farmers have shown preference for *Striga* tolerant open pollinated varieties because of accessibility to seed and crop management reasons than STR hybrids (Lagoke *et al*., 1999). The objective of this study therefore was to evaluate open pollinated maize varieties for resistance/tolerance to *S. hermonthica*.

MATERIALS AND METHODS

Field trials were conducted on the College of Agriculture experimental field with high and uniform *Striga* infestation at Mokwa (latitude 09^{o} 18'N and longitude 05^{o} 04'E) in the Southern Guinea agro-ecological zone of Nigeria during the 2004, 2005 and 2006 wet seasons. The treatments were laid down in a randomised complete block design and replicated four times. The fifteen treatments consisted of eleven open pollinated maize varieties bred for *Striga* resistance, an STR (9022-13) and a *Striga* susceptible hybrid (8338-1), a recommended open pollinated variety (TZB – STR) and a local selection (Mokwa Dzurugi). Details of the treatments are contained in Tables 1 and 2. The plot sizes were 15m^2 made up of four 5m long and 3m wide rows. The land was ploughed and harrowed at two weeks interval before ridging with tractor mounted equipment. Three seeds of maize were planted per hill at an intra-row and inter-row spacing of 50 and 75cm respectively and were thinned to two plants per hill three weeks later. Fertilizer at the rate of 100 kg N, 50 kgP_2O_5 and 50 kg K_2O/ha was split applied in two doses of 50 kg N, 50 kgP_2O_5 and 50 kg K_2O/ha at 2 weeks after planting (WAP) using NPK 15-15-15 and 50 kg N/ha at 6 WAP using urea. Weeding was done twice at 3 and 6 WAP before fertilizer application using hand hoe. Thereafter emerged weed seedlings other than those of *Striga hermonthica* were hand pulled.

Table 1: *Striga* shoot count and crop reaction syndrome score of maize varieties at Mokwa, 2004, 2005 and 2006 wet seasons

Treatments	Striga shoot count/15m2						Crop reaction score					
	8 WAP			10 WAP			8 WAP			10 WAP		
	2004	2005	2006	2004	2005	2006	2004	2005	2006	200 4	2005	2006
TZL Comp.1 Syn Y-1F2	0.3f1	0.2d	1.8cdef	0.1c	0.3e	8.8cde	1.3e	1.2d	2.3d	1.7g	1.7f	3.3e
IWB C2 Syn-F2	19.3a	20.7a	7.3cdef	28.1 a	29.3d	12.3c	3.7a	3.7a	4.0a	5.7c	6.0b	6.0b
Acr. 97 TZL Comp. 1-W	16.7bcd	19.3a	7.0cdef	27.4 a	28.6d	8.8cde	2.7c	2.7b	2.3bc	3.0f	3.3e	3.3e
TZL Comp1 SynW-1	14.3de	18.1ab	5.3def	28.2 a	29.4d	7.0de	2.7c	2.7b	2.0c	3.0f	3.3e	3.0f
Zea Diplo BC4-WC3	19.1ab	19.3a	8.8c	29.3a	30.3cd	11.3cd	3.0c	3.0b	2.8b	3.7e	3.7d	4.0d
TZL Comp1-WC6	14.7de	15.3bc	7.8cde	27.9a	30.2cd	9.3cde	2.7c	2.7b	2.3bc	3.3f	3.0e	3.3e
Cam. 1STR-1	0.1f	0.3d	4.5f	0.2c	0.3e	6.0e	1.3e	1.3d	2.3b	1.7g	1.7f	3.3e
Zea Diplo BC4-YC3F2	17.3abcd	18.7ab	6.0cdef	29.0a	28.3d	8.3cde	2.3d	2.3c	2.0c	3.3f	3.0e	3.0f
OBATANPA/Z. Diplo SynW-1	15.3cd	19.0a	6.5cdef	28.9a	29.0d	8.0cde	2.7c	2.7b	2.3bc	3.3f	3.0e	3.3e
Z.Diplo-BC4-C3 W/DOGONA -1/Z. Diplo-BC4-C3-W	18.3ab	21.7a	7.8cde	29.3 a	37.2a	12.3c	3.7a	3.7a	3.8 a	5.0d	5.0c	5.3e
Z. Diplo-BC4-C3-W/Dou-1Z.Diplo-BC4-C3-W	12.3e	14.7c	8.3cd	28.0a	29.7d	9.5cd	2.7c	3.0b	2.3bc	3.3f	3.3e	3.5e
TZB–STR (Susceptible)	19.0ab	19.7a	18.0a	29.9 a	34.1b	19.8b	3.0bc	3.7a	4.0a	6.0b	6.3b	7.0a
83381(Susceptible hybrid)	19.1ab	18.3ab	13.3b	30.1 a	33.2bc	26.5 a	3.3ab	3.7 a	4.0a	6.0b	6.3b	7.0a
9022-13 Resistant hybrid)	19.7 a	19.3a	7.5cdef	29.8 a	28.6d	9.8cde	2.7c	1.7b	2.0c	6.7 a	6.7 a	7.0a
Mokwa Dzurugi	16.8bc	18.2ab	5.0ef	23.6b	27.4d	8.0cde	2.7c	2.7c	2.3bc	3.0f	3.0e	3.0f
SE ±	1.42	I.51	1.52	1.45	1.50	2.45	0.15	0.16	0.30	0.15	0.15	0.16

1-Means followed by same letter(s) within a column are not significantly different at 5% level of probability (DMRT).
WAP – Weeks after planting.
Note-crop reaction score using scale 1 to 9 where 1 is assigned to plant normal growth and 9 completely dead plant as proposed by Kim (1994)

Data were collected on maize height at 12 WAP, maize grain yield, *Striga* shoot count and crop reaction score at 8 and 10 WAP. The data collected were subjected to analysis of variance (ANOVA) and means separated using Duncans Multiple Range Test at 5% level of probability.

RESULTS

Maize varieties, TZL Comp.1 Syn Y-1F2 and Cam. 1STR-1 consistently reduced *Striga* shoot count and exhibited crop reaction syndrome at 8 and 10 WAP than all the other varieties evaluated in 2004 and 2005 seasons (Table 1). In 2006, while the two varieties were comparable to the least in *Striga* shoot count, varieties TZL Comp.1 Syn Y-1F2, Acr. 97 TZL Comp.1- W, TZL Comp.1 Syn W- 1, Zea Diplo BC4- YC3F2, OBATANPA/Z.Diplo Syn W- 1, the STR control hybrid 9022-13 and the local selection Mokwa Dzurugi had *Striga* shoot count comparable to the lowest with Cam. STR-1 at 8 and 10 WAP. Maize variety TZL Comp. Syn Y- 1 also had the lowest crop reaction score at 8 WAP in 2006 while the same variety and Zea Diplo BC4- YC3F2 had the lowest at 10 WAP in the same year (Table 1).

Inspite of differences in Striga parasitism as reflected in the shoot count and syndrome reaction, grain yields were only significantly

Table 2: Effect of maize varieties on plant height and grain yield under *Striga hermonthica* infestation at Mokwa, 2004, 2005 and 2006 wet seasons

	Maize height at 12 WAP (cm)			Maize grain yield kg/ha		
Treatments	2004	2005	2006	2004	2005	2006
TZL Comp.1 Syn Y-1F2	171.2a1	170.7a	172.3a	2981a	3007a	2907a
1WBC2 Syn F2	176.3a	175.2a	178.7a	1322b	1407b	1035b
Acr. 97 TZL Comp.1-W	174.1a	173.0a	174.5a	2970a	2978a	2900a
TZL Comp.1 SynW-1	173.3a	174.5a	176.3a	2917a	2914a	2907a
Zea Diplo BC4-WC3	177.3a	175.5a	178.0a	2894a	2903a	2918a
TZL Comp1-WC6	170.2a	171.3a	168.7a	2814a	2914a	2883a
Cam. 1STR-1	169.3a	170.3a	169.9a	2973a	3019a	2872a
Zea Diplo BC4-YC3F2	169.3a	170.2a	168.3a	2916a	3007a	2983a
OBATANPA/Z. Diplo SynW- 1	170.3a	171.2[a]	168.7a	2840a	2879a	2907a
Z.Diplo-BC4-C3 W/DOGONA-1/Z. Diplo-BC4-C3-W	162.7a	169.7[a]	170.3a	1263b	1307b	1319b
Z. Diplo-DC4-C3-W/Dou-1/Z. Diplo BC4-C3-W	167.2a	170.3 a	171.2a	2817a	2798 a	2842a
TZB –STR (Susceptible)	103.7b	101.4b	116.0b	1015b	989c	993b
8338-1 (susceptible hybrid)	102.3b	102.4b	112.7b	1023b	993c	1021b
9022-13 (Resistant hybrid)	170.2a	169.4a	171.3a	2788 a	2807a	2849a
Mokwa Dzurugi	170.2a	169.4a	171.3a	2963 a	2942a	2907a
SE±	10.10	9.95	10.85	151.05	157.20	143.15

1- Means followed by same letter(s) within a column are not significantly different at 5% level of probability (DMRT). WAP – Weeks after planting.

lower in 8338-1, TZB- SR, IWBC2 Syn F2 and Z. Diplo BC4-C3W/Dogona Y/ Z. Diplo- BC4-C3-W compared with those of other varieties evaluated which were similar (Table 2).

DISCUSSION

TZL Comp.1Syn Y-1F2 and Cam.1STR-1 consistently exhibited resistanace to *S. hermonthica* in the study. These varieties supported lower *Striga* emergence, exhibited lower crop reaction score to *Striga* and produced maximum grain yields in 2004, 2005 and 2006. Under *Striga* infestation, grain yields of maize variety TZL Comp.1Syn Y-1F2 were 2.94, 3.04 and 2.93 times those of the recommended TZB – SR in 2004, 2005 and 2006, respectively. The corresponding values for Cam. 1 STR- 1 were 2.93, 3.05 and 2.89 times. Earlier report by Lagoke *et al*., 1999 have confirmed the performance of some of the STR maize varieties under various levels of *Striga* infestation at various savanna agro- ecological zones. They reported higher yield than the susceptible checks inspite of low to high *Striga* infestation thus confirming their tolerance. Kim (1994) earlier attributed the performance of STR maize to three sets of multiple genes separately controlling *Striga* emergence, crop reaction syndrome and maize yield. He enumerated the advantages of the horizontal resistance in the STR maize genotype which resides mainly in the back-up effect of the other set of genes in the event of breakdown of one set. This situation was said to allow production of adequate yield inspite of *Striga* infestation and prevent total crop failure due to parasitism. This seems to be the case with hybrid 9022-13 and open pollinated variety Acr. 97 TZL Comp.1-W which had been the recommended STR genotypes for 25 and 8 years, respectively. Farmers have expressed reservation on the use of 9022-13 because of the need to repurchase the seed every year and support for moderate *Striga* infestation; this could increase soil seed bank and make *Striga* management effort difficult. The development of the other two varieties which have additional traits of *Striga* emergence reduction will go a long way to facilitate the development of an effective *Striga* management technology. Farmers at Mokwa have also confirmed the good storability of TZL Comp,1 Syn Y 1F2 in their barns in on-farm demonstrations (Lagoke *et al*., 2007). However, in earlier studies, Kim *et al*. (1994) and Ejeta *et al*. (1998) observed that the ideal *Striga* tolerance and resistance would be that controlled by polygenes which induced high rates of germination and attachment of *Striga* but low emergence; thus depleting the *Striga* soil seed bank. Ransom *et al.* (1996) have also indicated that the superior grain yield of the resistant varieties of maize compared with the susceptible varieties was related to the delay or even lack of parasitism of the resistant varieties.

In this study, some of the other varieties that produced acceptable yields in spite of relatively moderate *Striga* shoot count and crop reaction scores include TZL Compl Syn W-1, Zea Diplo BC4-WC3, TZL Comp.1-WC6, Zea Diplo-BC4 YC3 F2, OBATANPA/ Z.Diplo Syn W-1, Z Diplo-BC4-C3-W/ DOGONA-1/Z. Diplo BC4-C3-W and the local selection Mokwa Dzurugi. The varieties therefore exhibited tolerance. The mechanism of *Striga* emergence reduction in TZL Comp.1Syn Y-1F2 and Cam.1STR-1 has not been investigated. It will be desirable if these varieties stimulate high *Striga* seed germination and low attachment or/and development of the seedlings due to physical barrier or antibiosis as earlier suggested by Ramaiah (1987).

The variety Z Diplo-BC4-C3-W/ DOGONA-1/Z. Diplo BC4-C3-W as well as others, IWB C2 Syn F2, TZB-SR and 8338-1 which had moderate to high syndrome reaction scores of between 5.3 to 7.0 at 10 WAP in 2006 and produced lower grain yields of 1319, 1035, 993 and 1021 kg/ ha, respectively have obviously exhibited susceptibility to *S. hermonthica* at Mokwa. In related studies Kim and Adetimirin (1997) and Lagoke *et al*. (2002) had reported susceptibility of maize varieties 8338-1 and TZB-SR. The introgression of *Striga* resistance genes from *Z. diploperennis* has resulted in four varieties which exhibited differential reactions to *Striga* in this study. Among the four varieties, Z Diplo-BC4-C3-W/ DOGONA-1/Z. Diplo BC4-C3-W exhibited the lowest tolerance to *Striga* as reflected in the relatively high *Striga* shoot count, crop reaction syndrome and low maize grain yield in the three years.

CONCLUSION

In conclusion, the two varieties TZL Comp.1Syn Y-1F2 and Cam.1STR-1 have supported reduced *Striga* emergence in addition to exhibiting other *Striga* tolerance traits in STR maize in this study. Their usage will go a long way in reducing *Striga* seed production and the population in soil seed bank and facilitate the development of a more sustainable management technology for *Striga*. The mechanism for *Striga* emergence reduction should, however, be investigated. The performance of the local selection Mokwa Dzurugi has been impressive and may need further evaluation for subsequent inclusion in the maize breeding programme for *Striga* tolerance/resistance.

REFERENCES

Adagba, M.A. 2000. Management of *Striga hermonthica* (Del) Benth. in upland rice *Oryza sativa* (L) using host plant resistance, nitrogen rate and herbicide seed treatments. Ph.D. (Agronomy) Thesis. Department of Agronomy, Ahmadu Bello University Zaria – Nigeria, pp. 224 - 259.

Adagba, M.A., Lagoke, S.T.O., Ndahi, W.B. 2003. Effect of nitrogen fertilizer on the response of resistant and susceptible upland rice varieties to *Striga hermonthica* infestation, *Nigerian Journal of Weed Science,* 16: 47-50.

Adagba, M.A., Lagoke, S.T.O., Ndahi, W.B. 2005. Control of *Striga hermonthica* Del. Benth. Through host plant resistance in upland rice (*Oryza sativa* L). *Nigerian Journal for Plant Protection,* 22: 57-71.

Berner, D.K., Kling, J.G., Singh, B.B. 1995. *Striga* Research and Control, A perspective from Africa. *Plant Disease,* 79(7): 652-660.

Botanga, C. J., Kling, J.G., Berner, O.K., Timko, M.P. 2002. Genetic variability of *Striga asiatica* (L) kuntze base on AFLP analysis and host parasite interaction. *Euphytica J*., 128: 375 – 388.

Debrah, D.K. 1994. Socio-economic constraints to the adoption of weed control techniques, the case of *Striga* control in West African Semi-Arid Tropics. *International J. Pest Management,* 40: 153-155.

Doggett, H. 1984. Botanists annual report 1951 – 52. In: Ukiruguru, Mwanza, Tanganyika Department of Agriculture. *Annual Report, Tanganyika*. P. 224.

Efron, Y., Kim, S.K., Parkinson, V., Bosque-Perez, N.A. 1989. IITA Strategies to develop *Striga* resistant maize Germplasm. In*: Striga*-Improved management in Africa.

T.O. Robson., H. R. Broaded Proceeding of FAO/OA.U. All African Government Consultation on Striga Control 20-24th October, 1986, Maroua Cameroon, FAO, Rome. P. 141-153.

Ejeta, G., Butler, I.G., Hess, D.E. Obilana, A.B. Reddy, B.V. 1998. Breeding for *Striga* resistance in sorghum p.504-516. In *Rosenow (ed.). Proc. of the Inter. Conference on Genetic improvement of Sorghum and Pearl millet*. 23-27 September, 1996, Lubbock, Texas.

Isah, K.M. 2008. Influence of trap crop rotation on the reaction of host crops to *Striga hermonthica* of different crop and location sources. A Ph.D. thesis (Crop Production). Department of Plant Physiology and Crop Production, University of Agriculture, Abeokuta, Nigeria. P. 40- 354.

Kim, S.K. 1991. Breeding maize for *Striga* tolerance and the development of a field infestation technique. In: *S.K. Kim (ed.) combating Striga in Africa. Proceedings of International Workshop by IITA, ICRICAT and IDRC* 22-24 August 1988, IITA, Ibadan, Nigeria. P. 96-108.

Kim, S.K. 1994.Genetics of maize tolerance to *Striga hermonthica. Crop Science,* 34: 960-967 .

Kim, S.K., Adetimirin, V.O. 1997. Responses of tolerant and susceptible maize varieties to timing and rate of nitrogen under *Striga hermonthica* infestation *Agron. J.,* 89:38-44.

Kim, S.K., Akintunde, A.Y., Walter, P. 1994. Responses of maize, sorghum and millet plants infestation by *Striga hermonthica. Crop protection,* 13(8): 582 - 590.

Koyama, M.L. 2000. Genetic variability of *Striga hermonthica* and effect of resistant sorghum cultivars on population Dynamics. In: *B. I. G. Haussmann, D. E. Hess, M. L. Koyama, L. Grivet, H. F. W. Ratunde and H. H. Geiger (eds)*. Breeding for *Striga* resistance in cereals. *Proceedings of a workshop held at IITA, Ibadan, Nigeria,* August 18th – 20th, 1999, P. 247 – 260.

Lagoke, S.T.O., Philip, B.B. Isah, K.M., Adeniji, I.A. 2007. Report of the 2007 on-farm demonstration of *Striga* management technologies in maize in the moist savanna agro-ecologies of Nigeria. Presented to PAN African *Striga* Control Network (PASCON), Burkina-Faso. P. 1-9.

Lagoke, S.T.O, Shebayan, J.Y. Adeosun, J.O. Iwuafor, E.N.O., Adu, J.O., Olukosi, J., Olufajo, O.O., Emechebe, A.M., Zaria, M., Chobe, S., Adeoti, A.A., Onyibe, J. 1994. Survey of *Striga* problem and on farm testing of integrated *Striga* control package and evaluation of various *Striga* control methods in maize, sorghum and cowpea in the Nigeria savanna pp50 – 79. in: *R. Trabouisi, S.T.O. Lagoke, R. Hoeversand, S.S. MBoob.* Towards an integrated control of *Striga* in Africa. *Proceeding of the General Workshop of the PAN Africa Striga control Network (PASCON)*, Ibadan, Nigeria 11th – 14th March, 1990.

Lagoke, S.T.O., Adagba, M.A., Shebayan, J.Y., Ndahi, W.B., Singh, B.N. 2002. Evaluation of upland rice varieties (*Oryza sativa* (L) for resistance/tolerance *Striga hermonthica* Del. Benth. In integrated *Striga* management technologies from research to farmers in sub-Saharan Africa. *Proceedings of the fourth general workshop, PAN Africa Striga Network (PASCON)*, Bamako Mali 28th October – 1st November, 1996 P. 146-151.

Lagoke, S.T.O., Kling, J.G., Kureh, I., Aliyu, L., Kim, S.K., Fajemisin, J.M. 1999. Reaction of open pollinated maize varieties to *Striga hermonthica* in the Nigerian Savanna. *Pp.285-301. In: Badu-Apraku, B., M. A. B. Fakorede, M. Ouedraogo and F. M. Quinn. 1999.* Strategy for sustainable maize production in West and Central Africa. *Proceedings of a Regional Maize Workshop, IITA,* Cotonou, Benin Republic, 21-25 April, 1997, WECAMAN/ IITA.

Lagoke, S.T.O., Parkinson, V., Agunbiade, R.M. 1991. Parasitic weed control methods in Africa p.3-14. In S.K. Kim (ed.). Combating *Striga* in Africa. *Proceeding of International Workshop-Organized by IITA, ICRISAT and IDRC at IITA*, Ibadan 22nd - 24th August, 1988.

Musselman, L.J. 1987. Parasitic weeds in Agriculture vol.1 *Striga*, CRC Press Florida, USA 317P.

Ramaiah, K.V. 1984. Physiological specialization in *Striga hermonthica* and crop specificity, In: Ayensu, E.S.(ed). *Proceedings of the workshop on biology and control of Striga,* Nov. 14th - 17th, 1983, Dakar, Senegal, ICSU, Press P. 71-72.

Ramaiah, K.V. 1987. Breeding cereal grains for resistance to witch weed pp 227-242. In: Musselmann l.J. (ed.). *Parasitic Weeds in Agriculture Striga* CRC Press Inc. Boca Raton Florida, USA.

Ransom, J.K., Odhiambo, G.D., Eplee, R.E., Diallo, A.O. 1996. Estimates from field studies of the phototoxic effects of *Striga* spp on maize p.327-333. In: Advances in Parasitic Plant Research, Junta de Andalucia.

(Manuscript received: 16th March, 2010; accepted: 25th October, 2010).