Archives of Phytopathology and Plant Protection Taylor & Francis
February, 2004, Vol. 37, pp. 29-34

VARIABILITY IN HOST PLANT RESISTANCE OF SORGHUM TO *STRIGA HERMONTHICA* INFESTATION IN WEST AFRICA

PAUL S. MARLEY. ABOUBACAR TOURE, J.A.Y. SHEBAYAN[3], D.A. ABA"
A.O. TOURE, A.G. DIALLO[b] and S.O. KATILE[b]

"Institute for Agricultural Research! Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Samaru Zaria, Nigeria;"Institut D'Economic Rwale (lER).Sotuha Station, BP 262 Bamako, Mali

(Received 10 October 2003)

Fourteen elite sorghum lines were evaluated for their resistance to *Striga hernumthica* at three locations in Nigeria and Mali. Results showed that many of the lines especially MALISOR 84-1, SAMSORG 41, 97-SB-F5DT-64 (Keninkcdie) and the check SRN 39 remained resistant to *Striga* in all locations with low emerged *Striga* counts, while SAMSORG 14 had the highest *Striga* infestation in all locations. Considerable variation in reaction to *Striga* infestation was observed on Seguetana, 97-SB-F5DT-63 (Wasa), 97-SB-F5DT-65, CMDT 38, CMDT 39 and CMDT 45 which were susceptible lo *Striga* at Samaru, Nigeria but were resistant to *Striga* at both locations in Mali. Based on low *Striga* resistance and high grain yield, lines MALISOR 84-1, SAMSORG 41, 97-SB-F5DT-64, 97-SB-F5DT-65, CMDT 39 and SAMSORT 14 have been nominated for wider evaluation across more West African countries.

Keywords: Striga hermontihica; Resistance; Sorghum; West Africa

INTRODUCTION

Striga hermonthica, a parasitic witchweed is endemic in the African savannas where it parasitizes cultivated crops such as sorghum (*Sorghum bicolour* [L.] Moench), rice (*Oryza sativa* L.), hungry rice (*Digitaria exilis* L.), millet (*Pennistum glaucum* L.), maize (*Zea mays* L.), sugarcane (*Saccharum officinarum* L.) as well as pasture and wild grasses (Salle *et al.* 1987; Obilana and Ramaih 1992; Weber *et al.* 1995).

It is the dominant parasitic weed species in the West African savanna occurring in ecological zones extending from latitude 7–18°N (Hess and Ejeta 1987; Lagoke 1988). It is one of the major threats to cereal production where severe damage can cause total crop loss in farmers' fields particularly under low fertility conditions (Haussman *et al.*, 2000). In other parts of WCA especially Burkina Faso, Niger and Mali where drought is prominent, it remains the main biotic constraint to sorghum and millet production (Debrah 1994; Mullen *et al.*, 2003). Yield losses in these areas, particularly under

*Corresponding author: Institut fur Pflanzenproduktion und Agrarokologie in den Tropen und Subtropen Universitat Hohenheim (380), D-70593 Stuttgart, Germany.

ISSN 0323-5408 print; ISSN 1477-2906 online © 2004 Taylor & Francis Ltd
DOI: 10.1080/03235400410001662157

drought conditions may be very high, between 90–100% (Haussmann *et al.*, 2000; Hess *et al.*, 2002; Marley *et al.*, 2002).

Management approaches for control of *Striga* in the region are generally based on cultural control strategies such as trap cropping, appropriate rates of fertilizer and suitable herbicide application, hand pulling and hoe weeding (Gurney *et al.*, 1995; Kureh *et al.*, 1999; Kuchinda *et al.*, 2003) and host plant resistance (Kim 1994; Lagoke *et al.*, 2000; Showemimo *et al.*, 1998; Showemimo 2002) where available. Recently, the national research programmes of Mali and Nigeria under the auspices of International Sorghum and Millet CRSP collaborated in the exchange of sorghum germplasm identified to have resistance or tolerance to *S. hermonthica* in their respective countries. The need for exchange of these germplasm arose on the important continuous need to identify, develop and release sorghum varieties resistant to *S. hermonthica*. This paper presents results on joint trials conducted in Mali and Nigeria to determine the response of selected genotypes to *S. hermonthica* infestation.

MATERIALS AND METHODS

The trials were conducted on Striga sick plots in both countries in 2001 and 2002. In Nigeria, the trial was conducted at Institute for Agricultural Research, Samaru, Zaria (Northern Guinea Savanna; 11°11′ N; 7°38′ E). Fourteen sorghum elite lines were used in the trial. The site of the trial during each year was harrowed twice and ridges made 0.75 m apart. Sorghum seeds were planted 50 cm apart. At planting, each hill was further inoculated with about 3000 germinable striga seeds (Lagoke *et al.*, 2000) using a calibrated scoop in order to provide uniform Striga seed infestation as suggested by Vasudeva Rao (1985). The trial was planted in a randomised complete block design with two replications. Each plot consisted of two ridges, 5 m long. Spot application of fertilizer was carried out at the rate of 90 kg N ha^{-1}, 45 kg P_2O_5 ha^{-1} and 45 kg K_2O ha^{-1} to sorghum using 15-15-15 N-P-K compound and Urea at three and six weeks after sowing (WAS).

In Mali, the trials were carried out in Striga sick plots by the Institut d'Economie Rurale (IER). Cultivars were evaluated systematically in the main sorghum research stations (Sotuba 12°39′ and Cinzana 13°17′). The sites of the trials were harrowed twice and ridged 0.75 m apart and sorghum plants planted at 50 cm apart.

The trial was planted in a randomised complete block design with two replications. Each plot consisted of two ridges, 5 m long. Spot application of fertilizer was carried out at the rate of 90 kg N ha^{-1}, 45 kg P_2O_5 ha^{-1} and 45 kg K_2O ha^{-1} to sorghum using 15-15-15 N-P-K compound and Urea at three and six WAS.

Data obtained were subjected to analysis of variance (ANOVA) to determine significant differences among the various genotypes using GENSTAT 5 (Release 3.2; Rothamsted Experimental Station, Harpenden, UK).

RESULTS AND DISCUSSION

The sorghum varieties evaluated differed significantly in their reaction to *Striga* and subsequent performance in the various locations. Many of the lines especially Malisor 84-1, SAMSORT 41, Keninkédié and the check SRN 39 remained resistant to *Striga* in all locations with low emerged *Striga* counts (Table I), while SAMSORG 14 had the

highest *Striga* infestation in all locations. The resistant varieties supported low *Striga* infestation and also had a low number of stands infested with *Striga* (data not shown). In each location and between the locations, genetic variation for resistance among elite sorghum lines occurred. We consider this an expression of partial or adult plant resistance usually associated with horizontal resistance. Despite heavy *Striga* seed inoculation and susceptible reactions in other sorghum lines, this type of resistance was characterized by reduced *Striga* epidemic build up in the field. This phenomenon has been observed on other sorghum lines such as SSV 4 and KSV 4 (Showemimo, 2002). He suggested that this type of mature plant resistance to *Striga* could likely be improved upon by conventional breeding methods. Further, similar observations have been reported by Dixon and Parker (1984), Obilana (1984), Hess *et al.* (1992), Ejeta and Butler (1993) and Showemimo *et al.* (1998).

Considerable variation in reaction to *Striga* infestation was observed on Séguétana, Wasa, 97-SB-F5DT-65, CMDT 38, CMDT 39 and CMDT 45 which were susceptible to *Striga* at Samaru, Nigeria but are resistant to Striga in Mali (Table I). These lines especially CMDT 45 were particularly selected for resistance to *Striga* in Mali. The behaviour of these lines support various suggestions on the existence of several races of *S. hermonthica* (Kim 1984; Lagoke *et al.*, 1991) within West and Central Africa making the search for *Striga* resistant sorghum lines with acceptable grains and yield across the region an extremely difficult task.

TABLE 1. Sorghum varietal response to *Striga hermonthica* infestation at three locations (Samaru, Nigeria; Sotuba & Cinzana, Mali) during 2001 and 2002 cropping seasons in West Africa

	Striga *stand count*[a]*/plot*[b] *at harvest*			
Sorghum cultivars	*Samaru*[c]	*Samaru*[c]	*Sotuba*[c]	*Cinzana*[c]
MALISOR-84-1	7	2	2	1
SAMSORG-41	1	4	4	1
MALISOR-92-1	2	5	7	2
SEGUETANA	10	9	0	1
97-SB-F5DT-63	2	13	4	1
CE-151-202-A1	8	7	7	3
CMDT-38	22	17	1	1
97-SB-F5DT-65	6	11	5	1
CMDT-45	28	12	3	1
97-SB-F5DT-64	1	7	5	1
N'TENIMISSA	5	13	5	2
SRN-39	1	4	4	1
SAMSORG-14	22	23	20	30
CMDT-39	18	12	3	1
KP-33-2	–[d]	–	2	4
SARIASO-1	–	–	8	4
SARIASO-2	–	–	8	4
IS-7777	–	–	0	2
Mean	9.5	10.071	5.519	1.907
CV (%)	25.76	31.39	52.86	31.81
Significance	**	**	**	**

[a]Data are averages of two replications per location.
[b]Plot size was 1.5 m wide × 5 m long.
[c]Locations where the trials were conducted in 2001.
[d]Locations where the trial was repeated in 2002.
[e]Sorghum lines not evaluated.

Grain yield was also variable among the elite lines. SAMSORG 14 gave the highest yields at Samaru in the two years tested followed by SAMSORG 41, MALISOR 92-1 and MALISOR 84-1 while CMDT 38 gave the lowest grain yield (Table II). At Cinzana, MALISOR 84-1 gave the highest grain yield followed by SAMSORG 41 and MALISOR 92-1 while SAMSORG 14 and CMDT 39 gave the lowest grain yield. At Sotuba, CMDT 39 was the highest grain yielder followed by SEGUETANA, 97-SB-F5DT-65, MALISOR 92-1, SAMSORG 41 and CMDT 38. SAMSORG 14 is a medium maturing sorghum line and under good moisture conditions as exists in Samaru compared to the other locations, gave consistently the highest grain yield although under highest *Striga* infestation among the lines. The results in Nigeria are consistent with other reports e.g. Lagoke *et al.* (2000) and Showemimo (2002) which show this cultivar to always have high *Striga* infestation, but give high grain yield. We consider that SAMSORG 14 (KSV 8) exhibits tolerance to *Striga* infestation. However, in Mali, SAMSORG 14 also had the highest *Striga* infestation but gave lowest grain yield. The low yield obtained from SAMSORG 14 in Mali indicates that the tolerance observed in Nigeria breaks down and it becomes susceptible to *Striga* infestation.

In conclusion, based on low *Striga* resistance and high grain yield MALISOR 84-1, SAMSORG 41, Keninkédié, 97-SB-S5DT-65, CMDT 39 and SAMSORG 14 lines have been nominated for wider evaluation across many West African countries. We find the

TABLE II. Some agronomic characteristics and yield of 18 sorghum varieties under *Striga hermonthica* infestation at three locations (Samaru, Nigeria; Sotuba & Cinzana, Mali) during 2001 and 2002 cropping seasons in West Africa

			Yield kg/ha at harvest[a]			
Sorghum cultivars	*Average[a] 50% Flowering*	*Average[a] plant height (m)*	*Samaru*[b]	*Samaru*[c]	*Sotuba*[b]	*Cinzana*[b]
MALISOR-84-1	66	1.85	1126	2122	1156	1556
SAMSORG-41	65	2.00	1621	2089	1578	1556
MALISOR-92-1	71	1.78	1213	2358	1600	1556
SEGUETANA	78	3.20	713	507	1867	1481
97-SB-F5DT-63	72	3.42	317	378	1466	1481
CE-151-202-A1	73	1.27	1099	1489	1311	1407
CMDT-38	73	3.34	389	369	1533	1185
97-SB-F5DT-65	74	3.10	775	686	1680	1185
CMDT-45	73	3.54	728	626	1200	1037
97-SB-F5DT-64	72	3.00	317	964	1400	1037
N'TENIMISSA	74	3.42	755	401	1466	963
SRN-39	64	1.20	1152	1629	1089	889
SAMSORG-14	82	2.81	2788	2873	377	815
CMDT-39	74	3.31	785	916	2000	667
KP-33-2	60	0.94	NE[d]	NE	622	709
SARIASO-1	87	3.36	NE	NE	2004	593
SARIASO-2	89	3.21	NE	NE	1600	222
IS-7777	NA[e]	NA	NE	NE	NE	148
Mean	73	2/63	984	1243	1333	1027
CV (%)	7.86	4.77	29.97	32.74	34.81	46.35
Significance	**	**	**	**	**	**

[a]Data are averages of two replications per location.
[b]Locations were the trials were conducted in 2001.
[c]Location where the trial was repeated in 2002.
[d]Sorghum lines not evaluated across all locations hence are not discussed.
[e]Data not available.

number of emerged *Striga* plants and grain yield among the most important traits in screening sorghum genotype performance under *Striga* infestation and these trials show the availability of some sorghum lines with multilocational resistance to *Striga* infestation in both countries.

Acknowledgement

We wish to acknowledge technical assistance by Messrs M Ahmed, Ahmed Abdullrahman (Samaru) and Sidaty Mahamane Baby (Sotuba) and Amadou Tembely (Cinzana). Financial support for this study was received from the International Sorghum and Millet CRSP, USA.

References

Debrah, S.K. (1994) Socio-economic constraints to the adoption of weed control techniques: the case of striga control in the West African semi-arid tropics. *Int. J. Pest Man.*, **40**, 153–158.

Dixon, N.H. and Parker, C. (1984) Aspects of resistance or sorghum varieties to Striga species. In: *Proceedings of the 3rd International Symposium on Parasitic Weeds* (Parker *et al.* Eds). Aleppo, Syria, pp. 123–132.

Ejeta, G. and Butler, L.G. (1993) Host plant resistance to Striga. In: *Proceedings of International Crop Science Congress* (Buxton *et al.* Eds). Crop Science Society of America, Madison, WI, USA, pp. 561–569.

Gurney, A.L., Press, M.C. and Ransom, J.K. (1995) The parasitic angiosperm Striga hermonthica can reduce photosynthesis of its sorghum and maize hosts in the field. *J. Exper. Bot.*, **46**, 1817–1823.

Haussman, B.I.G., Hess, D.E., Welz, H.G. and Geiger, H.H. (2000) Improved methodologies for breeding striga-resistant sorghums. *Field Crops Res.*, **66**, 196–211.

Hess, D.E. and Ejeta, G. (1987) Effect of cultural treatments on infestation of Striga hermonthica (Del.) Benth. (Scrophulariaceae) on sorghum in Niger. In: H.C. Weber and W. Forstreuter (Eds). *Parasitic Flowering Plants. Proceedings of 4th International Symposium on Parasitic Flowering Plants*, Marburg, pp. 367–375.

Hess, D.E., Ejeta, G. and Traore, L.G. (1992) Selecting sorghum genotype expressing a quantitative biosynthetic trait that confers resistance to Striga. *Phytochemistry*, **31**, 493–497.

Hess, D.E., Kroschel, J., Traore, D., Elzein, A.E.M., Marley, P.S., Abbasher, A.A. and Diarra, C. (2002) Striga: Biological control strategies for a new millennium. In: *Sorghum and Millets Diseases*. (Leslie, J. Ed.) Iowa State University Press, Ames, Iowa, USA, pp. 165–170.

Kim, S.K. (1994) Breeding for tolerance and general resistance in maize. A novel approach to combating striga in Africa. In: *Improving Striga management in Africa. Proceedings of 2nd General Workshop of Pan African Striga Control Network (PASCON) 23–29 June, 1991*. (Lagoke, S.T.O., Hoevers, R., M'Boob, S.S. and Traboulisi, R. Eds). Nairobi, Kenya. FAO Accra, Ghana, pp. 168–176.

Kuchinda, N.C., Kureh, I., Tarfa, B.D., Shinggu, C. and Omolehin, R. (2003) On-farm evaluation of improved maize varieties intercropped with some legumes in the control of *Striga* in the Northern Guinea Savanna of Nigeria. *Crop Protection*, **22**, 533–538.

Kureh, I., Lagoke, S.T.O., Shebayan, J.Y., Elemo, K.A. and Philip, D. (1999) On-farm verification of agronomic packages for the control of Striga in sorghum. In: J. Kroschel, H. Mercer-Quarshie and J. Seuerborn (Eds). *Advances in parasitic weed control of Striga in Africa*. Margraf Verlag Weikersheim, Germany, pp. 189–196.

Lagoke, S.T.O., Kureh, I., Aba, D.A. and Gupta, S.C. (2000) Host plant resistance for striga control in sorghum-activities at IAR, Samaru, Nigeria. In: B.I.G. Haussman, D.E. Hess, M.L. Koyama, L. Grivet, R.F.N. Rattunde and H.H. Geiger (Eds). *Breeding for Striga resistance in Cereals*. Margraf Verlag Weikersheim, Germany, pp. 325–334.

Lagoke, S.T.O., Parkinson, V. and Agunbiade, R.M. (1991) Parasitic weeds and control methods in Africa. In: Kim S.K. (Ed.). *Combating Striga in Africa*. International Institute for Tropical Agriculture, Ibadan, Nigeria, pp. 3–14.

Marley, P.S., Diourte, M., Neya, A., Nutsugah, S.K., Sereme, P., Katile, S.O., Hess, D.E., Mbaye, D.F. and Ngoko, Z. (2002) Sorghum and Pearl Millet Diseases in West and Central Africa. In: *Sorghum and Millets Diseases*. Leslie, J. (Ed.). Iowa State University Press, Ames, Iowa, USA, pp. 419–426.

Mullen, J.D., Taylor, D.B., Fofana, M. and Debe, D. (2003) A bio-economic model of long-run Striga control with an application to subsistence farming in Mali. *International Journal of Pest Management*, **4949251**–264.

Salle, G., Dembele, B., Reynals-Roques, A., Hallais, M.F. and Tuquet, C. (1987) Biological aspects of Striga species, pest of food crops. In: H.C. Weber and W. Forstrenter (Eds). *Parasitic Flowering Plants. Proceedings of 4th International Symposium on Parasitic Flowering Plants*. Marburg, pp. 719–731.

Showemimo, F.A. (2002) Evaluation of sorghum lines for Striga resistance. *Tropical Agriculture*, 79,(4), 237–240.
Showemimo, F.A., Asiribo, E.O., Alabi, S.O., Echekwu, C.A. and Yeye, M.Y. (1998) Screening sorghum varieties for resistance to Striga [*Striga hermonthica* (Del.) (Benth.)]. *Nigerian Journal of Botany*, 11, 133–137.
Vasudeva Rao, M.J. (1985) *Techniques for screening sorghum for resistance to Striga*. ICRISAT Information Bulletin No. 20. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patnacheru, A.P. India, p. 18.
Weber, G.K., Elemo, K.A., Awad, A., Lagoke, S.T.O. and Oikeh, S. (1995) *Striga hermonthica* in cropping systems of the northern Guinea Savanna. *Resource and Crop management Monograph* No. 19. International Institute of Tropical Agriculture, Ibadan, Nigeria.