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Efficacy of *Fusarium* based mycoherbicide formulation against *Striga hermonthica* in sorghum

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ABSTRACT: Efficacy of a *Fusarium oxysporum* based mycoherbicide formulation (Pesta) was evaluated under field condition in a trial conducted in 2005 and 2006 cropping seasons. The mycoherbicide, spot- applied at 2g formulation per hill significantly reduced *Striga* count, infested crop stand (incidence) and increased number of wilted *Striga* plant, plant height, panicle and grain yield in both local and improved Sorghum varieties as compared with the same variety not treated with the mycoherbicide. The result demonstrated the efficacy of the granular formulation of *Fusarium* based mycoherbicide.

Key words: *Striga* control, biological control, mycoherbicide formulation, *Fusarium oxysporum,* Sorghum, Nigeria.

Introduction

Striga hermonthica (Del.) Benth, a parasitic weed commonly known as witch weed, is a major biotic constraint to cereal production in West and Central Africa where many local and improved crop varieties are susceptible to the parasite (Lagoke *et al*., 1991; 2000; Kuchinda *et al*., 2003; Marley *et al*., 2005). Yield reduction caused by *Striga hermonthica* can be up to 79% even under good management (Lagoke *et al*., 1997) and this can be worst on the fields of resource poor farmers. Heavy *Striga* infestation, particularly under drought and low fertility conditions may lead to 100% yield loss (Haussman et al., 2001; Lagoke *et al*., 1991).

Sorghum bicolor (L.) Moench is a major staple cereal crop in West and Central Africa, where it is used mainly for human consumption, as well as an industrial raw material in the production of alcoholic and non-alcoholic beverages, live stock feeds and sweeteners (Ogungbile and Marley, 2001).

Several control measures against *Striga* are in existence such as crop rotation, land fallowing, trap cropping, weeding, use of fertilizers, resistant / tolerant varieties, use of herbicides, stimulation of suicidal germination and biological control (Obilana and Ranah, 1992; Crasky and Berner, 1995; Lagoke *et al*., 1997; Haussman *et al.*, 2001).

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The potential of using fungi for biocontrol of *Striga* was emphasized by Musselman (1983) and has since generated research interest. In Nigeria, surveys by Zunmo (1997), Adeoti (1993) and Weber et al. (1995) have shown that *Fusarium equiseti, Cercospora, Fusarium, Phoma, Alternaria and Macrophomina* spp. are associated with *Striga*. The potential of *Fusarium oxysporum* grown in grain sorghum as a biocontrol agent for the control of *Striga hermonthica* has been reported (Krocshel et al., 1996; Abbasher et al., 1998; Marley et al., 1999; Marley and Shebayan, 2005). Isolates of *Fusarium oxysporum* from *Striga hermonthica* have been shown to infect only *Striga* spp and no other crops or vegetables (Abbasher et al., 1998; Elzein, 2003; Marley and Shebayan, 2005)

The development of *Fusarium oxysporum* into a mycoherbicide in liquid and/ or granular formulation and their evaluation for efficacy under screen house and field conditions have been emphasized (Hess *et al.*, 2002). The present study evaluates the efficacy of a granular mycoherbicide formulation under field condition.

Materials and Methods

A field experiment was carried out at the Institute for Agricultural Research at Samaru Zaria, Nigeria (11o 11'N; 7o 38'E) in the 2005 and 2006 cropping seasons to determine the efficacy of pesta mycoherbicide formulation. A Striga-infested plot that have been developed and used for over five years was used. Two Sorghum varieties, local (farafara) and improved (SK5912) were used.

There were four treatments as follows: *Striga* susceptible variety with pesta; *Striga* susceptible variety without pesta granules; *Striga* resistant variety with pesta and *Striga* resistant variety without pesta granules. The treatments were arranged in a randomised complete block design with four replications. Each plot consisted of five ridges, 5m long with buffers between plots of one ridge or 1m spaces.

Data were collected from three inner rows to minimize border effects and the following observations were recorded: Sorghum stand counts at 9 weeks after sowing (WAS); *Striga* shoot count at 9, 12 WAS and at harvest, number of stands infected by *Striga* at 9, 12 WAS and harvest, number of *Striga* plants showing dieback at harvest; number of flowering *Striga* plants at harvest; *Sorghum* plant height at 9,12 WAP and at harvest, while panicle dry weight and grain yield at harvest were recorded on 10 randomly selected plants from the three inner rows. Data collected were subjected to combined analysis of variance (ANOVA) and means were separated using Students-Newman-Keuls Test (SNK)

Results and Discussion

Table 1 showed that, there were no significant differences among the treatments in respect to *Striga* count at 9 WAS and crop stands infested with *Striga* at 9 WAS.

Striga count at 12 WAS and at harvest was significantly higher in local sorghum sown without the mycoherbicide. Low Striga count using *Fusarium oxysporum* was reported by Marley *et al.*(1999), Ciotola *et al.*(1995; 1999) and Marley and Shebayan (2005). Reduction of *Striga* count of up to 92% using *Fusarium oxysporum* isolate M12-4A was reported by Ciotola *et al*. (2000). Number of crop infested with *Striga* at 12 WAS and at harvest were significantly higher in local than in improved sorghum. In the two varieties, there was no significant difference between plots sown with or without mycoherbicide both at 12 WAS and harvest. Marley and Shebayan (2005) made a contrary report when they recorded significantly fewer stands infested with *Striga* in mycoherbicide treated plots.

Table 2 showed that, there were no significant differences among the treatments in respect to crop stand at 3 and 9 WAS and plant height at 9 WAS. Marley and Shebayan (2005) also reported non significant differences between plots treated with *Fusarium oxysporum* isolate PSM 197 mycoherbicide and the untreated plots in respect to stand count at 3WAS. However, they reported significant decrease in stand count in the untreated plots at harvest. Plant height at 12 WAS and at harvest was significantly higher in local sorghum sown with the mycoherbicide. This was followed by local sorghum sown without the mycoherbicide.

Table 1: Effect of pesta mycoherbicide formulation on *Striga* plant

Treatment	*Striga* stand count at			Crop stands infested with *Striga* at			*Striga* die back at		
	9 WAS	12 WAS	Harvest	9 WAS	12 WAS	Harvest	9 WAS	12 WAS	Harvest
Farafara + pasta	0.75a	35.25b	72.25b	0.50a	12.75a	28.50a	1.25a	11.00a	18.75a
Farafara sorghum only	3.75a	70.75a	136.25a	3.25a	18.50a	41.00a	0.00a	0.5b	2.00c
SK 5912 + pasta	0.25a	7.00b	15.75b	0.25a	3.00b	9.00b	10.50a	4.50b	10.00b
SK5912 only	0.50a	8.25b	17.25b	0.25a	3.25b	10.00b	0.00a	0.25b	0.75c
Interaction (T*Y)	Ns	ns	ns	ns	ns	ns	ns	ns	ns

*Values in each column carrying the same letter(s) are not different (P= 0.05) from each other using Student-Newman-Keuls Test (SNK)
ns = not significant (P = 0.05)

Table 2 Effect of pesta mycoherbicide formulation on Sorghum host plant

Treatment	Plant height (cm) at			Plant count at 9WAS	Panicle dry weight/plant (kg)	Grain yield (kg/plot)
	9 WAS	12 WAS	Harvest			
Farafara + pasta	133.18a	180.13a	226.75a	96.75a	4.03a	2003.2a
Farafara sorghum only	127.48a	153.13b	188.6b	101.50a	2.93b	1099.2b
SK 5912 + pasta	119.63a	132.88c	149.30c	90.75a	3.20b	1909.3a
SK 5912 only	10453a	117.13c	137.85c	94.25a	2.53b	1460.1b
Interaction (T*Y)	ns	ns	ns	ns	ns	Ns

*Values in each column carrying the same letter(s) are not different (P= 0.05) from each other using Student-Newman-Keuls Test (SNK)
ns = not significant (P = 0.05)

The improved sorghum sown without the mycoherbicide had the shortest plants although they were not significantly different from those sown with pesta. *Striga* plants with die-back were highest in plots sown with local sorghum along with pesta, which was significantly higher than all the other treatments both at 12 WAS and at harvest. All the other treatments were not significantly different from each other at 12 WAS. At harvest, however, plots sown with improved sorghum and pesta were significantly higher than both local and improved sorghum sown without pesta. Similar results were reported by Marley and Shebayan (2005). The number of flowering *Striga* plants was significantly higher in local than in improved sorghum irrespective of pesta or non-pesta usage.

Panicle dry weight was highest in local sorghum sown with pesta compared with the other treatments, which did not differ from each other.

Grain yield was significantly highest in sorghum sown with pesta irrespective of variety. Among the plots sown without pesta, improved sorghum gave higher grains yield than local sorghum. Similarly, higher grain yields were recorded in mycoherbicide treated plots than the non-treated control at Bagauda and Samaru in an earlier trial (Marley and Shebayan, 2005).

The pesta formulation of *Fusarium* based mycoherbicide being evaluated has great potential since it gave similar results with grain sorghum used earlier as carrier indicating that pesta formulation process is not detrimental to the fungus. Also pesta is less bulky and its application and other handling (transportation, packaging, storage) are simpler than when the carrier is grain sorghum.

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References

Abbasher, A.A., D. E. Hess and J. Sauerborn 1998. Fungal pathogens for biological control of *Striga hermonthic*a on sorghum and pearl millet in West Africa. *African Crop Science Journal*.6: 179 – 188.

Adeoti, A.A. 1993. Fungi associated with *Striga hermonthica. Striga* Newsletter 4 (July), 9.

Crasky, R. J. and D.K. Berner 1995. Benefits of crop rotation with soyabean and cowpea in savanna cereal-based system. SAFGRAD Regional workshop on technology options and transfer systems for Food and grain production in Sub-Saharan Africa, April 26 – 28, Abidjan, Cote D′Ivoire 1995, pp 78 – 81

Ciotola, M., A. K. Watson and S. G. Hallet 1995. Discovery of an isolate of *Fusarium oxysporum* with potential to control *Striga hermonthica* in Africa. *Weed Research* 35: 303 – 309.

Ciotola, M., Diarra, C., Watson, A. k. and S. G. Hallet 1999. Fusarium oxysporum isolate M12-4A controls *Striga hermonthica* in the field in West Africa, in Proceedings of the IX International Symposium on Biological Control of Weeds, South Africa, 19 – 26 January, p. 508.

Ciotola, M., A. Ditommaso and A. K. Watson 2000. Chlamydospore production, inoculation methods and pathogenicity of *Fusarium oxysporum* M12-4A, a biocontrol for *Striga hermonthica*. *Biocontrol Sciences Technology*. 10: 129 - 145

Elzein, A. E. M., 2003. Development of granular mycoherbicidal formulation of *Fusarium oxysporum* Foxy2 for the biological control of *Striga hermonthica* (Del.) Benth. In: J. Kroschel (ed) Tropical Agriculture: Advances in Crop Research 2. Margraf Verlag. Weikersheim, Germany. 174pp.

Haussman, B.I.G., Hess, D.E., Omanya, G.O., Reddy, B.V.S., Welz, H. G. and H.H. Geiger 2001. Major and minor genes for stimulation of *Striga hermonthica* seed germination in Sorghum and interaction with different *Striga* population. *Crop Science*. 41 (5): 1507 – 151

Hess D.E., J. Kroschel, D. Traore, A.E.M. Elzeim, P.S. Marley, A.A.Abbasher and C. Diarra 2002 *Striga*: Biological control strategies for a new millennium. **In**; J.F.>Leslie(ed) Sorghum and millet Diseases 2000. Iowa State University Press Iowa, USA. Pp 165 – 170

Kuchinda, N.C., I. Kureh, B. D. Tarfa , C. Shinggu and R. Omolehin 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

Krocshel,J. A. Hundt, A.A.Abbasher and J. Sauerborn 1996. Pathogenicity of Fungi collected in Northen Ghana to *Striga hermonthica*. Zeitschift fur pfiankrankh and pflanschutz Sonderh XV: 389-395

Lagoke, S.T.O., Parkinson, V., Agunbiade, R.M. 1991. Parasitic weeds and control methods in Africa. In: Kim, S.K. (ed.). Combating *Striga* in Africa. Proceedings of the International workshop organized by IITA, ICRISAT and IDRC, August 22 – 24, IITA, Ibadan, Nigeria, 1998, pp. 5 –14.

Lagoke, S.T.O., J.Y. Shebayan, I. Magani, P. Olorunju, O.O Olufajo, K.A. Elemo, I. Uvah, A. A. Adeoti, P. S. Chindo, I. Kureh, S. Jatau, A.M. Emechebe, W.B. Ndahi, S. K. Kim, G. Webber, B. B. Singh, C. Odion & V. Avav 1997. *Striga* problem and development of appropriate control Technologies in various crops in Nigeria. In: *Integrated Management of Striga for the African Farmer, Proceedings, 3rd General Workshop of the Pan-African Striga Control Network (PASCON),* Lagoke, S.T.O., L.E. van der Straten and S.S. M'Boob (eds), 1997. 18-23 October 1993, Harare, Zimbabwe. 157 pp.

Lagoke, S.T.O., I. Kureh, D.A. Aba and S.C. Gupta.2000. Host plant resistance for *Striga* control in Sorghum: Activities at IAR, Samaru, Nigeria. In: B.I.G. Haussman, D.E. Hess, M.I. Kayoma, L. Grivet, H.F.W. Ratunde and H.H. Geiger (eds.). *Breeding for Striga Resistance in Cereals*. Margraf Verlag, Germany, pp.325-334.

Marley, P.S., S.M. Ahmed, J.A.Y. Shebayan, and S.T.O. Lagoke, 1999. Isolation of Fusarium oxysporum with potential for biocontrol of the witchweed (*Striga hermonthica*) in the Nigerian Savanna. *Biocontrol Science and Technology* 9:159-163.

Marley, P.S. and J.A.Y. Shebayan. 2005. Field assessment of *Fusarium oxysporum* based mycoherbicide for control of *Striga hermonthica* in Nigeria. *Biocontrol*.50: 389-399.

Musselman, L.J. 1983. A need for consideration of Biocontrol in *Striga*. Proceedings of the second International Workshop on *Striga*, 5-8 October 1981. Ramah. K.V. and Vaudeva Rao, M.J., (eds.), IDRC/ICRISAT, India, pp109-110.

Obilana, A.T. and Ramah. K.V.1992. Striga (witchweed) in sorghum and millet: Knowledge and future research needs. *In*: De Milliano, W.A.J. Fredericksen, R.A. and Bengson, G.D. (eds.) *Sorghum and Millet Diseases: a second world review*. ICRISAT, India, pp987-201.

Ogungbile, A.O. and P.S. Marley.2001. Industrial utilization of cereals; The case of sorghum and maize. **In**: *Agricultural Technology Transfer and Commercialization in Nigeria*. Proceedings of the OAU/STRC-SAFGRAD/IITA/USAID stakeholders' consultation workshop held at IITA, Ibadan, Nigeria. 9-11 April 2001. pp 59-72.

Weber, G.K., K.A. Elemo, A. Awad, S.T.O. Lagoke and S. Oikeh. 1995. *Striga hermonthica* in cropping systems of the Northern Guinea savanna. *Resource and Crop management Monograph* No. 19. IITA, Ibadan, Nigeria.

Zummo, N. 1997. Disease of giant witchweed, *Striga hermonthica* in West Africa. *Plant Disease Reporter* 61: 428-430.