RESEARCH ARTICLE

Evaluation of Sorghum Genotypes for Tolerance to *Striga hermonthica* (Del.) Benth. (Lamiales: Orobanchaceae) and Yield in the Rain Fed Areas of Damazin, Sudan

Evans Jimmy Kenyi[1*], Abdel Gabbar El Tayib Babikri[2], Siraj Mohammed Omer[3], Philip Wani Marchelo-D'Ragga[4*]

[1]Dr. John Garang Memorial University of Science and Technology, Juba South Sudan
[2]University of Sudan, Shambat, College of Agricultural Studies, Research Centre and Soil Laboratory, Khartoum Sudan
[3]Agricultural Research Corporation, Wad Medani, Sudan
[4]University of Juba, Department of Agricultural Sciences, College of Natural Resources and Environmental Studies, Juba, South Sudan

[*]**Address for Correspondence:** Dr. Philip Wani Marchelo-D'Ragga, Professor, Department of Agricultural Sciences, University of Juba South Sudan

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ABSTRACT- A field trial comprising eight sorghum varieties (as treatments) arranged in a randomized complete block design with four replicates was conducted in a *Striga* infested plot for two consecutive seasons (2006/07 and 2007/08) at Damazin (Lat. 11° 47' N, Long. 34° 21' E); Agricultural Research Station farm in the Sudan. The objectives of the trial were to determine resistance, tolerance and susceptibility of five sorghum genotypes on the basis of the population of *Striga* plants and grain yield of the crops. The five sorghum genotypes namely Wad Ahmed, Arfa Gadamak, Sham sham, Korokolo, and Moheireiba were compared to *Striga* population and sorghum grain yield with those of SRN 39, Um Bineine 7 and Tabat. Sorghum cultivars: SRN 39, Um Bineine 7 and Tabat were the *Striga* resistant, tolerant and susceptible checks respectively. Soil type of the trial was predominantly vertisol with decreasing nitrogen and organic matter contents corresponding to the consecutive seasons 2006/07 and 2007/08 during which the trial was conducted. Results obtained from correlating the population of *Striga* plants with sorghum grain yield of the various tested sorghum genotypes (Wad Ahmed, Arfa Gadamak, Sham sham, Korokolo and Moheireiba) with the checks showed that Wad Ahmed, Korokolo and Moheireiba were resistant, while Arfa Gadamak was tolerant to the parasite [*Striga hermonthica* (Del.) Benth].

Key-words- Cultivars, Resistance, Sorghum (*Sorghum bicolor*), Susceptibility, Tolerance, Witch weed (*Striga* sp.)

INTRODUCTION

Sorghum ranks second to maize as the most important cereal in Africa and it is the most consumed grain in the Sudan [1,2]. The crop is used as human food by grinding the grain to powder for making porridge and bread. In some African countries, including parts of Sudan, it is brewed for making local beer. The grain is also used as feed for livestock and the stalks provide safe green and dry fodder.

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Among the serious weeds infesting sorghum, *Striga* (witch weed) has become the most important parasitic weed in the production of major cereals such as millet, maize and sorghum. More than 50% of the total cereal production in the sub-Saharan Africa is estimated to be infested with *Striga* [3,4]. In the Sudan, Musselman and Riley [5] distinguished *Striga* especially *S. hermonthica* (Del.) Benth as a national pest. Sauerborn *et al.* [6] Was of the opinion and suggested that the severity of the parasite was associated with the abandoning of the traditional cropping system which included prolonged fallow, crop rotation and intercropping that kept the parasite at tolerable levels. The rapid increase in World population invites more food consumption from expected high production through intense land use in cereal mono cropping, which is a recipe for *Striga* development and spread. Also, drought in the rain fed sector without supplementary irrigation remedy aggravates *Striga* infestation [4].

Losses of sorghum due to *Striga* are usually high but vary with crop genotype and levels of parasite infestation. Annual losses due to *Striga* have been estimated at 40% [7]. however, in countries like Ethiopia and Sudan, about 65–100% losses have frequently been experienced in the field. Based on the reasons above, there is justification to control *Striga*. Many control measures have been tried some with success, but can't sustain due to high cost. Therefore, there was a need to explore other *Striga* control measures, which were suitable for the low income sorghum producers whose crop suffers from the effects of *Striga*.[8] Observed that the population of *S. hermonthica* (Del.) Benth varied in different sorghum cultivars. Variation in *Striga* infestation of a crop could be attributed to resistance or tolerance or susceptibility characteristics. [9] related *Striga* resistant to sorghum type, which supported fewer *Striga* plants and produced higher crop yield compared to susceptible ones, whereas *Striga* tolerance to the crop which supported as many *Striga* plants as susceptible sorghum without a proportionate reduction in productivity. Contrary to *Striga* resistant and tolerant sorghum, susceptible sorghum to *Striga* is the crop which supports very many *Striga* plants and produces very low crop yield. In most sorghum producing areas including the Sudan, studies on the reaction of *Striga* with many un-improved sorghum genotypes grown by peasants are scarce and neglected. Therefore, this study was incepted to objectively identify sorghum genotypes with reduced *Striga* infestation and damage to sorghum grain yield as a cost effective management strategy to combat the debilitating effects of this parasitic plant.

MATERIALS AND METHODS

Location and experimental materials

A field trial was conducted in a *Striga* infested plot for two consecutive seasons (2006/07 and 2007/08) at Damazin, (Lat.11º 47' N, Long. 34º 21' E) Agricultural Research Station farm in the Sudan. Eight sorghum varieties were used as treatments and the trial was laid in a randomized complete block design with four replications. The objectives of the trial were to evaluate five sorghum genotypes for resistance, tolerance or susceptibility to *Striga* through their effects on the parasite population and conversely, sorghum grain yield. The five sorghum genotypes were namely, Wad Ahmed, Arfa Gadamak, Sham sham, Korokolo and Moheireiba. They were selected because of their popularity with peasants across the Blue Nile State. Three sorghum varieties, namely, SRN 39, Um Bineine 7 and Tabat, which in previous studies were established as a resistant, tolerant and susceptible to *Striga*, were used as a check respectively.

Soils at the experimental site and land preparation

The soil on which the trial was conducted predominantly vertisol with nitrogen contents of 0.042 and 0.037(%) and organic matter 1.22 and 1.06 (%) assessed at 2006/07 and 2007/08 seasons, respectively. Rainfall was recorded for the same period (Table 1). The land was ploughed twice and leveled to ensure through mix of *striga* seeds with soil. Seeds of the sorghum varieties were dressed separately with Thiram 25% applied at 3 g/kg of seeds and were sown in holes spaced at 0.2 m along rows at the rate of about 5–6 seeds per hole, inter-rows spaced 0.8 m in sub plots measuring 2.4 m x 6 m on 12 July 2006 and 15 July 2007. Sorghum seedlings were later thinned to 2 plants/hole 3 weeks after emergence. The initial weeding of the seedlings was done immediately after thinning, however, in subsequent weeding operations; all the emerged witch weed plants were deliberately maintained.

Table 1: Monthly rainfall (mm) distribution and totals for the Years 2006 and 2007

Months	Rainfall (mm)	
	Year (2006)	Year (2007)
July	163.0	203.2
August	133.4	229.4
September	88.0	102.8
October	70.1	6.4
July-October Total	454.5	541.8

Statistical Analysis

Assessments of the trial were conducted in the area confined to the two sorghum middle rows of each subplot. Parameters assessed included population of witch weed plants 8 weeks after sorghum emergence and sorghum grain yield taken after harvest. The data were analyzed by the Statistical Analysis System (SAS) program separately and combined for the two seasons 2006/07 & 2007/08.

RESULTS AND DISCUSSION

Effects of sorghum genotypes on *Striga* population 8 weeks after sorghum emergence (WASE)

Table 2 below shows seasonal variations in *Striga* population. While there were no significant differences in *Striga* population in season 2006/07 significant differences (P=0 .01) were observed in seasons 2007/08 and 2006/07 and 2007/08 combined. Wad Ahmed, Korokolo and Moheireiba were each infested with Striga populations similar to those that infested SRN 39. However, *Striga* population was significantly (P=0.01) lower than in Tabat. On the other hand, Arfa Gadamak was infested with significantly (P=0.01) more *Striga* plants than those which infested SRN 39 but the level of infestation was similar to that in Um Bineine 7 or Tabat. With the exception of sorghum cultivar Sham sham a similar trend in *Striga* population were also observed for 2007/08 and for the combined seasons of 2006/07 and 2007/08. Wad Ahmed, Korokolo, Moheireiba and Sham sham were each infested with significantly (P= 0.01) fewer *Striga* plants than Tabat but the infestation levels were similar to that for cultivar SRN 39. On the other hand, the population of *Striga* plants that infested Arfa Gadamak Gadamak and Um Bineine 7 were similar.

Table 2: Population of *Striga* plants infesting sorghum 8 weeks after sorghum emergence (WASE)

Sorghum varieties	Population of *Striga* (plants/m²) in the Sorghum varieties		
	2006–2007	2007–2008	2006/07 and 2007/08 combined
Wad Ahmed	1.3 (1.26)	3.1 (1.87)bcd	2.2 (1.56)bcd
Arfa Gadamak	1.5 (1.34)	4.8 (2.31)ab	3.2 (1.82)abc
Korokolo	1.4 (1.32)	2.0 (1.56)cd	1.7 (1.44)bcd
Moheireiba	0.6 (1.05)	2.2 (1.59)bcd	1.4 (1.32)cd
Sham sham	0.1 (0.77)	4.1 (2.13)bc	2.1 (1.45)bcd
SRN 39	0.6 (1.01)	1.2 (1.30)d	0.9 (1.09)d
Um Bineine 7	2.5 (1.52)	5.4 (2.28)ab	4.0 (1.90)ab
Tabat	2.9 (1.70)	7.8 (2.86)a	5.4 (2.28)a
Sig. level	ns	**	**
SE ±	0.24	0.22	0.25
CV %	(43.2)	(22.4)	(30.5)

Means in a column followed by the same letters are not significantly different at 1% Ryan-Einot-Gabriel-Welsch Multiple Range Test (R-E-G-w MRT); Figures in parenthesis are transformed values to √(x + 0.5); ns= Not significant; (**)= Highly significant

Furthermore, Table 2 shows significant differences (P=0.01) in sorghum grain yield between sorghum genotypes for seasons 2006/07, 2007/08 and for both seasons combined. In season, 2006/07, grain yield from each of sorghum genotypes, Wad Ahmed, Korokolo and Moheireiba was either significantly (P=0.01) higher or similar to grain yield from SRN 39 or Tabat. On the other hand, Sorghum grain yield from genotypes Arfa Gadamak and Um Bineine 7 were similar. Tentatively, the same trend of results obtained above, were repeated in season 2007/08 and for both seasons combined.

Table 3: Grain yield of sorghum under *Striga* infestation

Sorghum varieties	Population of *Striga* (plants/m²) in the sorghum varieties		
	2006–2007	2007–2008	2006/07 and 2007/08 combined
Wad Ahmed	1172.4a	787.8a	980.1a
Arfa Gadamak	680.6bcd	706.3a	693.4bc
Korokolo	859.8abc	327.8cde	593.8c
Moheireiba	711.3bcd	472.8abcde	592.0c
Sham sham	169.5e	535.6abcd	352.6d
SRN 39	348.0de	289.9de	343.9d
Um Bineine 7	992.9ab	604.4abc	798.6ab
Tabat	465.0cde	222.7e	343.9d
Sig. level	**	**	**
SE ±	128.8	93.3	94.0
CV %	62.3	37.8	32.2

Means in a column having the same letters are not significantly different at 1% Ryan-Einot-Gabriel-welsch Multiple Range Test (R-E-G-w MRT); Values within brackets transform data to √(x + 0.5); **= Highly significant

All the sorghum genotypes tested influenced population of *Striga* variably between the two seasons (2006/07 and 2007/08). The variability in the population of *Striga* could be attributed to the generally low rainfall in 2006/07 which favored a significant development in *Striga*. This is in conformity with [10] findings to the point that leveled off variability of *Striga* population in all sorghum varieties; while lower soil fertility in 2007/08 (Table 1) promoted *Striga* development in accordance to the findings of Joel *et al.* [11] but at significantly different infestation levels in the various sorghum genotypes. The sorghum genotypes: Wad Ahmed, Korokolo, and Moheireiba that reduced population of *Striga* plants considerably, and resulted in high sorghum grain yield exhibited resistance to the parasite confirming the definition of resistance of sorghum to *Striga* [9]. On the other hand, sorghum genotypes namely, Arfa Gadamak and Sham sham which were infested with high populations of *Striga* plants but/ and produced high or low sorghum grain yields, were either tolerant or susceptible to *Striga* respectively, again confirming the definition of tolerant and susceptible sorghum *Striga* by Scientists mentioned above. Sorghum genotypes resistant or tolerant to *Striga* have anticipated being cost effective as *Striga* control tool for the poor sorghum producing peasants in Africa and Asia. Oswald and Ransom, [12]; Ezeaku and Gupta [13] noted that resistant/tolerant improved sorghum cultivars have not been widely cultivated because they were poorly adopted and have lower yield potential due to lack of certain required characteristics such as sorghum height or grain traits. Sorghum genotypes Moheireiba, Korokolo, Wad Ahmed and Arfa Gadamak were selected through the participation of the local peasants, who identified them as popular and accordingly, had already won the acceptance.

Similar or other related criteria for selecting sorghum resistance and tolerance to *Striga* may be adapted for implementation elsewhere as well.

CONCLUSIONS

On the bases of this study, we can conclude that sorghum genotypes Wad Ahmed, Korokolo and Moheireiba were resistant to *S. hermonthica* Del.) Benth, while Arfa Gadamak was tolerant to the parasite. Hence, it is recommended that farmers should grow the resistant genotypes namely, Wad Ahmed, Korokolo and Moheireiba and the tolerant genotype Arfa Gadamak. It is noteworthy that resistant sorghum cultivars are cost effective in the control of *Striga* in sorghum for the low income producers who may not afford costly *Striga* control measures. Although tolerant sorghum genotype Arfa Gadamak produced an acceptable grain yield, its support for a huge *Striga* population is unacceptable; hence its *Striga* buildup should be curtailed through other *Striga* control measures.

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