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Effects of Time and Level of Striga Infection on Pearl Millet Varieties in North Darfur

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Abstract

This study conducted to revise the interaction between the parasitic weed *Striga hermonthica* (Del.) and pearl millet (*Pennisetum glaucum*). The main objective of the study was to investigate the effects of time and level of *Striga* infection on the interaction between the host plant and parasite. (Dimbie) and the Ashana pearl millet varieties were grown in pots with and without seed infestation with Striga. Both pearl millet genotypes responded to infection by the *Striga* parasite, but it was evident that Dimbie was more strongly affected than Ashana pearl millet in plant height; final leaf number, green leaf area, and total dry weight which were significantly reduced by infection. The Ashana landrace showed significantly lower and delayed attachments of *Striga hermonthica* than the Dimbie cultivar, and this could be explained by a delay in the onset of attachments. *Striga hermonthica* infection had a stronger effect on the sensitive cultivar, although the parasite affected growth and dry matter allocation in both cultivars. The reduction in biomass production was accompanied by a relatively increased allocation of dry matter to the roots. It was observed that the pearl millet genotypes have different sensitivities to *Striga* infection. The tolerant millet variety Ashana is highly resistant to *Striga* infection while sensitive variety Dimbie is slightly resistant to the weed *Striga* infection and therefore the hypothesis is rejected. It is concluded that differences in root manner and the resulting early infection and higher *S. hermonthica* numbers are partly responsible for the stronger effects of the parasite on the Dimbie cultivar.

Key words: Pearl Millet, Striga hermonthica, Interaction, Parasitic

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Introduction

Pearl millet (*Pennisetum glaucum (L.) R. Br.*) Is the most commonly grown type of millet and accounts for almost half of global millet production? It is the sixth most important cereal globally and more than 90 million poor people rely on this crop for food and income (Taylor, 2016). In Eastern and Southern Africa, pearl millet is cultivated on about 2 million ha, with productivity ranging from 800 kg ha^{-1} to 920 kg ha^{-1} (Bhagavatula *et al*., 2013). Low and erratic rainfall, high temperatures, poor soil fertility among the abiotic stresses and downy mildew disease and widespread *Striga* infestation among biotic stresses, are the major constraints to the production of pearl millet. Parasitic weeds of the genus *Striga* (*Orobanchaceae*) strongly affect host crops such as sorghum (*Sorghum bicolor* (L.) Moench) pearl millet (*Pennisetum americanum* (L.) Beeke), maize (*Zea mays* L.) rice (*Oryza sativa* L.) and cowpea (*Vigna unguiculata* (L.) Walpers) and, as a consequence, they are important growth-reducing factors in crops in vast areas of the savannah zone in Africa (Parker and Riches, 1993). Differences in time of infection have been suggested as one of the possible causes behind these genotypic differences in response to parasite infection. Gurney *et al*. (1999) made a comparison between two cultivars of the cereal *Sorghum bicolor* (L.) Moench cultivar CSH-1 and the tolerant landrace Ochuti. They concluded that the time of parasite attachment might explain much of the variation in host tolerance (Van Ast *et al*., 2000). The recent research aimed to determine the role of time of infection on the subsequent interaction between host and parasite.

Material and Methods

In this study millet seeds of (Ashana) tolerant, (Dimbiee) sensitive obtained from Agricultural Research Corporation Elfasher, north Darfur, Sudan. *Striga hermonthica* seeds for these experiments were collected from pearl millet hosts at fields near Elfasher City. Plastic bags were sold from the local market. In the current experiment, a completely randomized block design was used with five blocks. Each block consisted of two factors (parasite and cultivar) at two levels. Within each block, each treatment was represented by 10 pots, resulting in a total of 200 (5 × 4 × 10) pots. Blocks were surrounded by border rows. Plants were grown in plastic bags 25X30 cm containing a mixture of sand and arable soil, collected from the top layer (0 - 0.25 m) of an arable field near the biological sciences lab, Faculty of Education, Alfashir University. Ten destructive harvests, in which a single pot per treatment was harvested per block, were carried out within the first 5 weeks after emergence of the millet plants at 3, 6, 10, 13, 17, 21, 25, 28, 32 and 35 Days After Emergence (DAE). For each harvest per treatment, one pot out of 10 was used from each block. Millet plants were dissected into leaf, stem and root, and green leaf area was determined.

Results and Discussion

The difference in attachments of the parasite between both cultivars was examined in this experiment, in which detailed observations on above- and belowground total dry weight of Pearl millet and *S. hermonthica* root attachments were made during the first 35 days after the emergence of Pearl millet. At 10 DAE of pearl millet, the first *S. hermonthica* attachments were observed on the roots of Dimbie, while for Ashana, the first attachments were seen at 17 DAE. The first emergence of the parasite was observed, at 32 DAE in Dimbie whereas at the end of this experiment (35 DAE) no Striga plants had emerged in pots with Ashana. Throughout the experiment, the number of attachments increased gradually for both cultivars but, for Dimbie, a higher number of attachments were always observed than for Ashana (data not shown). As both cultivars responded to a different extent to infection, at 35 DAE, reductions in total dry weight of 26% and 28% were found for Dimbie and Ashana, respectively. For the control plants, the total biomass accumulation of Dimbie at 35 DAE was again significantly lower than that of Ashana (Table 1). From data in table (1) clear difference was found in the total leaf area which was higher in Ashana recording 848 cm^2 but in Dimbie about 422cm^2 and it's half of that in Ashana, the infected Ashana plant species have biggest leaf area than that of Dimbie. The interaction of millet genotype x *Striga* effects was significant ($P > 0.05$) on leaf area (data not shown).

Table (1) parameter values of uninfected and infected Dimbie and Ashana Pearl millet cultivars from the final harvest (35 DAE).

Treatment	(Ashana)		(Dimbie)	
	Uninfected (control)	Infected	Uninfected	Infected
dry weight(g)	10.5	7.6	5.3	3.9
root length (m)	134.2	173	122.3	147.6
root dry weight(g)	3.81	3.18	1.25	1.65
leaf area(cm2)	848	680.3	611	422.3
Stem length(cm)	2.3	2.6	1.9	2.2
Leaf number	11	10	9	8
No. of *S. hermonthica* attachments /plant	----	9	----	14

Also, there were significant ($P < 0.05$) differences in leaf area amongst the two millet genotypes. A clear effect of *S. hermonthica* infection was observed on leaf development in Dimbie. Final leaf number and green leaf area were reduced by 9% and 30% respectively; despite the absolute reduction in green leaf area, for Ashana, most of these effects were smaller. In this cultivar, the total green leaf area was moderately (19%) reduced. The stem length for the uninfected species of Dimbie has a shorter stem giving about 1.9 cm, while in uninfected Ashana it was taller recording about 2.3 cm, the infected Ashana was recorded a higher stem length than that of uninfected Dimbie giving 2.6 and 2.2, respectively. The stem length of Ashana and Dimbie plants was reduced by 11% and 14%, respectively (Table 1). Dimbie variety has a lower leaf number than Ashana which were 9 and 11 respectively. The interaction of millet genotype x *Striga* effects was not significant ($P > 0.05$) on leaf number, while there were significant ($P > 0.05$) differences in leaf number amongst the two millet genotypes (Table data not shown).
The number of Striga attachments was significantly different ($P > 0.05$) amongst the millet genotypes. The *Striga* infested millet had a significantly higher number of Striga attachment's as compared to the uninfected millet. Similar differences were found in the number of the *Striga hermonthica* seed attachment's in infected Dimbie plants about 14 attachments which were bigger than that in infected Ashana recording 9 attachments (table 2). At the end of the experiment, at 35 DAE, Dimbie hosted 14 attachments per plant, representing 4.6 attachments m^{-1} root length of the upper contaminated soil layer, whereas 9 attachments per plant, representing 2.2 attachments m^{-1} root length, were observed in Ashana (data not shown).
Differences in root length were present in Ashana control and infected plants, differences were found in root dry weight, giving 0.63 and 0.57g respectively. Ashana infected plants were recorded bigger weights than that in Dimbie which recorded 0.49 g for uninfected and 0.31 g for infected respectively (data not shown). A difference in root dry weight in Ashana was twice times as high as in Dimbie. Clear differences were found in the response observed in the upper and lower soil layers. For both cultivars, root dry weight in the upper layer tended to decrease. Root length, however, increased significantly, indicating that SRL increased, meaning relatively thin roots, as a result of *S. hermonthica* infection. In Dimbie, this response was stronger than in Ashana.

The reduction in biomass production was accompanied by a relatively increased allocation of dry matter to the roots. These observations are well-known symptoms of infected host plants (Parker and Riches, 1993; Press and Graves, 1995). These observations are in agreement with those of Clark *et al.* (1994) in sorghum and millet. Detailed observations during the initial growth period of millet in this experiment showed that this delay in emergence can be explained, at least to some extent, by a delay in the onset of attachment. Attachment of the parasite to the roots of Ashana was delayed by approximately one week. Wilson *et al*., (2000) experiments demonstrated that Striga numbers on Pennisetum were affected by the days to Striga emergence and host maturity. It is well documented that differences in the production of germination stimulants exist between cultivars (Hess *et al*., 1992; Reda *et al.,* 1994). It is also well documented that the production of strigolactones among host genotypes could account for differences in the numbers of Striga attachments among genotypes (Jamil *et al*., 2011).

Observed differences between cultivars in the timing of the first parasite attachments and their expected influence on the final yield reduction are a strong indication that control practices based on a delay in first attachments could contribute to a reduction in the *S. hermonthica* problem (van Delft, 1997).

Table (2) Effect of pearl millet genotype on Striga seed attachment at (35) days after the emergence of pearl millet.

Pearl millet	Striga attachments
(Ashana)	9 a ♯
(Dimbie)	14 b
LSD	**0.341**
SED	**0.19**
CV%	**50**

♯ Values in the same column followed by different letters are significantly different at (P > 0.05).

Conclusions and Outlook:

The current study results suggested that the pearl millet genotypes have different compassion to *Striga* infection. The millet released variety Ashana showed high tolerance to Striga infection compared to population Dimbiee which is slightly tolerant to the weed *Striga* infection.

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