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ORIGINAL ARTICLE

CONTROL OF *STRIGA HERMONTHICA* ON SORGHUM INOCULATED WITH FENUGREEK (*TRIGONELLA FOENUM-GRAECUM*) SEEDS POWDER

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ABSTRACT: Laboratory and pot experiments were undertaken to study the effect fenugreek (*Trigonella foenum-graecum*) on Striga and sorghum growth. In the laboratory study, the allelopathic effect of fenugreek seeds powder on germination phase of Striga was studied. Fenugreek seeds aqueous extract at 2 and 6% (w/w) reduced Striga seeds germination significantly in absence of the germination stimulant as compared to the positive control. It reduced germination by 74 to 42%, respectively. The effect of Fenugreek on Striga hermonthica infesting sorghum Arfa Gadamic variety was studied under greenhouse conditions in a Randomized Complete Block Design with four replications. Sorghum inoculated with fenugreek seeds powder at 5-40 g / pot significantly influenced Striga count, days to Striga emergence, plant height and total sorghum dry weight. Plants treated with fenugreek seeds powder at 20 to 40 g /pot reduced and delayed *Striga* emergence, while the lowest concentration (5g/pot) induced plant emergence. Application of fenugreek at 35 and 40 g/pot produced higher plant height, dry matter and leaf area. Inhibition of Striga germination by allelochemicals released by fenugreek is suggested as the mechanism for reduction of Striga infestation.

KEYWORDS*:* Fenugreek, S*triga,* Sorghum, Allelopathy.

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is an erect annual legume with a long history of cultivation both for culinary and medicinal uses. The seeds are reported to have restorative and nutritive properties and its nutrient composition is moisture, protein, fat, saponins, and dietary fibers (Ikeuchi *et al.,* 2006). Recent research efforts have made it possible to use allelopathy for increasing crop production with quality food, reduce reliance on synthetic pesticides and improve the ecological environment (An *et al.,* 2005). In present agricultural systems heavy amounts of synthetic chemicals are being used to control weeds and other pests. But the adverse impact of these chemicals on the environment has made it necessary to search substitute at weed control strategies and the current trends in agriculture production are to find a biological solution to reduce the apparent harmful impacts from herbicides and pesticides (Khanh *et al.,* 2005). The germination stimulants play an important role in the fine-tuning of the lifecycle of the parasites to that of their hosts. Several studies confirmed that germination of *Striga*, *Orobanche* and *Phelipanche* seeds is induced by other natural compounds including Sesquiterpene lactones (which are not strigolactones), cytokinins, auxins, gibberellins, cotylenins, fusicoccins and jasmonates (Logan and Stewart, 1991). Ethylene has been found to efficiently stimulate witchweed (*Striga* spp) seed germination. There are also several synthetic compounds that induce germination of parasitic plants. Among them are the strigolactones GR24 and Nijmegen-1. Suicidal germination is regarded as the induction of germination in the absence or away from the hosts root. Suicidal germination could be achieved by introducing either natural or synthetic germination stimulants into the soil in the absence of a suitable host leading to both seed bank depletion and death of weed germling because of complete dependence on the host for their sustenance (Parker and Riches, 1993). Plant allelopathy offers a great prospective to resolve this critical issue and may be used in different ways to manage weeds (Javaid *et al.,* 2006). Lack of stability precludes leaching of the chemical to desired soil depths. Another limitation of this approach is that the synthetic stimulants should be easy to handle and affordable to peasant farmers particularly in the African continent, where the problem exists. Ibrahim *et al.,* (1985) reported that aqueous extracts from several *Euphorbia spp.* including *E. hirta* and *E. aegyptiaca* induced germination and haustorium initiation in *Striga hermonthica*. The objective of

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the present work was to study the allelopathic effects of fenugreek seeds powder on *S. hermonthica* and sorghum germination.

MATERIALS AND METHODS

2.1. Plant materials

2.1.1. Striga hermonthica seeds collection

Striga hermonthica seeds, used in this study, were collected from parasitic plants growing under sorghum in 2006 at the Gezira Research Station Farm in Wad Medani, Sudan.

2.1.2. Fenugreek seeds

Seeds were purchase from the local market.

2.1.3. Sorghum seeds

Seeds of sorghum Arfa Gadamic variety were obtained from the Seeds Company Ltd. Khartoum, Sudan.

2.2. Laboratory experiment

2.2.1. Plant aqueous extracts

Aqueous extracts were obtained by soaking 10 g powder plant material (fenugreek seeds) in 250 ml glass beaker with 100 ml of sterilized distilled water for 24 hours at 28º C. Each suspension was then filtered through two tools, nylon cloth followed by Whatman filter paper No. 1. Further dilutions of 2, 4, and 6 % (v/v) were prepared and stored at 4º C.

2.3. Bioassay

2.3.1. Effects of fenugreek seed aqueous extracts on Striga seeds germination

Fenugreek aqueous extract with different concentrations was evaluated under the laboratory condition. Striga seed was conditioned in water. Glass fiber filter papers (GF/C) discs (8 mm diameter) were cut, wetted thoroughly with water and placed in an oven at 100 ºC for 1 h to be sterilized and ready for further use. The sterilized discs, placed in 9 cm petri dishes lined with glass fiber filter papers (GF/C), were moistened with 3-4 ml distilled water. About 25-50 surface disinfected *S. hermothica* seeds were sprinkled on each of the glass fiber discs in each petri dish. The dishes, sealed with para film, placed in black polythene bags were incubated at 30 ºC in the dark for 10 days. Each disc was treated with 20 µl aliquot, of each concentration of fenugreek aqueous extract. Conditioned seeds, on discs treated with 20 µl distilled water or with the synthetic germination stimulants GR24 (10 mg/ l), were included as controls for comparison. Subsequently, seeds were examined for germination under a stereomicroscope. A seed was considered germinated when the radical protruded from the seed coat. All statistical analysis was performed using analysis of variance method by means of Excel software. Mean separation was performed using LSD test at 0.05 probability level.

2.4. Pot experiment

2.4.1. Effects of fenugreek seeds powder on S. hermonthica incidence on sorghum cv. Arfa Gadamic

In this experiment, a soil mix made of river silt and sand (2:1 v/v) was placed in plastic bags (19 cm diameter) with drainage holes at the bottom. *Striga* infestation was accomplished by mixing 10 mg of sterilized *Striga* seeds (*Ca* 1500) in the top 6 cm soil in each bag. Surface sterilized sorghum seeds Arfa Gadamic (7/bag) were sown and immediately irrigated. Aliquots of the respective fenugreek seeds powder (5, 10, 15, 20 25 and 30 g/pot) were injected, within the root zone, in each bag. Subsequent irrigations were made every 2 days. *Striga* infested and uninfested controls were included for comparison. Emergent *Striga* plants were counted weekly starting three weeks after crop emergence. Sorghum height was measured at 2, 4, 6 and 8 weeks after sowing (WAS), while leaf area was determined at 4 and 8 WAS. Root and shoot dry weights were recorded at the end of the experiment. Treatments were arranged in factorial design with randomized complete block design with four replicates. Data from the greenhouse experiment was subjected to analysis of variance (ANOVA). Means were tested for significance by LSD at 5% (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

3.1. Laboratory experiment

Striga seeds treated with distilled water displayed negligible germination (data not shown). Conditioned Striga seeds treated with GR24 (0.1 ppm) displayed high germination (89.1%) (Figure1). Results displayed that all fenugreek extract was reduced Striga germination significantly as compared to the control. In among all fenugreek concentration, fenugreek at 2% was the inhibitoriest activity. It reduced germination by 74%. While, at the highest concentration (6%) decreased germination by 42% (Figure 1).

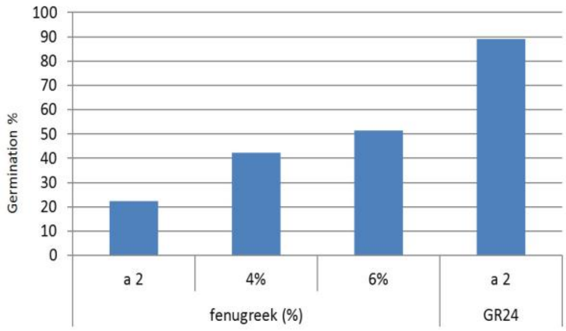

Figure 1: Effects of different fenugreek level on Striga germination in absence of GR24. Vertical bar indicates LSD

3.2. Pot experiment

3.2.1. Effects of fenugreek powder seeds on Striga incidence

Results displayed that fenugreek reduced Striga emergence significantly in sorghum plants as compared to un-inoculated control. At 5WAS, *Striga* emergence was very low as only 1.25 average *Striga* plants emerged on the untreated control (Figure 2). At six WAS, *Striga* emergence increased, substantially, and was heighest at 5 gram of fenugreek concentration (4 *Striga* plants/bag). Inoculated sorghum with fenugreek at the heighest concentrations (30, 35 and 40g/pot) sustained significantly less *Striga* emergence than the respective control. At 8 WAS, in plants inoculated with fenugreek at 30, 35 and 40g/pot were reduced *Striga* emergence was reduced significantly by 75- 86% as compared to the control. Parasite emergence consistently decreased with increasing fenugreek level.

Generally, sorghum treated with fenugreek at the lowest concentration (5%w/w) displayed considerable germination (5.5%) (Figure 2). However, a further decline in germination occurred at higher concentrations and the lowest germination (1.5%) was obtained in soil treated with the highest concentrations (30-40% w/w) (Figure 2). Striga seeds treated with fenugreek at 10 and 15% (v/v) germinated at similar rates.

The use of allelopathic substances could inhibit the germination and seedling growth of crops and weeds (Farooq *et al*., 2008). Water extract of rice plant suppressed the growth of barnyard grass (Lin *et al*., 2000) and weed growth inhibition increased with increasing extract concentration. Azizi *et al*., (2011) reported that extracts of different parts of fenugreek had the stimulating effect in low concentration and inhibition effect in higher concentration on several weeds.

African farmers traditionally intercrop maize or sorghum with legumes to increase crop production, achieving better returns on fertilizer, pesticide, energy and manpower resources. These intercrops also reduce infection by Striga hermonthica (Oswald *et al*., 2002). It has recently been shown that intercrops with oat reduce the infection by *O. crenata* on legumes (Ferna´ ndez-Aparicio *et al*., 2008).

The results indicate that metabolites produced by some plants may have the potential to be used as bio-herbicides to control *Striga*. Allelopathic crop residues can be used for managing weeds in crops. The main inhibitory metabolite from fenugreek was isolated and characterized as a mono substituted trioxazonane (Evidente *et al*., 2007).

The physiological mechanisms involved in the conditioning process of *Striga* seeds were attributed to an increase in permeability of cellular membranes, leaching of an inhibitor and/or promotion of synthesis of a germination stimulant.

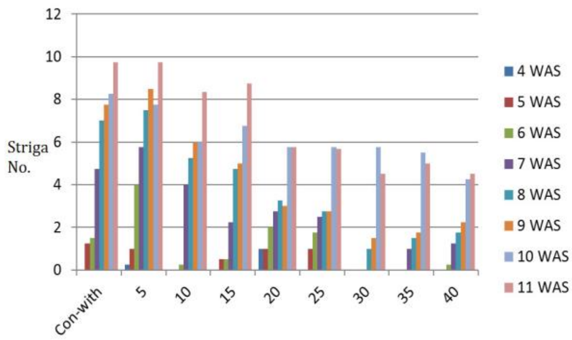

Figure 2: Effect of fenugreek on *Striga* incidence. Vertical bar indicates LSD

3.2.2. Effects of fenugreek on Sorghum height

At 3WAS, untreated *Striga* free crop displayed the tallest plants (16 cm) as compared with infested uninoculated control (Figure 3). Unchecked *Striga* infestation reduced crop height by 25%. At 7 WAS, most of treatments were sorghum plant height, as compared to infested control. In among all treatments, plant inoculated with fenugreek at 40g/pot increased height significantly as compared to infested and un-infested control. It increased sorghum height by 63% as compared to infested control (Figure 3). At 9 WAS, fenugreek at 35 and 40g/pot sustained the highest plant height as compared to the control. It increased sorghum height by 68 and 77%, respectively as compared to the infested control (Figure 3). Generally, all fenugreek increased sorghum height, significantly, in comparison with the *Striga* infested control.

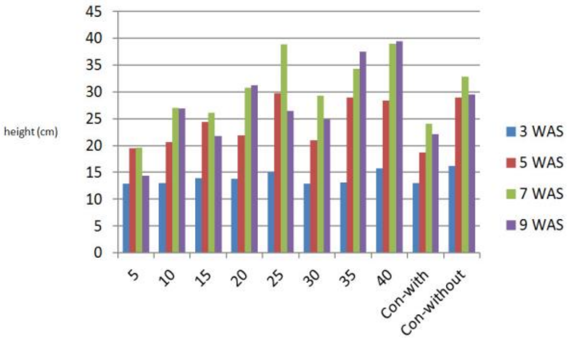

Figure 3: Effects of fenugreek on sorghum plant height. Vertical bar indicates LSD

3.2.3. Effects of fenugreek on sorghum leaf area

Leaf area was affected by *Striga* infestation. Un-infested control displayed the higher leaf area as compared with the infested control (Figure 4). Sorghum plants inoculated with fenugreek at 40g/pot sustained the highest leaf area as compared to the infested control and others treatments, irrespective to the times as shown in figure 3. However, at 8 WAS, sorghum plants inoculated with fenugreek at 40g/pot displayed the highest leaf area as compared to the control. It increased plant leaf area by 133% as compared with the infested control (Figure 4).

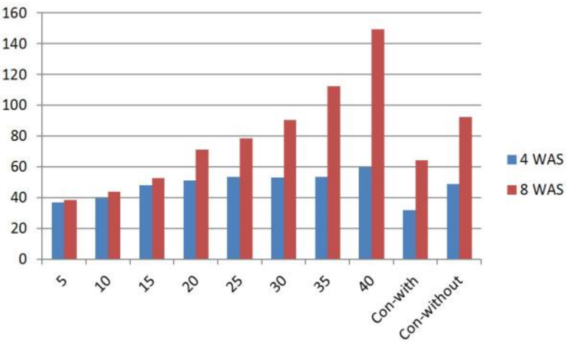

Figure 4: Effects of fenugreek on sorghum leaf area. Vertical bar indicates LSD

3.2.4. Effect of fenugreek on sorghum dry matter

Sorghum dry matter was affected with fenugreek seeds powder. Sorghum inoculated with fenugreek at 35 and 40g/pot sustained the highest root and shoot dry weight as compared with infested control and others treatments (Figure 5). Results displayed that plant treated with fenugreek at the highest concentrations (35 and 40g/pod) sustained the highest dry weight as compared to the infested control. It increased sorghum shoot dry weight by 68 and 74%, respectively. With respect to sorghum root dry weight it increased to 134 and 136, respectively (Figure 5).

Sorghum plants inoculated with fenugreek in addition to reduced Striga infestation also increased plant height, leaf area, root and shoot dry matter. This result agrees with finding of Bakheit *et al.*, (2002). Differences in dry matter accumulation between infested and uninfected plants partly result from the parasite acting as a sink for carbon, inorganic solutes and water, particularly in the later stages of infection, but also because of lower rates of carbon gain by infested cereals (Smith *et al.*, 1995).

Intercropping is a method for simultaneous crop production and soil fertility building (Willey, 1985). Identification of the compounds released from fenugreek, involved in the suppression of *Striga* may give more opportunities for developing reliable intercropping strategies, as well as new approaches in the molecular biology of *Striga hermonthica*.

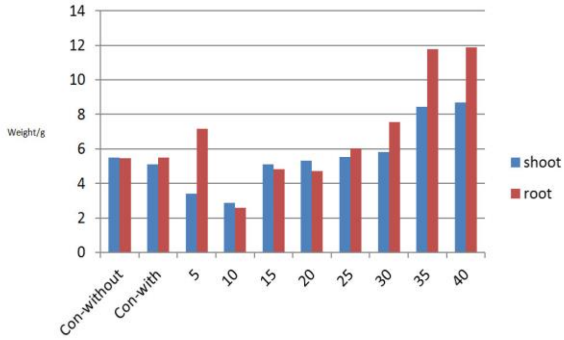

Figure 5: Effects of fenugreek on sorghum dry matter. Vertical bar indicates LSD

CONCLUSIONS

From these results it can be concluded that *T. foenum-graecum* can be used as a trap crop to reduce *Striga* seeds bank in agricultural land. In this way, a plant-based protection method would be available for resource-poor farmers. Further experiment needed to be conducted for practical utilization of fenugreek as weed suicidal germination plant by using this plant in the intercropping or crop rotation systems. Allelopathic potentials of these plants which induce identifying and purification of allelopathic substances, may entitle them to control specific weeds by preparing them as natural herbicides.

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