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RESEARCH ARTICLE

POTENTIAL OF SOME LEGUME SEEDLINGS AS STIMULANTS TO WITCH WEED [*STRIGA HERMONTHICA (DEL.) BENTH.* (LAMIALES*:* OROBANCHACEAE)] SEED GERMINATION AND ROOT ATTACHMENT

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ABSTRACT

A laboratory experiment was conducted at the Weed Science Laboratory of Agricultural Research Corporation, Wad Medani (Sudan) in 2007. The experiment adopted the El Mubarak (1998) improvised disc technique. Tentatively, *Striga* seed germination and attachment of germinated striga seeds to roots of four legumes species namely, Bambara nuts, *Vigna*subterranea; ground nuts, *Arachishypogoea*; Clitoria, *Clitoria* spp. and *Desmondium* spp) were tested and two sorghum cultivars (Wad Ahmed and ArfaGadamak) were used as checks. Results showed that, Bambara nuts, *Clitoria* and Desmondium spp were antagonistic and resulted in less *Striga* seed germination than sorghum while Ground nuts resulted in high *Striga* germination similar to those for the sole sorghum checks. Nevertheless, all four legume species tested resulted in less *Striga* attachment to roots than for sorghum. Therefore, this study recommends the use of ground nuts as a rotational crop in striga infested soils as they can effectively reduce the striga seed load in the soil.

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INTRODUCTION

Striga is an obligate root parasite that includes 50 to 60 species though only about a quarter of these parasitize crops (Joel *et al.,* 2007). It is most damaging to grain grasses and some legumes endangering food security in many developing countries (Parker and Riches, 1993). The name "witch weed" given to *Striga* was coined from the debilitating effects it inflicts on its host even before emergence. The genus *Striga*(*S.*) has many species parasitizing many crops and weeds in different regions of similar agro-climatic zones. The most destructive species on cereals are *S. hermonthica*, (Del.) Benth *S. asiatica* (L.) Kuntze, *S. densiflora* Benth *S. angustifolia* Sadanha and *S. aspera* (Willd). Of interest to this study is *S.hermonthica* (Del.) Benth.*Striga* has tiny seeds measuring 0.15-0.31 mm and weighs 3-15µg (Stump, 2007; Parker and Riches, 1993).

The number of seeds per capsule is about 700 and number of capsules per plant averages 60-70 in *S. hermonthica* (Parker and Riches, 1993). For successful host attachment, germination must take place within 3-4 mm of the host root since *Striga* radicles can only manage 2-4 mm (Ramaiah *et al.,* 1991). To compensate for this biological restriction, *Striga* produces up to 450,000 seeds per plant which persist in the soil for up to 10 years (Eplee, 1992). Well-grown *Striga* plant may produce up to 500,000 seeds which under specific soil conditions may remain viable for 14 years (Parker and Riches, 1993). *S. hermonthica* is one among four species of economic importance because of their impact as yield reducers (Parker and Riches, 1993). According to Joel *et al.* (2007), *S. hermonthica* has the largest geographical distribution. It spreads in Africa between latitudes 5°N and 20°S. It is also found in South-East Asia. The plant is erect 50 to 100 cm high with pink flowers, five ribs on the calyx and bracts below each flower fringed with hairs. It is a parasite of a number of cereal crops in Africa and Arabia and most destructive to sorghum, (*Sorghum bicolor*); maize, (*Zea mays* L.) and millet (*Pennisetumglaucum* L.). Joel *et al.,* (1995) pointed out that

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Striga exhibited two main life phases: independent and parasitic. The independent phase begins with seed imbibition and germination and lasts a few days until the germinated parasite finds a host and attaches to it. The parasitic phase is that during which the parasite becomes dependent on nutrients derived from the host and starts as soon as the haustorium invades the host root eventually forming a physiological bridge between the vascular system of the host and parasite (Joel, 2000). The following are the developmental stages of the parasite:

Joel *et al.,* (2007) observed that when seeds of *Striga* from a mature fruit are released, they enter a period of dormancy or after – ripening during which seeds complete preparation for later germination. He suggested that this period is influenced by temperature and seems to limit germination of freshly shed seeds in the field at the end of the growing season ensuring germination only in the next season when host plants are able to support the whole life cycle of the parasite. Alternatively, even after being imbibed and environmentally primed for germination, when seeds failed to find a suitable host, they can re-enter a low energy dormant state or "Wet dormancy" (Vallance, 1950). This ensures seed longevity and is reversible with desiccation (Joel *et al.,* 2007). A chemical stimulus is needed to trigger germination of root parasites (Press and Graves, 1995). Before a chemical stimulus was needed to trigger germination of the parasite, some metabolic processes must occur in order for the seed to become responsive to stimuli and germinate. Joel *et al.,* (1995) further indicated that *Striga* seeds are conditioned after exposure to moist environment, imbibition of water and suitable temperature before they respond to germination stimulus in order to germinate. Conditioning lasts for 10 to 21 days within a temperature range between 20 and 40ºC but optimum temperature is between 25 and 35ºC. After this, seeds respond to stimuli in order to germinate. Joel, (2000) found that parasitic plants of Orobanchaceae are capable to perceive the presence of adjacent living host roots by sensing strigolactones that are released by the plant roots even at extremely low concentrations. Several strigolactones were found in root exudates of various plant species that proved to stimulate plants of Orobanchaceae (Yasuda *et al.,* 2003). Conditioned *Striga* seeds in the presence of strigolactones produced by sorghum are stimulated to germinate. Another *Striga* seed germination stimulant is the reduced form of sorgoleone, a plant growth inhibitor produced by sorghum roots (Czarnota *et al.,* 2003; Hejl and Koster, 2004). After germination, the radicle is elongated towards the host root. In order for *Striga* to attach to its host, a haustorium is formed through which the parasite acquires host substances vital throughout its life. As with germination, the parasite uses host-derived signals like kinetin, simple phenolic compounds and quinones to trigger haustorium initiation (Riopel and Timko. 1995).

The remaining *Striga* seed reserves are rapidly consumed once newly germinated *Striga* are exposed to haustorium initiation factors (Chang and Lynn, 1987). Hair – like projections cover the haustorium that develops on the radicle of *Striga*. Baird and Riopel (1983) discovered that these projections secrete adhesive that fixes the parasite to host root. After attachment, the host root is penetrated and continuity channel is formed with the host xylem through which the root parasite withdraws nutrients from the host roots (Kuijt, 1969). Of all control practices developed, cultural management practices that includes crop rotation once neglected is to be revived. Crop rotation has the advantage to control *Striga* and diversify food. Rotating *Striga* susceptible cereal crops with none susceptible crops particularly false hosts had long been advocated as a simple way of reducing *Striga* seed bank in the soil. Odhiambo and Ransom, (1994); Carsky *et al.,* (2000); Sauerborn *et al.,* (2000); Hess and Dodo (2004) demonstrated that rotations effectively reduce *Striga* numbers and increase yield in subsequent cereal crops. Berner *et al.,* (1995) suggested that selected crops for rotations should be of high efficacy in germinating *Striga* seeds. Ransom (2000), Oswald and Ransom (2001) emphasized that selection of rotational crops must be based on socioeconomic considerations (market value and availability). Development of ready and steady market for alternative crops may have a greater impact on adoption of rotations than biological effectiveness. Cowpeas of family Leguminoceae (Fabaceae) arehighly parasitized by *Striga gesnerioides* (Willd) Vatkewhile other Legumes are not. This study was incepted to investigate the reaction of some legumes with *Strigaspp., in* order to identify false hosts.

MATERIALS AND METHODS

A laboratory experiment was undertaken in 2007-2008 season at the Weed Science Laboratory at Wad Medani in the Sudan. In this experiment, the improvised disc technique of El Mubarak (1998) was adopted. About 100 glass fiber discs (0.5mm diameter) were placed on filter papers moistened with sterilized distilled water in three glass Petri-dishes of 9 cm internal diameter.

Experimental materials

Seeds of *Striga hermontheca* (Del.) Beth collected in 2006 at Damazin were sieved to remove trash, washed with distilled water to remove dust and then dried at room temperature in the laboratory for two days. The seeds were then sterilized with sodium hypochloride. Some of the sterilized seeds were sprinkled on the filter paper discs in each of three Petri-dishes. The Petri-dishes were then covered and sealed with cellotape wrapped in aluminum foil and placed in an incubator at 30°C in the dark for 17 days. On 2 September 2007, nine seeds of Bambara nut, groundnuts, Clitoria and Desmodium spp were selected and surface sterilized with sodium hypochloride at chloral concentration of 1%. Seeds of *Desmodium* were scarified with sand paper before sterilization to induce rapid germination. Small seedling pots were almost filled to brim with a mixture of silt and sand at a ratio of 2:1. Three seeds of each legume were sown in each of three pots and then irrigated. Later irrigation was done when necessary. On 4 September 2007, nine sterilized seeds of each sorghum cultivar, Wad Ahmed and Arfa Gadamak, were sown in two separate pots and irrigated in a similar way to the legumes. On 9 September 2007, pots with emerged germinated seeds of legumes and sorghum were wetted with tap water in the laboratory. Seedlings of both legumes and sorghum were carefully pulled out and thoroughly washed to free the roots from attached soil. Sterilized sand soil was placed in 18 Petri dishes each with punctured holes in the upright position between cover and the body. The soil was wetted with distilled water and covered with a filter paper. On each Petri- dish, three discs with conditioned *Striga* seeds were placed. Three seedlings from each legume and sorghum were introduced to three Petri-dishes (three replicates) with seedling roots placed in contact with the discs while the seedling shoots rested outside through the hole at the sides of Petri-dishes. Petri-dish covers were replaced and sealed with cellotape. All Petri-dishes with seedlings were completely randomized and wrapped together in aluminum foil and placed in illuminated incubator at a temperature of 30 °C. Observations were made daily and distilled water added through the holes when necessary.

Data collection and statistical analysis

On 16 September 2007, the three Petri- dishes (replicates) from each legume and sorghum were removed and germinated *Striga* counted under the microscope and expressed as percentage of all *Striga* seeds. Data was transformed to arc sin before analysis. All the Petri - dishes were retained in the incubator to detect attachment. On 18 September, (9 days from the time roots of legume seedlings were introduced to conditioned *Striga* seeds) the Petri- dishes were removed from the incubator, unwrapped and viewed under the microscope for *Striga* attachment to legume roots. Data on number of attached *Striga* was expressed as percentage of the number of conditioned *Striga* seeds, transformed and analyzed by the computer program MSTATC. Treatment means with significant differences were separated by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Effects of legumes on *Striga* seed germination and attachment

All legumes, except groundnuts, induced significantly (P= 0.01) lower germination of conditioned *Striga* seeds than sorghum cultivars; Arfa Gadamak and Wad Ahmed. Groundnuts induced significantly (P=0.01) more germination of conditioned *Striga* seeds than the rest of the legumes but this Striga infestation was similar to that for each of the two sorghum cultivars (Table 1.). After *Striga* seeds germinated, they were significantly (P= 0.01) lower in attachment to the legume roots than to sorghum roots. Striga germinated seeds failed completely to attach to *Desmodium* and groundnut root. Attachment of *Striga* to *Clitoria* and Bambara nuts was negligible (1.0-1.3%). On the other hand, *Striga* attachment to roots of Arfa Gadamak was significantly (P=0.01) higher (9.5%) than the attachmentto Wad Ahmed (5.2%) (Table 1).

Table 1. Response in*Striga* germinated seeds and attachment to legume roots

Legumes	Germinated *Striga* (%)	Attached *Striga* (%)
Desmodium sp.	11.0 (19.4) b	0.0 (0.00)c
Clitoria sp.	22.0 (27.3) b	1.0 (0.09)
Bambara nut	24.0 (29.3)	1.3 (0.15)c
Groundnuts	69.0 (58.4)a	0.0 (0.00)
ArfaGadamak	82.0 (69.5)a	9.5 (2.67)a
Wad Ahmed	87.0 (69.6)	5.2 (0.83)b
Sig. level	**	**
SE ±	6.8	0.24
CV %	23.1	19.8

Means in a column with same letters are not significantly different at (P=0.01) according to DMRT; Numbers for germination (in parenthesis) were transformed to arc sine x +0.5; and Numbers in parenthesis for attachment were square root transformed by $\sqrt{x}$ +0.5; ** = highly significant.

Under the laboratory conditions, all the four legumes (groundnuts, Bambara nuts, *Clitoria* and *Desmodium*) induced *Striga* germination. Groundnuts exceeded the other three legumes in *Striga* germination and the parasitic germination for the ground nuts was similar to that for the two sorghum checks (Wad Ahmed and Arfa Gadamak). Generally, the legumes (Bambara nuts, groundnuts, *Clitoria* and *Desmodium*) proved inferior to sorghum in attaching *Striga* germinated seeds to their roots despite their ability to induce *Striga* germination. Although Wad Ahmed and Arfa Gadamak were similar in stimulating germination of *Striga* seeds but differ in that Arfa Gadamak attached to its roots more germinated *Striga* seeds than Wad Ahmed did. Therefore, ground nuts among the other legumes according to Berner *et al.* (1995) would be an appropriate choice for a rotational crop in *Striga* infested land where sorghum is grown.

Conclusion and recommendations

From the results in this study we can conclude that, amongst the tested legume species groundnuts induced relatively lower germination of conditioned *Striga* seeds than sorghum; also, they have poor attachment support capabilities for striga. Therefore, groundnuts are a better choice as rotational crop in Striga infested soils.

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