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Variation in Trap-Crop Capacity of Soybean Genotypes for the Control of *Striga hermonthica*

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ABSTRACT

Studies were undertaken to assess the variability in the ability of soybean genotypes to induce germination in *Striga hermonthica* seeds and to relate such differences to their differences in root mass, nodulation and dry matter production. There were significant differences among the 60 soybean genotypes for all agronomic traits. However, the study found no significant correlation between the capacity of a soybean genotype to induce germination in seeds of *S. hermonthica* and any of these agronomic characters. The capacity to induce germination varied significantly among the soybean genotypes, ranging from 0-50%. There is the need to screen more soybean genotypes to increase the potential for the use of this control strategy.

Key Words: Farming system; Seed bank; Soybean genotype; *Striga hermonthica;* germination

INTRODUCTION

The parasitic weed *Striga hermonthica*, is a major biological hindrance to grain production in Africa. In the 1980s it was estimated that 2.1 million hectares of cereals in Africa were infested with *Striga*, with an annual grain production loss of 40% (M'boob, 1986). More recent surveys in Ghana (Sprich & Schellinger, 1992; Vogt, 1993) have revealed increase in the proportion of infested fields from 12% to 27%. Similar results have been reported from Malawi (Shaxson *et al*., 1993), Kenya (Frost, 1995) and Tanzania (Reichmann *et al*., 1995).

Most of the effective control techniques for *Striga hermonthica* involve the use of chemicals (Eplee, 1981). However, for most African cereal growers, the most appropriate method would be one that uses a simple and inexpensive technique adapted to their farming systems. One such simple, yet promising control method, is the use of non-hosts or trap crops. These crops have root exudates that stimulate *Striga* seed to germinate but the germinated *Striga* plants cannot parasitize them. Hence when used as components of cropping systems, such trap crops have led to considerable reduction in *Striga* seed bank and infestation (Kroschel & Saurborn, 1988).

Soybean (*Glycine_max* L. Merrill) has been identified as one of the most effective trap crops of *S. hermonthica* (Kroschel & Sauerborn, 1988). However, a large variability exists among soybean cultivars with respect to this trait (Alabi *et al*., 1994; Berner *et al*., 1994). Soybean production is rapidly expanding in Africa, in areas where mixed farming, intercropping and crop rotation are the common farming systems. Varieties with effective trap-crop capacity will provide farmers with a cheap tool to fight the *Striga* menace. This will increase cereal crop yields, improve food security and economic status of farmers.

The objective of this study was therefore to determine the variability among soybean varieties in their ability to stimulate germination of *S. hermonthica* seeds, to control the parasite.

MATERIALS AND METHODS

Fifty-eight varieties of soybean belonging to different maturity groups, recently introduced from the International Institute of Tropical Agriculture (IITA) were used in the studies. Two local varieties "Salintuya I" and "Salintuya II", which are commonly grown in northern Ghana, were also included in the studies. The studies were conducted at the Savanna Agricultural Research Institute (SARI), Nyankpala, Ghana. Two pot experiments were carried out between April and July 1998 and between May and August 1999, to assess variability of agronomic traits and also to relate plant growth to ability to stimulate germination in *S. hermonthica*. Pots measuring 28 cm high and having a diameter of 25 cm at the top and 19 cm at the bottom were each filled with 10 kg of disturbed soil from an experimental field previously cropped to soybean. The 60 soybean varieties were each represented by five pots in every replicate. A completely randomised design was used with four replications. Each pot was sown with six soybean seeds. A week after seedling emergence, the seedlings were thinned to two per pot. The plants were watered every other day until flowering, when the plants were harvested. Each plant had the soil carefully washed off its roots. The plant was then separated into nodules, roots and shoot. The three plant parts were oven-dried at 70°C for 48 h and the dry weights taken.

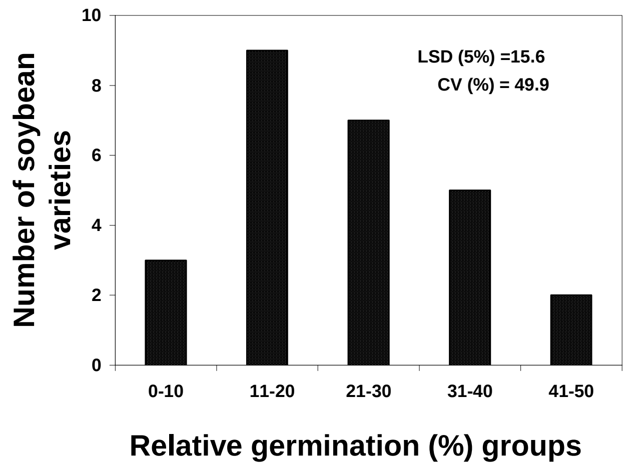
An *in vitro* experiment was also set up in November 1998, to assess variability among genotypes of soybean in their ability to stimulate germination in *S. hermonthica* seeds. The "cut root method" procedure described by Berner *et al.* (1997) was used. Twenty-six varieties of soybean out of the 60 were randomly selected for this study. Soybean plants were grown in pots for four weeks, after which they were gently removed from the soil. The roots were then cut into pieces with an average length of 1cm. one gram of roots of each variety was placed in a petri dish and 300 micro-litres (µL) of distilled de-ionized water added. The roots were surrounded with conditioned *Striga* seeds on disks of glass fibre filter paper. The Petri dishes were then sealed with parafilm, covered with aluminium foil to exclude light and incubated at 28°C for three weeks. After incubation, the *Striga* seeds were examined under a light microscope. Roots of sorghum variety "Kadaga", a true host of *Striga* were used as control. The percentage germination of *Striga* seeds for each soybean variety was calculated as a percentage of the sorghum control. The set-up was repeated between May and July 1999 with the same soybean entries.

RESULTS AND DISCUSSION

There were significant ($p < 0.05$) differences among the genotypes of soybean for shoot dry weight, root dry weight and number of days to flowering (Table I). The broad sense heritability estimates were medium to large. Variation in the ability of soybean genotypes to stimulate germination of *Striga* seeds was to a large extent due to genetic effects. (Table II).

The wide genotypic coefficient of (42%) observed in the ability of varieties of soybean to induce germination in

Fig. 1. Distribution of 26 soybean varieties for capacity to induce germination in *S. hermonthica*



Striga indicates a high potential for selecting high stimulators. Shoot dry weight, number of nodules per plant and days to first flowering may not be useful as genetic markers for distinguishing among soybean genotypes in the selection of genotypes for their ability to induce germination in *S. hermonthica.*

The distribution of the 26 soybean genotypes with respect to inducing ‘’ germination of *Striga* seeds appeared fairly normal though the sample size was small (Fig. 1). These results compare favourably with those obtained by Alabi *et al.* (1994), who found significant differences among 56 cultivars of soybean in their efficacy in stimulating germination in *S. hermonthica.* There were significant ($p < 0.05$) differences among the soybean varieties for this trait, but only 8% of the soybean varieties

Table I. Means, ranges and coefficients of variability for days to flower, root and shoot growth, and nodulation of 60 soybean varieties

Plant character	Mean	Range	CV (%)	LSD (p=0.05)
Number of days to flower	41.0	30.0 - 54.0	12.5	8.0
Shoot dry Weight (g)	30.7	7.3 - 69.9	45.5	22.6
Root dry weight (g)	6.6	2.7- 14.0	33.5	3.6
Nodule number plant^{-1}	102.5	13.0- 340.0	60.0	99.5
Nodule dry weight plant^{-1} (g)	1.00	0.13-2.63	51.4	0.83

Table II. Genotypic (σ^2_g) and phenotypic variances (σ^2_p), broad sense heritability (h_b^2) and genotypic coefficient of variation (gcv) for growth and nodulation of soybean varieties, and percent *Striga* seed germination

Character	σ_g^2	σ_p^2	h_b^2	gcv (%)
Days to flower	15.5	24.2	0.64	9.63
Nodules plant^{-1}	3108	4371	0.71	54.38
Nodule dry weight plant^{-1} (g)	0.16	0.25	0.64	40.00
Root dry weight plant^{-1} (g)	4.50	6.13	0.77	32.00
Shoot dry weight plant^{-1} (g)	221.6	286.8	0.77	48.43
[a]Striga seed germination (%)	29.4	42.6	0.69	42.06

[a]Twenty-six soybean varieties were used. Sixty varieties were used for other traits

screened could induce germination of *S. hermonthica* above 40%.

There was no significant relationship between root or shoot growth and the ability to stimulate germination of *S. hermonthica* seeds in these studies. Thus the capacity of a variety to induce germination in *S. hermonthica* may be independent of its growth habit or rate of growth.

Root structure was not studied in detail in the present work. Berner *et al.* (1994) found that soybean cultivars with fine root structure were more effective in inducing germination of *S. hermonthica* seeds than those with coarse roots. There is the need therefore to study in detail, the structure and mass of the soybean root and relate these to their ability to induce germination in the *S. hermonthica.* More genotypes of soybean must be screened for their trap-crop capacity to enhance the chances of selecting high stimulator genotypes. The results indicate clearly the need for farmers seeking to use soybean as a trap crop for Striga control, to plant varieties that have been tested and found to be efficacious.

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