BREEDING FOR STRIGA RESISTANCE IN SORGHUM

M.J. Vasudeva Rao, V.L. Chidley and L.R. House

Paper Presented at the

All India Coordinated Sorghum Improvement Project Workshop,
Navsari, Gujarat - 11-14 May 1981

SORGHUM IMPROVEMENT PROGRAM
International Crops Research Institute for the Semi-Arid Tropics,
ICRISAT Patancheru P.O., Andhra Pradesh 502324, India.

BREEDING FOR STRIGA RESISTANCE IN SORGHUM

M.J. Vasudeva Rao[1], V.L. Chidley[2], and L.R. House[3]
Sorghum Improvement Program, ICRISAT,
Patancheru P.O., Andhra Pradesh 502 324.

Striga, a root parasite of cereals, is recognized as a serious problem of sorghum crop in several countries. *Striga hermonthica* has assumed economic proportions in West African countries. *Striga asiatica*, which is more widespread than *Striga hermonthica* has been identified as an important problem in Southern Africa and in the Americas and is being recognized as a potential problem of sorghum in India. Genetic resistance in sorghum to *Striga* is recognized as the most economic way to combat this problem. Research efforts to incorporate *Striga* resistance into an agronomically *elite* background in the past have met with little success. In this paper an attempt has been made to describe *Striga* resistance breeding activities at ICRISAT and explain developments on the resistance screening methodology.

Striga Resistance Breeding at ICRISAT:

ICRISAT *Striga* resistance breeding work has the objectives to identify *Striga* resistant sources and transfer the resistance into good agronomic backgrounds. During the initial years, it was identified that *Striga* resistance in sorghum was a function of three independent mechanisms, viz., low stimulant production by the host roots, mechanical barriers to the

---

Paper presented at the All India Sorghum Improvement Project Workshop held at Navsari (Gujarat, India), 11-14 May 1981.

1. Sorghum Breeder, 2. Research Technician and 3. Program Leader (Sorghum).

establishment of Striga, and antibiosis factors. Field resistance is the sum total of all the three mechanisms. The initial work was to screen the germplasm for low stimulant producing lines and use them in breeding to incorporate this character into elite lines. To date about 14,000 germplasm lines have been screened and a set of 640 low stimulant lines have been identified (Table 1). Studies were conducted to verify the relationship between low stimulant production and field resistance to Striga asiatica, by growing sets of low stimulant lines in Striga sick fields in several locations. Table 2 shows the number of low stimulant lines tested in multilocation testing and the number of lines selected for field resistance. Generally, the results indicate that not all low stimulant lines are resistant in field. However, a good number of them turned out to be field resistant. This was further indicated in the studies on field resistance of advance generation lines in different trials. Out of 23 advance generation progenies which turned out to be field resistant across locations, 18 were observed to be low stimulant producers (Table 3).

Results of three different trials conducted at different locations of 156 advance generation progenies during kharif 1980 are presented in Table 4. Entries were classified as high -and low-stimulant producers and the porportion of field resistants in each category was verified. Without exception, in all three trials at all locations, the proportion of field resistants in the low stimulant category was higher than the proportion of field resistants in the high stimulant category. These results suggest that there are strong indications that low stimulant production screening could be a valuable adjunct in a Striga resistance breeding program. If the material is screened for low stimulant production at least once during the process of selection, then, it appears that the chances of obtaining field resistance in the end product is high. However, these indications need to be confirmed.

Efforts have also been invested in the past to incorporate Striga resistance into an agronomically good backgrounds. Several hundred crosses have been made over the past few years between different resistant sources and agronomically elite and adapted stocks. Material has been advanced in Striga sick fields and selected for low levels of susceptability. Selection has been made of plants with suitable height and maturity, tan plant type, improved seed characteristics apart from Striga resistance. This process of selection for Striga resistance and other desirable traits has shown that though several resistant sources are available, not all of them are "good breeding" stocks. Most of the sources are eliminated in the process of selaction. One parent, 555, a resistant source line has been a parent in number of useful advanced lines. We now have several breeding stocks which are improvements over the original source lines. These are being tested further and confirmed for Striga resistance. If found consistently resistant, they would become improved source material for breeding purposes. During kharif 1979, seven out of 56 advanced generation lines evaluated at three locations were selected for further screening (Table 5). Similarly during kharif 1980, more than 150 advance generation lines were tested and we could select 23 lines with *Striga* resistance. *Striga* resistance of these lines will be verified. Efforts will continue to improve the yield levels of the identified *Striga* resistant derivatives and diversification of the *Striga* resistant sources.

Screening Methodology for Striga Resistance Breeding:

Research efforts to incorporate *Striga* resistance into agronomically *elite* backgrounds in the past have met with several problems. An attempt will be made to analyse the existing systems of screening and some improved screening methodologies will be considered.

For screening sorghum lines for genetic resistance to *Striga*, laboratory techniques, pot screening techniques and field screening techniques have been used in the past. Laboratory techniques have been developed in the past to test the host line for any one of the mechanisms of resistance to *Striga*, i.e., low stimulant production or mechanical barriers to the establishment of *Striga* on the host. Laboratory techniques, obviously, have several advantages. They are easy, readily standardized, least influenced by the environment , quick and reproducible. However, in general, they have been frequently not been found useful in breeding for field resistance. This lacunae arises from the basic fact that field resistance cannot be explained by any one mechanism and there are strong environmental interactions which influence the field reactions.

Generally, pot screening involves growing of the host by artificially inoculating *Striga* seeds in pots of different dimensions and observing *Striga* after they emerge from the ground. Pot tests have been found to be more reliable than field screening for obtaining an attack by *Striga*.

Growing the sorghum lines in a field which is naturally or artificially infested with *Striga* seed and observing for field resistance to *Striga* has been a very common and useful technique. Field screening is often unreliable due to ununiform *Striga* infestation. The common problems that are encountered in field screening are:

i) Unreliable occurrence of *Striga* through years in the same field.

ii) Absence of any control on levels of infestation.

iii) Ununiform *Striga* distribution in the field.

iv) Total dependence on environment for *Striga* infestation.

v) High CV's in the experiments making the conclusions unreliable.

The Seed Pan Technique:

At ICRISAT, a seed pan technique is under development. The procedure involves growing of the test material in a shallow seed pan containing a soil medium. The shape and size of the pan are important. The pan measures approximately 35 cm in top diameter, 15 cm in bottom diameter and a height of 15 cm. These dimensions accommodate about 2½ kg of a mixture of sand and clay soil. This specific shape of the pan concentrates the host roots and thus favours a higher proportions of the *Striga* establish-

...

ment . A 1:1 mixture of sand and clay soil has been found to provide optimum conditions for the growth of Striga. Striga seed has to be pre-tested in the laboratory for its germination before planting. Striga seed has to be planted 10 to 15 days preceeding planting of the test material so as to condition the Striga seeds before they come in contact with the host roots. Striga seed is recommended to be sown at the rate of 100 mg per pan which would approximate to 20,000 Striga seeds. Seeds may preferably be applied at the bottom 6 to 8 cm region. We have noticed that this is the best region in the pan to place the Striga seed since the host root is most concentrated there.

Two alternatives are available with this technique for measuring the Striga reaction of the test entry. It is possible to uproot the plant around 50 days after sowing and count the subterrainian Striga, or the host may be allowed to grow further and the Striga could be counted after they emerge above the soil surface.

It may often be required that the host being tested for Striga resistance, be continued to maturity. In such cases, the soil in the seed pan is insufficient. A wooden flat with the dimensions of 60 cm x 60 cm x 15 cm has been found useful instead of a seed pan. The other procedure is same as in the seed pan.

A few experiments have been conducted using both seed pan and wooden flats for verifying the usability of these techniques. The experiments generally have indicated that these techniques are useful.

...

Field Screening Methodology for Striga Resistance:

At ICRISAT, an improved system of testing for field resistance to Striga is under development. Basically, this involves a three-stage testing procedure.

(1) Observation Nursery: This consists of an unreplicated trial of a large number of test entries with a frequently replicated susceptible check. Test entries may be grown in two row plots and Striga observed in between the two rows. Any augmented design may be followed for yield observations, while, for Striga resistance, lines may be rejected based on the presence of Striga.

(2) Family Screening: This is the second stage of testing including those nursery entries which were agronomically good and on which Striga was low or did not appear. The entries are tested in 3 row plots and they are replicated at least thrice with a systematic check which is arranged in such a way that every test plot will have one check plot adjacent to it (Figure 1). The existing system of data interpretation from the multilocation family screening has been to obtain the Striga reaction of the test entry as a percent of the adjacent check to adjust for ununiformity in the field and then average over replications. However, the CV's in the experiment are still high. Therefore, the existing system of family screening for field resistance has been modified to include the following set of criteria:

i) High Striga counts in the checks - comparison valid. ii) Test entry Striga reactions less than 10 percent of the adjacent check.	) Test entries) selected

...

iii) Test entry selected in all the replications in a location.

iv) Test entry selected across locations.

v) No averages to be used.

Based on the above criteria, test entries can be classified into six classes of Striga reactions. They are:

i) Confirmed Resistant	(R)
ii) Confirmed Susceptible	(S)
iii) Check Low, therefore, Comparison not Reliable	(NR)
iv) Resistant, Susceptible	(R/S)
v) Resistant, Not Reliable	(R/NR)
vi) Susceptible, Not Reliable	(S/NR)

The confirmed resistants are those which are registering less than 10 percent Striga count of the adjacent checks when the comparison is valid (high Striga count in the check). Further, selected entries show a valid resistance reaction across all locations. The confirmed susceptibles are those which have shown more than 10 percent of the check. This group also includes those which are infested irrespective of the infestation in the chec The third category contains those entries where the comparison was not valid since the check had low Striga counts. Resistant/Susceptible category include those which are showing resistant and susceptible reaction across replication or locations. Resistant/Susceptible reaction across locations may be an indi cation of Striga strain differences. The last two categories are again those

...

which are showing different combinations of the first three categories of reactions. The above six classes give a set of valid creteria for evaluating Striga resistance. We have analysed two years of trial data across locations and the results are encouraging. Three test entries which were selected in kharif 1979 based on the above classification were found to be resistant in kharif 1980 also.

(3) Advance Screening: This is the final stage of testing in which the confirmed resistant entries from family screening will be tested in large plots with a susceptible check plot all around the test entry. Figure 2 represents the field layout for such a trial. Each plot would be at least a 5 row plot so that yield estimates and Striga reaction could be obtained from fairly reliable plot sizes. The entire trial has to be covered on all four sides with a strip of the susceptible check plots as shown in Figure 2. For want of a name, we are calling this type of field layout as chess-board layout. The layout could be useful in screening the Striga resistant sources and advanced generation lines which requires higher precision and wherein it should be possible for us to have reliable estimates of yield. This layout makes it possible for us to use statistical designs. The test entry Striga reaction could be adjusted by using the test entry Striga reactions as a covariate of its four adjacent check plots. Further, this layout is likely to avoid creating ununiformity of Striga infestation because of differences in the susceptibility among the previous season genotypes in those plots.

Table 1. Details of germplasm and breeders' lines screened for low stimulant production against Patancheru isolate of *Striga asiatica*.

Source	No. of lines tested	No. of low stimulant producers
Germplasm	14098	646
Breeding stocks	1108	165
Others	1161	31
Total:	16367	842

Table 2. Field resistance of germplasm low stimulant sorghum lines.

Year	Location	No. of lines tested	No. of lines resistant	%
1978K	Patancheru	79	21	28%
1979K	Bhavanisagar	196	18	9%
	Phaltan	392	276	70%
1980K	Akola	80	26	32%
	Phaltan	80	4	5%