STRIGA - ADVANCES IN CONTROL

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Is Striga control possible?

Striga can be controlled. Given good farming with ample inputs, this parasite is only a minor nuisance. Striga is widespread in Southern Africa, yet it is kept well under control by increasing soil fertility (especially through the addition of nitrogenous fertiliser); by herbicides; by crop rotation; and by trap cropping. Combinations of these methods work well.

The eradication of Striga would be an impossible task in Africa or India, since the witchweed is a parasite of many wild grasses. Eradication is being attempted in the U.S.A. S. asiatica was accidentally introduced to the Carolinas, probably towards the end of the war. Approximately 200,000 ha are affected, and Striga has been eradicated on about 90,000 of these, but the process is very costly (Eplee, 1983).

The Problem for Small Farmers

Striga does much damage to the cereals grown by the small farmer.

As a generalisation, the poorer the land, the poorer the management, the fewer the inputs, then the greater is the amount of Striga damage. The parasite can be devastating. Yields of only 70-340 kg/ha have been recorded in Tanzania. In the Sudan, grain yield losses were quoted as 70% under severe infestation; 60% in Nigeria: 25 thousand tons of sorghum grain annually are lost in the State of Andhra Pradesh, India (Doggett, 1965; Hamdoun & El Tigani, 1977; Obilana, 1979; Gebisa, 1980; Rana et al, 1980; Hanumantha Rao et al, 1981; Ramaiah & Parker, 1982).

The same trend is now becoming apparent in India. Local farmers had selected Striga resistant types: the new hybrids are largely based on exotic germplasm, and are very susceptible. On the red soils of Maharashtra, the farmers have had to replace the sorghum hybrids with pearl (bulrush) millet, and problems are reported on other soils also (Sanghi and Vishnu Murthy, 1982; Tarhalkar, 1982). The damage done by Striga is seldom realised. The losses are borne by the small subsistence farmer, and do not get into the statistics. Traditionally, he may just abandon his land, or grow an alternative crop. I have no doubt that the light soils of the Sukumaland catena were sown to millet (mawele) because of the burden of the seed in the soil of S. asiatica which attacks sorghum (and soon builds up on maize). With increasing population pressures on the land, Striga is steadily becoming more serious.

Advances in control

(i) Resistance is the primary control measure for small farmers, although it must be supported by good cultural practices. Good resistance sources are being identified in Africa, in the ICRISAT project in Upper Volta, at Samaru in Northern Nigeria, and in the Striga project in the Sudan. Framida, N-13, Najjad, IS9830, SRN 6838A, SPV 103, and the derivative of a Framida cross, "entry 39" (Ramaiah, 1983).

Agronomic characteristics of some Striga Resistant sorghum varieties (Results are from different trials) (from Ramaiah 1983)

Variety	Origin	Days to flower	Plant ht(cm)	Grain yield (Kg/ha)	Grain color	Mechanism of resistance
N-13	India	89	306	760	Yellow	Anti-haustorial factors
Framida	Africa	80	253	1930	Brown	Low stimulant + anti-haustorial factors
IS 9830	Sudan	61	281	920	White	Low stimulant
SPV 103	India	65	153	910	White	Anti-haustorial or antibiosis factors
Najjad	Sudan	78	216	1010	White	Anti-haustorial factors
Ent. 39 (148 x Framida)	India	70	150	1500	White	Low stimulant

Framida has shown convincing evidence of good resistance to S. hermonthica in farmers' trials in W. Africa, as well as in formal trials. Seed has been sent for trial in eastern Africa - the Ethiopian lowlands and the Sudan. Some of the CV's in the table, especially Framida, have been used as parents in crosses. Framida has a brown grain, unacceptable to many people. "Entry 39" in the table has an improved grain type, Striga resistant derivatives with much better grain quality are showing promise in trials in W. Africa. Lines 82-S-47, 50, 52, 59 and 79 all look hopeful, especially 59 and 79 which are white-grained versions of Framida. (Ramaiah, 1983). Two lines with resistance combined with good grain quality, SAR-1 and SAR-2 have been released in India. (Vasudeva Rao, 1983).

(ii) Selection Methodologies. Selection for Striga resistance presents many problems. Striga seed distribution in the soil is very uneven. Good progress has been made at ICRISAT in improved methodologies.

(a) Comparing two varieties in farmers' fields by planting in strips, and sampling (Figure 1).

(b) Screening sorghum seedlings for low stimulant production. This helps to reduce numbers, as more low-stimulant varieties show Striga resistance than do high stimulant cultivars.

(c) The systematic use of check plots, and relating Striga incidence to the adjoining checks, is working well. Figure 2 illustrates this.

(iii) Nitrogenous Fertiliser. There are indications that nitrogenous fertiliser may enhance the degree of resistance shown by resistant sorghum cultivars (Ramaiah & Parker, 1982). Very heavy dressings of ammonium nitrate (over 1,100 kg/ha of N) completely suppressed Striga in the U.S.A. (Shaw et al 1962). Stewart et al (1983) have shown that the nitrate ion is toxic to Striga except at very low concentrations. Reports of the effects of rather low levels of nitrogen application vary: sometimes more Striga plants occur on the treated plots: in other places, their numbers may be fewer. The probable explanation lies in the fact that there are sometimes many Striga below ground which do not get enough resources from the host plants to emerge. Nitrogen improves the growth of the host, so more of these Striga are able to emerge. As the burden of Striga seed in the soil diminishes, so the benefit of nitrogen becomes more apparent - perhaps especially so on resistant varieties. There can be no doubt that steadily increasing the fertility of the land - which includes providing a good level of nitrogen in the fertiliser used - is an essential component of any Striga control system designed to produce better cereal yields.

(iv) Herbicides. Dinitroaniline herbicides such as "Treflan" used pre-emergence act as a barrier to Striga emergence, the parasite grows below ground but does not emerge. Some diphenyl ethers, such as "Goal" and "Flex" are proving to be excellent post-emergence herbicides against Striga. 2, 4-D is the most commonly used herbicide in the USA, but it can be very damaging to some crop plants, such as cotton. Paraquat is also useful, so long as the cereal plants themselves are not touched by the herbicide (Eplee, 1983). The work of Stewart et al (1983) has shown that mannitol is very important in the carbohydrate metabolism of Striga, and this is true also of some other parasites. This holds out the possibility of identifying a herbicide which would be specific to a number of parasitic species, e.g. Orobanche. This wider market could make it worthwhile manufacturing such a herbicide. At present, the costs of launching new chemical compounds for agricultural use are very high because of the health safety testing programe which must be done to satisfy regulations.

(v) Germination stimulants. Ethylene is an effective agent for germinating Striga seed in the soil when the necessary pre-treatment moisture and temperature conditions have been satisfied. It is easily applied by tractor-mounted equipment on a field scale, and a knapsack injector has been devised for small, difficult patches. This treats about 1 m^3 at a time. Recently, a probe injector system has been devised, which has two wheels, and can be towed along. It injects every 90 cm, and a 30 lb. cylinder of ethylene can treat 2-4/ha in a day (Eplee 1983) Again, the practicality of this for small subsistence farmers remains to be demonstrated.

Analogues of one of the natural Striga seed stimulants (Strigol) which are not very difficult to produce, show promise. These are known in the U.S.A. as "Strigalogs". GR24, developed at Sussex University (Johnson et al 1976) is quite effective at germinating the Striga seed, and could be particularly useful applied to a rotation crop, such as cotton, which itself produces Strigol. The combination of GR24 and "Goal" herbicide is particularly effective (Norris and Eplee, 1983). Since these can be applied with a knapsack sprayer, they should be within the reach of the small farmer to use. Unfortunately, the costs of launching GR24 appear to be much greater than the profits to be expected from a market consisting largely of subsistance farmers.

Control of Striga by small farmers

The basic requirement of adequate, stable prices was mentioned in the Chairman's remarks. In any area where shifting cultivation is no longer economic, inputs will be needed.

The first requirement for small farmers is the Striga resistant cultivar. This needs an effective seed production and distribution service, handling certified seed.

The second requirement is fertiliser, which needs a relatively large nitrogen component. Farmyard manure is valuable, but some added nitrogen will prove worth while.

The third requirement is weed control. Striga is extremely difficult to control by weeding out the parasite. An appropriate herbicide must be used in most situations.

The fourth requirement is crop rotation, using non-cereal crops which germinate some Striga seed. Cotton in India and groundnuts in West Africa have been used in this way by farmers for many years.

This appears to be the minimum farming level needed to help stay on top of Striga. Inputs are low: the cost of seed, the cost of some nitrogenous fertiliser (and complete fertiliser if F.Y.M. is not available), and the cost of herbicide. Clearly, there is much scope here for cropping/farming systems work - a practicable system that really did control Striga would be of such great evident benefit to the farmer that it would be adopted.

From the standpoint of donor agencies and National Governments, it may be necessary to clean up substantial areas of land. This will require operations such as ethylene injection, trap cropping (ploughing under susceptible cereal cultivars before the Striga germinated by them can flower) and the use of some of the new herbicides on appropriate, well-farmed crops.

The development of commercial scale production of the "Strigalog" GR24, and research and development for a specific Striga herbicide based on blocking the synthesis of mannitol in the parasite, both need to be undertaken. Both could be useful tools in the hands of the small farmer.

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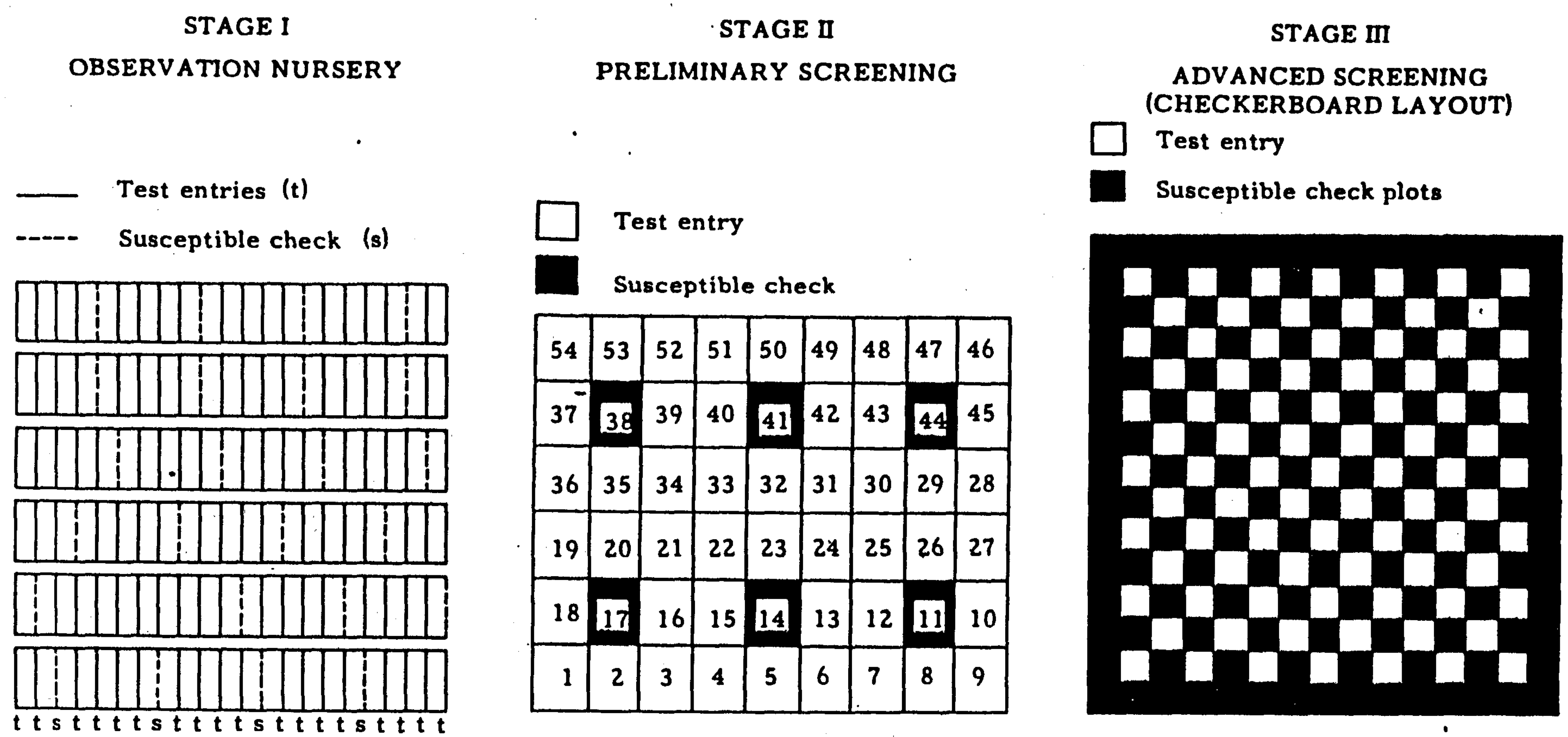
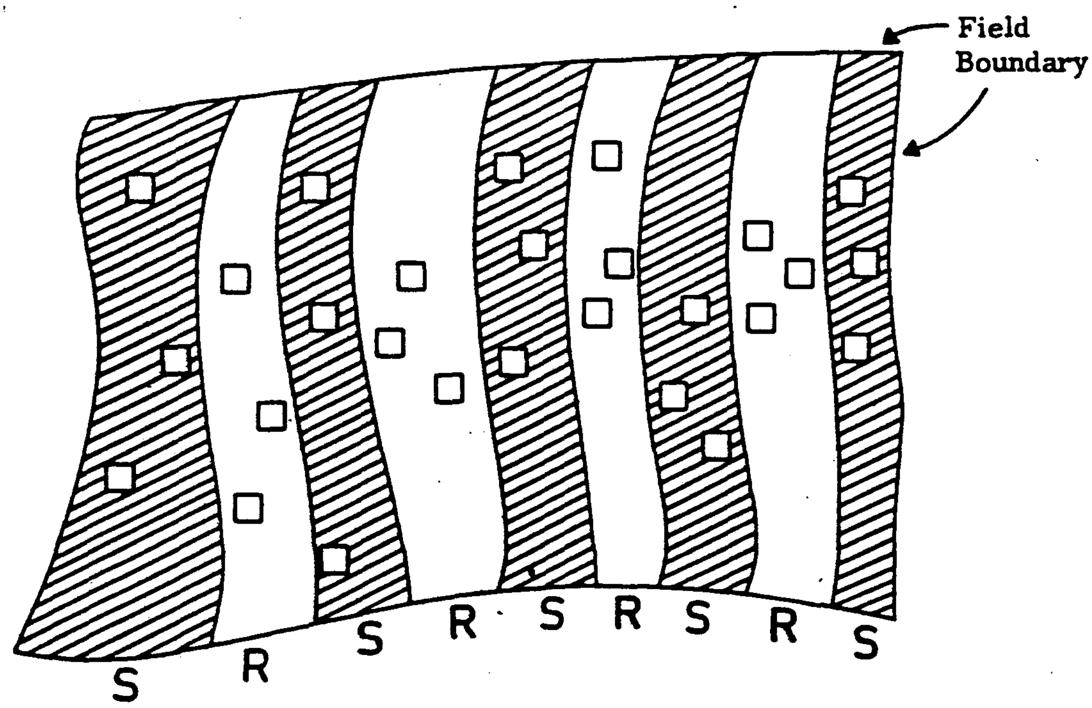


Fig. 2. A three-stage Screening Methodology for Striga Resistance Breeding in Sorghum (Vasudeva Rao et al., 1983c).



S = Susceptible check

R = Resistant varieties

☐ = Sample area for Striga counts and yield estimation

Fig. 1. Farmer's Field Testing of Striga resistant Varieties in Alternate Strips