STRIGA

Facts and Peculiarities

Information Report

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Introduction

Striga is one of the very few flowering plants that are parasitic on other plants, dodder and mistletoe being other examples. Striga has been given the common name of "witchweed" because of the various debilitating effects inflicted upon its host in addition to attaching to the roots and robbing the host of water and nutrients. Two species attack sorghum, millet, and maize while another is specific to cowpeas. Depending upon the extent of infestation, reductions in per hectare grain yield of 30-60% are common. Striga is most severe in low moisture, low fertility soils and the thousands of seeds it produces can remain dormant but viable for many years. Practical control methods consist of a combination of crop rotation with non-hosts, weeding/sanitation, and resistant varieties. Therefore once Striga becomes established in a field, eradication is very difficult.

Description and Occurrence

The parasitic weed Striga exists as several species, the common economic ones being *Striga hermonthica* in East and West Africa and *Striga asiatica* occurring in South Africa, India, and to a small extent Mid-Atlantic United States (Figures 1&3). Both attack sorghums, millet and maize, becoming the most devastating in the semi-arid tropics. The plants emerge from the soil adjacent to the host plant, produce many upright green stems with pink to white flowers. The third common species *Striga gesneroides* parasitises cowpeas and less often sweet potato (Figure 2) producing purple flowers and occurs largely in West Africa.

Yellowish green Striga plants with rough hairs on the stems will emerge 2-3 weeks around the plants of the field crop that has been planted. Plants per hectare in badly infested fields may number in the hundreds of thousands. Flowering can begin within 2 weeks and seeds begin to mature 2-4 weeks later. The seed capsules may contain 400-500 seeds and a single plant may produce 20,000 seeds. Mature seeds are dispersed by wind, rainwater, cultivation, soil on tools, or even grazing and manure fertilization. Underground, the Striga plant appears to have a thick tuft of roots but many of them are attached to the root system of the host by a thickened parasitizing nodule called a haustorium (See Diagram 1). This structure functions in extracting water and nutrients from the host plant. Only the Striga roots attached to host roots are functional and little direct soil adsorption is thought to occur through the non-attached Striga roots.

Biology and Physiology

Seeds of Striga occurring in infested soils require about 6 months of dormancy and the stimulation of root exudates from the new crop in order to germinate. Striga seeds further than 4 mm from the root zone or those deeper with less oxygen will not germinate and can remain dormant for up to 10 years. Striga germinates by sending an infection peg to the host, gluing to the root and invading the vascular system with specialized structures called haustoria (singular haustorium) where water, minerals, and carbohydrates are robbed (Diagram 1). Once the connection to the host is secured, initiation of the shoot and additional roots is begun. About 35% of the carbon for Striga plant growth comes from the host photosynthate. Also, Striga plants transpire much more water than is normal for other plants, even under moisture stress, thus maximizing the flow of water and nutrients from the host. Both of these factors contribute to the 65% reduction in plant growth and 95-100% reduction in grain yield of the parasitized plants in the field. In addition, the low correlation between % of infected roots and % growth reduction is a strong indication of the presence of an unidentified toxin.

Crop Losses

The prevalence of Striga soil infestation is steadily increasing as population pressures result in more continuous cultivation of cereal crops. In Ethiopia and elsewhere, land pressures cause farmers needing to feed their families to opt for continuous cropping of the higher yielding cereal crops without rotation or moving to other land. Again in the northern regions of Ethiopia, Striga is favoured by low soil fertility and soil moisture stress conditions (less shading by the poor growth of the host crop). This compounds the problem for the small-scale farmer who can least afford inputs on unproductive land. Infestation in some areas has reduced yields to the extent that abandonment and migration were necessary. Due to civil conflict, over-population, and droughts, farmer education and assistance programs have not been effectively applied in Ethiopia.

Crop losses from on-farm studies and conservative estimates are reported (1,2,3) to be 40% for all Africa (US $7 billion), ranging from 20-95% in East Africa, 20-35% in Gambia, 10-90% with an average of 35% in Nigeria (US $250 million), and 60% in Sudan. A good method of estimating grain loss in an infested field is 3-4 kg/100 Striga plants/Ha for sorghum and 5-6 kg/100 Striga plants/Ha for maize, the lower number being used for fields or areas with less productive potential.

Control Measures

1. <u>Chemical</u>

A number of chemical control measures that have been practised in the western hemisphere are not practical or are to risky for reasons which will be given. Soil sterilization by means of stimulating Striga seed germination with non-host plants (cotton or soybeans) or chemical stimulants (Strigol and ethylene) is not practical in Ethiopia because of cost and the resulting delay in planting the food crop in an area where the season length is already moisture limited. Since Striga is a broadleaf plant, preplant herbicides such as Atrazine, Goal, and Flex show some effect though not efficient enough to be justified. Post-emergence use of 2,4-D is effective when sprayed on the Striga leaves. Though low in cost, this herbicide is quite volatile and drift to nearby sensitive broadleaf crops (legumes, pepper, tomato and duba) is possible and could be devastating. Also maize and sorghum are vulnerable to stalk twisting and lodging if 2,4-D is sprayed into the leaf whorl. Spraying should only be done after users have been trained and cautioned to the hazards. Experimentally anti-transpirant type herbicides applied only to the base of the row of sorghum-Striga or maize-Striga were very effective.

2. Soil Fertility

It has been noted in western countries that host plant shading can restrict Striga growth when generous soil fertilizer is applied (Table 1). In areas of high rainfall, factors such as high plant populations, recommended fertility levels, and good weed control encourage lush crop growth and shading in spite of Striga parasitism. This is not feasible in moisture stressed areas of Ethiopia since high fertilizer applications would burn up the crop should normal soil moisture restrictions occur. However, it appears that several small applications of fertilized adjusted to the level of available soil moisture could raise crop yields and shading in favorable rainfall years.

3. Crop Rotation

Practical control measures include a combined program of crop rotation, weeding/sanitation, and resistant varieties. Crop rotation is the easiest control measure to implement because it requires only commitment and planning. However small-holder farmers desiring to maximize the grain production potential of their land may be difficult to be persuaded to grow other crops. Rotating the infested maize or sorghum areas to wheat/barley, pulses, or groundnuts are viable and effective options in Ethiopia. A season of non-host cropping allows for a large portion of the Striga seeds to deteriorate into nonviability. Seriously infested areas should be rotated to non-host crops for two years followed by closely supervised weeding. Two years of cropping to a non-host was reported to reduce Striga infestation by 50%.

4. Weeding/Sanitation

Although weeding the small Striga plants is a tedious task and may not increase the yield of already infected plants, it is necessary to prevent seed production and reinfestation of the soil. Weeding must begin at the first sign of flowering because pod formation and seed setting will soon follow. New shoots may sprout out below the soil from infected plants requiring a second weeding before crop maturity. Sanitation consists of taking care to note infested areas and to isolate them. Seeds in the soil can be spread by wind, rainwater, plowing, and soil on tools or root crops. Seed pods on Striga plants attached to maize or sorghum plants pulled for forage will infest manure and feeding areas. It is suggested that a Striga disposal pit be constructed to prevent seed maturation of green or drying plants that are pulled.

5. Genetic Resistance

Varietal resistance to Striga infection in maize and sorghum has long been recognized but only recently have attempts been made to utilize it. Basically the resistant varieties were low yielding and not desirable in other agronomic characteristics. Recent efforts to utilize resistance in breeding and improvement programs have met with limited success. Table 1 shows the difference in plant height of two resistant maize hybrids compared to two susceptible hybrids. Unfortunately the authors did not compare yields. A number of resistant germplasms have been identified by the Institute of Tropical Agriculture (IITA) in Nigeria and the International Wheat and Maize Improvement Center (CIMMYT) in Tanzania but have not been tested in Ethiopia.

More than 80 resistant sorghum lines have been selected by the International Center for Dryland Research (ICRSAT) in India. Of these, three selections made by the Ethiopia Institute of Agriculture Research at Nazreth (contact through Dr. Abera Debelo) have performed well in research trials and are currently being verified on large scale tests. Seed of these varieties are available for adaptational testing in Striga infested areas. Care must be taken in distinguishing resistance from tolerance since good yielding tolerant varieties will allow Striga growth and seed production increasing soil contamination.

In summary, control of Striga infestation is difficult and requires an integrated approach. Non-host crops must be rotated (for two years in heavily infested fields) with resistant sorghum varieties. Good husbandry of the sorghum crop should include: a)plant populations and fertility adjusted for soil moisture availability to maximize shading, b)weeding and Striga control through hand pulling and perhaps limited 2,4-D spraying, and finally c)care not to spread seeds of Striga though fodder, manure or contaminated soil on tillage tools.

Table 1. Effect of soil fertility level on Striga growth and plant characters of 4 maize hybrids in Nigeria

N P K % of recommended fertilizer	No of Striga plants/m of row[1]	No of Striga seed capsules /plant[1]	Maize plant height(cm) Res/Sus[1]	Grain Yield g/plant[1]
0	150	12	102/53	10
30	102	54	103/65	17
50	85	33	124/75	13
100	23	6	146/119	36

[1]Data for 2 resistant and 2 susceptible hybrids

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