

Management of parasitic weeds

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Parasitic weeds are becoming major constraints to many crops in tropical agriculture and the efficacy of available means to control them is minimal. There are around 3,000 species of parasitic angiosperm, distributed amongst 17 families. The transfer of host solutes in to a parasitic plant relies on the formation of a bridge between the two organisms. This organ, the haustorium (from the Latin, haurire, to drink) is thus the defining feature of all parasitic plants. True plant parasites can be hemi-parasitic (semi-parasitic) with photosynthetic leaves (such as Striga and mistletoe), or holo-parasitic and completely dependent on their host (such as dodder and broomrape). They may also be classified as stem parasites (Cuscuta and Loranthus) and root parasites (Striga and Orobanche) depending on their attachment with host plant. Some stem parasites are endo-parasitic and live completely within the stems of their host. The only part of pilostyles that emerges from the host is a tiny bud that opens into a minute red flower.

Key words: Cuscuta, Loranthus, Orobanche, Parasitic weeds, Striga

The major organ of the parasitic weeds for attachment and penetration of the host tissue is known as haustorium. The major function of haustorium is attachment and subsequent transport of material from host plant to parasitic plant. The hyphae of the haustoria contact both xylem and phloem of the host plant for transport of water, minerals and assimilates. Unlike other weeds, parasitic weeds remove nutrients and extract water from the host plant causing heavy losses to agricultural crops. The adverse effect of these parasitic weeds was so devastating; the crop yield losses of 10 to 100% were recorded, which leads to complete crop failure and sometimes abandonment of land.

Field dodders

In India, *Cuscuta* spp. pose a serious problem in oilseeds (niger, linseed) and pulses (blackgram, greengram, lentil, chickpea, especially in rice-fallows) and fodder crops



Niger crop severely infested with *Cuscuta*

(*Lucerne* and berseem) in Andhra Pradesh, Chhattisgarh, Gujarat, Odhisa, West Bengal and parts of Madhya Pradesh under rainfed as well as in irrigated conditions. Dodder infestations can weaken the host plant, making it susceptible to other pests and diseases, and may eventually kill its host. Dodder is believed to be a vector for various plant pathogens including several 'yellowing' viral diseases. The yield

reductions due to *Cuscuta* are reported to the tune of 30% in greengram and black gram to 85% in lentil, chickpea and alfalfa depending upon severity of infestation.

Seeds usually germinate on or near the soil surface. After emergence, the seedlings twin around the leaf or stem of a suitable host plant. In the absence of suitable host, *Cuscuta* seedlings die within a week time. Haustoria from the *Cuscuta* penetrate



Niger crop treated with pendimethalin as pre-emergence

the host and establish a parasitic union. Once the *Cuscuta* is attached to a host plant, it remains parasitic until harvest. A well-established single plant of *Cuscuta* produces more than one lakh of seeds, which remain viable for many years. It reproduces mainly by seeds and to a lesser extent by shoot fragments.

Control measures: Non-chemical methods such as use of *Cuscuta* free crop seed, use of resistant crops/varieties, deep ploughing, burning, crop rotation and inter-cropping, stale seed technique, mechanical weeding, etc. may be useful in preventing/reducing *Cuscuta* infestation. *Cuscuta* is one of very few weeds that can be controlled completely by crop rotation with members of the Poaceae, forage grasses or cereal grains. Without a host plant nearby, *Cuscuta* seedlings emerge and die. There are genotypic differences with regards to tolerance to *Cuscuta* infestation. *Lucerne*

paraquat (1% spray) and glyphosate (1%) and others like 2,4-D kill *Cuscuta* effectively in areas where it occurs in patches. Use of pre-emergence herbicides viz., trifluralin or pendimethalin at 0.75 to 1.0 kg ai/ha (relevant to crops) will lower the menace of *Cuscuta* in addition to other weeds in niger, linseed, chickpea and lentil. In lucerne, early post-emergence (10 days after sowing) of pendimethalin at 0.50 kg/ha was also effective in killing the emerging *Cuscuta*.

Broomrape

Broomrape (*Orobanch* spp.) is complete root parasite with about 130 species world over parasitizes wide range of hosts comprising food leguminous crops, oilseed crops, solanaceous crops and medicinal plants belonging to families—Solanaceae, Chenopodiaceae and Asteraceae. Locally known as *Margoja*, *Rukhri*, *Khumbhi* or *Gulli*,

variety 'T9' was found to be highly sensitive, whereas 'LLC 6' and 'LLC 7' were moderately tolerant to *Cuscuta* infestation. Greengram cv. 'M2', blackgram cv. 'T9' and linseed cv. 'Garima' was found relatively tolerant to *Cuscuta*. The shade from dense crop foliage suppresses *Cuscuta* sufficiently.

Non-selective herbicides like

the weed has emerged as a major threat to rapeseed-mustard production in northern Rajasthan, Haryana, Punjab, and north-east Madhya Pradesh; tobacco in Andhra Pradesh and Karnataka, and vegetables like tomato (*Lycopersicon esculentum*) and brinjal (*Solanum melongena*) in Haryana and Karnataka. Even *Orobanch* infestation on cauliflower and cabbage was observed in Dadri areas of Bhiwani and *Parthenium* in Mewar areas of Haryana. In India, *Orobanch cernua* and *O. aegyptiaca* are occurring on crops – tobacco, cumin, mustard, plantago, lentil, potato, brinjal and tomato, and cause from 30 to 35% losses in tobacco to more than 80% in solanaceous vegetables.

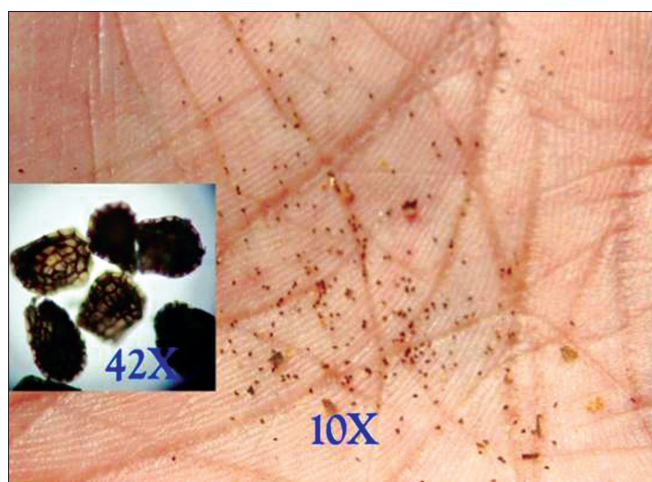
Orobanch is an annual, host specific parasitic herb propagated by seeds and gets germinated, if the host root exudates reaches the seed for one week and if the seeds lie within 10 mm distance from host fibrous roots. The parasite seedlings then infect the nearby host roots forming haustoria on them. Soon thereafter the broomrape emerges through the soil as pale shoots, devoid of chlorophyll around 45 to 55 days after planting of host crops. It starts flowering a week after emergence, fleshy shoot grows up to 20 to 30 cm and dries up in 30 to 40 days. The fruits are capsular and contain numerous tiny black seeds. Broomrapes reproduce only by seeds which are usually dark brown, oval-shaped, measure 0.35 mm × 0.25 mm dust-sized weighing 3 to 6 µg and very difficult to



Cuscuta fruits



Cuscuta seeds



Orobancha seeds



Orobancha on mustard root

recognize without a magnifying microscope. Each capsule contains between 600 and 800 seeds and a single plant may produce more than one lakh seeds depending upon species. Seed generally remains viable in soil for 10 to 13 years but the viability can be up to 20 years.

Control measures: The broomrape can be managed by following suitable preventive, cultural and chemical methods. Possible methods of broomrape control include hand weeding of shoots before seed set, soil solarization, trap crops such as maize, sorghum, linseed, shifting of planting time of the crop, flooding, fertilizer management, use of tolerant cultivars and spraying of herbicides. Mechanical control is not feasible since most of the parasite plants appear with in crop rows. Crop rotation of mustard with non-host crops like wheat, barley, chickpea etc. is the most effective and commonly used management strategy for reducing the weed seed bank in heavily infested areas. Longer viability of its seeds is however, the major restriction in adopting crop rotation in long-run. Sunhemp and greengram are proved to be the promising trap crops for *Orobancha cernua* control where *bidi* tobacco. Late planting of mustard (last week of October-first fortnight of November) was observed to be helpful in reducing the parasitism of *Orobancha* a result of specific weed and host plant differential response to low temperatures. Application of neem cake/vermi-compost/castor

cake and higher dose of nitrogen (N) was found effective in reducing parasitism of *Orobancha* and enhancing growth of tomato plants.

Seed treatments with imidazolinones and sulfonylureas proved to be effective for controlling *Orobancha*. The herbicide is incorporated as a coating on the seeds and distributed with them at the planting. Results of experiments conducted under farmers' management practices revealed that seed treatment of mustard with triasulfuron, sulfosulfuron and chlorsulfuron were found to reduce 55 to 98% population of *Orobancha*, but the results were inconsistent over the years. Moreover over-dosing of the herbicide seed treatment sometimes causes poor germination and suppression in crop growth. Seed coating of broad bean and pea with imazethapyr, and sunflower with propyzamide was also reported. Post-emergence application of ethoxysulfuron/sulfosulfuron at 25 g/ha at 30 days after sowing followed by sulfosulfuron at 50 g/ha at 30 and 60 days after sowing, respectively, provides 85 to 90% control of Egyptian broomrape in tomato without any adverse effect on crop with yield increase of 46 to 58% as compared to untreated check. No herbicide residues were found in tomato fruits and soil at maturity. However, residual carry over effect of sulfosulfuron was observed on succeeding sorghum crop depending upon soil type, rainfall during the season and number of irrigations applied to tomato crop. Glyphosate

applied twice at 25 g/ha at 30 days after sowing followed by 50 g/ha at 55 days after sowing provided 65 to 85% control of *Orobancha* in mustard even up to harvest (without any crop injury) with yield improvement from 12 to 41% over the traditional farmers' practice.

Witch weed: *Striga* or witch weed is an obligate parasitic plant infects major cereal crops such as sorghum, maize, upland rice, millets and sugarcane. It extracts essential nutrients from crops for its survival. Members of this genus are obligate annual hemi-parasites; they are chlorophyllous, but require a host to complete their life-cycle. *Striga* is commonly known as witch weed because plants infected by *Striga* display stunted growth and an overall drought-like phenotype long before *Striga* plants appear. It belongs to the family Orobanchaceae. In genus *Striga*, approximately 30 species are identified so far. Three species viz., *S. asiatica*, *S. gesneroides*, *S. hermonthica* are reported to be the most damaging. *Striga* causes yield losses of 15 to 75% in India in sorghum, pearl millet, maize and sugarcane depending on the severity of infestation. The stimulants secreted from the host plants which cause germination of *Striga* are kinetin, zeatin, ethylene, strigol, scopoletin, thiourea, allylthiourea, sulphuric acid and sodium hypochlorite. The *Striga* seeds lying within a few millimeters of host roots and receiving stimulants continuously for 24-28 hr, will germinate and have attachment with host roots through haustoria. *Striga*



Crop damage due to *Strig*

emerges after 50 to 55 days of sowing of host crops and continues growth for another 50 to 70 days coinciding with harvest of crops. Each shoot may produce seeds up to 50,000 to 75,000 having seed dormancy up to 20 years. The above ground parts of mature plants have green foliage sparsely covered with coarse, short, white, hairs. Plants are normally 15-30 cm tall but can grow to 60 cm.

Striga are major weedy pests throughout semi-arid sub-Saharan Africa and parts of Asia on crops like sorghum, sugarcane, maize, pearl millet, dryland rice etc. Resource-poor, small-scale subsistence farmers are severely affected with *Striga* infestation. It was estimated that the yield losses attributable to this weed exceed US\$ 7 billion in value, without accounting for adverse effects on the welfare and livelihoods of over 100 million people in Africa.

Control measures: If populations are low, hand weeding before seeds are produced is an option. Hand weeding of *Striga* plants as soon as they emerge was helpful in the long run control but most of the damage occurred while the *Striga* is still in the soil. Farmers usually do not think for the long run. Single hand-weeding of *Striga* in millet fields just before harvest pulled and burned showed reduction in *Striga* population in

following two years as the seeds still on the *Striga* plants are destroyed and increasing millet yield.

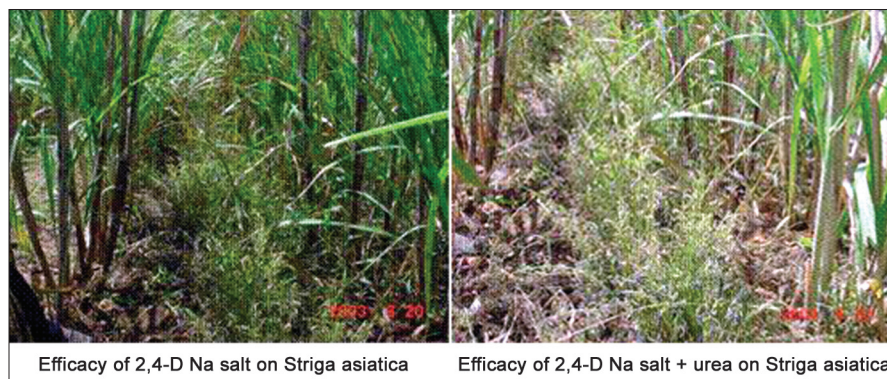
Cultural practices such as stubble cleaning after crop harvest, crop rotation with non-hosts and with catch crops, mixed cropping without host crops, fertilizer management with high doses of nitrogen as top dressing, and use of resistant or tolerant varieties help in reducing *Striga* infestation. Trap crops stimulate *Striga* germination but are not themselves attacked. Without supply of food from the plant root, the germinated *Striga* seeds die. It is therefore possible to rotate these crops with sorghum (*Sorghum bicolor*) to induce suicidal germination. Crop rotation with trap/catch crops like soybean and cotton, intercropping of sorghum with groundnut, soybean and cowpea and green manuring crops like sunhemp help in reducing the problem of parasitic weed *Striga* in sorghum. Complete control of *Striga* and a dramatic increase in sorghum yield were achieved with 100 kg N/ha in the 1:1 sorghum + *Desmodium* intercrop. Fertilizer, especially nitrogen, tends to reduce, or at least delay, *Striga* emergence and can be used to further reduce the numbers of parasite that need to be hand-pulled to prevent seeding.

Post-emergence application of 2, 4-D is effective when sprayed on

the *Striga* leaves. In sugarcane, pre-emergence application of atrazine 1.0 kg/ha + hand weeding at 45 days after planting (DAP) with an earthing up at 60 DAP combined with post-emergence spraying of 2,4-D Na salt 5 g/l (0.5%) + urea 20 g/l (2%) at 90 DAP. Deep placement of oxyfluorfen 250 g/ha into the furrows at 90 DAP is very effective in reducing *Striga* seed bank, while surface application of herbicide mixtures at 110 to 150 DAP after emergence of *Striga* prevents further enrichment of *Striga* seed bank, as the parasitic weed is controlled before flowering in sugarcane.

Herbicide seed treatments may provide a highly effective tool for managing *Striga* in sorghum. Results showed that Imazapyr seed dressing suppressed *Striga* emergence to 0.0 plant/m as compared to about 5 plants/m in untreated plots at 12 weeks after sowing.

Several germination stimulants were isolated which include strigolactones, dihydro-sorogoleone, sesquiterpene, kinetin, coumarin, jasmonate, ethylene and fungal metabolites. These made the emergence of parasitic seeds in absence of host and eventually parasite dies due to non-availability of host. This aspect was successfully exploited during an *S. asiatica* eradication programme in the USA,



when so-called 'suicide germination' was induced by fuming farm land with ethylene to trigger striga germination in the absence of host plants.

Mistletoes, Loranthaceae and Viscaceae, are obligate, semi-stem parasite, most troublesome weeds of tree crops and bushes. In India 70 species of Mistletoes are reported attacking several hundreds of trees and shrubs extending from the sea level to about 3,500 m in the Himalayan hills. They attack numerous trees and shrubs of forests and plantations bringing untimely death of the host plant. In forests, they are reported to reduce the productivity of both timber and related forest products. Mistletoes affect host foliage, phenology and respiration; reduce growth, yield, quality and increase operational and protection cost of plantation. In trees, the parasite enters the entophytic system, invades the bole/heartwood and thus affects wood quality. Wood quality is also affected by production of larger knots and other altered physical properties. They also alter the pattern of plant succession, and disturb the vegetation pattern of the landscape. Mango and cashew plantations are some of the most seriously affected ones.

Loranthus is the largest genera (having 600 species) under sub-family Loranchoideae (family Loranthaceae). *Loranthus longiflorus*, *L. ampullaceus*, *L. cochinchinensis*, *L. elasticus*, *L. pentandrus* etc. are some

common species. *Loranthus longiflorus* is a common parasite on subtropical trees. The plant bears beautiful orange or scarlet flowers in dense, one-sided upcurved axillary clusters. The flowers are 2.5 to 5.0 cm long having a cup-shaped calyx and corolla. *Viscum* is another genera of the sub-family Viscoidae (family Loranthaceae).

V. articulatum, *V. album* are the most common species occurring in the Himalayas. They depend on their hosts for water, and under wet conditions may do little harm. Under drought stress, however, they often cause death of infected branches. In India a wide range of species occur, of which *Dendrophthoe falcata* is perhaps the more common, damaging many fruit, ornamental and forest tree species. The weed occurs on the terminal growing point resulting in stunted growth of the tree, which affects timber value considerably.

The seeds of parasite are spread by birds, flower pecker, to fresh tree branches. In many parts of India, it occurs on almost all forest trees, high value timbers (teak, rose, sandalwood, eucalyptus, casuarina, neem, copperpod, banyan, ficus, flame of the forest), fruit/commercial trees (mango, citrus, sapota, guava, pomegranate, cocoa, coffee). Occurrence of the parasite was not observed on Tamarind.

Control measures

On *Loranthus*, scrape the bark of

the parasite at the point of attachment of the haustoria on the tree and pad with cotton containing 1 g 2,4-D Na salt 80 WP in 20 ml. Directed spraying of ethrel (Ethephon 39 SL) 25 ml/lit on the parasite causes complete defoliation without harming the host plants and regrowth do not occur for at least 6 months. Other method is to lop off the branch infested with *Dendrophthoe* to prevent further growth and spread in the initial stage itself.

SUMMARY

Parasitic weeds are becoming major constraints to many crops in tropical agriculture and the efficacy of available means to control them is minimal. Control strategies were largely focused on agronomic practices, the use of resistant/tolerant cultivars and the use of herbicides, although success was marginal. There is, thus, an urgent need to re-evaluate the control methods in the light of recent developments in herbicide molecules, crop breeding and molecular genetics and to place these within a framework that is compatible with current agronomic practices. Emphasis should be given to understand the interaction between parasitic plants and their hosts to implement sustainable means of control. Interdisciplinary research across the disciplines is required to develop effective integrated management strategy for parasitic weeds.

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Protect environment.*

