

# Orobanche Aegyptiaca: An Important Parasitic Weed of Indian Mustard

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## SUMMARY

Indian mustard (*Brassica juncea*) is a major edible oilseed crop of India. This crop has many biotic and abiotic challenges leading to limit its optimum production potential. Among various biotic stresses, a parasitic weed, Orobanche is becoming very serious problem in major mustard growing areas. It is an achlorophilus, annual parasitic weed which attaches to the mustard roots and obtained its nutrition from the mustard plant and causes massive yield losses. In present article, the life cycle of Orobanche, its mode of parasitism and available management techniques are presented.

## INTRODUCTION

*Orobanche aegyptiaca* is a member of the Orobanchaceae family of parasitic plants. In rapeseed mustard crops, it is the most destructive agricultural weed. Numerous Orobanche species, including *O. ramosa*, *O. crenata*, *O. cumana*, *O. foetida*, and *O. cernua*, parasitize a variety of host plants and cause harm to ecosystems around the world (Table-1). Particularly damaging and having a significant global impact are orobanche species (Figure -1). Orobanche is a significant pest in the main mustard-growing regions of India (Figure -2). It can be found in states that grow mustard, including Uttar Pradesh, Madhya Pradesh, West Bengal, and Haryana, and is extremely invasive in several districts of the state of Rajasthan. Orobanche infestation can cause up to 50% crop loss and it is very hard to control due to its robust survival mechanisms.

## BOTANICAL DESCRIPTION

*Phelipanche aegyptiaca* (Syn. *Orobanche aegyptiaca*) is an annual root parasite. The stems are slender (15-50 cm x 0.4-0.6 cm), branched, glandular, and hairy. The leaves are reduced to colorless bracts up to 12 mm long. The flower is a corolla, 20-35 mm long, distinctly funnel-shaped, constricted above the ovary and pale violet to blue, with shaggy anthers. The calyx is four-lobed and bell-shaped, extending to the constriction of the corolla. Plants flower

from January to March, and seeds measure between 0.25 and 0.3 mm long.

## CLASSIFICATION

**Domain:** Eukaryota  
**Kingdom:** Plantae  
**Phylum:** Spermatophyta  
**Subphylum:** Angiospermae  
**Class:** Dicotyledonae  
**Order:** Scrophulariales  
**Family:** Orobanchaceae  
**Genus:** Orobanche  
**Species:** *Orobanche aegyptiaca*

Orobanche is popularly known as Egyptian broomrape in English speaking countries. It is locally known as margoja, rukhri, khumbhi, gulli, bhuiphod and tokra in North India, vakumba in Gujarat, bambaku in Maharashtra, pokayilaikalan in Tamil Nadu, 'bodu' or 'malle' in Andhra Pradesh. The genus Orobanche has more than 150 species among which only a few parasitize agronomic crops. The parasitic members of the Orobanchaceae family are divided into two groups i.e., Broomrapes (*Orobanche spp.*, holoparasites), and Witch weeds (*Striga spp.*, hemiparasites).

*Orobanche aegyptiaca* is considered a severe pest throughout its range and in some cases; infestations have caused farmers to abandon the production of host plants in favor of less profitable non-host crops. It is a prolific producer of tiny seeds, which spread through animals, wind and water, and through cultivation practices. The seeds easily spread from field to field,

and the species has been characterized as a “fast-spreading parasite”. The tiny seeds are “difficult to detect in harvested crop seeds and in soil. Now, scientists at ICAR-DRMR have developed a PCR-based soil testing technique for the detection of Orobanche seeds in the soil. Orobanche can establish a long-term seed bank in the field. One report from a field in Israel suggests that seeds can survive more than 40 years.

## ETIOLOGY

The causal organism *Orobanche aegyptiaca* is an annual, fleshy flowering plant, erect, 25-50 cm high. Stem is more or less round, pale-brown, solitary (or in bunches) thickened at the base, covered with scaly leaves ending in spike, calyx with 2 narrow lobes. Corolla is a white tube with bluish or violet lobes; stamens 4 epipetalous with lobed anthers; ovary superior, one-celled with numerous ovules; stigma rather big and 4-lobed, fruit is 2-valved, capsule containing numerous seeds. Seeds are very minute and very light, ovoid and reticulate. In black soil under normal growing conditions, Orobanche completes its life cycle in 12-14 weeks. Orobanche seed germinates during the 2nd week of the mustard crop and infects the root during 3rd week. Till the end of 5th week, underground infection of Orobanche develops into

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various sizes. On the 6<sup>th</sup> week onwards, Orobanche shoots emerge above ground. Flowering is completed by 8th week, seed formation by 9th week and capsule drying by 10th week end. Drying off commences by 12th week, withering of stem and

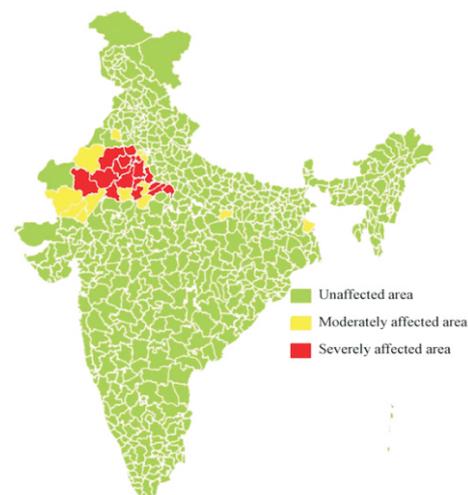
dehiscence of capsules by eleventh and twelfth weeks.

Host root exudates stimulate germination in 21 days at 21°C. Orobanche seeds, being very minute in size, are produced in enormous numbers in

each capsule. When the capsule is dry, it splits open at the top and the small dust-like seeds are easily scattered by wind. They mix up with the soil and remain viable for long periods. Irrigation and drainage water carry the seeds from one field to another. It is also spread through the animals, man or cultivation equipment. Seeds present in the soil and germinate in presence of susceptible hosts.

S. N.	Orobanche Species	Chromosome Number	Host Plants	Yield Loss	Infected Area	Reference
1	<i>Phelipanche aegyptiaca</i> (syn <i>Orobanche aegyptiaca</i> )	2n = 24	Rapeseed-mustard, tomato	Up to 80%	Mediterranean, Africa, Eastern and Southern Europe and Asia	Parker (2013)
2	<i>Orobanche ramosa</i> (L.) Pomel	2n = 24	Carrot, aubergine, hemp, lentil, potato, tomato & tobacco	Up to 70%	Europe, Northern Africa, Asia, southwestern Australia, South and North America	Buschmann et al. (2005)
3	<i>Orobanche cinnamomea</i> Wallr.	2n = 38	Sunflower	up to 50%	Central and Eastern Europe, Spain, Turkey, Israel, Iran, Kazakhstan, and China	Fernández-Martínez et al. (2012)
4	<i>Orobanche crenata</i> Forsk.	2n = 38	Members of family Fabaceae viz. faba bean, chickpea, pea, lentil, vetches etc.	Up to 90%	Mediterranean region, especially in North Africa and the Near East and Western Asia	Ennam et al. (2020)
5	<i>Orobanche cernua</i>	2n = 38	Solanaceous crops: tomato, tobacco, pepper and eggplant	Tomato (30-55%) Tobacco (25-50%)	Pakistan, India, Nepal, Iran, Arabian Peninsula and Egypt	Parker (1994), Parker and Riches (1993)
6	<i>Orobanche foetida</i> Poir.	2n = 38	faba bean	Up to 90%	Western Mediterranean countries, Tunisia, Algeria, Morocco, Spain and Portugal	Abbes et al. (2007)

**TABLE 1.** Important parasitic Orobanche species and its host crops.



**FIGURE 2.** District-wise *Orobanche aegyptiaca* infestation in India.

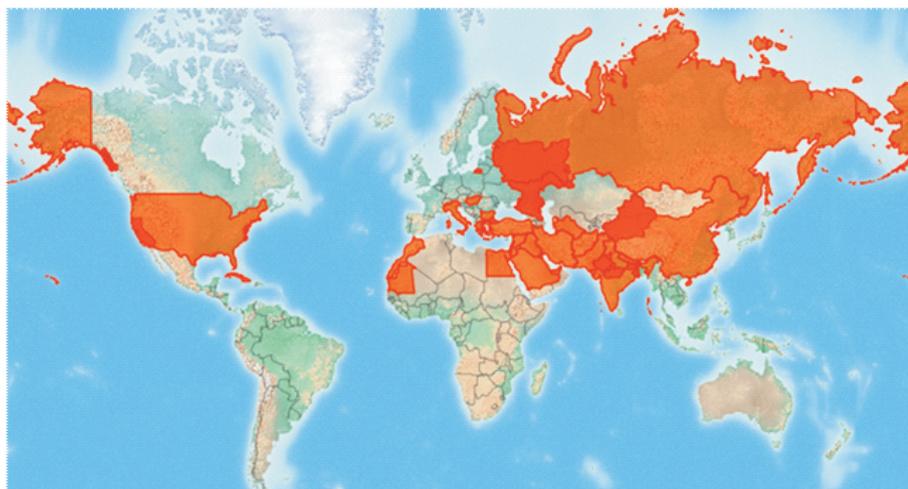
## Management of Orobanche

### (a) Why Orobanche is difficult to control

Unlike non-parasitic weeds, the management of Orobanche has been proved to be exceptionally difficult in rapeseed-mustard crops due to its underground location, close association with host plant roots. This in combination to complex mechanisms of seed dispersal, germination, and longevity make the control of Orobanche very difficult.

### (b) Preventive Method

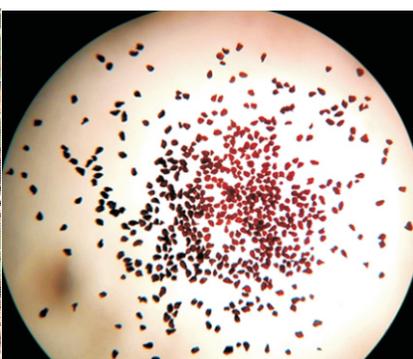
- I. Use healthy and certified planting material of improved varieties free from Orobanche seed contamination.
- II. Clean farm machinery and equipment's to prevent the movement of infested soil to newer areas.
- III. Use well-rotten decomposed farm yard manure, since Orobanche seeds may pass easily through digestive system of the animals without losing viability, so grazing or feeding hay from infested fields should be prohibited/restricted.
- IV. Collect parasite weeds prior to flowering, collect at a place and burn it.



**FIGURE 1.** *Orobanche aegyptiaca* infestation in the world (Orange area), (CABI, 2021).



**FIGURE 3.** *Orobanche aegyptiaca* infested field of Indian mustard (*Brassica juncea*). The highest infestation was observed as 65 Orobanche inflorescence per square meter.



**FIGURE 4.** Seeds of *Orobanche aegyptiaca*. A single plant of *Orobanche* can produce 1-2 lakh seeds and the seeds have the ability to remain viable in the soil for more than 15 years.

S N	Biocontrol Agent	Type	Effective Against	Crop	Mode of Action	Reference
1	<i>Fusarium oxysporum</i> f. sp. <i>orthoceras</i>	Fungus	<i>Orobanche aegyptiaca</i> and <i>Orobanche cumana</i>	Mustard and sunflower	Increases the number of dead spikes	Sharma et al., (2011), Thomas et al., (1999) and Muller-Stover et al., (2004)
2	<i>Ulocladium atrum</i> and <i>Ulocladium botrytis</i>	Fungus	<i>Phelipanche crenata</i>	Legume	Tubercles in vitro and disease symptoms on the shoots	Linke et al., (1992) and Muller-Stover and Kroschel (2005)
3	<i>Myrothecium verrucaria</i>	Fungus	<i>P. crenata</i>	Faba bean	Germination inhibition due to macrocyclic trichothecene and verrucaric alkaloids	El-Kassas et al., (2005)
4	<i>Phytomyza orobanchia</i>	Insect, Agromyzid fly	<i>Phelipanche ramosa</i> and <i>P. crenata</i>	Faba bean and tomato	Monophagous larvae feed within the capsules, markedly diminishing seed multiplication	Klein and Kroschel (2002)

**TABLE 2:** Important biological agents that is effective against different broomrape species.

### (c) Cultural Method

- I. Crop rotation with Orobanche host crops, trap crops and catch crops and non-host crops may reduce the Orobanche infestation. Mono-culture with the same Orobanche host crop, or with other hosts of the same Orobanche species, rapidly increases Orobanche infestation.
- II. Use of trap crops like sorghum, maize, capsicum and castor may help in the reduction of Orobanche seed bank.
- III. Delay in mustard sowing has negative effect on Orobanche.
- IV. The growth and development of Orobanche is affected by high moisture level in the field. Proper water management has negative effect on Orobanche.

### (d) Mechanical and Physical Methods

- I. Hand weeding or hand pulling before flowering followed by burning can be an effective and practical method of checking Orobanche seed production.

- II. Soil solarization of moist soil in summer months kills the imbibed Orobanche seeds.

### (e) Chemical Methods

Use of systemic herbicides can be very effective against Orobanche but it can also damage the host plant. Development of herbicide tolerant Indian mustard to control Orobanche infestation can be an option. Soil fumigation is another method to kill Orobanche seeds but large scale adoption is expensive and may have adverse effect on the environment.

### (f) Biological Methods

There are some reports on managing Orobanche through biological control methods. Table 2 briefed the various biological control methods used for different Orobanche species.

## CONCLUSION

Because of its invasive nature and negative impacts on the mustard plant, Orobanche became a significant economic weed. Due to its underground life cycle, Orobanche is resistant to many chemical and cultural management strategies. As a

result, biotechnological tools and techniques for generating resistance against this parasitic weed must be used. Developing systemic herbicide-mediated resistance in mustard plants can also be explored to manage this notorious weed. Combining all possible integrated pest management approaches can diminish the Orobanche seed bank in soil and successfully restrict its spread.

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