



Short Communication

Effect of Broomrape (*Orobanch* sp.) on yield and contributing traits in Taramira (*Eruca sativa*)

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Abstract

Phelipanche aegyptiaca (Formally is known as *Orobanch* *aegyptiaca*) is a serious parasitic weed and a major constraint on *Brassicaceae* crops, particularly for Rapeseed and Mustard, which causes about 75-80% of yield losses in India. Effect of Broomrape on Taramira (*Eruca sativa*) is a major constraint in its production in Rajasthan. Five Taramira varieties viz. - RTM 2002, RTM 314, RTM 1351, T 27 and RTM 1355 were evaluated in *Orobanch* infested fields and uninfested field in Jobner, Jaipur, Rajasthan. The aim of the study was to determine the critical stage of host plants affected by parasitic weed and to evaluate resistance level of taramira genotypes. The degree of infection and host resistance level was evaluated at three host growing stages (flowering, siliqua formation and maturity stages) using different traits like number of *Orobanch* emerged per plant, per plot, incidence and severity. The agronomic data such as stand count at emergence, flowering, siliqua, maturity, plant height, number of siliquae, seeds per siliqua, test weight and seed yield were recorded from ten randomly selected plants in the field. The analysis of variance showed that there were high significant variations ($p < 0.01$) in measured traits between the three host growing stages and among genotypes in agronomic traits. The effect of *O. aegyptiaca* on host plant was started from the flowering stage, but the siliqua initiation to seed formation stage is economically important stage at which actual effect of the parasite was observed in field experiments. The analysis of variance was carried out for various characters observed under normal and *Orobanch* stress condition. All the genotypes exhibited significant differences for all the characters under both the conditions. The pooled analysis of variance also indicated presence of significant difference among the genotypes for all the characters studied.

Keywords: Broomrape, *Orobanch*, Taramira, *Phelipanche aegyptiaca*, rapeseed and rocket salad

Introduction

Broomrape (*Phelipanche/Orobanch*), regarded as a severe “super sink,” has emerged as a major biotic constraint to taramira [*Eruca sativa* (L.)] cultivation in India, posing a serious challenge to the farming community (Punia 2014). Broomrape belongs to the *Orobanchaceae* family and has several species that infest the roots of many plant species (Fernández-Aparicio, Reboud, and Gibot-Leclerc 2016). Although rapeseed–mustard crops are infested by several weed species, the extent of yield loss and competition for resources varies considerably across agro-ecological regions. Among these, broomrape is particularly destructive due to its obligate holoparasitic nature, as it lacks chlorophyll and is entirely dependent on host plants for its nutritional requirements. The parasite attaches to the roots of rapeseed–mustard plants and continuously withdraws

water, minerals, and photosynthates, resulting in stunted growth, poor crop establishment, and substantial yield reductions. Widespread infestation of *Broomrape* has been reported from major rapeseed–mustard-growing states of India, including Rajasthan, Haryana, Punjab and Madhya Pradesh. Conventional management approaches, such as hand weeding and application of chemical herbicides, have largely failed to provide effective control due to the subterranean nature and prolonged seed viability of the parasite. At present, broomrape-resistant cultivars are not available in most of the rapeseed and mustard due to the underground mechanism of parasitism, infestation of broomrape is not possible to detect at early stages and effective chemical control is not feasible (Watts *et al.*, 2024). Consequently, the development and utilization of *Orobanch*-resistant or tolerant rapeseed–mustard genotypes remain the most promising, economically viable, and environmentally sustainable

strategy for managing this parasitic weed.

Materials and Methods

To address this problem, an initiative was undertaken under the Consortium Research Platform (CRP) on Agrobiodiversity, coordinated by the National Bureau of Plant Genetic Resources (NBPGR), New Delhi. The project aims to identify, evaluate, and utilize resistant germplasm and wild relatives of rapeseed-mustard to develop *Orobanch*-resistant varieties. The field experiments were conducted at the research farm of S.K.N. College of Agriculture, Jobner, a center actively involved in oilseed research and breeding. The release varieties of taramira were used in the experiment against *Phelipanche* /*Orobanch* weed. A spacing of 60 cm between rows and 10 cm between plants was maintained, with each genotype sown in two rows of 4 m length. The number of broomrape weed plants was recorded on fruiting stage of the plants. Total number of parasites on each host plant was also determined randomly from sampling beds. Later, their means were calculated to compare the relative incidence of parasitic weeds among all sampling areas.

Results and Discussion

The analysis of variance was carried out for various characters observed under normal and *Orobanch* stress condition is presented in (Table 1). All the genotypes exhibited significant differences for all the characters under both the conditions. The pooled analysis of variance also indicated presence of significant difference among the genotypes for all the characters (Table 2). Under normal conditions, the analysis revealed that the mean sum of squares due to genotypes was significant to all characters except number of primary and secondary branch, number of *Orobanch* plants/plot indicating that there were substantial differences among the genotypes for excepting some of these. Under *Orobanch*-infestation genotypes revealed that the mean sum of square were significant across all characters except number of secondary branches. *Orobanch* stress markedly influenced the expression of most traits and the significant genetic variation observed suggesting the possibility of selection of superior genotypes with improved yield and broomrape tolerance.

Pooled analysis of variance

The pooled analysis of variance (ANOVA) revealed highly significant differences among genotypes for all the characters studied, indicating the presence of substantial genetic variability in the experimental material (Table 2). Mean sum of squares due to genotypes were significant for days to 50% flowering, days to maturity, plant height,

primary branches per plant, secondary branches per plant, siliquae per plant, 1000 seed weight, seed yield and number of branches per plot. The effect of *Orobanch* indicating highly significant for all traits under study except no. of primary branches, suggesting considerable influence of environmental conditions on the expression of these characters. The genotype x *Orobanch* (G X O) interaction is significant for days to maturity, plant height, siliqua/plant, 1000 seed weight, number of *Orobanch* plant/plot etc. indicating differential performance of genotypes across environments. The pooled error variances were comparatively low for all the characters, reflecting good experimental precision. The significance of (G X O) interaction for important yield and yield contributing traits such as number of branches/plot, seed yield, number of siliquae/plant suggests the need for multi-environment testing to identify stable and widely adapted genotypes.

The mean performance of different varieties under normal and broomrape stress conditions along with per cent reduction in various traits are presented in Table 3. The results clearly indicated that *Orobanch* infestation caused a marked reduction in most of the growth, yield and yield attributing characters across all the varieties studied. Days to 50 percent flowering and days to maturity showed a marginal reduction under broomrape stress. The reduction in days to 50 percent flowering ranged from 4.95 to 5.99 percent, while days to maturity decreased from 1.13 to 4.61 percent across the varieties. Among the varieties, RTM 1351 recorded the minimum reduction in days to 50 percent flowering (4.95%), whereas RTM 2002 exhibited the highest reduction (5.99%). Plant height was adversely affected by *Orobanch* infestation, with percent reduction ranging from 1.64 to 5.61 per cent. The highest reduction in plant height was observed in variety T 27 (5.61%), while RTM 1351 showed the least reduction (1.64%). The number of primary and secondary branches per plant decreased considerably under stress conditions. The per cent reduction in number of primary branches ranged from 0.00 to 6.67%. Variety RTM 1351 did not show any reduction in primary branches, whereas RTM 314 recorded highest reduction (6.67%) while reduction in secondary branches varied from 6.45 to 21.62 per cent.

Yield-contributing traits such as number of seeds per siliqua, siliqua length and number of siliqua per plant were significantly reduced under *Orobanch* stress. The reduction in number of seeds per siliqua ranged from 25.35 to 28.57 per cent, siliqua length from 8.49 to 13.59 per cent and number of siliquae per plant from 19.42 to 27.16 per cent. Among the varieties, T 27 recorded the highest reduction in number of seeds per siliqua (28.57%), whereas RTM 2002 showed comparatively lower

Table 1: ANOVA showing mean sum of squares of various characters

Treatment	Source of variation	df	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branch (no.)	Secondary branch (no.)	Seed/silique (no.)	Silique length (cm)	Siliquae/plant (no.)	1000 seed weight	Seed yield (kg/ha)	Orobanchae/plot (no.)
Normal	Genotype	4	21.13**	25.30**	28.57**	2.05	1.55	3.17**	0.18**	907.07**	0.24**	21182.83**	1.18
	Error	12	0.72	1.70	0.91	1.48	0.82	0.51	0.01	17.61	0.03	1383.22	0.51
Orobanchae	Genotype	4	17.80**	50.20**	28.95**	1.70*	1.00	2.58**	0.13*	400.12**	0.46**	160310.70**	2349.58**
	Error	12	0.67	1.53	2.18	0.60	0.73	0.34	0.03	29.52	0.01	1715.90	251.14

*Significant at 5% and **1% level of significance

Table 2: Pooled ANOVA for different characters

Source of variation	df	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branch (no.)	Secondary branch (no.)	Seed/silique (no.)	Silique length (cm)	Siliquae/plant (no.)	1000 seed weight	Seed yield (kg/ha)	Orobanchae/plot (no.)
Genotype (G)	4	38.78**	67.40**	83.02**	4.29**	1.71**	5.65**	0.30**	1219.24**	0.63**	136150.34**	1195.96**
Orobanchae(O)	1	87.03**	152.10**	122.50**	0.63	16.90**	240.10**	0.90**	7270.79**	19.50**	2354675.63**	112678.23**
G x O	24	0.02	1.35**	0.75*	0.01	0.14	0.02	0.00	14.66**	0.01*	7557.20	192.46**
Pooled Error	120	0.19	0.41	0.45	0.25	0.20	0.15	0.01	6.72	0.01	334.50	41.87

*Significant at 5% and **1% level of significance

reduction. The 1000 seed weight was severely affected by *Orobanche* infestation, with per cent reduction ranging from 29.74 to 46.32%. The highest reduction was recorded in RTM 314 (46.32%), while RTM 1355 showed the lowest reduction (29.74%). Seed yield showed a substantial decline under *Orobanche* stress across all varieties. The per cent reduction in seed yield ranged from 30.91 to 49.57%. The highest reduction in seed yield was observed in RTM 314 (49.57%), whereas RTM 1355 recorded the minimum reduction (30.91%), indicating better tolerance to *Orobanche* infestation. The number of *Orobanche* shoots per plot was considerably higher under infested conditions, with maximum infestation recorded in variety T 27, while RTM 2002 and RTM 1351 showed relatively lower infestation levels.

Overall, the results demonstrated that *Orobanche* stress significantly reduced growth and yield attributes of all the varieties; however, RTM 1355 and RTM 1351 exhibited comparatively better performance and tolerance under *Orobanche* stress conditions.

There is not much information about the broomrape losses to *E. sativa* in India. Therefore, the present study identified the infestation and damage caused by broomrape to *E. sativa*. Furthermore, various morphological and yield loss by broomrape was also estimated to collect more information on this species. In India, different species of broomrape infest a range of agriculturally important crops (Akhter, Khan, and Zafar 2018; Dinesha and Dhanapal 2013; Maharshi 2001; Rani *et al.*, 2023). Taramira is highly affected by broomrape and damaged upto 73% yield losses. Broomrape is emerging as a great menace affecting many agriculturally important crops. In *B. juncea* it can affect plant height, number of branches, and number of siliques (Khatun *et al.*, 2016). Similarly, in our experiment results exhibited significant reduction in plant height, number of primary and secondary branches, number of siliques, and seed yield. Under normal conditions, highly significant variation among genotypes was observed for days to 50% flowering, days to maturity, plant height, seeds per silique, silique length, siliques per plant, 1000-seed weight and seed yield per plant, while primary branches, secondary branches and *Orobanche* count per plot showed non-significant differences.

The genotype $\times$ *Orobanche* interaction was significant for days to maturity, plant height, secondary branches, siliques per plant, seed yield and *Orobanche* count per plot, suggesting variable levels of tolerance among genotypes and the possibility of identifying stable performers under both normal and infested conditions. Data (Table 3) showed a consistent reduction in growth

Table 3: Mean values and percent reduction of different traits of the varieties under *Orobanche* stress condition

Variety	Environment	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branch (no.)	Secondary branch (no.)	Seed/silique (no.)	Silique length (cm)	Siliques/plant (no.)	1000 seed weight	Seed yield (kg/ha)
RTM 2002	Normal	54.25	132.50	99.75	6.75	7.75	17.75	2.28	117.25	3.35	1090.75
	<i>Orobanche</i>	51.00	131.00	95.75	6.50	6.25	13.25	2.05	92.84	1.93	715.75
RTM 314	Per cent reduction	5.99	1.13	4.01	3.70	19.35	25.35	9.89	20.82	42.45	34.38
	Normal	56.75	136.75	102.75	7.50	8.25	19.25	2.48	88.50	3.33	1039.50
RTM 1351	<i>Orobanche</i>	53.75	133.75	99.50	7.00	7.50	14.25	2.15	71.31	1.79	524.25
	Per cent reduction	5.29	2.19	3.16	6.67	9.09	25.97	13.13	19.42	46.32	49.57
T 27	Normal	50.50	130.25	106.50	7.75	8.50	19.50	2.85	102.50	3.69	1175.25
	<i>Orobanche</i>	48.00	124.25	104.75	7.75	6.75	14.50	2.48	74.75	2.13	686.25
RTM 1355	Per cent reduction	4.95	4.61	1.64	0.00	20.59	25.64	13.16	27.07	42.24	41.61
	Normal	55.00	135.25	102.50	7.75	7.75	17.50	2.58	116.25	3.14	976.50
T 27	<i>Orobanche</i>	52.00	129.25	96.75	7.50	7.25	12.50	2.23	85.34	1.77	259.75
	Per cent reduction	5.45	4.44	5.61	3.23	6.45	28.57	13.59	26.59	43.59	73.40
RTM 1355	Normal	53.50	134.25	105.50	8.75	9.25	18.75	2.65	127.25	3.69	1068.50
	<i>Orobanche</i>	50.50	131.25	102.75	8.50	7.25	13.75	2.43	92.69	2.59	738.25
T 27	Per cent reduction	5.61	2.23	2.61	2.86	21.62	26.67	8.49	27.16	29.74	30.91

and yield traits under *Orobanche* infestation. Flowering and maturity were slightly reduced, indicating stress-induced early phenology. Plant height and branching traits were moderately affected, while greater reductions were observed in seeds per silique, silique length, siliques per plant and 1000-seed weight, reflecting the severe effect of the parasite on reproductive development. Seed yield declined substantially under infestation across all varieties, though the extent of reduction varied among genotypes. Varieties RTM-1355 and RTM-1351 showed comparatively lower reduction in yield traits, suggesting better tolerance to *Orobanche* stress. *Orobanche* shoots per plot also varied widely among varieties, and genotypes with lower *Orobanche* count generally maintained better yield performance, indicating possible resistance or tolerance mechanisms.

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