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Screening of brinjal (*Solanum melongena* L.) varieties against obligate root parasite, *Orobanche aegyptiaca*

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ABSTRACT

Among the major weed groups that cause huge economic losses to important cropping systems, Egyptian broomrape, Orobanche aegyptiaca is a parasitic weed causing major yield loss in many field and vegetable crops. It is also a serious threat to brinjal. So far no efficient and economic control has been found. Hence, in the present study, thirty brinjal varieties were screened for their resistance to obligate holo root parasite, O. aegyptiaca infection. Out of 30 brinjal varieties, sixteen varieties (Black Beauty, Brinjal No. 38, Chamak, Govinda, Green Round, Harshit, Nav Kiran, Nishant, P.K.123, Prabha Kiran, Prasad, Sukhda, Surya Kiran, Ujjwal, VNR-51 and VNR-60) were highly susceptible, ten varieties (Brinjal 1 Hybrid, Brinjal Advance, Brinjal BSS 1013, Brinjal Green long, Hybrid Green, J.K Kajal, Neel Kamal, Prapti, Shamli and Utkal) were susceptible, three varieties (Mahy 112, Mahy 80 and Nagina) were tolerant, and only one Mahy Ruby was moderately resistant. Moreover, none of the brinjal variety was recorded as resistant against O. aegyptiaca.

Keywords **:** *Orobanche aegyptiaca*, parasitic weed, *Solanum melongena*, resistance and susceptibility

Brinjal or eggplant (*Solanum melongena* L.) is an important solanaceous vegetable of sub-tropics and tropics. In India, brinjal is one of the most common, popular and principal vegetable crops grown throughout the country except at higher altitudes. Among the major weed groups that cause huge economic losses to important cropping systems, *Orobanche* species are greatly devastating. They are widespread and attacking crops in the Mediterranean areas in Asia, Southern and Eastern Europe and North Africa (Parker and Riches, 1993). In India, due to the high parasitic seed bank in agricultural soils of Haryana, Punjab, Northern Rajasthan, Western Uttar Pradesh, Bihar and Northeast Madhya Pradesh, the biotic potential of crops has declined greatly below the optimal levels (Pathak and Kannan, 2014; Punia *et al.*, 2014; Akhter and Khan, 2018a).

The *Orobanche* spp. cause severe damage to a wide array of dicotyledonous families such as Apiaceae, Amaryllidaceae, Asteraceae, Brassicaceae and Solanaceae (Parker and Riches 1993; Gibot-Leclerc *et al.*, 2001; Akhter *et al*., 2018(a &b); Akhter and Khan 2018(a); Akhter and Khan 2018(b); Akhter and Khan 2018(c). The yield losses due to *Orobanche* spp. vary between 5 to 100 per cent depending upon host susceptibility, level of infestation and environmental conditions (Abang *et al.*, 2007). In brinjal, *Orobanche aegyptiaca* has been reported to cause a yield loss of about 30-35% (Prasad *et al*., 2009). The modus operandi of these highly competitive plant parasites is to attach themselves with the crop root and divert minerals, water and even nutrients, mainly carbohydrates and amino acids (Foy *et al*., 1988). The wide spread and incidence of herbicide resistant weeds is a global problem. The chemical control and cultural practices have been developed against the weed, but, these have been reported to be quite unsuccessful (Sauerborn *et al*., 1989; Castejon-Munoz *et al.*, 1993; Bhowmik, 2014; Bhutadra and Bhale, 2015; Ghosh *et al.*, 2016). The use of resistant crop varieties is viewed as the most reliable and economically feasible means of parasitic weeds management. Therefore, present study was conducted to evaluate the response of different varieties of brinjal against *O. aegyptiaca*to find out the resistant variety.

The seeds of *O. aegyptiaca* were collected during a preliminary field survey of Banda district of Uttar Pradesh (2014-15). The preconditioning of surface sterilized seeds of *O. aegyptiaca* was done according to Plakhine *et al*.(2009). The required amount of preconditioned seeds was mixed with sterilized soil sieved thorough 25 mesh sieve, in such a way that 10 g soil contained 8 mg orobanche seeds. To raise the brinjal seedlings, surface sterilized seeds of each brinjal variety *viz*., Black Beauty, Brinjal 1 Hybrid, Brinjal Advance, Brinjal BSS 1013, Brinjal Green long, Brinjal No- 38, Chamak, Govinda, Green Round, Harshit, Hybrid green, JK Kajal, Mahy 112, Mahy 80, Mahy Ruby, Nagina, Nav Kiran, Neel kamal, Nishant, P.K-123, Prabha Kiran, Prapti, Prasad, Shamli, Sukhda, Surya kiran, Ujjwal, Utkal, VNR-51 and VNR-60 were sown in 12"inches autoclaved pots containing 4 kg sterilized soil + farm yard manure (3:1) mixture. After that, three weeks old seedlings of each variety were transplanted in 12 inches autoclaved earthen pots containing 4 kg sterilized soil + farm yard manure (3:1) mixture.

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Five days after transplantation, the top layer of the soil was carefully removed to expose the root system and roots of the seedlings were inoculated with preconditioned seeds of *O. aegyptiaca* @ 8 mg seeds pot^{-1}. For inoculation, 10 g soil infested with 8mg orobanche seeds was sprinkled uniformly all around the exposed roots of the test plant with the help of common salt sprinkler. Thereafter, exposed roots were immediately covered after inoculation by leveling the soil properly. The uninoculated brinjal seedlings of respective varieties were served as control. Each treatment was replicated three times. The pots were arranged in complete randomized block designs in an open field. The pots were irrigated as and when required. The newly emerged *O. aegyptiaca* shoots were counted periodically till the termination of experiment. After 90 days of inoculation, the brinjal plants were carefully uprooted. The roots were gently washed in water to observe the attachment of *O. aegyptiaca* with brinjal roots. The dry weight and number of necrotic and non-necrotic tubercles, unemerged and emerged shoot per plant were determined. The growth parameters of brinjal such as plant length (cm), plant fresh and dry weight (g) were also measured. The percentage reduction in growth parameters over respective control was calculated. Data was analyzed by one-way analysis of variance and Least Significant Difference was calculated at p = 0.05 and p =0.01 level of probability to test for significance by using SPSS software version 16.

The degree of resistance and susceptibility of different brinjal varieties against *O. aegyptiaca* was determined by using the following index.

1. Necrotic tubercles present, unemerged and emerged *O. aegyptiaca*shoots absent and no significant reduction in host dry weight = **Resistant (R**).
2. Number of non-necrotic tubercles < 5.0, unemerged and emerged *O. aegyptiaca* shoots absent, dry weight of non- necrotic tubercles < 2.0 g and no significant reduction in host dry weight = **Moderately Resistant (MR).**
3. Number of *O. aegyptiaca* (non- necrotic tubercles, unemerged and emerged shoots) 5.1-10.0, dry weight of *O. aegyptiaca* (non- necrotic tubercles, unemerged and emerged shoots) 2.1-5.0 g and significant reduction in host dry weight <10.0 % = **Tolerant (T).**
4. Number of *O. aegyptiaca* (non- necrotic tubercles, unemerged and emerged shoots) 10.1-15.0, dry weight of *O. aegyptiaca* (non- necrotic tubercles, unemerged and emerged shoots) 5.1-10.0 g and significant reduction in host dry weight 10.1- 25.0 % = **Susceptible (S).**
5. Number of *O. aegyptiaca* (non- necrotic tubercles, unemerged and emerged shoots) >15.0, dry weight of *O. aegyptiaca* (non- necrotic tubercles, unemerged and emerged shoots) >10.0 g and significant reduction in host dry weight > 25.0 % = **Highly Susceptible (HS).**

The results presented in the table 1 and 2 revealed that the brinjal varieties grown in pots inoculated with *O. aegyptiaca* seeds responded differently to the infection of *O. aegyptiaca* and no variety was observed as immune or resistant to *O. aegyptiaca*. Among the 30 varieties of brinjal, the highest reduction in dry weight of brinjal plant, maximum number of *O. aegyptiaca* (tubercles, unemerged and emerged shoot) pot^{-1} and its dry weight were recorded in variety Nav Kiran grown in pots infested with *O. aegyptiaca.* However, on the other hand, the lowest reduction in host dry weight, minimum number of *O. aegyptiaca* per pot and its dry weight were seen in variety Mahy Ruby.Out of thirty varieties tested, sixteen varieties (Black Beauty, Brinjal No. 38, Chamak, Govinda, Green Round, Harshit, Nav Kiran, Nishant, P.K.123, Prabha Kiran, Prasad, Sukhda, Surya Kiran, Ujjwal, VNR-51 and VNR-60) exhibited highly susceptible reaction to *O. aegyptiaca* on the basis of percentage reduction in dry weight of brinjal against their respective control, number and dry weight of *O. aegyptiaca* (tubercles, unemerged and emerged shoots). Ten varieties (Brinjal 1 Hybrid, Brinjal Advance, Brinjal BSS 1013, Brinjal Green long, Hybrid Green, J.K Kajal, Neel Kamal, Prapti, Shamli and Utkal) showed the susceptible response on the basis of percentage reduction in brinjal dry weight as compared to the control, number and dry weight *O. aegyptiaca*(tubercles unemerged and emerged shoots). Furthermore, three varieties *viz.*, Mahy 112, Mahy 80 and Nagina showed tolerant reaction on the basis of same rating index. However, on the other hand, only one brinjal variety Mahy ruby showed moderately resistant response to *O. aegyptiaca* when reduction in dry weight of brinjal plant, number of *O. aegyptiaca* shoots and their dry weight were collectively taken as the parameters for resistance rating.

To the best of our knowledge, so far no work has been carried out to on the screening of brinjal varieties against *O. aegyptiaca*. However, Dalela and Mathur (1971) screened 128 varieties of brinjal against *Orobanche cernua*. They found that out of 128 varieties, only seven brinjal varieties *viz.*, D-12-2-66, DC-4-1-67, E-147, Pusa Purple Long x Manjri Gota, Pusa Purple Long x Nurki, Running King and Verma's Giant showed resistant reactions, and variety Black beauty was found

Table1: Response of brinjal varieties on the growth parameters against *Orobanche aegyptiaca*

Variety	Treatment	Plant dry weight (g)			Percentage reduction over control
		Shoot	Root	Total (mean ± SE)*	
Black Beauty	Control	22.35	12.44	34.79±1.146	
	Inoculated	15.63	8.30	23.93±0.897	31.22
	LSD(0.05)			3.142	
Brinjal 1Hybrid	Control	33.35	21.43	54.78±1.483	
	Inoculated	26.8	15.90	42.70±1.232	22.05
	LSD (0.05)			3.953	
Brinjal Advance	Control	27.47	14.77	42.24±1.345	
	Inoculated	21.65	11.4	33.05±1.201	21.76
	LSD(0.05)			3.565	
Brinjal BSS 1013	Control	25.33	17.23	42.56±1.495	
	Inoculated	18.45	15.35	33.80±1.231	20.58
	LSD(0.05)			3.326	
Brinjal Green long	Control	31.10	18.20	49.30±1.203	
	Inoculated	26.33	14.21	40.54±1.102	17.77
	LSD(0.05)			3.431	
Brinjal No- 38	Control	32.33	17.55	49.88±1.453	
	Inoculated	22.33	11.33	33.66±0.892	32.52
	LSD(0.05)			4.355	
Chamak	Control	20.33	14.45	34.78±1.254	
	Inoculated	14.52	10.62	25.14±0.942	27.72
	LSD(0.05)			3.426	
Govinda	Control	14.43	11.33	25.76±0.890	
	Inoculated	10.30	8.11	18.41±0.485	28.53
	LSD(0.05)			2.792	
Green Round	Control	21.10	16.04	37.14±1.304	
	Inoculated	16.02	8.55	24.57±1.212	33.84
	LSD(0.05)			3.106	
Harshit	Control	24.33	13.45	37.78±1.365	
	Inoculated	15.55	9.25	24.80±1.023	34.36
	LSD(0.05)			3.416	
Hybrid green	Control	24.25	19.10	43.35±1.465	
	Inoculated	23.05	12.10	35.15±1.203	18.92
	LSD(0.05)			3.731	
JK Kajal	Control	24.20	16.10	40.30±1.249	
	Inoculated	19.20	12.12	31.32±.980	22.28
	LSD(0.05)			3.843	
Mahy 112	Control	22.04	14.13	36.17±1.457	
	Inoculated	20.75	12.2	32.95±1.203	8.90
	LSD(0.05)			3.116	
Mahy 80	Control	14.23	8.93	23.16±.983	
	Inoculated	13.50	7.90	21.40±.902	7.60
	LSD(0.05)			2.026	
Mahy Ruby	Control	23.33	13.40	36.73±1.293	
	Inoculated	22.49	12.20	34.69±0.893	5.55
	LSD(0.05)			2.755	
Nagina	Control	20.67	10.15	30.82±1.203	
	Inoculated	19.22	8.67	27.89±.908	9.51
	LSD(0.05)			2.474	

Contd..

Table 1 Contd..

Variety	Treatment	Plant dry weight (g)			Percentage reduction over control
		Shoot	Root	Total (mean ± SE)*	
Nav Kiran	Control	35.2	15.67	50.87±1.683	
	Inoculated	21.4	10.25	31.65±1.203	37.78
	LSD(0.05)			3.345	
Neel kamal	Control	18.29	13.60	31.89±1.013	
	Inoculated	15.19	9.52	24.71±1.070	22.51
	LSD(0.05)			2.943	
Nishant	Control	27.67	18.45	46.12±1.203	
	Inoculated	19.33	14.33	33.66±1.084	27.02
	LSD(0.05)			3.202	
P.K-123	Control	18.45	14.83	33.28±0.945	
	Inoculated	14.35	7.22	21.57±0.982	35.19
	LSD(0.05)			2.941	
Prabha Kiran	Control	26.67	17.20	43.87±1.023	
	Inoculated	18.12	9.63	27.75±1.304	36.74
	LSD(0.05)			3.353	
Prapti	Control	25.00	16.67	41.67±1.453	
	Inoculated	19.43	11.93	31.36±1.304	24.74
	LSD(0.05)			3.704	
Prasad	Control	27.60	18.35	45.95±1.453	
	Inoculated	19.20	10.1	29.30±1.343	36.24
	LSD(0.05)			2.962	
Shamli	Control	25.8	13.57	39.37±1.394	
	Inoculated	20.67	10.85	31.52±1.230	19.94
	LSD(0.05)			2.345	
Sukhda	Control	21.13	16.25	37.38±1.203	
	Inoculated	15.83	9.45	25.28±0.956	32.37
	LSD(0.05)			2.345	
Surya kiran	Control	26.67	17.2	43.87±1.145	
	Inoculated	18.12	9.63	27.75±0.976	36.74
	LSD(0.05)			3.353	
Ujjwal	Control	25.00	16.67	41.67±1.543	
	Inoculated	19.43	11.93	31.36±0.873	24.74
	LSD(0.05)			3.704	
Utkal	Control	26.67	17.55	44.22±1.254	
	Inoculated	19.45	14.45	33.90±1.203	23.34
	LSD(0.05)			4.021	
VNR-51	Control	21.67	10.72	32.39±0.902	
	Inoculated	14.77	8.20	22.97±0.897	29.08
	LSD(0.05)			2.403	
VNR-60	Control	18.43	17.33	35.76±1.302	
	Inoculated	15.60	9.25	24.85±1.056	30.51
	LSD(0.05)			2.935	

Note: Each value is the mean of three replicates

Table 2: Response of brinjal varieties on the growth parameters of *Orobanche aegyptiaca*

Name of Variety	No. of *Orobanche* pot^{-1}			Total	Dry weight of *Orobanche* shoots pot^{-1} (g)				Response of variety
	Tubercles	Unemerged	Emerged		Tubercles	Unemerged	Emerged	Total	
Black Beauty	5.67	4.33	5.33	15.33	3.24	3.08	6.45	12.77	HS
Brinjal 1 Hybrid	4.33	4.67	2.67	11.67	3.33	2.47	2.86	8.66	S
Brinjal Advance	6.67	4.67	2.33	13.67	3.24	1.73	3.61	8.58	S
Brinjal BSS 1013	4.33	4.33	3.67	12.33	3.33	3.55	2.86	9.74	S
Brinjal Green long	3.33	3.33	4.33	10.99	2.02	0.74	3.81	6.57	S
Brinjal No- 38	5.33	4.67	5.33	15.33	1.75	4.56	8.67	14.98	HS
Chamak	6.33	5.33	6.67	18.33	1.74	2.67	8.35	12.76	HS
Govinda	4.33	8.33	5.33	17.99	3.74	1.73	7.92	13.39	HS
Green Round	2	10.33	3.33	15.66	3.65	3.08	6.75	13.48	HS
Harshit	2	13.33	5	20.33	1.67	2.85	12.45	16.97	HS
Hybrid green	4	2.67	3.67	10.34	3.01	0.99	2.25	6.25	S
JK Kajal	4.67	6.67	3.33	14.67	1.99	2.13	1.5	5.62	S
Mahy 112	4	4.44	0	8.44	1.32	1.64	0	2.96	T
Mahy 80	3	5.33	1	9.33	1.35	3.34	0	4.69	T
Mahy Ruby	3.67	0	0	3.67	0.6	1.33	0	1.93	MR
Nagina	3.33	4.33	0	7.66	1.63	3.1	0	4.73	T
Nav Kiran	10.33	8.67	12.33	31.33	5.75	4.32	12.26	22.33	HS
Neel kamal	4.33	3.33	5.33	12.99	3.33	2.47	3.19	8.99	S
Nishant	4.33	3.0	9.33	16.66	1.74	1.9	12.2	15.84	HS
P.K-123	3.33	5.33	4.67	13.33	4.2	3.82	7.18	15.2	HS
Prabha Kiran	3.67	6.67	5.33	15.67	5.46	5.89	6.67	18.02	HS
Prapti	3.33	4.67	6.67	14.67	2.22	1.9	2.4	6.52	S
Prasad	4.33	5.33	3	12.66	2.36	4.21	6.33	12.9	HS
Shamli	5.67	4.67	3.33	13.67	3.12	2.71	4.05	9.88	S
Sukhda	3.67	5.33	4.67	13.67	1.35	2.1	8.34	11.79	HS
Surya kiran	4.33	5.67	6.67	16.67	3.43	4.48	9.98	17.89	HS
Ujjwal	4.33	4.67	8.33	17.33	2.67	4.82	7.39	14.88	HS
Utkal	4.33	2.67	6.33	13.33	1.33	2.47	3.67	7.47	S
VNR-51	6.33	5.33	6.67	18.33	2.49	4.32	7.68	14.49	HS
VNR-60	3.67	3.33	8.33	15.33	2.56	3.62	9.64	15.82	HS

susceptible to *O. cernua*. However, in our findings the variety Black beauty exhibited highly susceptible reaction to *O. aegyptiaca.*

The application of herbicide, though very effective, is not attractive to the farmer community due to their high costs and hazardous effects. The use of resistant varieties and herbicide are the main strategies to prevent yield losses caused by this parasitic weed. Therefore, it was concluded from the above results that the brinjal varieties exhibited moderately resistant (Mahy Ruby) and tolerant (Mahy 112, Mahy 80 and Nagina) response against *O. aegyptiaca* may be used as a key component of integrated management programme.

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