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Control of broomrape in Indian mustard

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ABSTRACT

To study the efficacy of pendimethalin alone or in combination with neem cake and castor cake, seed treatment with various herbicides and post-emergence application of glyphosate at very low concentrations, field experiments were conducted during *Rabi* season of 2008-09 and 2009-10, at village Obera, Distt. Bhiwani and Dry land Research Area of CCS HAU Hisar (Haryana). Feasibility of adoption of results of study was tested by multi location field trials conducted through farmers' participatory approach in different parts of state during 2010-2013. Pre-emergence, pre-plant incorporation or herbigation of pendimethalin along with hoeing as well as use of organic manures, *viz.* castor cake and neem cake proved ineffective in minimizing density of this weed. Seed coating of mustard seeds with 1.0 ppm of chlorsulfuron or triasulfuron gave 70-98% control of *Orobanche aegyptiaca* but efficacy of seed treatment with sulfosulfuron was poor. Post emergence application of glyphosate at 25 and 50 g/ha with 1% solution of $(NH_4)_2SO_4$ at 25 and 55 DAS showed promise with 63-100% control of this weed not only in experimental fields but in large scale farmers' fields. Glyphosate dose range is very limited. Over dosing of glyphosate, resulted in 15-35% toxicity to mustard in terms of marginal leaf chlorosis, slow leaf growth and bending of apical stems and stunting with yield penalty. Bleaching of few leaves of mustard occurred with 50 g/ha dose at 55 DAS, which also recovered within 20 days resulting with no loss in yield.

Key words: Castor cake, Chlorsulfuron, Glyphosate, Indian mustard, Neem cake, *Orobanche*, Sulfosulfuron, Triasulfuron

Orobanche or Broomrape (*Orobanche* spp.), locally known as Margoja, Rukhri, Khumbhi or Gulli, is a phanerogamic, obligate, troublesome holo root parasite that lack chlorophyll (Saghir *et al.* 1973) and obtain carbon, nutrients, and water through haustoria which connect the parasite with the host vascular system. (Press *et al*. 1986). The attached parasite functions as a strong metabolic sink, often named "super- sink", strongly competing with the host plant for water, minerals and assimilates. The diversion of these substances to the parasitic weed causes moisture and assimilate starvation, host plant stress and growth inhibition leading to extensive reduction in crop yield and quality in infested fields. Depending upon the extent of infestation, environmental factors, soil fertility, and the crops' response, damage from *Orobanche* can range from zero to complete crop failure (Dhanapal *et al.* 1996). This parasitic weed has the tendency to proliferate well in coarse textured soils with high pH, low nitrogen status and poor water holding capacity. In Haryana state, infestation of obnoxious weed *Orobanche aegyptiaca* has been observed in mustard fields in 0.25 m ha area in South-Western part of the state. Pre-emergence, Pre- plant incorporation or herbigation of trifluralin along with hoeing proved ineffective in minimizing the density of this weed. Post emergence application of glyphosate at normal doses, kerosene oil and paraquat caused toxicity to mustard crop. Change in the genotype or sources of nutrient supply did not prove effective in minimizing density of this weed. Keeping it in view, present experiment was planned to study the effectiveness of neem and castor cakes, seed treatment with herbicides and post-emergence application of glyphosate at low doses against *Orobanche* in mustard crop.

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MATERIALS AND METHODS

The experiment was conducted at the farm of farmer of village Obera of Distt. Bhiwani situated at latitude of N 28 ° 41' 07.1" and E 075 ° 45' 18.9". During *Rabi* 2008-09. Variety '*RH-30*' was planted on 18.10.2008 in randomized block design in plot size of 25 x 5 m^2 with three replications and 15 treatments. During 2009-10, same experiment with some modifications like addition of castor cake and seed treatment with chlosulfuron and neem cake in combination with glyphosate was conducted at Dry land Research area of CCS HAU Hisar in randomized plot design with three replications in a plot size of 6 x 6 m^2. In the same year, another study to evaluate the effect of neem and castor cakes alone and with post-

emergence treatment of glyphosate at 50 g/ha was also conducted in Village Obera (Bhiwani) on 24 october 2009 in a plot size of 16 x 6 m². During all the years of study, fields selected were heavily infested with *Orobanche aegyptiaca* during previous years. Various treatments were imposed as per schedule as given in tables 1-3. Data on per cent visual control of the weed was recorded at 80 and 120 days of sowing. Results obtained from these trials were further validated in large scale multi-location trials conducted at different locations in Haryana through farmers' participatory approach during the *Rabi* seasons of 2010-11 to 2013-14. A total of 157 demonstrations were conducted in mustard growing areas of Haryana state covering 253 ha area.

RESULTS AND DISCUSSION

During both the years, pendimethalin alone or in combination with neem cake did not prove useful in minimizing population of *Orobanche aegyptiaca* at village Obera (Bhiwani) as well as at Hisar. Neem and castor cakes either alone or in combination with pendimethalin, did not prove effective in minimizing *Orobanche* population as shown by significantly higher population and poor control of this weed in these treatments as compared to glyphosate at various dose (Table 1 and 2). Even application of neem cake twice (in furrow as well as before first irrigation) at 400 kg/ha did not prove effective against *Orobanche* (15-22% control only) but when neem and castor cakes were supplemented with glyphosate at 50 g/ha at 55 DAS, it proved highly effective with 90-92% control of *Orobanche* with 5% crop suppression but with out any yield penalty (Table 3). Seed coating of mustard seeds with 1.0 ppm solution of chlorsulfuron or triasulfuron gave 70-98% control of *O. aegyptiaca*. Efficacy of seed treatment with sulfosulfuron at 1.0 ppm was less (55-65%) but its use with post-emergence glyphosate application at 25 g/ha at 55 DAS provided good (81-87%) control of *Orobanche* up to 120 days after sowing (Table 1 and 2). The crop showed growth suppression from the very initial stage, resulting in poor yield. All glyphosate treatments proved very effective and provided 86-100% control of *O. aegyptiaca*. Although application of glyphosate 50 g/ha at 25 DAS with 1% solution of $(NH_4)_2SO_4$ gave 98% control of this weed with 35% suppression in crop growth in terms of marginal leaf chlorosis, slow leaf growth, bending of apical stems and even stunting. The crop recovered with irrigation after 3-4 days of herbcide application but with less yield even to untreated check during 2008-09. During 2009-10, although application of glyphosate 50 g/ha at 30 DAS and 25 g/ha at 55 DAS along with $(NH_4)_2SO_4$ gave 100% control of the weed, about 15% suppression in crop growth was observed at Hisar. Three hand hoeings employed at 30, 60 and 90 DAS did not prove effective against this weed.

Table 1. Effect of weed control measures on *Orobanche* population and seed yield of mustard (2008-09)

Treatment	*Orobanche* panicles /plot (80 DAS)	*Orobanche* panicles /plot (120 DAS)	% *Orobanche* reduction over WC (120 DAS)	Mustard yield (t/ha)	Remarks
Pendimethalin 1.0 kg/ha *fb* HW at 60 DAS	1.0 (0)	8.4 (70)	26.6	1.52	
Neemcake 200 kg/ha in furrow *fb* HW at 60 DAS	1.4(1)	6.2(38)	59.6	1.56	
Neemcake 200 kg/ha in furrow and pendimethalin 0.5 kg/ha *fb* HW at 60 DAS	2.0(3)	8.4(69.3)	26.6	1.46	
Neemcake 400 kg/ha in furrow *fb* HW at 60 DAS	2.1(4)	9.0(79.7)	14.9	1.38	
Neemcake 400 kg/ha in furrow and pendimethalin 0.5 kg/ha *fb* HW at 60 DAS	1.4(1)	10(100)	+8.8	1.27	
Glyphosate 25 g/ha with 1% $(NH_4)_2SO_4$ at 25 DAS	1.4(1)	4.2(16.7)	83.0	1.78	
Glyphosate 25 g/ha with1% $(NH_4)_2SO_4$ at 55 DAS	1.7(2)	1.7(2)	96.9	1.84	
Glyphosate 25 g/ha with $(NH_4)_2SO_4$ at 25 DAS and 50 g/ha at 55 DAS	1.0(0)	1.6(1.7)	97.8	1.98	
Glyphosate 50 g/ha with 1% $(NH_4)_2SO_4$ at 25 DAS	1.0(0)	1.3(0.7)	98.0	1.25	35% crop suppression
Glyphosate 25 g/ha with 1% $(NH_4)_2SO_4$ at 25 and 55 DAS	1.0(0)	1.4(1)	98.0	1.96	
Seed treatment with triasulfuron 1.0 ppm	1.9(3)	5.4(28)	70.2	1.79	
Seed treatment with sulfosulfuron 1.0 ppm	1.4(1)	5.8(32.3)	65.9	1.65	
Seed treatment with sulfosulfuron 1.0 ppm+ glyphosate 25 g/ha at 55 DAS	1.4(1)	4.4(18.3)	80.8	1.56	Crop suppression
HW at 30, 60 and 90 DAS	1.0(0)	9.7(92.3)	2.12	1.44	
Weedy check	3.1(9)	9.6(91.3)	-	1.40	
LSD(P=0.05)	0.5	0.8	-	0.18	

The data are square root transformed and values in the parentheses are original values.

Table 2. Effect of different weed control measures on *Orobanche* population and seed yield of mustard (Hisar) 2009-10

Treatment	*Orobanche* panicles/plot (80 DAS)	*Orobanche* panicles /plot (120 DAS)	% *Orobanche* reduction over control (120 DAS)	Mustard yield (t/ha)	Remarks
Pendimethalin 1.0 kg/ha *fb* HW at 60 DAS	14.4(212)	18.4(337)	11.0	0.68	
Neem cake 200 kg/ha in furrow *fb* HW at 60 DAS	14.5(245)	19.2(368)	2.6	0.64	
Neem cake 400 kg/ha in furrow *fb* one HW at 60 DAS	3.9(144)	7.6(327)	13.4	0.76	
Neem cake 200 kg/ha in furrow *fb* glyphosate 50 g/ha	1.7(2)	2.8(7)	98.1	0.86	
Castor cake 300 kg in furrow	6.4(41)	8.5(71)	81.2	0.79	
Castor cake 400 kg (broadcasting) *fb* HW	5.8(32)	7.3(52)	86.2	0.88	
Castor cake 500 kg in furrow	6.1(37)	9.0(81)	78.5	0.92	
Castor cake 400 kg/ha in furrow *fb* HW	5.4(28)	6.8(46)	87.8	0.90	
Glyphosate 25 g/ha with 1% $(NH_4)_2SO_4$ at 25 DAS	3.6(12)	7.5(56)	85.1	0.85	
Glyphosate 25 g/ha with 1%$(NH_4)_2SO_4$ at 55 DAS	4.7(20)	7.1(50)	86.7	0.86	
Glyphosate 25 g/ha with1% $(NH_4)_2SO_4$ at 25 DAS and 50 g/ha at 55 DAS	1(0)	3.9(14)	96.2	0.94	5% crop suppression
Glyphosate 50 g/ha with 1%$(NH_4)_2SO_4$ at 55 DAS	1(0)	1.4(1)	99.7	0.86	15% crop suppression
Glyphosate 50 g/ha with 1% $(NH_4)_2SO_4$ at 25 DAS and 25 g/ha at 55 DAS	1(0)	1(0)	100	0.88	15% crop suppression
Seed treatment with chlorsulfuron 1.0 ppm	1(0)	2.8(7)	98.1	0.90	
Seed treatment with triasulfuron 1.0 ppm	1.4(1)	2.7(6)	98.4	0.89	
Seed treatment with sulfosulfuron 1.0 ppm	5.3(25)	13.0(168)	55.5	0.76	
Seed treatment with sulfosulfuron 1.0 ppm+ glyphosate 25 g/ha at 55 DAS	1.5(2)	6.6(43)	88.6	0.88	
HW at 30, 60 and 90 DAS	2.7(8)	4.7(21)	94.4	0.92	
Control	15.7(248)	19.5(378)	0	0.73	
LSD (P=0.05)	1.0	0.4	-	0.62	

The data are square root transformed and values in the parentheses are original values

Table 3. Effect of different weed control measures on *Orobanche* control and seed yield of mustard (Obera, Bhiwani) 2009-10

Treatment	*Orobanche* control (%)	Seed yield (t/ha)	Remarks
Neem cake 400 kg/ha in furrow	24.8(18)	1.69	
Neem cake 400 kg/ha in furrow+ neem cake in furrow before first irrigation	22.5(15)	1.77	
Neem cake 400 kg/ha in furrow *fb* glyphosate 50 g/ha at 60 DAS with 1%$(NH_4)_2SO_4$	73.0(91)	1.90	5% crop suppression
Castor cake 400 kg/ha in furrow	28.2(22)	1.72	
Castor cake 400 kg/ha in furrow+ castor cake in furrow before first irrigation	22.8(15)	1.86	
Castor cake 400 kg/ha in furrow *fb* glyphosate 50 g/ha at 60 DAS with 1% $(NH_4)_2SO_4$	71.9(90)	1.94	5% crop suppression
Farmers practice (one hoeing)	16.6(8)	1.57	
Farmers practice + glyphosate 50 g/ha at 60 DAS with 1% $(NH_4)_2SO_4$	73.4(92)	1.85	5% crop suppression
LSD (P=0.05)	6.0	0.12	

The data are square root transformed and values in the parentheses are original values

Maximum seed yield of mustard (1.98 and 0.94 t/ha) was observed with use of glyphosate 25 g/ha at 25 DAS and 50 g/ha at 55 DAS along with 1% $(NH_4)_2SO_4$ which was at par with glyphosate 25 g/ha at 55 DAS with 1% $(NH_4)_2SO_4$ and glyphosate 25 g/ha at 25 and 55 DAS with 1% $(NH_4)_2SO_4$ during 2008-09 and three hand hoeing, glyphosate 50 g/ha at 25 DAS and 25 g/ha at 55 DAS along with 1% $(NH_4)_2SO_4$. during 2009-10. Competition from *Orobanche* through out crop season caused 29.4 and

Table 4. Comparative performance of glyphosate application *vis-à-vis* farmers' practice for *Orobanche* management and its subsequent effect on seed yield of mustard in large scale multi-locational trials

Year	No. of trials	Area covered (ha)	*Orobanche* control (%)	Seed yield (t/ha)		Percent reduction in yield
				Treated*	Farmer's practice**	
2010-11	12	5	82 (70-95)	1.72 (1.40-2.10)	1.49 (1.20-1.95)	15.5
2011-12	24	20	79 (65-90)	1.59 (1.20-2.20)	1.37 (0.90-1.80)	16.3
2012-13	86	156	72 (55-90)	1.75 (1.25-2.25)	1.54 (1.00-1.95)	13.9
2013-14	35	82	63 (40-90)	1.65 (1.25-2.40)	1.44 (1.10-2.10)	14.6

*25 g/ha at 30 DAS and 50 g/ha at 55-60 DAS-2 sprays; **one hoeing at 25-30 DAS; figures in parenthesis indicate range of the treatment effect on *Orobanche* control and mustard seed yield

22.0% reduction in seed yield of mustard during 2008-09 and 2009-10, respectively. At Obera during 2009-10, maximum seed yield of mustard (1941 kg/ha) was obtained with the use of castor cake 400 kg/ha in furrow *fb* glyphosate 50 g/ha at 55 DAS with 1% $(NH_4)_2SO_4$ which was at par with neem cake 400 kg/ha in furrow *fb* glyphosate 50 g/ha at 55 DAS with 1% $(NH_4)_2SO_4$ and farmer's practice of two hoeing *fb* glyphosate 50 g/ha at 55 DAS. Application of either neem cake or castor cake twice (sowing + first irrigation) although helped to boost crop growth, was not effective in controlling *Orobanche*. This is in conformity of results of Punia *et al.* (2012) and Punia and Singh (2012) who reported 65-85% control of *Orobanche* even up to harvest (without any crop injury) with glyphosate applied twice at 25 g/ha at 25 DAS followed by 50 g/ha at 55 DAS and yield improvement from 12 to 41% over the traditional farmers' practice at farmers fields in different years of the study.

Results of 157 demonstrations conducted on use of glyphosate at low doses in mustard growing areas of Haryana state covering 253 ha area showed that overall 74.4% (range 63-82%) reduction in *Orobanche* weed infestation with 15.0% (range 13.9-16.3%) increase in yield in glyphosate treated plots (25 g/ha at 30 DAS followed by 50 g/ha at 55-60 DAS) when compared with the farmers' practice of one hoeing at 25-30 DAS (Table 4).

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