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Screening of herbicides for broomrape (*Orobanche*) control in mustard

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ABSTRACT

A field study was conducted for two years during *Rabi* season of 2012-13 and 2013-14 on the fields of farmers' of Jhunjhunu and Bikaner districts infested with broomrape (*Orobanche*) to test the efficiency of herbicides in mustard crop under AICRP on Weed Management at Agriculture Research Station, Swami Keshwanand Rajasthan Agricultural University, Bikaner. The experiment comprising ten weed control treatments consisting of neem cake (200 kg/ha) + pendimethalin 1.0 kg/ha, neem cake (200 kg/ha) + glyphosate 25 g/ha at 25 DAS, pendimethalin 0.75 kg/ha + glyphosate 35 g/ha + 55 g/ha at 25 and 55 DAS, pendimethalin 1.0 kg/ha, glyphosate 25 g/ha + 50 g/ha at 25 and 55 DAS, glyphosate 50 g/ha + 50 g/ha at 25 and 55 DAS, oxyfluorfen (200 g/ha), imazethapyr (20 g/ha), manual weeding and weedy check in a randomized block design with three replications. Among the different herbicides, application of glyphosate at 25 g/ha + 50 g/ha at 25 and 55 DAS controlled broomrape effectively with nil phytotoxicity and produced significantly the highest seed yield in mustard during both the years over all the other herbicidal treatments.

Mustard (*Brassica juncea*) is an important oil seed crop being third world's important oil seed crop after soybean and palm contributing 28.6% in the total production of oil seeds with 34.19 mha area, 63.09 mt production and 1.85 t/ha productivity. In India it is the second most important edible oil seed after groundnut sharing 27.8% in the India's oil seed economy with 6.8 mha area, 8.2 mt production and 1.18 t/ha productivity in Rajasthan it stand at first with 3.7 mha area, 4.4 mt production and 1.20 t/ha productivity. Weed growth is an important constraint in proper harvest of the crop. Simultaneous emergence and rapid growth of weeds lead to severe crop-weed competition for light, moisture, space and nutrients. Broomrape (*Orobanche* spp.) is an annual, root holoparastic herb propagated by seeds. It is one of the most serious weed in the mustard crop. The host root exudates induce germination of seed within soil. *Orobanche* or broomrape (*Orobanche* spp.) locally known as *margoja, rukhri, khumbhi* or *gulli* or *bhumiphod* is a phanerogamic, obligate, troublesome root parasite that lack chlorophyll (Baccarini and Melandri 1967, Saghir *et al.* 1973) and obtain carbon, nutrients, and water through haustoria which connect the parasites with the host vascular system (Punia *et al.* 2012). The attached parasite functions as a strong metabolic sink, often named "supersink", strongly competing with the host plant for water, mineral nutrition and assimilate absorption and translocation. 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. Broomrape is thus a total parasite. Each plant produces more than a million seeds in a short period of about eight weeks. Considering the importance of management practices on broomrape (*Orobanche ramosa*.) control in mustard, the present experiment was conducted.

A field study was conducted for two consecutive years during *Rabi* season of 2012-13 and 2013-14 on the fields of farmers' of Jhunjhunu and Bikaner districts, infested with *Orobanche* in mustard crop under AICRP on weed management at Agriculture Research Station, Swami Keshwanand Rajasthan Agricultural University, Bikaner. The experiment comprising ten weed control treatments consisting of neemcake (200 kg/ha) before sowing + pendimethalin 1.0 kg/ha at pre-emergence, neem cake (200 kg/ha) before sowing + glyphosate 25 g at 25 DAS, pendimethalin 0.75 kg/ha at pre-emergence + glyphosate 35 g/ha + 55 g/ha at 25 and 55 DAS, pendimethalin 1.0 kg/ha at pre-emeergence,

glyphosate 25 g/ha + 50 g/ha at 25 and 55 DAS, glyphosate 50 g/ha + 50 g/ha at 25 and 55 DAS, oxyfluorfen (200 g/ha) at pre-emergence, imazethapyr (20 g/ha) at 25 DAS, manual weeding and weedy check in a randomized block design with three replications. During 2012-13, mustard variety '*Bio-902*' was sown on 28.10.2012 in plot size of 10 x 10 m^2 while during 2013-14, sowing was done on 29.10.2013, 05.11.2013 and 01.11.2013 at Varishpura, Derwala and Shekhsar villages, respectively. During both the years of study, fields selected were heavily infested with *Orobanche*. Various treatments were imposed as per schedule as given in **table 1**. Data on per cent visual control of the weed was recorded at 80 days after sowing. Results obtained from these trials were further validated in large scale multi location trials conducted at different locations in Bikaner, Jhunjhunu and Churu districts of Rajasthan through farmers' participatory approach during the *Rabi* seasons of 2013-14 to 2015-16. A total of 40 on farm trials (OFTs) were conducted in mustard growing area of Rajasthan state.

Effect on weed

Application of glyphosate 25 g/ha + 50 g/ha at 25 and 55 DAS recorded significantly the lowest count of broomrape, *i.e.* 0.33 and 0.78/m^2 during 2012-13 and 2013-14, respectively but it was statistically at par with glyphosate 50 g/ha at 25 DAS + 50 g/ha at 55 DAS, pendimethalin 0.75 kg/ha + glyphosate 35 g/ha + 55 g/ha at 25 and 55 DAS and imazethapyr 20 g/ha (**Table 1**). Significantly lowest weed density was recorded by imazethapyr 20 g/ha and manual weeding during both the years. It might be due to manual weeding, which was most efficient and widely practiced method in India for all crops that suffer from their parasites. The present findings were supported from the results reported by Krishnamurthy and Rao (1976), Dhanapal (1996) and Prasad (2011). Glyphosate 25 g + 50 g/ha at 25 and 55 DAS provided 70-80% control of *Orobanche* even up to harvest without any crop injury with yield improvement from 7 to 54% over the farmers' practice during both the years of study. Similar findings on the control of *Orobanche* in mustard through herbicide application were also reported by the scientists at Gwalior and Bikaner (DWSR 2009). The tolerance of plants to glyphosate was mainly attributed to readily degradation of this herbicide to non-toxic metabolites (Punia *et al.*2010, Punia and Singh 2012). It is readily absorbed by the mustard plant foliage and translocated to the young parasites attached to the roots, leaves and meristems, thereby inhibiting the synthesis of enzyme 5-enolpyruvylshikimate-3-phosphate (EPSP) synthetase leads to the production of aromatic amino acids(phenylalanine, tyrosine and tryptophan) and thus protein synthesis and growth (Amerhein *et al*. 1980).

These results were further validated in large scale multi-locational trials conducted at different locations in Bikaner, Jhunjhunu and Churu districts of Rajasthan through farmers' participatory approach during the *Rabi* seasons of 2013-14 to 2015-16. A total of 40 on farm trials (OFTs) were conducted in mustard growing area of Rajasthan state. The result of OFT on *Orobanche* indicated that *Orobanche* was not observed at 30 and 60 DAS while infestation started at 90 DAS onwards. Application of glyphosate at 25 and 50 g/ha + 1% ammonium sulphate at 25 and 55 DAS, respectively reduced the population of the parasitic weed at all locations. The weed reduction

Table 1. Effect of weed control measures on *Orobanche* population, weed intensity, seed yield and phytotoxicity of mustard

Treatment	*Orobanche*/ m^2		Weeds/m^2		Seed yield (t/ha)		Phytotoxicity (0-100 scale)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Neem cake (200 kg/ha) + pendimethalin 1.0 kg/ha	45.0	24.2	25.8	21.2	0.98	1.01	0	0
Neem cake (200 kg/ha) + glyphosate 25 g	21.0	7.7	32.5	27.3	1.08	1.10	0	0
Pendimethalin 0.75 kg/ha + glyphosate 35 + 55 g	0.3	1.4	17.5	16.4	1.14	1.16	10	8
Pendimethalin 1.0 kg/ha	39.7	28.3	22.1	20.4	0.97	0.89	0	0
Glyphosate 25 g + 50 g	0.3	0.8	32.4	31.3	1.26	1.24	0	0
Glyphosate 50 g + 50 g	0.3	0.1	21.4	20.1	1.06	0.91	15	15
Oxyfluorfen (200 g/ha)	46.7	29.1	11.5	7.6	0.52	0.43	0	60
Imazethapyr (20 g/ha)	1.0	0.5	4.3	3.6	0.76	0.82	30	30
Manual weeding	8.7	10.1	5.8	3.6	1.18	1.12	0	0
Weedy check	33.3	30.0	41.7	40.9	0.81	0.80	0	0
LSD (p=0.05)	10.1	3.6	3.5	4.5	0.11	0.12	-	-

was in the range of 72-82 per cent at four locations and consequently increased the seed yield of mustard as compared to neem cake treatment.

Effect on yield

Among the different herbicidal treatments, seed yield of mustard was found maximum with the treatment received glyphosate 25 g/ha + 50 g/ha at 25 and 55 DAS which was significantly superior to all other herbicides but statistically at par with manual weeding and imazethapyr 20 g/ha during 2012-13, however, significantly superior to weedy check, pendimethalin 1.0 kg/ha, imazethapyr 15 g/ha and 20 g/ha but statistically at par with manual weeding during both the years. Effective control of weeds by herbicides might have resulted in better availability of soil moisture and nutrients as evidenced by the beneficial effect on crop growth. The higher seed yield in glyphosate 25 g/ha + 50 g/ha at 25 and 55 DAS might be due to suppression of weed seed germination and seedling development at early stages due to pre-emergent herbicides. The proper time and dose of glyphosate have better efficacy of herbicide application as repetitive/higher/lower than the recommended dose may lead to adverse impact on mustard crop or may result in development of herbicide-resistant weeds.

The present study has shown that glyphosate, if used at desired concentrations can be very helpful in reducing the parasitic weed infestation while affording tolerance to the mustard crop. This would definitely obviate the *Orobanche* seed bank to further increase as well as improve the overall productivity and economic well-being of the mustard growing farmers' fraternity.

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