Indian Journal of Weed Science **49**(3): 248–251, 2017
DOI: 10.5958/0974-8164.2017.00064.8

Herbicides efficacy for managing weeds in greengram and their residual effect on succeeding mustard

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Received: 24 June 2017; Revised: 2 August 2017

ABSTRACT

A field experiment was conducted at Research Farm of S. K. Rajasthan Agricultural University, Bikaner during *Kharif* 2014 and 2015 to study the efficacy of pre- and post-emergence herbicides in managing weeds in greengram (*Vigna radiata*) and herbicides carryover effect on Indian mustard (*Brassica juncea*) grown during succeeding *Rabi* seasons of 2014-15 and 2015-16. Ten weed control treatments, *viz*. pendimethalin 1000 g/ha pre-emergence (PE), imazethapyr 50 and 70 g/ha (early post-emergence; PoE), imazethapyr + pendimethalin (ready mix) 800, 900, and 1000 g/ha pre-emergence (PE), imazethapyr + imazamox 60 and 70 g/ha, two hand weedings at 20 and 40 days after seeding (DAS) and weedy check were evaluated in greengram grown in three replications with randomized block design (RBD). Two hand weedings at 20 and 40 DAS resulted in lowest weed density of broad-leaf and grassy weed, total weed biomass at 60 days after sowing, significantly highest number of branches per plant, pods per plant, seeds per pod and seed and straw yield compared to other treatments. Imazethapyr + pendimethalin 800 g/ha PE was at par with two hand weedings in managing weeds and increasing greengram yield. Application of herbicides did not cause any adverse effect on succeeding mustard in both years.

Key words: Greengram, Imazethapyr, Mustard, Herbicide residues

Greengram (*Vigna Radiata*) is an important pulse crop of India which is cultivated in 3.35 million hectares mainly during *Kharif* (rainy) seasons (Anonymous. 2015). Besides other constraints, weed infestation is one of the major factors responsible for low productivity of greengram (512 kg/ha). Traditionally, weeds in greengram are controlled by manual weeding and hoeing at appropriate growth stages. Manual weeding is time-consuming and expensive and often not feasible due to intermittent rains during rainy season. The labour is also becoming scarce, not available in time and expensive to further increase the cost of cultivation. Under such situations, use of appropriate herbicide with suitable dose remains the pertinent choice for timely control of weeds.

The effectiveness of pendimethalin and imazethapyr on weed control and productivity of greengram/pulses was reported (Kaur *et al.* 2010). Certain effective herbicides were reported to have long persistence in soil (Das 2008) and therefore, the knowledge of their residual effect on succeeding crop in a crop sequence is essential before making any recommendation for the farmers. Greengram Indian mustard is common crop rotation in the semi-arid North-Western region of India. Hence, the present study was conducted to study the efficacy of ready-mix pre- and early post-emergence herbicides in managing weeds in greengram and to assess the herbicides carryover effect on succeeding Indian mustard.

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MATERIALS AND METHODS

A field study was conducted for two consecutive years during 2014-15 and 2015-16 at the research farm of Agricultural Research Station, Swami Keshwanand Rajasthan Agricultural University, Bikaner. The treatments comprised of pre-emergence application PE of pendimethalin at 1000 g/ha and imazethapyr + pendimethalin ready-mix at 800, 900 and 1000 g/ha, early post-emergence application (PoE) of imazethapyr at 50 and 70 g/ha, imazethapyr + imazamox (ready-mix) at 60 and 70 g/ha, two hand weedings at 20 and 40 days after sowing (DAS) and weedy checkin greengram. These treatments were evaluated in randomized block design with three replications. The soil of experimental site was loamy sand having 0.08% organic carbon, 8.22 pH, 78, 22 and 210 kg/ha available N, P and K, respectively. Greengram '*SML-668*' was sown on 16 July 2014 and 02 July 2015 at

30 cm row to row spacing using seed rate of 20 kg/ha and was harvested on 10 October in 2014 and on 08 October in 2015. Recommended dose of fertilizers (20 kg N, 40 kg P_2O_5 and 40 kg K_2O per ha) was applied as basal dose. The total rainfall during the season was 427.9 mm with 12 rainy days in 2014 and 394.2 mm with 18 rainy days in 2015.

Pre-emergence application of pendimethalin and imazethapyr + pendimethalin was done on the next day of sowing whereas post-emergence application of imazethapyr and imazethapyr + imazamox was made at 25 DAS (3-4 leaf stage) as per the treatments with knapsack sprayer. Weed density was recorded at 60 DAS by using quadrate of 0.25 m^2 in all the treatments and then expressed as a number of weeds/ m^2. The weeds were dried in oven till a constant weight was observed and then expressed as weed biomass (g/m^2). Growth, yield parameters and yield of greengram were recorded for two consecutive years.

The data on total weed density and weed biomass were subjected to square root transformation to normalize their distribution (Gomez and Gomez 1984). The residual effect of different herbicides applied in greengram was studied on the succeeding Indian mustard. All the recommended package of practices was followed to raise the mustard crop. In case of Indian mustard, plant population per unit area, plant height and yields were recorded at maturity.

RESULTS AND DISCUSSION

Effect on weeds

The experimental field was infested with *Amaranthus spinosus*, *Digera arvensis*, *Trianthema portulacastrum*, *Gisekia poredious*, *Mollugo verticillata*, *Euphorbia hirta*, *Aristida depressa*, *Portulaca oleracea*, *Cenchrus biflorus*, *Cleome viscosa*, *Tribulus terrestris*, *Corchorus tridense*, *Cyperus rotundus*, *Eleusine verticillata* and *Eragrostis tennela* during the two seasons of experimentation.

The density of both broad-leaf and grassy weeds and their biomass at 60 DAS were significantly reduced by all weed control treatments compared to weedy check (**Table 1**). However, two hand weedings recorded lowest number of broad-leaf, grassy and total weeds compared to rest of the weed control treatments. Among different herbicides, pre-emergence application of imazethapyr + pendimethalin at 1000 g/ha was the most effective in reducing the density of both broad-leaf and grassy weeds and biomass of weeds followed by its lower doses (imazethapyr + pendimethalin at 900 g/ha and 800 g/ ha) and application of imazethapyr + imazamox at 60 and 70 g/ha (**Table 1**). Application of pendimethalin at 1000 g/ha as pre-emergence was effective against grassy weeds, whereas imazethapyr at 50 and 70 g were at par with each other and significantly reduced the density of broad-leaf weeds as compare to weedy check. The present results were in close accordance with finding of Yadav *et al.* (2011).

Imazethapyr and imazethapyr + imazamox are selective herbicides and are applied as post-emergence with a view to control late emerging weeds. Results of weed density corroborate with the findings of Rao and Rao (2003) and Sasikala *et al.* (2007). Weedy check registered significantly higher weed density. Reduction in both density of grassy weeds and biomass of weeds with application of imazethapyr + imazamox might be due to the greater effectiveness of imazamox against grassy and thick broad-leaf weeds. Hand weedings twice removed the

Table 1. Effect of tested weed management treatments on weed density and weed biomass at 60 days after sowing in greengram

Treatment	Weed density (no./m^2)*						Weeds biomass (g/m^2)	
	Broad-leaved		Grass		Total			
	2014	2015	2014	2015	2014	2015	2014	2015
Pendimethalin (1000 g/ha) PE	5.6 (31.0)	6.0 (35.4)	0.9 (0.3)	0.9 (0.3)	5.6 (31.3)	6.0 (35.8)	5.9 (34.0)	5.9 (35.0)
Imazethapyr (50 g/ha) 3-4 leaf stage	3.1 (9.3)	3.4 (11.5)	2.0 (3.7)	2.3 (4.7)	3.7 (13.0)	4.1 (16.2)	2.3 (5.0)	2.6 (6.3)
Imazethapyr (70 g/ha) 3-4 leaf stage	2.8 (7.3)	3.1 (9.1)	1.6 (2.0)	1.8 (2.7)	3.1 (9.3)	3.5 (11.8)	1.7 (2.7)	2.0 (3.7)
Imazethapyr + pendimethalin (800 g/ha) PE	1.9 (3.3)	2.2 (4.6)	0.7 (0)	0.7 (0.0)	1.9 (3.3)	2.2 (4.6)	1.2 (1.0)	1.2 (1.0)
Imazethapyr + pendimethalin (900 g/ha) PE	1.46 (1.7)	1.8 (3.0)	0.7 (0)	0.7 (0.0)	1.5 (1.7)	1.8 (3.0)	1.0 (0.7)	1.0 (0.7)
Imazethapyr + pendimethalin (1000 g/ha) PE	0.9 (0.3)	0.9 (0.4)	0.7 (0)	0.7 (0.0)	0.9 (0.3)	0.9 (0.4)	0.9 (0.3)	0.9 (0.3)
Imazethapyr + imazamox (60 g/ha) 3-4 leaf stage	2.3 (5.0)	3.0 (8.3)	1.0 (0.7)	1.0 (0.7)	2.5 (5.7)	3.1 (9.0)	1.9 (4.0)	2.1 (4.3)
Imazethapyr + imazamox (70 g/ha) 3-4 leaf stage	1.6 (2.0)	1.9 (3.2)	0.7 (0)	0.7 (0.0)	1.6 (2.0)	1.9 (3.2)	1.0 (0.7)	1.0 (0.7)
Two hand weeding 20 and 40 DAS	0.7 (0.0)	0.8 (0.2)	0.7 (0)	0.7 (0.0)	0.7 (0.0)	0.8 (0.2)	0.7 (0)	0.7 (0)
Weedy check	8.0 (63.7)	8.2 (66.3)	2.5 (5.7)	2.5 (6.0)	8.3 (69.3)	8.5 (72.3)	7.6 (56.7)	7.7 (58.3)
LSD (p=0.05)	0.67	0.64	0.32	0.29	0.67	0.62	0.81	0.68

*Square root transformed value; Actual values are given in parentheses

weeds completely and created conditions, which were more favourable for crop growth and ultimately resulted in lowest density of later emerged weeds and their lowest biomass during the crop growth period. The results of study also corroborate with the finding of Punia *et al.* (2011). May be ascribed to broad spectrum activity of herbicidal combination particularly on emergence of both broad leaf and grassy weeds and their greater efficiency to retard cell division of meristems causing rapid drying of weeds. In earlier study, Kanter *et al.* (1999) reported about 84.6% control of weed biomass with application of imazethapyr in chickpea. Papierniks *et al.* (2003) also reported that imazethapyr application was effective for weed control in legumes.

Effect on greengram

All weed management practices resulted in significant increase in number of branches per plant, number of pods per plant, seeds per pod and seed and straw yields over weedy check (**Table 2**). The highest number of branches per plant, number of pods per plant, seeds per pod and seed and straw yields recorded with two hand weedings and was at par with all doses of imazethapyr + pendimethalin (800, 900 and 1000 g/ha). This might be due to better availability of resources to the crop in absence of weeds. The lowest number of branches per plant recorded under weedy check might be due to severe competition by weeds to crop for resources. The results corroborated with the findings of Singh *et al.* (2006) and Yadav *et al.* (2014). Reduced crop weed competition during critical phase of crop growth better regulates the complex process of yield formation due to better availability of resources to the crop plant. Reduced crop-weed competition under different weed control treatments might have influenced the 'source' by virtue of higher photosynthetic and metabolic activity which in turn improved growth and consequently yield components of crop. The adverse effect of weed competition on crop performance under present investigation is clearly reflected under weedy check wherein dense population of weeds reduced crop growth compared to two hand weeding treatment as well as other treatments and ultimately resulted in reduced number of pods per plant and seeds per pod.

Among different treatments, application of imazethapyr + pendimethalin 800 g/ha resulted in higher seed and straw yield over weedy check and was at par with its higher doses, and two hand weeding (**Table 2**). Kanter *et al.* (1999) observed 63.6% higher seed yield of chickpea over unweeded check with application of imazethapyr. The reduced crop weed competition caused significant improvement in growth and yield attributes and ultimately led to higher seed yield of greengram. The significant improvement in seed as well as straw yield as a result of two hand weeding treatment and all herbicidal weed control treatments could be ascribed to the fact that yield of crop depends on several yield components which are interrelated. Under weedy situation, at early crop growth stage a greater part of resources present in soil and environment are depleted by weeds for their growth. The crop plant thus, faced stress which ultimately affected their growth, development and yield. Similar results were also reported in soybean by Upadhayay *et al.* (2013).

Residual effect on succeeding mustard

Different weed management practices or application of different herbicides applied to greengram did not cause any adverse effect on plant population, plant height and yield of succeeding Indian mustard crop in both the years (**Table 3**).

Table 2. Effect of weed management treatments on yield attributes and yields of greengram

Treatment	Branches/ plant		Pods/plant		Seeds/pod		Yield (t/ha)			
							Seed		Straw	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Pendimethalin (1000 g/ha) PE	3.53	3.93	55.7	58.3	4.68	5.62	0.76	0.81	1.51	1.68
Imazethapyr (50 g/ha) 3-4 leaf stage	3.33	3.69	52.7	54.2	4.26	5.38	0.76	0.76	1.58	1.64
Imazethapyr (70 g/ha) 3-4 leaf stage	3.42	3.72	55.0	54.3	4.37	5.41	0.75	0.78	1.59	1.70
Imazethapyr + pendimethalin (800 g/ha) PE	3.94	4.14	63.3	64.3	5.15	5.83	0.88	0.90	1.66	1.74
Imazethapyr + pendimethalin (900 g/ha) PE	3.86	4.10	61.3	65.5	4.97	5.79	0.88	0.93	1.62	1.78
Imazethapyr + pendimethalin (1000 g/ha) PE	3.78	4.04	60.0	62.4	4.87	5.73	0.88	0.89	1.60	1.71
Imazethapyr + imazamox (60 g/ha) 3-4 leaf stage	3.65	3.88	54.3	55.7	4.53	5.57	0.76	0.80	1.56	1.64
Imazethapyr + imazamox (70 g/ha) 3-4 leaf stage	3.62	3.77	55.7	56.8	4.41	5.46	0.77	0.80	1.58	1.65
Two hand weeding 20 and 40 DAS	4.14	4.25	65.3	68.7	5.32	5.98	0.94	1.03	1.59	1.81
Weedy check	3.05	2.95	40.0	43.7	3.94	4.64	0.61	0.66	1.13	1.20
LSD (p=0.05)	0.35	0.53	8.79	7.44	0.32	0.13	0.09	0.15	0.11	0.25

Table 3. Residual effect of different herbicides and other treatments applied in greengram on succeeding mustard

Treatment	Plant stand/m row length at maturity		Plant height (cm) at maturity		Seed yield (t/ha)		Straw yield (t/ha)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Pendimethalin (1000 g/ha) PE	7.7	7.7	150.8	159.4	1.11	1.22	2.45	2.61
Imazethapyr (50 g/ha) 3-4 leaf stage	8.0	8.4	151.1	159.7	1.11	1.18	2.45	2.58
Imazethapyr (70 g/ha) 3-4 leaf stage	8.7	8.7	153.8	165.6	1.07	1.21	2.25	2.50
Imazethapyr + pendimethalin (800 g/ha) PE	8.0	8.3	151.2	162.9	1.06	1.15	2.22	2.54
Imazethapyr + pendimethalin (900 g/ha) PE	8.7	8.7	151.2	162.8	1.05	1.21	2.21	2.53
Imazethapyr + pendimethalin (1000 g/ha) PE	8.3	7.6	151.7	161.2	1.04	1.27	2.18	2.52
Imazethapyr +imazamox (60 g/ha) 3-4 leaf stage	8.0	7.9	152.0	161.4	1.07	1.16	2.22	2.57
Imazethapyr + imazamox (70 g/ha) 3-4 leaf stage	8.7	8.4	155.3	165.0	1.04	1.20	2.15	2.47
Two hand weeding 20 and 40 DAS	7.7	8.1	153.3	162.4	1.09	1.23	2.26	2.61
Weedy check	8.3	8.0	150.7	159.6	1.05	1.19	2.18	2.52
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

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