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Weed management in blackgram with pre-mix herbicides

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ABSTRACT

Pre-mix combination of imazethapyr + pendimethalin at 1000 g/ha had maximum weed kill efficiency over alone application of herbicides applied as pre- or post-emergence. Similarly, the maximum grain yield (1.38 t/ha) was achieved with pre-mix combination of imazethapyr + pendimethalin at 1000 g/ha plot followed by its lower dose applied at 900 g/ha and both doses were found significantly superior over other herbicidal treatments. Supremacy of this treatment was proved by increment of grain yield to the tune of 63.3% over the weedy check and only 3.7% lesser than the hand weeding (20 and 40 DAS). Pre-mix combination of imazethapyr + pendimethalin also proved to be effective in improving other parameters like plants/m^2, pods/plant, seed/pod and 100 seed weight (g).

Key words: Blackgram, Herbicides, Herbicide efficiency index, Weed persistence, Weed control,Yield

Blackgram (*Vigna mungo*), is a bean grown in the Indian subcontinent. Blackgram is very nutritious as it contains high level of carbohydrate (60 g/100 g), protein (20-25 g/100 g), phosphorus (385 mg/100 g), calcium (145 mg/100 g) and iron (7.8 mg/100 g). It has been shown to be useful in mitigating elevated cholesterol levels (Indira and Kurup 2013). Blackgram is usually accompanied by luxuriant weed growth during rainy *(Kharif)* season owing to abundant rainfall received during monsoon leading to serious crop losses by weeds. The crop is not very good competitor against weeds (Choudhary*et al*. 2012) and therefore, weed control initiatives are essential to ensure proper growth of crop particularly in the early growth period.

Weeds compete for water, nutrient and space and cause up to 45% yield loss in Blackgram (Yadav*et al*. 1997). Among the different methods of weed control, the chemical method is becoming popular among farmers due to non-availability of cheap labour. Blackgram is less competitive against many weeds during early stage of crop as most sensitive period of weed competition is between 15 to 45 days after sowing. Unchecked weeds have been reported to cause a considerable reduction in seed yield of Blackgram, which in case of summer Blackgram could be 46-53% (Bhandari *et al.* 2004, Kumar and Tewari 2004), whereas, in *Kharif* Blackgram the losses could be 43.2-64.1%. (Chand *et al*. 2004, Rathi*et al*. 2004).

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Imazethapyr, a broad-spectrum herbicide, has soil and foliar activity that allows flexibility in its application timing and has low mammalian toxicity (Tan *et al.* 2005). In blackgram, Nandan *et al.*(2011) reported that post-emergence application of imazethapyr at 25 g/ha had no adverse effect on growth characters and resulted statistically similar grain yield to that of twice hand weeding (20 and 40 DAS). Pendimethalin is basically pre-emergence herbicide. In rainfed condition, if weeds have not yet germinated, this herbicide may be effective when applied after first shower.

Hence, the present study was conducted to determine the tolerance of the herbicides on blackgram at different doses and find out the efficacy of post-emergence of herbicides against the weeds and yield of blackgram.

MATERIALS AND METHODS

An experiment was conducted to evaluate the bioefficacy of pendimethalin and imazethapyr alone and their combination as pre-mix against mixed flora of weeds in blackgram during *Kharif* seasons of 2012 and 2013 at N.E.Borlaug Crop Research Centre of G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand India. The experiment was laid out in a randomized block design with 10 treatments in three replications. Treatments were comprised of pendimethalin 1000 g/ha, two doses of imazethapyr at 50 and 70 g/ha, pre-mix combination of pendimethalin and imazethapyr (Velor/Squaroz) at

800, 900 and 1000 g/ha and imazethapyr + imazamox (Odissay) at 60 and 70 g/ha, twice hand weeding at (20 and 40 DAS) and weedy check. Among the herbicidal treatment, pendimethalin and imazethapyr + pendimethalin were applied as pre-emergence (2 DAS) while remaining herbicides were applied as post-emergence (19 DAS) with knapsack sprayer using flat fan nozzle with 500 liters of water volume per hactare. Blackgram variety '*Pant Urd-19*' was sown on September 5, 2012 and August 20, 2013 with a row spacing of 30 cm. All other recommended package of practices was adopted to raise the crop.

The weed samples were collected randomly at two places in each plot with 0.25 m^2 quadrate after 30 days of sowing and total weed density was calculated. The weeds inside each quadrate were uprooted, cleaned and dried. After drying, weight and weed control efficiency was calculated by using slandered formula. Herbicide efficiency index and weed persistence index determined as per formula given by Walia (2003). At maturity, the blackgram crop was harvested and air dried for 72 h. Besides, pod/plant (no./m^2), seed/pod and 100-seed weight were determined. Increase in yield over weedy check and per cent increase was also calculated for all the treatments. Data recorded were statistically analyzed according to Gomez and Gomez (1984). Means were compared at 5% levels of significance by the least significant difference (LSD) test. Data on weed population were subjected to square root transformation.

RESULTS AND DISCUSSION

Weed flora

The weed flora of the experimental site was pooled over the years and comprised of *Echinochloa colona* (18.5%), *Eleusine indica* (17.1%), *Dactyloctenium aegyptium* (4.9%), *Digitaria sanguinalis* (1.8%), *Panicum maximum* (1.8%), among the grasses, *Digera arvensis* (1.4%), *Cleome viscosa* (0.5%), *Celosia argentia* (3.9%), *Malugo stricta* (2.5%), *Trianthema monogyna* (2.5%) were major broad-leaf weeds (BLWs). *Cyperus rotundus* (44.9%) was most dominating among all the weeds species.

Effect on weeds

All the herbicidal treatments convincingly suppressed the weeds growth and were superior over the weedy check (Table 1). Among the herbicides applied alone, application of pendimethalin at 1000 g/ha resulted in lowest density of grassy weeds while lowest density of BLWs and sedges was obtained with post-emergence application of imazethapyr at 70 g/ha. Among various pre-mix, imazethapyr + pendimethalin 1000 g/ha was the most effective and recorded 89.7 and 87.2% suppression of grassy and BLWs, respectively as compared to weedy check. Higher flushes of *C. argentia* and *E. indica* were observed during crop growth period. Among the alone herbicides, total minimum weed density was recorded with pre-emergence application of pendimethalin at 1000 g/ha and was at par with application of imazethapyr at 70 g/ha applied as post-emergence. On the other hand, imezathapyr + pendimethalin (pre-mix) 1000 g/ha (12.1 weeds/m^2) was the best of all followed by imazethapyr + imazamox (pre-mix) 70 g/ha (12.3 weeds/m^2) as compared to weedycheck (19.9 weeds/m^2). These two pre-mix reduced total weed population by 63.2 and 62.3%, respectively over the weedy check. The better performance of combination of herbicides might be due to synergistic effect between the two herbicides reducing the population as well as dry matter accumulation of different weed species.

Table 1. Effect of herbicidal treatment on density and dry weight of weeds and weed control efficiency at 30 DAS

Treatment	Weed density (no./m^2)			Total weed density (no./m^2)	Total weed dry weight (g/m^2)	WCE (%)
	Grassy	BLWs	Sedges			
Pendimethalin PE (1000 g/ha)	3.4(11.3)	4.7(25.7)	11.7(139)	13.1(176)	5.8(33.1)	57.5
Imazethapyr PoE (50 g/ha)	10.4(107.7)	5.1(29.0)	11.1(126)	16.1(262)	6.5(41.4)	46.9
Imazethapyr PoE (70 g/ha)	9.4(88.7)	4.5(21.0)	10.1(104)	14.5(214)	5.9(34.3)	55.9
Imazethapyr + pendimethalin (pre-mix) PE (800 g/ha)	6.3(39.3)	5.0(33.3)	11.8(140)	14.5(212)	5.7(32.0)	58.9
Imazethapyr + pendimethalin (pre-mix) PE (900 g/ha)	5.1(25.3)	4.6(21.0)	11.3(126)	13.1(172)	5.3(28.6)	63.3
Imazethapyr + pendimethalin (pre-mix) PE (1000 g/ha)	4.3(17.7)	2.9(9.3)	10.9(122)	12.1(149)	4.9(23.3)	70.1
Imazethapyr + imazamox (pre-mix) PoE (60 g/ha)	6.9(48.9)	4.9(25.7)	10.5(110)	13.5(185)	6.5(41.6)	46.6
Imazethapyr + imazamox (pre-mix) PoE (70 g/ha)	5.6(31.7)	3.7(15.7)	10.2(105)	12.3(152)	6.0(34.6)	55.6
Hand weeding at 20 and 40 DAS	4.0(15.0)	3.7(14.0)	7.3(53)	9.0(82)	4.9(22.8)	70.7
Weedy	2.9(171.0)	8.2(72.7)	12.6(160)	19.9(404)	8.9(77.9)	-
LSD (P=0.05)	0.9	0.6	1.4	1.4	0.4	-

PE: Pre-emergence; PoE: Post-emergence; DAS - Days after sowing; Value in parentheses was original and transformed to square root $(\sqrt{x+1})$ for analysis, WCE - weed control efficiency

Table 2. Effect of herbicidal treatments on herbicidal efficiency index and weed persistence index

Treatment	Herbicide efficiency index (%)	Weed persistence index (%)
Pendimethalin PE (1000 g/ha)	3.0	0.97
Imazethapyr PoE (50 g/ha)	2.1	0.80
Imazethapyr PoE (70 g/ha)	2.2	0.84
Imazethapyr + pendimethalin (pre-mix) PE (800 g/ha)	3.0	0.78
Imazethapyr + pendimethalin (pre-mix) PE (900 g/ha)	4.4	0.85
Imazethapyr + pendimethalin (pre-mix) PE (1000 g/ha)	5.8	0.81
Imazethapyr + imazamox (pre-mix) PoE (60 g/ha)	1.9	1.2
Imazethapyr + imazamox (pre-mix) PoE (70 g/ha)	2.7	1.2
Hand weeding at 20 and 40 DAS	6.3	1.5
Weedy	-	-
LSD (P=0.05)	-	-

PE: Pre-emergence, PoE: Post-emergence, DAS- Days after sowing

Among alone application of herbicides, minimum weed dry matter accumulation was achieved with application of pendimethalin at 1000 g/ ha which was at par with imazethapyr applied as post-emergence at 70 g/ha. Whereas, among various pre-mix application of imazethapyr + pendimethalin at 1000 g/ha followed by its respective lower dose applied at 900 g/ha was found more effective in reducing the dry matter accumulation of weeds. Twice hand weeding was also found comparable with combination of imazethapyr + pendimethalin at 1000 g/ha in reducing the dry matter accumulation of weeds. However, all the weed control treatments were proved to be significantly superior to weedy check.

Among various pre-mix herbicidal application, the higher weed control efficiency was obtained with pre-mix combination of imazethapyr + pendimethalin applied at 1000 g/ha followed by its respective lower dose applied at 900 g/ha, while it was low with application of imazethapyr + imazamox at 60 g/ha. Weed control efficiency (WCE) was higher with application of pendimethalin 1000 g/ha among the alone application of herbicides (Table 1). This might be due to better control of grassy weeds which led to less dry matter accumulation by weeds. Pre-emergence application of imazethapyr + pendimethalin (pre-mix) at 1000 g/ha resulted in 70.1% WCE which was followed by imazethapyr + imazamox (pre-mix) applied at 70 g/ha (63.3%) which might be due to broad spectrum control of weeds.

WPI and HEI

Weed persistence index (WPI) and herbicide efficacy indices (HEI) express the tolerance of weeds to different herbicide treatments as well as their efficacy to eradicate the weeds (Table 2). Among the various pre-mix combination of imazethapyr + pendimethalin applied at 800 g/ha recorded lowest WPI (0.78%) followed by its highest dose applied at 1000 g/ha. Among all treatments, highest WPI was recorded with twice hand weeding followed by post-emergence application of imazethapyr + imazamox (pre-mix) at 60 and 70 g/ha. Regarding HEI, pre-mix combination of imazethapyr + pendimethalin applied at 1000 g/ha produced higher HEI than all other herbicidal treatments followed by its respective lower dose applied at 900 g/ha. However, twice hand weeding (20 and 40 DAS) proved to be superior to all the herbicidal treatments.

Effect on yield attributes and yield

Pooled data of two years indicated that pre-mix combination of imazethapyr + pendimethalin at 1000 g/ha recorded higher number of plant/m^2 followed by its respective lower dose applied at 900 g/ha. Among different herbicidal treatments, higher pods/plant was obtained with pre-mix combination of imazethapyr + pendimethalin at 1000 g/ha which was at par with alone application of pendimethalin applied at 1000 g/ ha and pre-mix combination of imazethapyr + pendimethalin at 800 and 900 g/ha. With an increase in doses of imazethapyr + pendimethalin (pre-mix) from 800 to 1000 g/ha, the yield and yield attributing characters increased but the differences were not significant.

Among the different pre-mix, maximum grain/ pod was recorded with the pre-emergence application of imazethapyr + pendimethalin at 1000 g/ha which was at par with all other pre-mix combinations. Alone application of pendimethalin at 1000 g/ha as well as twice hand weeding (20 and 40 DAS) were also found comparable with imazethapyr + pendimethalin (pre-mix) applied at 1000 g/ha. Maximum 100-seed weight was achieved with the application of imazethapyr + pendimethalin (pre-mix) applied at 900 and 1000 g/ha as well as twice hand weeding whereas post-emergence application of imazethapyr + imazamox (pre-mix) applied at 60 and 70 g/ha recorded minimum 100-seed weight.

Table 3.Effect of herbicidal treatments on yield and yield attributes of blackgram

Treatment	Plants (no./m^2)	Pods / plant	Seed / pod	100 seed weight (g)	Seed yield (t/ha)
Pendimethalin PE (1000 g/ha)	49.5	26.7	3.6	3.1	1.15
Imazethapyr PoE (50 g/ha)	47.5	23.2	3.2	3.1	0.96
ImazethapyrPoE (70 g/ha)	50.7	23.0	3.3	3.1	1.00
Imazethapyr + pendimethalin (pre-mix) PE (800 g/ha)	49.5	24.3	3.4	3.2	1.13
Imazethapyr + pendimethalin (pre-mix) PE (900 g/ha)	53.7	24.9	3.5	3.3	1.31
Imazethapyr + pendimethalin (pre-mix) PE (1000 g/ha)	53.8	27.0	3.6	3.3	1.38
Imazethapyr + imazamox (pre-mix) PoE (60 g/ha)	48.3	23.2	3.5	3.0	1.02
Imazethapyr + imazamox (pre-mix)PoE (70 g/ha)	50.2	23.3	3.4	3.0	1.11
Hand weeding at 20 and 40 DAS	53.3	26.6	3.6	3.3	1.43
Weedy	40.5	17.2	2.4	2.7	0.50
LSD (P=0.05)	6.8	2.9	0.3	0.3	0.10

PE: Pre-emergence, PoE: Post-emergence, DAS- Days after sowing

Among alone application of herbicide, higher seed yield (1.15 t/ha) was recorded with the application of pendimethalin at 1000 g/ha, which showed 56.1% increment over the weedy check. Among the various pre-mix combination, imazethapyr + pendimethalin at higher dose (1000 g/ ha) performed best by recording the highest seed yield (1.38 t/ha) which was at par with its respective lower dose applied at 900 g/ha and was significantly superior to all other pre-mix combinations as well as other herbicidal treatments (either applied pre- or post-emergence) and was comparable with twice hand (20 and 40 DAS) (1.43 t/ha). Per cent increase in seed yield of blackgram was reported higher (63.3%) with the pre-mix combination of imazethapyr + pendimethalin at 1000 g/ha over the weedy check. It was followed by the application of same herbicide at 900 g/ha resulting in increment of seed yield with the tune of 61.6% over the weedy check.The seed yield was negatively associated with total weed density, weeds biomass and positively associated with plants (no./m^2), pods/plant, seed/pod and 100-seed weight (g). This might be due to effective control of weeds, less crop weed competition throughout the crop growth period which resulted in improved growth parameters of the crop (Table 3).

Rao *et al*. (2010) also reported that alone application of pendimethalin and among different combinations, imazethapyr + pendimethalin were found better in reduction of the dry matter accumulation of weeds with maximum seed yield.

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