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Weed management in blackgram and its residual effect on succeeding mustard crop

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ABSTRACT

The investigation was undertaken at Birsa Agricultural University, Ranchi during *Kharif*, 2014 and 2015. The experiment was laid out in randomized block design with sixteen treatments replicated thrice. The treatments comprised of pre- and post-emergence of imazathepyr 50, 70 and 80 g/ha; pre- and post-emergence of ready mix imazethapyr 35% + imazamox 35% (Odyssey) 50, 70 and 80 g/ha; pre-emergence (PE) of pendimethalin 1000 g/ha, ready mix imazethapyr 2% + pendimethalin 30% (Vallor) 1000 g/ha, hoeing twice and weedy check. Post-emergence (PoE) of imazethapyr 35% + imazamox 35% 70 g/ha similar to PE of imazethapyre 80 g/ha, imazethapyr 35% + imazamox 35% 70 g/ha, imazethapyr 35% + imazamox 35% 80 g/ha, pendimethalin 1000 g/ha and PoE of imazethapyr 80 g/ha, imazethapyr 35% + imazamox 35% 50 g/ha recorded 69.86 and 126.72% significantly higher seed (1.12 t/ha) and straw yield (2.33 t/ha) respectively, 168.63% higher net return (` 24,126/-) and 192.41% higher B:C ratio (2.31) compared to weedy check owing to 87.29 and 86.08% weed control efficiency.

Key words: Blackgram, Imazethapyr, Phytotoxicity, Ready mix, Weed management

Pulse crops are very slow in growth at seedling stage. In addition, they do not have much canopy in terms of branching and leaf size during initial growth to stand up to weed competition. One of the major causes for poor yields in pulses is attributed to the luxurious growth of weeds in these crops and failure to control them in time. Weed infestation in black gram may reduce yield up to an extent of 45 to 60%. With the identification of short-statured, compact and early-maturing varieties, the weed problem has become more acute. The most commonly employed method is weeding through physical methods which include both manual and mechanical operations. Manual weeding is also cumbersome and uneconomical to practice (Sasikala *et al.* 2014).

Use of herbicides under such conditions is advantageous as the operation is not only economical but also provides timely protection. Some important considerations have to be borne in mind while using the herbicides for weed control; the herbicides besides being selective on a particular crop should not leave residues in the soil to affect the succeeding crops in rotation. In the case of pulses an additional important point to be kept in view is that these herbicides should not be harmful to the soil micro flora that build up soil fertility and to the nodule-inducing organisms which fix atmospheric nitrogen. Although pre-emergence use of pendimethalin at 1.0 kg/ha has been found effective to control weeds in blackgram but a residual herbicide is needed to control second flush of weeds emerging after rains. Imazethapyr and its ready mix combination with imazamox, new herbicides of imidazolinone group have been found promising to control weeds in blackgram. Imazethapyr being highly persistent in soil may cause residual toxicity in succeeding crops (Hollaway *et al*. 2006). Keeping these in view, herbicides imazethapyr alone or in combination with imazamox and pendimethalin as pre-mixture were tested under pre and post-emergence conditions.

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MATERIALS AND METHODS

A field experiment was conducted in agronomical farm of Birsa Agricultural University, Ranchi during *Kharif*, 2014 and 2015 to find out the effect of weed control methods on weed dynamics and productivity of blackgram and succeeding mustard and also system productivity of blackgram and mustard cropping system. The treatments comprised of pre- and post-emergence application of imazathepyr 50, 70 and 80 g/ha; pre- and post-emergence application of ready mix imazethapyr 35% + imazamox 35% (Odyssey) 50, 70 and 80 g/ha; PE application of pendimethalin 1000 g/ha, ready mix imazethapyr 2%+ pendimethalin 30% (Valor) 1000 g/ha, hoeing twice at 25 and 50 DAS and weedy check. All herbicides were sprayed using knapsack sprayer fitted with flat fan nozzle with 600 L water/ha. The experiment was laid out in a randomized block design

with three replications. The experimental soil was sandy loam in texture with pH 5.6. The soil was poor in nitrogen (189 kg/ha), medium in phosphorus (21.0 kg/ha) and potash (155 kg/ha). The organic carbon was 4.30 g/kg soil. Cultural practices recommended for blackgram and mustard was adopted during crop growth period.

Weed density was counted at 30, and 60 DAS. Yield and yield attributes were recorded at harvest. To evaluate bioefficacy of herbicide against grassy, broad-leaf and sedges the weeds were removed at 30, and 60 DAS. The blackgram crop variety '*T9*' was sown on 16th and 3rd July 2014 and 2015 and was harvested on 22nd and 12th September, 2014 and 2015 respectively. The succeeding mustard crop variety '*Shivani*' was sown on 29th October and 2nd November, 2014 and 2015 and harvested on 10th and 28th February, 2015 and 2016 respectively. The phytotoxic effect on blackgram was assessed by visual observations of crop injury at 10 scales.

RESULTS AND DISCUSSION

Weed density

Post-emergence application of imazethapyr 35% + imazamox 35% 80 g/ha was most effective in reducing grassy weeds at 30 and 60 DAS while imazethapyr 2% + pendimethalin 30% 1000 g/ha was effective against broad-leave weeds at 30 DAS and PoE of imazethapyr 70 g/ha against sedges at 30 and 60 DAS (**Table 1**).

Weed dry-matter

Among different herbicides, application of imazethapyr + pendimethalin 1000 g/ha was most effective in reducing weed dry matter of total weeds at 30 and 60 DAS. However at 30 DAS, it was similar to all herbicides except PoE of imazethapyr irrespective of doses and PoE of imazethapyr + imazamox 50 g/ha, as well as PE of imazethapyr 50 g/ha and pendimethalin 1000 g/ha. Among different categories of weeds PE of imazethapyr + imazamox 80 g/ha was most effective in reducing dry matter of grassy and sedges weeds at 30 DAS and also broad-leaved weeds at 60 DAS (**Table 2**).

Phytotoxicity and weed control efficiency in blackgram

Post-emergence imazethapyr and ready mix imazethapyr and imazamox irrespective of doses showed mean weed control efficiency of 66.53 and 66.77% and 82.65 and 78.93%, respectively at 30 and 60 DAS but at the same time showed slight phytotoxicity in black gram plants at 15 days after application of herbicides in the form of stunted growth of plants which mitigated after some time. Kumar *et al.* (2015) have also observed post-emergence use of imazethapyr + imazamox at 60-80 g/ha, which exhibited 78-83% control of weeds with slight crop suppression in form of chlorosis, leaf crinkling and stunting, which mitigated within 15 days after spray (**Table 3**).

Table 1. Weed density (no./m^2) as influenced by imazathepyre and its ready mix in blackgram (pooled of 2014and 2015)

Treatment	Weed density (no./m^2)							
	30 DAS			60 DAS			30 DAS	60 DAS
	Grassy	BLW	Sedges	Grassy	BLW	Sedges	Total	Total
Imazethapyr 50 g/ha PE	13.47 (182)	17.05 (291)	6.04 (38)	12.65 (160)	19.12 (366)	6.07 (37)	20.91 (438)	23.71 (563)
Imazethapyr 70 g/ha PE	9.99 (126)	13.28 (254)	3.80 (22)	11.06 (135)	16.78 (329)	5.20 (34)	15.94 (340)	20.76 (498)
Imazethapyr 80 g/ha PE	11.24 (99)	15.94 (176)	4.77 (14)	11.62 (122)	18.03 (282)	5.85 (27)	18.44 (255)	22.25 (431)
Imazethapyr 50 g/ha PoE	12.53 (158)	15.77 (249)	6.66 (44)	11.07 (122)	15.51 (240)	4.48 (20)	20.05 (405)	19.55 (382)
Imazethapyr 70 g/ha PoE	7.86 (109)	11.36 (169)	2.29 (13)	8.84 (97)	12.83 (239)	1.79 (12)	19.75 (359)	15.70 (348)
Imazethapyr 80 g/ha PoE	10.44 (62)	12.97 (130)	3.71 (6)	9.86 (78)	15.26 (166)	3.52 (3)	18.96 (395)	18.51 (248)
Imazethapyr + imazamox 50 g/ha PE	13.31 (178)	16.14 (261)	5.74 (33)	10.87 (119)	17.70 (315)	5.26 (27)	19.45 (378)	21.40 (461)
Imazethapyr + imazamox 70 g/ha PE	10.91 (119)	15.50 (245)	4.72 (22)	10.28 (106)	14.13 (200)	4.11 (17)	16.08 (261)	17.93 (323)
Imazethapyr + imazamox 80 g/ha PE	8.74 (77)	12.84 (164)	3.18 (10)	9.21 (85)	12.20 (150)	2.49 (6)	12.85 (166)	15.50 (240)
Imazethapyr + imazamox 50 g/ha PoE	10.94 (122)	16.84 (283)	5.12 (27)	12.07 (145)	16.74 (281)	4.18 (17)	20.07 (403)	21.05 (444)
Imazethapyr + imazamox 70 g/ha PoE	5.92 (35)	10.51 (111)	3.95 (15)	8.17 (66)	14.22 (202)	3.68 (13)	14.45 (209)	16.80 (282)
Imazethapyr + imazamox 80 g/ha PoE	3.73 (15)	9.40 (90)	2.85 (10)	5.73 (34)	11.30 (131)	2.11 (4)	10.04 (102)	12.83 (168)
Pendimethalin 1000 g/ha PE	4.60 (21)	10.14 (103)	5.46 (30)	5.32 (28)	7.28 (55)	4.86 (23)	10.57 (112)	10.29 (106)
Imazethapyr 2% + pendimethalin 30% 1000 g/ha	5.14 (26)	5.71 (33)	4.00 (16)	4.97 (26)	12.84 (168)	3.91 (15)	12.57 (160)	14.41 (209)
Hoeing twice	3.80 (14)	8.82 (78)	4.19 (17)	5.45 (30)	9.78 (99)	2.46 (6)	37.87 (1441)	11.53 (134)
Weedy check	15.83 (251)	14.60 (215)	11.77 (140)	9.99 (99)	15.16 (230)	10.11 (102)	35.50 (1265)	20.77 (431)
LSD (p=0.05)	2.22	2.88	2.46	2.06	3.76	1.69	3.53	3.34

Values in parentheses are original. Data transformed to square root transformation

Table 2. Weed dry-matter as influenced by imazathapyr and its ready mix in blackgram (pooled of 2014 and 2015)

Treatment	Weed dry matter (g/m^2)							
	30 DAS			60 DAS			30 DAS	60 DAS
	Grassy	BLW	Sedges	Grassy	BLW	Sedges	Total	Total
Imazethapyr 50 g/ha PE	5.03 (24.9)	3.08 (9.0)	1.78 (2.73)	5.69 (32.9)	2.64 (6.51)	0.71 (0.00)	6.09 (36.7)	6.26 (39.4)
Imazethapyr 70 g/ha PE	3.06 (13.8)	2.19 (7.5)	0.88 (0.40)	3.74 (17.6)	2.17 (5.01)	0.73 (0.00)	3.74 (21.7)	4.28 (22.6)
Imazethapyr 80 g/ha PE	3.77 (9.0)	2.83 (4.4)	0.95 (0.28)	4.16 (14.0)	2.34 (4.21)	0.71 (0.03)	4.71 (13.7)	4.74 (18.2)
Imazethapyr 50 g/ha PoE	6.52 (42.0)	3.51 (11.9)	2.47 (5.61)	7.48 (58.4)	3.96 (15.8)	0.86 (0.27)	7.74 (59.5)	8.52 (74.5)
Imazethapyr 70 g/ha PoE	3.29 (24.4)	2.97 (11.1)	1.12 (0.90)	6.04 (56.9)	2.41 (8.68)	0.81 (0.07)	4.48 (36.4)	6.48 (65.6)
Imazethapyr 80 g/ha PoE	4.97 (10.6)	3.37 (8.3)	1.18 (0.93)	7.57 (36.4)	2.99 (5.37)	0.75 (0.17)	6.08 (19.8)	8.12 (41.9)
Imazethapyr + imazamox 50 g/ha PE	4.24 (17.7)	2.30 (4.8)	1.18 (0.90)	5.41 (29.1)	2.43 (5.56)	0.79 (0.13)	4.86 (23.4)	5.93 (34.8)
Imazethapyr + imazamox 70 g/ha PE	2.96 (8.3)	2.08 (4.1)	0.76 (0.08)	3.59 (12.6)	2.12 (4.12)	0.71 (0.01)	3.57 (12.5)	4.12 (16.7)
Imazethapyr + imazamox 80 g/ha PE	2.15 (4.6)	2.01 (3.8)	0.74 (0.05)	2.79 (7.6)	1.99 (3.57)	0.75 (0.07)	2.88 (8.5)	3.41 (11.2)
Imazethapyr + imazamox 50 g/ha PoE	4.58 (21.1)	2.94 (8.2)	1.67 (2.30)	6.88 (47.5)	3.47 (11.6)	2.39 (5.26)	5.64 (31.6)	8.01 (64.3)
Imazethapyr + imazamox 70 g/ha PoE	2.47 (5.6)	2.85 (7.6)	1.60 (2.08)	3.57 (12.6)	3.04 (8.81)	2.31 (4.83)	3.98 (15.3)	5.16 (26.3)
Imazethapyr + imazamox 80 g/ha PoE	2.30 (4.9)	2.69 (6.9)	1.44 (1.60)	3.15 (10.7)	2.89 (7.84)	1.77 (2.65)	3.70 (13.4)	4.58 (21.2)
Pendimethalin 1000 g/ha PE	3.28 (10.6)	2.52 (6.3)	4.01 (15.7)	3.75 (13.7)	2.53 (5.91)	2.73 (7.21)	5.69 (32.6)	5.23 (26.9)
Imazethapyr 2% + pendimethalin 30% 1000 g/ha	2.31 (5.6)	1.07 (0.8)	0.83 (0.20)	1.78 (3.2)	2.50 (6.29)	0.98 (0.58)	2.47 (6.6)	3.09 (10.1)
Hoeing twice	2.62 (7.5)	2.37 (5.2)	0.84 (0.21)	1.91 (3.7)	2.03 (3.64)	0.78 (0.13)	3.57 (12.9)	2.80 (7.51)
Weedy check	5.93 (36.9)	4.03 (16.1)	4.17 (16.9)	10.63 (118.9)	4.25 (18.4)	2.93 (8.14)	8.28 (69.9)	11.86 (145.4)
LSD (p=0.05)	1.67	1.01	0.53	2.91	1.26	0.51	1.60	2.60

Values in parentheses are original. Data transformed to square root transformation

Table 3. Effect of weed control methods on economics of blackgram production (pool of 2014 and 2015)

Treatment	WCE%		Phytotoxicity 15 days after application of herbicides	Yield (t/ha)		Gross return (x10^3 /ha)	Net return (x10^3 /ha)	B:C ratio
	30 DAS	60 DAS		Seed	Straw			
Imazethapyr 50 g/ha PE	63.72	77.29	0	0.92	1.32	28.55	18.15	1.74
Imazethapyr 70 g/ha PE	75.57	85.78	0	0.94	1.48	29.05	18.64	1.79
Imazethapyr 80 g/ha PE	86.89	84.88	0	1.07	2.17	33.23	22.80	2.19
Imazethapyr 50 g/ha PoE	55.44	54.97	4	0.86	1.26	26.51	16.11	1.55
Imazethapyr 70 g/ha PoE	64.69	65.87	4	0.93	1.34	28.90	18.48	1.77
Imazethapyr 80 g/ha PoE	79.47	79.49	4	1.00	1.77	31.05	20.63	1.98
Imazethapyr + imazamox 50 g/ha PE	73.13	73.76	0	0.86	1.28	26.57	16.14	1.55
Imazethapyr + imazamox 70 g/ha PE	84.91	86.61	0	1.03	2.00	31.78	21.33	2.04
Imazethapyr + imazamox 80 g/ha PE	90.16	89.38	0	1.07	2.91	33.19	22.72	2.17
Imazethapyr + imazamox 50 g/ha PoE	71.68	64.03	5	0.97	1.71	30.01	19.58	1.88
Imazethapyr + imazamox 70 g/ha PoE	87.29	86.08	5	1.12	2.33	34.58	24.13	2.31
Imazethapyr + imazamox 80 g/ha PoE	88.98	86.70	5	1.10	2.50	34.12	23.66	2.26
Pendimethalin 1000 g/ha PE	69.79	83.33	3	1.10	2.28	34.00	23.09	2.12
Imazethapyr 2% + pendimethalin 30% 1000 g/ha	94.07	83.67	2	0.94	1.51	29.04	17.94	1.62
Hoeing twice	76.36	91.46	0	0.96	1.58	29.73	12.68	0.74
Weedy check	0.00	0.00	0	0.66	1.03	20.38	8.98	0.79
LSD (p=0.05)	17.72	22.57	0.45	0.16	0.71	4.58	4.58	0.42

WCE - Weed control efficiency

Table 4. Weed control methods in blackgram and its effect on yield attributing character and yield of mustard

Treatment	No. of siliqua/plant	1000 seeds weight	No. of branches/ plant	No. of plants/m^2	Yield (t/ha)	Straw yield (t/ha)
Imazethapyr 50 g/ha PE	95	3.78	6	34	1.01	3.13
Imazethapyr 70 g/ha PE	83	3.83	5	36	1.07	2.88
Imazethapyr 80 g/ha PE	94	3.70	8	36	1.07	2.82
Imazethapyr 50 g/ha PoE	150	3.74	7	35	1.38	3.54
Imazethapyr 70 g/ha PoE	88	3.83	5	38	1.10	2.80
Imazethapyr 80 g/ha PoE	114	3.76	7	32	0.96	2.69
Imazethapyr + imazamox 50 g/ha PE	115	3.77	8	35	1.29	3.38
Imazethapyr + imazamox 70 g/ha PE	101	3.72	6	37	1.09	3.10
Imazethapyr + imazamox 80 g/ha PE	63	3.72	4	38	1.25	3.54
Imazethapyr + imazamox 50 g/ha PoE	62	3.74	4	38	1.16	3.11
Imazethapyr + imazamox 70 g/ha PoE	79	3.74	5	32	1.21	3.01
Imazethapyr + imazamox 80 g/ha PoE	107	3.74	7	36	1.11	2.91
Pendimethalin 1000 g/ha PE	92	3.87	6	30	0.92	2.64
Imazethapyr 2% + pendimethalin 30% 1000 g/ha	102	3.52	7	37	1.25	3.38
Hoeing twice	102	3.93	6	37	1.23	3.48
Weedy check	65	3.91	4	32	0.85	2.62
LSD (p=0.05)	NS	NS	NS	2.8	0.40	1.22

Yield and economics

Post-emergence of imazethapyr + imazamox 70 g/ha similar to PE of imazethapyre 80 g/ha, imazethapyr + imazamox 70 g/ha, imazethapyr + imazamox 80 g/ha, pendimethalin 1000 g/ha and PoE of imazethapyr 80 g/ha, imazethapyr + imazamox 50 g/ha, recorded significantly higher seed (1.12 t/ha) and straw yield (2.33 t/ha), gross return (` 34,583/-ha), net return (` 24,126/-) and B:C ratio (2.31).

Residual effect of herbicides applied in black-gram on succeeding mustard crop

No residual effect of herbicides application on succeeding mustard crop was observed except PE of pendimethalin 1000 g/ha and PoE of imazethapyr 80 g/ha when these herbicides reduced mustard plant density to the extent of 10.58 and 16.17% compared to mean plant density of 35.79 plant/m^2. Post-emergence application of imazethapyr 50 g/ha applied in blackgram similar to all treatments except PoE of imazethapyr 80 g/ha, PE of pendimethalin 1000 g/ha and weedy check recorded significantly higher mustard seed yield (1.38 t/ha) and PoE of imazethapyr 50 g/ha similar to PE of imazethapyr + imazamox 50 g/ha, PE of imazethapyr + imazamox 80 g/ha, application of imazethapyr + pendimethalin 1000 g/ha and hoeing twice recorded significantly higher straw yield (**Table 4**). Punia *et al*. (2015) have also reported no residual carry over effect of these herbicides applied in blackgram was visible on succeeding mustard crop as number of plants/meter row length., number of leaves/plant and seed yield of mustard in untreated and herbicide applied treatments was same

On the basis of two year pooled data it can be inferred that PoE of imazethapyr + imazamox 70 g/ha recorded maximum seed (1.12 t/ha) and straw yield (2.33 t/ha), net return (` 24,126/-) and B:C ratio (2.31) without affecting succeeding mustard yield (1.21 t/ha).

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