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Pre- and post-emergence herbicides effect on weed dynamics, microbial population and yield of summer blackgram

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ABSTRACT

An investigation was carried out at Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu during 2015 and 2016 to study the effect of pre- and post-emergence application of herbicides on weed dynamics, microbial population and yield of summer blackgram. Thirteen weed management treatments was comprised of imazethapyr 70 g/ha as pre and post-emergence, imazethapyr 80 g/ha as pre- and post-emergence, imazethapyr + imazamox 70 g/ha as pre- and post-emergence, imazethapyr + imazamox 80 g/ha as pre- and post-emergence, pendimethalin 1000 g/ha as pre-emergence, imazethapyr + pendimethalin 1000 g/ha as pre-emergence, two hoeings at 15 and 30 DAS, weedy check and weed free were assessed. The results revealed that a significant reduction in total weed density and total weed biomass was observed with two hoeings at 15 and 30 DAS, imazethapyr + pendimethalin 1000 g/ha as pre-emergence and imazethapyr + imazamox 80 g/ha as post-emergence. Aapplication of imazethapyr + pendimethalin 1000 g/ha as pre-emergence recorded the highest seed yield and B:C ratio. Initially, after the herbicides treatment (15 and 30 DAS) microbial counts were slightly less in pre-emergence, reaching a maximum at 30 DAS.

INTRODUCTION

Blackgram (*Vigna mungo* L.) is one of the most important pulse crops, which can be grown in tropical and sub-tropical countries. It is grown in (*Kharif*) rainy and summer seasons in India where weed infestation causes considerable loss in yield. The weed causes maximum damage initially (25 to 35 days after sowing) (Randhawa *et al.* 2002), and reduces the yield up to 43.2-64.1% (Rathi *et al.* 2004). Therefore, removal of weeds at appropriate time using a suitable method is essential to obtain high yields of blackgram. In blackgram, weeds can be controlled by hand weeding (Chand *et al.* 2004). Hand weeding is laborious, time consuming, costly and tedious. Many a times labours are not available at the critical period of weed removal. Furthermore, weather conditions during *Kharif* do not permit timely hand weeding due to wet field conditions. Use of herbicides offers an alternative for possible effective control of weeds. Therefore, in the present study, the effect of various herbicides was compared with hand weeding for weed control and yield in blackgram.

MATERIALS AND METHODS

A field experiment was conducted during summer seasons of 2015 and 2016 at Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu under irrigated conditions. The soil of the experimental field was sandy clay loam in texture with slightly alkaline in reaction (pH 7.81), medium in organic carbon (0.51%), available phosphorus (11.63 kg/ha) and potassium (147.3 kg/ha) and low in available nitrogen (246.5 kg/ha). The treatments comprised of imazethapyr 70 g/ha as pre-emergence, imazethapyr 80 g/ha as pre-emergence, imazethapyr 70 g/ha at 3-4 leaf stage, imazethapyr 80 g/ha at 3-4 leaf stage, imazethapyr + imazamox 70 g/ha as pre-emergence, imazethapyr + imazamox (RM) 80 g/ha as pre-emergence, imazethapyr + imazamox (RM) 70 g/ha at 3-4 leaf stage, imazethapyr + imazamox (RM)

80 g/ha at 3-4 leaf stage, pendimethalin 1000 g/ha as pre-emergence, imazethapyr + pendimethalin (RM) 1000 g/ha as pre-emergence, two hoeings 15 and 30 DAS, weedy check) and weed free. The experiment was laid out in a randomized block design replicated thrice.

Blackgram variety *'Uttara'* was sown on 20th April in 2015 and 17th April in 2016, with a plant to plant distance of 10 cm in a row spacing of 30 cm. The crop was harvested on 6th July in 2015 and 3rd July in 2016. Recommended dose of fertilizers 16 kg N and 40 kg P/ha was applied to the crop at time of sowing through di-ammonium phosphate (DAP). Pre-emergence (PE) application was made on next day of sowing and post-emergence (PoE) application was done at 18 DAS (3-4 leaf stage of weeds) by knapsack sprayer fitted with flat fan nozzle by using 500 l/ha of water. Likewise four and five irrigations was applied during the crop growth period.

Observations on growth of crop and weeds were recorded at 15 and 30 DAS. In each plot, grasses, broad-leaves and sedges were counted from 2 randomly selected places in each plot using 0.5 × 0.5 m quadrate. Weed count was expressed as no./m^2 and subjected to square-root transformation to normalize their distribution. The weeds removed from the selected areas were dried at 65°C to obtain constant weight and the weight was expressed in g/m^2. Weed control efficiency (WCE) was calculated by using the formulae suggested by Mishra and Mishra (1997). Benefit: cost ratio was calculated on the basis of prevailing market prices of inputs and produce. Enumeration of fungi, bacteria and actinomycetes was done by the serial dilution-agar plating method or viable plate count method. A known amount (10 ml or 10 g) of material is suspended or agitated in known volume of sterile water blank (90 ml or so to make the volume to 100 ml) to make a microbial suspension. Serial dilution 10^{-2}, 10^{-3}, …10^{-7} are made by pipetting measured volumes (usually 1.0 ml or 10.0 ml) into additional dilution blanks (having 99 ml or 90 ml sterile water). Finally, 1.0 ml aliquat of various dilutions are added to sterile petri dishes (triplicate for each dilution) to which are added 15 ml (approx.) of sterile, cool, molten (45°C) media (Nutrient agar for bacteria, Glycerol yeast agar for actinomycetes and Sabouraud agar medium, supplemented with streptopenicillin, 10 µg/ml, for fungi). The dilutions 10^{-2} to 10^{-5} are selected for enumeration of fungi, 10^{-3} to 10^{-6} for actinomycetes and 10^{-4} to 10^{-7} for bacteria relative to their proportion in soil. Upon solidification, plates are incubated, in an inverted position for 3-7 days at 25°C. The number of colonies appearing on dilution plates are counted, average and multiplied by the dilution factor to find the number of cells/spores per gram (or millimeter) of the sample:

RESULTS AND DISCUSSION

The predominant weed flora in summer blackgram comprised of mainly *Cyperus rotundus, C. iria*, *Cynodon dactylon, Digitaria sanguinalis, Solanum nigrum, Physalis minima* and *Phyllanthus niruri* during both the years of experimentation and their mean relative weed density were 35.46, 19.06, 10.00, 8.87, 8.12 and 12.45% at 15 DAS and at 30 DAS, 39.24, 16.87, 10.34, 8.57, 8.85 and 11.38%, respectively.

Effect on crop growth

Different weed management treatments significantly influenced the plant height and dry matter accumulation at 30 DAS during summer seasons of 2015 and 2016 **(Table 1)**. Being non-significant, treatment weed free recorded numerically the highest plant height (6.40 and 6.33 cm) and dry matter accumulation (7.00 and 7.25 g/m^2) over weedy check. At 30 DAS, weed free treatment recorded significantly the highest plant height (26.15 and 28.69 cm) and dry matter accumulation (17.52 and 19.02 g/m^2) whereas the lowest plant height and dry matter accumulation were recorded in weedy check. The increase in growth parameters was due to the reduction in weed competitiveness with the crop which ultimately favored better environment for growth and development of crop. Similar findings were reported by Kaur *et al.* (2009). Application of imazethapyr + pendimethalin 1000 g/ha as pre-emergence recorded significantly the highest plant height (24.93 and 27.26 cm) and dry matter accumulation (16.30 and 17.80 g/m^2), which was at par with imazethapyr + imazamox 80 g/ha at 3-4 leaf stage, imazethapyr 80 g/ha at 3-4 leaf stage, imazethapyr + imazamox 70 g/ha at 3-4 leaf stage and imazethapyr 70 g/ha at 3-4 leaf stage. The increasing trend in terms of growth parameters might have happened due to better control of both grassy as well as broad-leaved weeds during early crop growth period and also due to safe behaviour of herbicides against crop plants and phytotoxic effects on weeds. These results were in close confirmity with those reported by Yadav *et al.* (2015) and Kaur *et al.* (2016).

Effect on weeds

Application of imazethapyr + pendimethalin 1000 g/ha as pre-emergence recorded significantly the lowest total weed density (4.6 and 4.6/m^2) and

total weed dry weight (1.60 and 1.70 g/m^2), which was statistically at par with imazethapyr + imazamox 80 g/ha as pre-emergence. While at 30 DAS and 75 DAS, imazethapyr + pendimethalin 1000 g/ha as pre-emergence significantly reduced the total weed density and weed dry weight, and was at par with imazethapyr + imazamox 80 g/ha at 3-4 leaf stage, imazethapyr 80 g/ha at 3-4 leaf stage, imazethapyr + imazamox 70 g/ha at 3-4 leaf stage and imazethapyr 70 g/ha at 3-4 leaf stage. The better performance of combination of herbicides was due to the synergistic effect between the two herbicides reducing the population as well as dry matter accumulation of different weed species (Singh *et al.* 2016). Imazethapyr + pendimethalin 1000 g/ha as pre-emergence at 15 DAS recorded the maximum weed control efficiency among herbicidal treatments. Whereas, at 30 and 75 DAS two hoeing at 15 and 30 DAS (79.02, 79.02% and 71.55, 70.52%) and imazethapyr + pendimethalin 1000 g/ha as pre-emergence (71.75, 71.78% and 69.01, 68.94%) showed better performance (**Table 2** and **3**). Higher weed control efficacy and long lasting effects of imazethapyr in reducing weed dry matter might be due to broad-spectrum activity of herbicide particularly on established plants of both narrow and broad-leaf weeds and its greater efficiency. The lowest weed control efficiency was recorded with treatment weedy check. Similar findings with respect to weed control efficiency were reported by Kumar *et al.* (2015).

Table 1. Effect of pre- and post-emergence application of herbicides on growth parameters of summer blackgram

Treatment	15 DAS				30 DAS			
	Plant height (cm)		Dry matter accumulation (g/m^2)		Plant height (cm)		Dry matter accumulation (g/m^2)	
	2015	2016	2015	2016	2015	2016	2015	2016
Imazethapyr 70 g pre-emergence (PE)	5.77	5.84	6.40	6.51	20.70	21.83	14.12	14.72
Imazethapyr 80 g (PE)	6.00	6.10	6.60	7.20	21.30	22.96	14.50	15.40
Imazethapyr 70 g (3-4 leaf stage)	5.57	5.52	5.70	6.10	23.70	25.68	15.49	16.55
Imazethapyr 80 g (3-4 leaf stage)	5.43	5.49	5.33	5.60	24.27	26.37	15.82	17.02
Imazethapyr + imazamox 70 g (PE)	5.57	5.63	6.20	6.80	21.00	22.52	14.31	15.21
Imazethapyr + imazamox 80 g (PE)	6.33	6.44	6.70	7.30	21.47	23.52	14.60	15.80
Imazethapyr + imazamox 70 g (3-4 leaf stage)	5.40	5.45	5.60	6.20	24.07	26.00	15.49	16.59
Imazethapyr + imazamox 80 g (3-4 leaf stage)	5.53	5.64	5.40	5.30	24.63	26.67	15.93	17.23
Pendimethalin 1000 g (PE)	5.63	5.69	6.20	6.50	22.50	21.52	14.00	14.60
Imazethapyr + pendimethalin 1000 g (PE)	6.27	6.37	6.75	7.00	24.93	27.26	16.30	17.80
Hoeing (2) 15 and 30 DAS	5.40	5.44	5.40	5.40	25.20	27.61	16.82	18.32
Weedy check	5.43	5.49	5.35	5.70	18.50	19.30	11.51	12.11
Weed free	6.40	6.33	7.00	7.25	26.15	28.69	17.52	19.02
LSD (p=0.05)	NS	NS	NS	NS	3.17	3.66	2.22	2.56

Table 2. Effect of pre- and post-emergence application of herbicides on weed density, weed dry weight and weed control efficiency of summer blackgram

Treatment	15 DAS						30 DAS					
	Weed density (no./m^2)		Weed dry weight (g/m^2)		Weed control efficiency (%)		Weed density (no./m^2)		Weed dry weight (g/m^2)		Weed control efficiency (%)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Imazethapyr 70 g (PE)	5.8(33.0)	6.1(36.7)	1.9(2.8)	2.0(3.0)	66.31	66.1	7.7(58.3)	8.0(63.7)	4.0(15.1)	4.2(16.6)	45.4	43.8
Imazethapyr 80 g (PE)	5.6(30.7)	5.8(33.3)	1.9(2.5)	1.9(2.6)	69.73	70.6	7.3(53.0)	7.6(56.3)	3.8(13.7)	4.0(14.8)	50.5	49.9
Imazethapyr 70 g (3-4 leaf stage)	8.6(73.3)	9.0(79.3)	3.0(8.3)	3.2(9.3)	-	-	6.8(45.7)	7.1(49.0)	3.3(9.8)	3.4(10.5)	64.7	64.5
Imazethapyr 80 g (3-4 leaf stage)	8.8(76.0)	9.1(81.3)	3.0(8.0)	3.1(8.4)	-	-	6.5(41.3)	6.6(43.3)	3.1(9.0)	3.2(9.4)	67.6	67.9
Imazethapyr + imazamox 70 g (PE)	5.2(26.3)	5.6(30.0)	1.9(2.6)	1.9(2.8)	68.19	68.4	7.4(54.0)	7.8(59.3)	3.9(14.2)	4.0(15.3)	48.7	48.1
Imazethapyr + imazamox 80 g (PE)	4.9(23.3)	5.1(24.7)	1.8(2.3)	1.9(2.5)	71.44	72.3	7.2(50.7)	7.5(55.3)	3.7(12.9)	3.8(13.7)	53.5	53.5
Imazethapyr + imazamox 70 g (3-4 leaf stage)	8.8(77.3)	9.2(83.0)	3.0(8.0)	3.1(8.7)	-	-	6.5(41.7)	6.8(45.7)	3.2(9.3)	3.3(9.8)	66.3	66.6
Imazethapyr + imazamox 80 g (3-4 leaf stage)	8.7(74.7)	9.0(79.3)	3.0(8.2)	3.1(8.5)	-	-	6.4(40.0)	6.6(43.0)	3.1(8.6)	3.2(9.2)	68.8	68.8
Pendimethalin 1000 g (PE)	6.0(35.7)	6.4(41.0)	1.9(2.7)	2.0(3.0)	66.44	66.0	7.7(58.0)	8.0(64.0)	4.1(15.7)	4.3(17.1)	43.3	41.8
Imazethapyr + pendimethalin 1000 g (PE)	4.6(20.0)	4.6(20.0)	1.6(1.6)	1.7(1.9)	80.85	79.0	6.3(39.0)	6.1(36.3)	3.0(7.8)	3.0(8.3)	71.7	71.8
Hoeing (2) 15 and 30 DAS	8.5(72.3)	9.0(79.7)	3.0(8.2)	3.2(9.1)	-	-	5.2(26.7)	5.4(28.0)	2.6(5.8)	2.7(6.2)	79.0	79.0
Weedy check	8.9(78.0)	9.1(82.7)	3.0(8.2)	3.1(8.9)	-	0.0	10.4(107)	10.9(118)	5.3(27.7)	5.5(29.5)	0.0	0.0
Weed free	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	100.0	100.0	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	100.0	100.0
LSD(p=0.05)	0.62	0.56	0.10	0.11	-	-	0.55	0.55	0.20	0.19		

Effect on yield attributes and yield

Among different weed management treatments, yield attributes, *viz*. number of seeds/pod showed non-significant results. Weed free treatment significantly recorded the highest values of yield attributes, *viz*. number of branches/plant (7.00 and 7.06), pods/plant (20.00 and 19.00) and 1000-seed weight (35.54 g and 35.33 g), which was at par with 2 hoeing at 15 and 30 DAS (**Table 4**).This was perhaps due to minimized competition of weeds with the crop for various resources, *viz*. space, light, nutrients and moisture due to adaptation of effective weed control methods. Thus, reduced crop-weed competition resulted into overall improvement in crop growth and better development of reproductive structures and translocation of photosynthates to the sink. These results were in close conformity with those of Singh *et al.* (1994) and Yadav *et al.* (2014).

Among the herbicidal treatments, application of imazethapyr + pendimethalin 1000 g/ha as pre-emergence significantly recorded the highest yield attributes, *viz*. number of branches per plant (6.54 and 6.61), pods per plant (18.33 and 17.00) and 1000-seed weight (33.00 g and 32.71 g), which was statistically at par with imazethapyr + imazamox 80 g/ ha at 3-4 leaf stage, imazethapyr 80 g/ha at 3-4 leaf stage, imazethapyr + imazamox 70 g/ha at 3-4 leaf stage and imazethapyr 70 g/ha at 3-4 leaf stage which were significantly superior over rest of the treatments and remained superior to treatment weedy check. This might have happened due to effective control of weeds, less crop weed competition throughout the crop growth period and due to better control of both grassy as well as broad-leaved weeds during early crop growth period, which ultimately resulted in improved yield attributes of the crop. Almost similar findings were reported by Yadav *et al.* (2015), Singh *et al.* (2016) and Balyan *et al.* (2016).

Seed and stover yield of blackgram recorded significant variations with respect to different weed management treatments. It was observed that among the different weed management treatments, weed free recorded significantly highest seed yield (910 and 883 kg/ha) and stover yield (2.15 and 2.49 t/ha) which was at par with treatment 2 hoeing at 15 and 30 DAS **(Table 4)**. The increase in seed and stover yield of blackgram under weed free conditions were obviously due to reduced crop weed competition, higher weed control efficiency by providing below threshold weed situation. Thus, the crop plants being vigorous efficiently utilized nutrients, moisture, sunlight, space and other input factors hence, gave better yield. Whereas, the weedy check plots recorded significantly lowest yields due to heavy competition for nutrients, moisture and light between the crop and weeds at critical phenophases of crop. Similar findings were reported by Chand *et al.* (2003), Mirjha *et al.* (2013) and Yadav *et al.* (2015).

Among the herbicidal treatments, application of imazethapyr + pendimethalin 1000 g/ha as pre-emergence significantly recorded highest seed yield (786 kg/ha and 743 kg/ha) and stover yield (1.88 and 2.18 t/ha), which was statistically at par with imazethapyr + imazamox 80 g/ha at 3-4 leaf stage, imazethapyr 80 g/ha at 3-4 leaf stage, imazethapyr + imazamox 70 g/ha at 3-4 leaf stage and imazethapyr 70 g/ha at 3-4 leaf stageand significantly superior over rest of the treatments, which were at par and remained superior to weedy check . This might have happened probably due to better control of both

Table 3. Effect of pre- and post-emergence application of herbicides on weed density, weed dry weight and weed control efficiency of summer blackgram

Treatment	75 DAS					
	Weed density (no./m^2)		Weed dry weight (g/m^2)		Weed control efficiency (%)	
	2015	2016	2015	2016	2015	2016
Imazethapyr 70 g pre-emergence (PE)	7.88 (61.3)	8.59 (73.0)	4.95 (23.6)	5.14 (25.5)	47.36	47.88
Imazethapyr 80 g (PE)	7.81 (60.0)	8.18 (66.0)	4.91 (23.1)	5.12 (25.2)	48.45	48.53
Imazethapyr 70 g (3-4 leaf stage)	5.94 (34.3)	6.53 (41.7)	4.16 (16.3)	4.36 (18.0)	62.71	62.74
Imazethapyr 80 g (3-4 leaf stage)	5.50 (29.3)	5.94 (34.3)	4.09 (15.7)	4.28 (17.3)	64.84	64.60
Imazethapyr + imazamox 70 g (PE)	7.83 (60.3)	8.35 (68.7)	4.97 (23.8)	5.18 (25.8)	46.93	47.27
Imazethapyr + imazamox 80 g (PE)	7.52 (55.7)	8.04 (63.7)	4.86 (22.6)	5.08 (24.8)	49.43	49.43
Imazethapyr + imazamox 70 g (3-4 leaf stage)	5.63 (30.7)	6.19 (37.3)	4.07 (15.6)	4.28 (17.4)	65.08	64.54
Imazethapyr + imazamox 80 g (3-4 leaf stage)	5.38 (28.0)	5.77 (32.3)	3.99 (14.9)	4.14 (16.1)	66.67	67.06
Pendimethalin 1000 g (PE)	8.08 (64.3)	8.65 (74.0)	5.04 (24.4)	5.26 (26.7)	45.48	45.50
Imazethapyr + pendimethalin 1000 g (PE)	5.18 (26.0)	5.40 (28.3)	3.86 (13.9)	4.03 (15.2)	69.01	68.94
Hoeing (2) 15 and 30 DAS	6.63 (43.0)	7.57 (56.3)	3.71 (12.7)	3.93 (14.4)	71.55	70.52
Weedy check	10.70 (113.7)	11.07 (121.7)	6.76 (44.8)	7.07 (49.0)	0.00	0.00
Weed free	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	100.00	100.00
LSD(p=0.05)	0.82	1.13	0.32	0.35	-	-

grassy as well as broad-leaved weeds during early crop growth stages, higher weed control efficiency, higher nutrient uptake by the crop and better yield attributes (Yadav *et al.* 2015). However significantly the lowest seed and stover yields were recorded in weedy situations due to excessive weed infestations.

Economics

Among the different weed management tretaments, imazethapyr + pendimethalin 1000 g/ha as pre-emergence) recorded the highest B:C ratio of 2.56, which was closely followed by imazethapyr 80 g/ha at 3-4 leaf stage, imazethapyr + imazamox 80 g/ha at 3-4 leaf stage and imazethapyr + imazamox 70 g/ha at 3-4 leaf stage (**Table 4**). Whereas, the lowest B:C ratio (0.68) was obtained with weedy check.

Effect on microbial population

Initially, after the herbicides treatment (15 DAS) microbial counts were slightly less in pre-emergence of imazethapyr, imazethapyr + imazamox and pendimethalin, reaching a maximum at 30 DAS (**Table 5**). The toxic effect of herbicides normally appears immediately after the application when their concentration in the soil is the highest. Later on, micro-organism take part in degradation process and herbicide concentration and its toxic effect decrease (Radivojevic *et al*. 2004). The total microbial population was the highest with cultural operations and lower with herbicides. The application with herbicides in recommended dose did not affect the microbial population significantly. Balasubramanian and Sankaran (2004) also reported initial suppression of soil micro flora by the herbicides application in different soils, which recovered later on.

Conclusion

It can be concluded that imazethapyr + pendimethalin 1000 g as pre-emergence or imazethapyr 80 g at 3-4 leaf stage found suitable for

Table 4. Effect of different weed management practices on yield attributes, seed yield, stover yield and benefit cost ratio of summer blackgram

Treatment	No. of branches /plant		No. of pods/plant		No. of seeds/pod		1000-seed weight (g)		Seed yield (kg/ha)		Stover yield (t/ha)		B:C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Imazethapyr 70 g pre-emergence (PE)	5.83	5.92	13.33	12.00	4.67	5.00	29.85	29.20	623	581	1.36	1.58	1.97	1.71
Imazethapyr 80 g (PE)	5.93	5.95	14.33	13.00	5.00	4.67	30.03	29.46	686	642	1.50	1.74	2.23	1.96
Imazethapyr 70 g (3-4 leaf stage)	6.24	6.29	17.00	15.33	5.00	4.67	31.31	30.82	730	690	1.81	2.10	2.48	2.22
Imazethapyr 80 g (3-4 leaf stage)	6.34	6.42	17.67	16.33	5.33	5.00	32.15	31.89	746	695	1.85	2.14	2.52	2.21
Imazethapyr + imazamox 70 g (PE)	5.90	5.93	14.00	12.67	4.67	4.67	29.87	29.16	666	621	1.38	1.60	2.08	1.81
Imazethapyr + imazamox 80 g (PE)	6.05	6.10	14.67	13.67	5.00	4.67	30.22	29.89	688	646	1.61	1.87	2.13	1.88
Imazethapyr + imazamox 70 g (3-4 leaf stage)	6.27	6.33	17.33	15.67	5.00	4.67	31.80	31.39	743	690	1.82	2.12	2.44	2.13
Imazethapyr + imazamox 80 g (3-4 leaf stage)	6.44	6.54	18.00	16.67	5.33	5.00	32.33	32.03	759	711	1.88	2.18	2.46	2.17
Pendimethalin 1000 g (PE)	5.73	5.76	12.67	11.67	4.67	4.33	29.70	29.09	620	565	1.24	1.43	1.94	1.62
Imazethapyr + pendimethalin 1000 g (PE)	6.54	6.61	18.33	17.00	5.33	5.00	33.00	32.71	786	743	1.88	2.18	2.56	2.29
Hoeing (2) 15 and 30 DAS	6.68	6.78	18.67	18.33	5.67	5.33	34.70	34.46	820	782	1.90	2.21	1.92	1.74
Weedy check	5.22	5.17	10.33	9.00	4.33	4.00	24.52	24.13	316	297	1.09	1.26	0.68	0.55
Weed free	7.00	7.06	20.00	19.00	5.33	5.33	35.54	35.33	910	883	2.15	2.49	1.43	1.33
LSD (p=0.05)	0.36	0.39	1.62	1.77	NS	NS	4.25	4.21	96	100	0.24	0.27	-	-

Table 5. Effect of different weed management practices on microbial count at 15 and 30 DAS in summer blackgram

Treatment	Bacteria (x 10^6 CFU/g) 2015		Fungi (x 10^3 CFU/g) 2015		Actinomycetes (x 10^4 CFU/g) 2015	
	15 DAS	30 DAS	15 DAS	30 DAS	15 DAS	30 DAS
Imazethapyr 70 g pre-emergence (PE)	13.83	18.74	11.43	15.83	9.14	14.35
Imazethapyr 80 g (PE)	13.55	18.54	11.35	15.66	9.08	14.11
Imazethapyr 70 g (3-4 leaf stage)	15.42	17.23	13.21	14.15	11.14	12.17
Imazethapyr 80 g (3-4 leaf stage)	15.31	17.11	13.14	13.94	10.96	11.97
Imazethapyr + imazamox 70 g (PE)	13.76	18.84	11.27	15.82	8.98	14.23
Imazethapyr + imazamox 80 g (PE)	13.45	18.56	11.08	15.91	8.85	14.05
Imazethapyr + imazamox 70 g (3-4 leaf stage)	15.46	16.95	13.29	13.85	11.04	12.07
Imazethapyr + imazamox 80 g (3-4 leaf stage)	15.54	17.28	13.34	13.67	11.14	11.97
Pendimethalin 1000 g (PE)	13.91	19.07	11.76	15.88	9.32	14.53
Imazethapyr + pendimethalin 1000 g (PE)	13.23	18.52	11.02	15.06	8.73	13.92
Hoeing (2) 15 and 30 DAS	15.48	19.90	13.31	15.97	11.14	15.10
Weedy check	15.57	19.87	13.27	15.88	11.03	14.97
Weed free	15.72	20.14	13.63	16.20	11.41	15.27
LSD (p=0.05)	1.62	1.67	1.50	1.57	1.40	1.55

weed control in summer blackgram as these provide higher seed yield and B:C ratio with higher weed control efficiency.

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