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RESEARCH ARTICLE

Weed growth, productivity and profitability of blackgram as influenced by pre- and post-emergence herbicidal application

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ABSTRACT

The field experiment was conducted at the Research Farm of the Punjab Agricultural University, Ludhiana during rainy season 2022 and 2023 to study the effect of pre- and post-emergence herbicides on the weeds, growth, productivity and profitability of blackgram. The experiment consisted of ten treatments replicated four times in a randomized complete block design. Two hand weeding significantly reduced the weed biomass and density followed by application of imazethapyr 75 g/ha as well as 50 g/ha at 15 days after sowing (DAS). In 2022, more frequent rains were received than in 2023, which resulted in several flushes of weeds. As compared to weedy check, pre-emergence (PE) application of imazethapyr 50 g/ha at 15 DAS in 2022 and pre-mix pendimethalin + imazethapyr 450 g/ha as well as 750 g/ha in 2023 showed significant superiority in managing weeds and increasing crop growth. On the basis of pooled mean, application of imazethapyr 50 and 75 g/ha at 15 DAS and pendimethalin + imazethapyr 750 g/ha (PE) resulted in 97.8, 88.1 and 84.4% higher grain yield over weedy check. On pooled mean basis, the highest net returns were provided by imazethapyr 50 g/ha at 15 DAS (Rs 61804/ha) followed by hand weeding (Rs 59812/ha), imazethapyr 75 g/ha at 15 DAS (Rs 56618/ha) and pendimethalin + imazethapyr 750 (Rs 54650/ha). It can be concluded that imazethapyr 50 g/ha at 15 DAS or pendimethalin + imazethapyr 750 g/ha can be applied in *Kharif* blackgram for managing weeds effectively and obtaining high productivity and profitability.

Keywords: Blackgram, Economics, Grain yield, Imazethapyr, Weeds

INTRODUCTION

Blackgram [*Vigna mungo* (L.) Wilczek], commonly known as urdbean, mash and urd, is grown mainly in the South Asian region. The main grower and the consumer of blackgram is India. Apart from India, blackgram is also widely produced in Afghanistan, Bangladesh, Nepal and Pakistan (Gupta *et al* 2022). It forms an important component of diet due to high protein content and part of cropping systems due to the short duration of the crop. Blackgram, being a leguminous crop, improves health of the soil due to fixation of atmospheric nitrogen. Productivity of blackgram is limited due to different factors - poor cultural practices, cultivation of the crop on low-fertility soils, insufficient fertilization, weed infestation and a high vulnerability to pests and diseases; among these factors, infestation of weeds being a major one.

Weeds cause 9.1-37.0% decline in grain yield in blackgram (Mahajan *et al* 2021, Tripathy *et al* 2022). By competing with the crop for moisture, nutrients, space and light at every stage of its development, weeds suppress the growth of the crop. Traditionally, weed management has been done using mechanical and physical methods. Weeds can be managed effectively by manual weeding (Patel *et al* 2015) however, it is a very costly and time consuming task. Further, generally there is lack of labour availability during the critical period of weed removal. Thus, using herbicides to manage weeds is a more cost-effective way than manual weeding. The use of pre-emergence (PE) and post-emergence (PoE) herbicides becomes an important aspect of weed management in the present labour-scarce situation. Therefore, a field experiment was conducted to study the effect of PE application of pendimethalin + imazethapyr (pre-mix) and imazethapyr, and PoE application of imazethapyr at different doses and time of application in *kharif* blackgram.

MATERIALS AND METHODS

The field experiment was conducted at the Research Farm of Pulses Section, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, Punjab during the *Kharif* (rainy season) of 2022 and 2023. Ludhiana is positioned at North latitude of 30°542 , East longitude of 75°482 in the central plain region of Punjab which falls under Transgangetic Agro-climatic Zone of India. It has an

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average elevation of 247 metres above sea level. The meteorological data were recorded during the crop growing season (from July to October) at the Meteorological Observatory located at Punjab Agricultural University, Ludhiana. Gross rainfall received during the crop growing season was 577.9 (25 rainy days) and 203.2 mm (11 rainy days) during 2022 and 2023, respectively (**Figure 1**). The soil was loamy sand with pH 7.4 and 7.6, organic carbon 0.36 and 0.35%, available nitrogen 164 and 156.3 kg/ha, available phosphorus 23.89 and 29.9 kg/ha, available potassium 195 and 135.3 kg/ha and electrical conductivity 0.18 and 0.19 dS/m in 2022 and 2023, respectively.

Experiment was laid out in RCBD design replicated four times with 10 treatments (pendimethalin 30 EC + imazethapyr 2 SL 450 g/ha (PE), pendimethalin 30 EC + imazethapyr 2 SL 750 g/ha (PE), imazethapyr 10 SL 50 g/ha as PE, imazethapyr 10 SL 75 g/ha as PE, imazethapyr 10 SL 50 g/ha at 15 DAS, imazethapyr 10 SL 50 g/ha at 25 DAS, imazethapyr 10 SL 75 g/ha at 15 DAS, imazethapyr 10 SL 75 g/ha at 25 DAS, hand weeding at 4 and 6 weeks after sowing and weedy check). PE herbicides were applied on the same day as of sowing and PoE was applied according to the treatments at 15 or 25 DAS. The herbicides were applied by using a knapsack sprayer. For PE application of herbicides 500 L of water per ha and for POE application 375 L of water per ha was used. In the case of two hand weedings treatment, weeds were removed manually with a *khurpa* 4 and 6 weeks after sowing. In the case of weedy check plots, weeds were not removed during the whole crop growing season. The blackgram variety Mash 883 was sown on 7 July 2022 and 11 July 2023 at a row spacing of 30 cm apart using a seed rate of 20 kg/ha. Recommended dose of 12.5 kg nitrogen and 40 kg P/ha was applied through urea and single superphosphate at sowing.

The data on weed count (species-wise) were taken at 45 DAS from random spots using the quadrat of 0.5 m × 0.5 m. Weed density was calculated by counting all the weeds inside the quadrat and computed as number per square metre (no./m^2).

The data on dry matter of weeds were taken at 45 DAS and at harvest from the quadrat of 0.5 m × 0.5 m and whole plot basis, respectively. For this, the weeds present in the quadrat were counted and removed from the area under the quadrat without roots and after that these were sun dried for a few days and then dried in an oven at temperature of 60°C to obtain a constant weight and expressed in kg/ha. Weed control efficiency (WCE) was calculated from the dry matter of the weeds and it was computed in percentage (%) using the formula (Walia 2018).

Accumulation of dry matter of shoot (crop) was taken at 45 DAS. Plants were removed slightly above the surface of soil from an area of 0.5 m × 0.3 m per plot (50 cm area of one row). Samples were first dried in the sun before being dried in an oven at 60°C to achieve a constant weight and computed in kg/ha. At harvest, data on plant height and number of branches of five randomly chosen plants were recorded and averaged. At harvest, pods were taken from 10 randomly chosen plants, pods counted, data averaged and results computed as the number of pods/plant. Ten randomly chosen pods from various plants were manually picked, grains were removed, counted, data were averaged and expressed as the number of grains/pod. After the threshing and winnowing of each plot's bulk product, 100 randomly chosen grains were weighed and the data were recorded as 100-grain weight. For biological yield, from each treatment 7.2 m^2 of net plot was harvested, then plants dried in the sun and weighed, and results expressed in kg/ha. The 7.2 m^2 of net plot area was used to record each plot's grain production after the threshing and winnowing of the grains and the figures were then expressed in kg/ha. The stover yield of every plot was obtained by subtracting the grain yield from the biological yield. Harvest index (Donald 1968) indicates the capacity of the crop to generate optimum economic output. Harvest index was calculated.

Correlation and regression analysis of weed dry matter at harvest and grain yield was calculated. Economic analysis was also done. Gross returns were calculated by multiplying the minimum support price (MSP) with the grain yield and in case of the byproduct i.e. stover yield, it was multiplied with the price that was prevalent in the market. It was expressed in Rs/ha.

Net returns were determined by subtracting the variable cost/ha from the gross returns. It was calculated in Rs/ha.

To obtain a benefit cost ratio (B:C) the net returns were divided by the variable cost i.e. cost of cultivation.

The data were analyzed statistically in randomized complete block design (RCBD) using CPCS1 software which was developed at the Department of Statistics, Punjab Agricultural University, Ludhiana, India by Cheema and Singh (1991). This software is based on the procedure given by Cochran and Cox (1967). Data on weed count were square root transformed before statistical analysis. The significance level for each comparison was set at 5 percent.

RESULTS AND DISCUSSION

Effect on weeds

The major weeds observed at the experimental location at 45 DAS were *Cyperus rotundus* and *Digitaria sanguinalis* in 2022 and *Cyperus rotundus, Digitaria sanguinalis, Mollugo* sp. and *Trianthema portulacastrum* in 2023. The lowest weed density was recorded in hand weeding treatment followed by imazethapyr 50 and 75 g/ha at 15 DAS (**Table 1)**. Imazethapyr effectively controlled the sedges, grasses and broad-leaf weeds when applied at the critical stage of competition between weeds and crop, as also reported by Priyadarshini *et al* (2023). Pendimethalin + imazethapyr (PE) controlled *Cyperus rotundus* effectively in 2023 but not in 2022 due to frequent rains (**Figure 1**) which resulted in several flushes of the weed. Application of pre-mix pendimethalin + imazethapyr effectively controls the grassy weeds due to the broad-spectrum effect of the combination of herbicides having the different modes of action but this did not control the sedges effectively (Kumar *et al* 2016).

At 45 DAS, the lowest weed dry matter (DM) was observed in hand weeding treatment during both the years. Lower weed DM was observed in imazethapyr 75 and 50 g/ha at 15 DAS (**Table 2**) than treatments of pre-emergence application and weedy check in 2022. Lower weed DM was also observed in pendimethalin + imazethapyr 750 g/ha as PE than weedy check and other treatments in 2023. In 2022, application of pre-mix of pendimethalin + imazethapyr 450 as well as 750 g/ha and imazethapyr 50 as well as 75 g/ha as PE controlled weeds for initial period only; after some time, these became inefficient in controlling weeds, resulting in high weed dry matter. This could be due to frequent rains, which increased the availability of moisture resulting in more proliferation and growth of weeds and heavy rainfall resulted in leaching of herbicides.

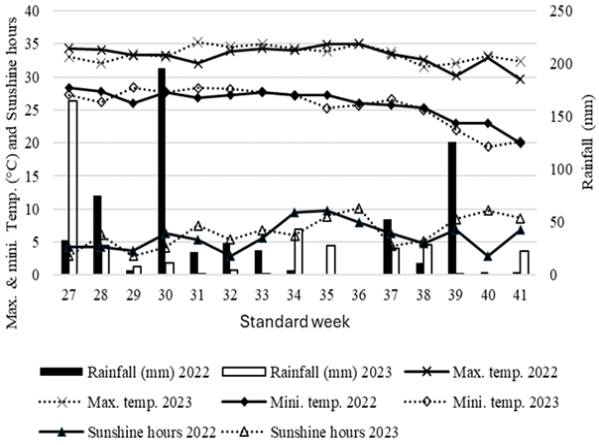

Figure 1. Meteorological data during crop season 2022 and 2023

The highest WCE was obtained in hand weeding in both years, followed by application of imazethapyr 75 and 50 g/ha at 15 DAS in year 2022 and pendimethalin + imazethapyr 750 as well as 450 g/ha and imazethapyr 50 as well as 75 g/ha as PE in year 2023 due to more effective management of weeds. Application of imazethapyr 50 as well as 75 g/ha at 25 DAS also resulted in higher WCE than weedy check due to less weed dry matter and efficient control of weeds. At harvest, the lowest weed dry matter was observed in hand weeding treatment and all treatments recorded significantly lower weed dry matter than weedy check.

At harvest, hand weeding recorded the highest WCE in both years followed by imazethapyr 75 g/ha at 15 DAS due to less weed dry matter and efficient control of weeds. Similar results were reported with application of imazethapyr 50 g/ha by Painkra *et al* (2021) and Prajapati *et al* (2018) in blackgram.

Effect on crop

At 45 DAS, shoot dry matter accumulation was the highest in hand weeding which was statistically at par with the application of imazethapyr 50 as well as 75 g/ha at 15 DAS and 25 DAS during 2022 (**Table**

Table 1. Influence of different weed control treatments on weed density at 45 DAS in blackgram

Treatment	No. of weeds /m^2									
	Cyperus rotundus		*Digitaria sanguinalis*		*Mollugo* sp.		*Trianthema portulacastrum*		Total	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
Pendimethalin + imazethapyr 450 g/ha (PE)	6.3(40.2)	3.2(10)	4.0(15.7)	2.9(8)	-	2.9 (8)	-	2.6 (6)	10.4(56.0)	5.7(32)
Pendimethalin + imazethapyr 750 g/ha (PE)	6.34(39.7)	3.1(9)	4.0(15.5)	2.8(8)	-	3.(10)	-	2.1 (4)	10.3(55.2)	5.6(31)
Imazethapyr 50 g/ha (PE)	5.5(30)	3.3(12)	4.41(19.0)	3.9(17)	-	3.0(10)	-	2.4 (5)	9.9(49.0)	6.4(44)
Imazethapyr 75 g/ha (PE)	5.4(29)	3.7(13)	4.13(17.2)	2.9(8)	-	2.6 (6)	-	2.1 (5)	9.5(46.2)	5.7(32)
Imazethapyr 50 g/ha at 15 DAS	3.9(15.2)	4.1(16)	2.83(7.5)	3.2(10)	-	1.0(0)	-	2.7 (7)	6.7(22.7)	5.7(33)
Imazethapyr 50 g/ha at 25 DAS	4.9(24)	4.9(24)	3.9(15.0)	4.2(17)	-	2.4(6)	-	2.3 (5)	8.8(39.0)	7.3(52)
Imazethapyr 75 g/ha at 15 DAS	3.8(14.5)	4.3(18)	3.0(8.5)	2.9(8)	-	2.9(8)	-	2.4 (6)	6.8(23.0)	6.3(40)
Imazethapyr 75 g/ha at 25 DAS	4.92(24.2)	4.8(22)	4(16)	2.7(7)	-	2.7(7)	-	2.3 (5)	9.0(40.2)	6.4(41)
Hand weeding at 4 and 6 WAS	1.0(0)	1.0(0)	1.0(0)	1.0(0)	-	1.0(0)	-	1.0 (0)	1.0(0)	1.0(0)
Weedy check	6.98(48.5)	9.4(88)	4.4(19.2)	6.7(45)	-	5.2(27)	-	4.1 (17)	11.4(67.7)	13.3(177)
LSD (p=0.05)	0.5	1.1	0.5	1.4	-	1.3	-	2.5	0.7	1.5

Original data on weed density given in parentheses were subjected to square root transformation $\sqrt{x+0.5}$ before analysis

3). In 2023, shoot dry matter accumulation was the highest in hand weeding which was statistically at par with the pendimethalin + imazethapyr 450 as well as 750 g/ha, imazethapyr 75 g/ha as PE, imazethapyr at 50 as well as 75 g/ha at 15 DAS and imazethapyr at 75 g/ha at 25 DAS. Shoot dry matter accumulation was higher in 2022 than 2023, which could be due to frequent light rains (577.9 mm) in 2022. Among the herbicidal treatments, the high dry matter accumulation was in the case of application of imazethapyr 50 and 75 g/ha at 15 DAS due to effective control of weeds at the critical crop-weed competition period. Similar results were also reported by Aggarwal *et al* (2014).

Hand weeding resulted in the highest plant height, which was statistically at par with the application of imazethapyr 50 g/ha at 15 DAS and imazethapyr 75 g/ha at 15 DAS due to better control of weeds (**Table 3**). Similar results for imazethapyr applied at 50 and 75 g/ha at 15 DAS were also reported by other researchers (Aggarwal *et al* 2014, Priyadarshini *et al* 2023). Application of different herbicides did not affect the number of branches/ plant significantly.

The highest number of pods/plant was observed in treatment of imazethapyr 50 g/ha at 15 DAS, which was statistically at par with hand weeding and imazethapyr 75 g/ha at 15 DAS during 2022 (**Table 4**). However, the highest pods/plant were observed in pendimethalin + imazethapyr 750 g/ha, which was statistically at par with the pendimethalin + imazethapyr 450 g/ha, imazethapyr 50 as well as 75 g/ha as PE, imazethapyr at 50 g/ha at 15 DAS and hand weeding in 2023. Different weed control treatments had no significant effect on the grains/pod. The highest 100-grain weight was observed in hand weeding treatment, which was statistically similar with imazethapyr 50 and 75 g/ha at 15 DAS. Different weed control treatments had no significant effect on the 100-grain weight in 2023. The highest biological yield was recorded in hand weeding treatment, which was, however, statistically at par with imazethapyr 50 g/ha at 15 DAS and imazethapyr 75 g/ha at 15 DAS in 2022 (**Table 4**). It was observed that different weed control treatments had no significant effect on the biological yield and harvest index in 2023. Weedy check had the lowest biological yield due to more crop-weed competition. The pre-emergence application of herbicides resulted in low biological yield. The highest grain yield was recorded by hand weeding treatment, which was, however, statistically at par with application of imazethapyr 50 as well as 75 g/ha at 15 DAS. The lowest grain yield was recorded in a weed check. Pre-emergence application of herbicides (pendimethalin + imazethapyr and

Table 2. Influence of different weed control treatments on weed dry matter and weed control efficiency at 45 DAS and harvest in blackgram

Treatment	Weed dry matter at 45 DAS (kg/ha)		Weed control efficiency at 45 DAS (%)		Weed dry matter at harvest (kg/ha)		Weed control efficiency at harvest (%)	
	2022	2023	2022	2023	2022	2023	2022	2023
Pendimethalin + imazethapyr 450 g/ha (PE)	784	140	45.5	96.4	1716	503	49.6	87.1
Pendimethalin + imazethapyr 750 g/ha (PE)	808	93	43.9	97.7	1425	475	58.3	88.3
Imazethapyr 50 g/ha (PE)	848	138	41.1	96.5	1679	637	50.6	83.9
Imazethapyr 75 g/ha (PE)	801	130	44.5	96.6	1450	627	57.3	81.8
Imazethapyr 50 g/ha at 15 DAS	567	262	60.4	93.0	955	1193	72.0	70.6
Imazethapyr 50 g/ha at 25 DAS	777	336	45.1	91.2	1392	1286	59.4	68.1
Imazethapyr 75 g/ha at 15 DAS	521	242	64.0	93.6	950	394	71.7	89.3
Imazethapyr 75 g/ha at 25 DAS	742	272	48.5	93.0	1350	1212	60.3	69.6
Hand weeding at 4 and 6 WAS	0	0	100.0	100.0	883	289	74.0	92.3
Weedy check	1452	3930	0.0	0.0	3433	3933	-	-
LSD (p=0.05)	105	90	6.5	2.1	197	637	4.1	15.5

Table 3. Influence of different weed control treatments on shoot dry matter accumulation at 45 DAS, plant height and branches at harvest of blackgram

Treatment	Shoot dry matter accumulation at 45 DAS (kg/ha)		Plant height (cm)		Branches/plant	
	2022	2023	2022	2023	2022	2023
Pendimethalin + imazethapyr 450 g/ha (PE)	801	716	40.6	36.5	5.9	6.1
Pendimethalin + imazethapyr 750 g/ha (PE)	973	750	41.5	38.5	6.4	6.1
Imazethapyr 50 g/ha (PE)	799	656	45.3	36.1	6.3	5.8
Imazethapyr 75 g/ha (PE)	778	690	41.3	37.9	6.5	6.0
Imazethapyr 50 g/ha at 15 DAS	1263	678	52.0	40.6	6.7	5.9
Imazethapyr 50 g/ha at 25 DAS	1125	658	44.3	35.8	6.2	6.0
Imazethapyr 75 g/ha at 15 DAS	1215	706	51.0	35.7	6.4	6.0
Imazethapyr 75 g/ha at 25 DAS	1129	714	45.1	33.9	5.8	6.0
Hand weeding at 4 and 6 WAS	1340	829	51.8	40.7	6.9	6.1
Weedy check	522	490	46.3	37.1	5.2	5.9
LSD (p=0.05)	233	152	4.7	3.9	NS	NS

imazethapyr) also recorded low grain yield in the year 2022. In 2023, the highest grain yield was observed in pendimethalin + imazethapyr 750 g/ha, which was, statistically similar with all other treatments except application of imazethapyr 50 g/ha at 25 DAS, imazethapyr 75 g/ha at 15 DAS and the weedy check. On the basis of pooled mean, application of imazethapyr 50 and 75 g/ha at 15 DAS and pendimethalin + imazethapyr 750 g/ha (PE) resulted in 97.8, 88.1 and 84.4% higher grain yield over weedy check. The highest harvest index was recorded in hand weeding treatment, which was statistically similar with all other treatments except the weedy check.

These treatments resulted in high yield and yield attributes due to better control of weeds (**Table 1** and **2**) at critical crop-weed competition period which resulted in less competition for space, nutrients and water among weeds and crop plants and ultimately better yield attributes. Weedy check resulted in the lowest grain yield due to low yield attributes owing to less growth attributes, symbiotic parameters and more weeds (Singh *et al* 2016, Tripathy *et al* 2022). The PE herbicides performed better in 2023 than in 2022 due to less rainfall (203.2 mm) and rainy days (11) as compared to in 2022. The lowest harvest index was recorded in weedy check due to more competition from weeds and less grain yield whereas higher harvest index was recorded in other treatments due to high grain yields (Patel *et al* 2015).

Correlation (r) between total weed dry matter at harvest and grain yield was -0.98 and -0.90 and coefficient of determination (R^2) was 0.971 and R^2 = 0.813 in 2022 and 2023, respectively. It showed that the grain production of blackgram decreased as the dry matter of weeds increased (**Figure 2**). Equation of regression analysis Y= -0.3734x + 1808 and Y= -0.1368x + 1433 was found to fit for the dry matter of weeds and grain yield of blackgram in the year 2022 and 2023, respectively, where Y= Grain yield (kg/ha) and X= Weed dry matter (kg/ha).

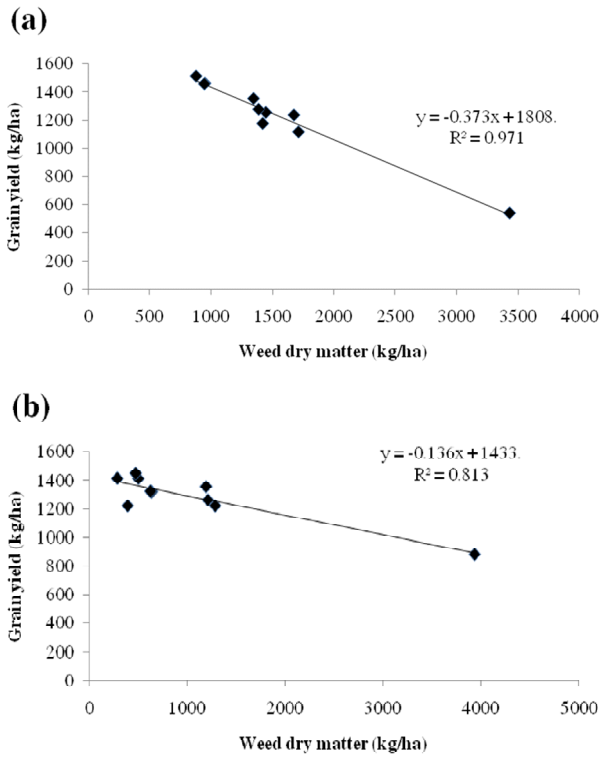

Figure 2. Effect of weed dry matter at harvest on grain yield production in blackgram during (a) 2022 and (b) 2023

Effect on economics

The hand weeding at 4 and 6 weeks after sowing had the highest overall variable costs in both the years, followed by the treatments of pre-mix herbicides pendimethalin + imazethapyr 750 g/ha as PE and imazethapyr 75 g/ha applied at 15 and 25 DAS and as PE (**Table 5**). The highest gross returns in 2022 were obtained in hand weeding treatment followed by imazethapyr 50 and 75 g/ha at 15 DAS. Weedy check recorded the lowest gross returns. The highest net returns were recorded in imazethapyr 50 g/ha at 15 DAS, followed by imazethapyr 75 g/ha at 15 DAS and hand weeding treatment due to less variable cost and more gross returns. In 2023, the

Table 4. Influence of different weed control treatments on yield attributes, yield and harvest index of blackgram

Treatment	Pods/plant		Grains/pod		100 grain-weight (g)		Biological yield (t/ha)		Grain yield (t/ha)			Harvest index (%)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	Pooled mean	2022	2023
Pendimethalin + imazethapyr 450 g/ha (PE)	22.0	26.0	5.9	5.8	2.96	3.50	5.60	6.57	1.11	1.41	1.26	20.0	21.8
Pendimethalin + imazethapyr 750 g/ha (PE)	22.1	26.7	6.1	6.0	3.00	3.60	5.87	6.67	1.17	1.45	1.31	20.0	21.9
Imazethapyr 50 g/ha (PE)	22.4	25.0	6.0	5.9	3.05	3.63	5.80	6.07	1.23	1.32	1.28	21.3	22.3
Imazethapyr 75 g/ha (PE)	23.9	25.2	5.7	5.4	3.13	3.50	5.97	5.95	1.25	1.32	1.29	21.4	22.7
Imazethapyr 50 g/ha at 15 DAS	29.4	25.1	6.0	6.0	3.77	4.25	6.72	5.92	1.46	1.35	1.41	21.7	23.5
Imazethapyr 50 g/ha at 25 DAS	24.0	23.8	6.1	5.5	3.32	3.48	6.24	5.67	1.27	1.22	1.25	20.4	21.5
Imazethapyr 75 g/ha at 15 DAS	26.2	23.7	5.7	6.0	3.63	3.48	6.72	5.30	1.45	1.22	1.34	21.8	23.2
Imazethapyr 75 g/ha at 25 DAS	24.2	24.4	5.8	5.7	3.37	3.50	6.25	5.65	1.35	1.26	1.31	21.7	23.0
Hand weeding at 4 and 6 WAS	27.5	25.5	6.0	6.0	3.92	3.55	6.90	5.87	1.51	1.41	1.46	22.0	24.3
Weedy check	19.4	19.9	6.1	5.1	2.52	3.15	3.55	4.30	0.54	0.88	0.71	15.2	20.7
LSD (p=0.05)	4.0	2.2	NS	NS	0.48	NS	0.64	NS	0.14	0.22	0.16	3.0	NS

Table 5. Influence of different weed control treatments on economics of blackgram

Treatment	Total variable cost (×10³ ₹/ha)		Returns (×10³ ₹/ha)					B:C	
			Gross		Net				
	2022	2023	2022	2023	2022	2023	Pooled mean	2022	2023
Pendimethalin + imazethapyr 450 g/ha (PE)	34.40	35.20	77.07	98.45	42.66	63.25	52.96	1.24	1.80
Pendimethalin + imazethapyr 750 g/ha (PE)	36.04	36.84	81.20	100.99	45.15	64.14	54.65	1.25	1.74
Imazethapyr 50 g/ha (PE)	35.13	35.93	84.93	91.94	49.79	56.00	52.90	1.42	1.56
Imazethapyr 75 g/ha (PE)	35.48	36.28	86.35	92.23	50.86	55.94	53.41	1.44	1.54
Imazethapyr 50 g/ha at 15 DAS	35.13	35.93	100.21	94.47	65.07	58.53	61.80	1.85	1.63
Imazethapyr 50 g/ha at 25 DAS	35.13	35.93	87.99	85.06	52.85	49.12	50.99	1.50	1.37
Imazethapyr 75 g/ha at 15 DAS	35.48	36.28	99.94	85.06	64.45	48.77	56.62	1.82	1.34
Imazethapyr 75 g/ha at 25 DAS	35.48	36.28	92.82	87.96	55.33	51.67	54.50	1.62	1.42
Hand weeding at 4 and 6 WAS	40.84	41.64	103.65	98.45	62.81	56.81	59.81	1.54	1.36
Weedy check	33.64	34.44	38.39	61.53	4.74	27.09	15.92	0.14	0.79
LSD (p=0.05)			9.17	14.68	9.17	14.68	10.58	0.30	0.39

highest gross and net returns were obtained in pendimethalin + imazethapyr 750 g/ha as PE, which was, statistically similar with all other treatments except the imazethapyr 50 at 25 DAS, imazethapyr 75 g/ha at 15 DAS and weedy check. On pooled mean basis, the highest net returns were provided by imazethapyr 50 g/ha at 15 DAS (Rs 61804/ha) followed by hand weeding (Rs 59812/ha), imazethapyr 75 g/ha at 15 DAS (Rs 56618/ha) and pendimethalin + imazethapyr 750 (Rs 54650/ha). In 2022, the highest B:C ratio was observed in the treatment of imazethapyr 50 g/ha at 15 DAS followed by imazethapyr 75 g/ha at 15 DAS and hand weeding treatment and in 2023, the highest B:C ratio was observed in pendimethalin + imazethapyr 450 g/ha as PE, which was, statistically similar with all other treatments except the imazethapyr 50 at 25 DAS, imazethapyr 75 g/ha at 15 DAS and weedy check. The high cost of hand weeding and herbicides attributed to high variable costs in these treatments. The higher gross returns in blackgram were obtained in hand weeding and imazethapyr 50 and 75 g/ha at 15 DAS due to increased yield of grain and stover. The highest net returns were recorded in imazethapyr 50 g/ha at 15 DAS, followed by imazethapyr 75 g/ha at 15 DAS and hand weeding treatment due to less variable cost and more gross returns owing to high grain and stover yield. PoE application of imazethapyr at 75 g/ha at 14 DAS resulted in higher B:C ratio than other treatments due to less variable costs and more net returns (Prajapati *et al* 2018).

It can be concluded that application of pendimethalin + imazethapyr 750 g/ha as PE and imazethapyr 50 g/ha at 15 DAS as post-emergence successfully manage weeds and achieve high production and profitability of blackgram.

REFERENCES

Aggarwal N, Singh G, Ram H and Khanna V. 2014. Effect of post-emergence application of imazethapyr on symbiotic activities, growth and yield of blackgram (*Vigna mungo*) cultivars and its efficacy against weeds. *Indian Journal of Agronomy* **59**: 421–426.

Cheema HS and Singh B. 1991. *Software statistical CPCS-1*. Department of Statistics, Punjab Agricultural University, Ludhiana, India.

Cochran WG and Cox GM. 1967. *Experiment designs*. Asia Publishing House, New Delhi, India.

Donald CM. 1968. In search of yield. *Journal of Australian Institute of Agricultural Science* **28**: 171–178.

Gupta DS, Kumar J, Parihar AK, Chandra A, Sujayanand GK and Gupta S. 2022. Urdbean Breeding. Pp.1151-1179. In: *Fundamentals of Field Crop Breeding*. (Eds. Yadava DK, Dikshit HK, Mishra GP and Tripathi S). Doi 10.1007/ 978-981-16-9257-423.

Kumar N, Nath CP, Hazra KK and Sharma AR. 2016. Efficient weed management in pulses for higher productivity and profitability. *Indian Journal of Agronomy* **61**: 93–105.

Mahajan A, Kumar A, Puniya R, Singh AP, Sharma A, Stanzen L, Kumar R and Khajuria S. 2021. Bioefficacy and phytotoxicity of herbicides in urdbean and their residual effect on succeeding transplanted basmati rice. *Agricultural Mechanization in Asia* **52**(2): 3393–3399.

Painkra D, Gupta DK, Sinha AK, Paliwal AK, Chouksey N and Singh SK. 2021. Effective weed management strategy for blackgram (*Vigna mungo* L.) under north hill situation of Chhattisgarh. *The Pharma Innovation journal* **10**(7): 85–88.

Patel KR, Patel BD, Patel RB, Patel VJ and Darji VB. 2015. Bio-efficacy of herbicides against weeds in blackgram. *Indian Journal of Weed Science* **47**(1): 78–81.

Prajapati P, Jain N and Badkul AJ. 2018. Pre-and post-emergence herbicides for weed control in blackgram. *Indian Journal of Weed Science* **50**(2): 177–179.

Priyadarshini S, Singh R, Indu T and Jakhad A. 2023. Effect of nitrogen and weed management practices on growth and yield of blackgram (*Vigna mungo* L.). *International Journal of Environment and Climate Change* **13**: 431–438.

Singh VP, Singh TP, Singh SP, Kumar A, Satyawali K, Banga A, Bisht N and Singh RP. 2016. Weed management in blackgram with pre-mix herbicides. *Indian Journal of Weed Science* **48**(2): 178–181.

Tripathy S, Mohapatra S, Tripathy SK and Mohanty AK. 2022. Sole and sequential application of herbicides for economical weed management in blackgram. *Indian Journal of Weed Science* **54**(1): 66–70.

Walia US. 2018. *Weed Management*. Kalyani Publishers, New Delhi, India.