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Efficacy of different herbicides on weed index, yield and economics of blackgram

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Abstract
A field study titled "Efficacy of different herbicides on weed index, yield and economics of blackgram" was conducted at the Research Field of AICRP on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the *kharif* season of 2024-25. The experiment was set up using a randomized block design with three replications and eight herbicide treatments. Among the treatments, propaquizafop 2.5% + imazethapyr 3.75% ME (RM) applied at 125 g a.i. ha^{-1} (17DAS) showed the lowest weed index. This treatment also had the best yield characteristics, followed by quizalofop-ethyl 7.5% + imazethapyr 15% EC (RM) at 98.43 g a.i. ha^{-1} (17 DAS). From an economic point of view, propaquizafop 2.5% + imazethapyr 3.75% ME (RM) at 125 g a.i. ha^{-1} (17DAS) was the most effective, giving the highest values for net monetary return (61899 Rs per hectare) and benefit-cost ratio (3.10).

Keywords: Blackgram (*Vigna mungo*), herbicides, weed index, Propaquizafop

Introduction
Blackgram is a rich source of protein, containing around 26%, which is about three times more than that found in cereals. In India, the production of blackgram in 2022-23 was estimated at 15.05 lakh tonnes (Advance Estimate, GoM, 2023-24). In Maharashtra, during 2023-24, the total production was 1029 tonnes from an area of 2597 hectares. In the Vidarbha region, the area under blackgram cultivation was 158.42 hectares with a production of 99.16 tonnes, giving a productivity of 625.85 kg per hectare (Anonymous, 2025).
High weed infestation is one of the biggest problems affecting blackgram production. The critical time for competition between the crop and weeds is during the first 20-40 days after sowing. If weeds are not controlled throughout the season, they can reduce blackgram yield by up to 27-84%, depending on the type and density of weeds (Bhowmick *et al.* 2015) [1]. In recent years, chemical weed control in blackgram has become a focus for researchers. Using pre and post-emergence herbicides in a ready-mix form may be more effective than using a single herbicide, which might not control all types of weeds. Imazethapyr is effective against annual broadleaved and grassy weeds but can cause some visible damage to the crop, like chlorosis and reduced growth. Recently, pre-mix post-emergence herbicides like propaquizafop + imazethapyr are available for use in pulse crops like blackgram. Therefore, this study was conducted to evaluate the effectiveness of different herbicides on weed population, growth, and yield of *kharif* blackgram.

Materials and Methods
A study was conducted in the research field of AICRP on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the kharif season of 2024-25. The PDKV Blackgold variety of blackgram was planted on July 2, 2024, with a spacing of 45 cm between rows and 10 cm between plants. The seed rate applied was 20 kg per hectare. A total of 583.1 mm of rainfall was recorded during the crop's growing period. The field experiment was arranged in a randomized block design with three replications. The recommended fertilizer dose was 20 kg N, 40 kg P, and 20 kg K per hectare, applied at sowing using urea, diammonium phosphate (DAP), and muriate of potash (MOP). The study included eight treatments. Next day after sowing, pre-emergence applications of Pendimethalin 38.7% CS

at 678 g a.i. ha^{-1} and Pendimethalin 30% + imazethapyr 2% EC (RM) at 800 g a.i. ha^{-1} was done. At 17 DAS post emergence applications of Imazethapyr 10% SL at 75 g a.i. ha^{-1}, imazethapyr 70% WG at 70 g a.i. ha^{-1}, propaquizafop 2.5% + imazethapyr 3.75% ME (RM) at 125 g a.i. ha^{-1}, and quizalofop-ethyl 7.5% + imazethapyr 15% EC (RM) at 98.43 g a.i. ha^{-1} were applied. In the farmers' practice, hoeing was done at 15 DAS and hand weeding at 25 DAS. Weed density was measured using a 1m x 1m quadrant in all treatments. The data on total weed density was transformed using square root to normalize the distribution. Weed index is the reduction in yield due to different treatments compared to the recommended practice or the treatment with the highest yield. It was calculated using the formula by Gill and Kumar (1969) [3].

$$WI (\%) = (X - Y) / X \times 100$$

Where,
X = Grain yield (kg ha^{-1}) from the weed-free check or highest yield treatment (complete removal of weeds)
Y = Grain yield (kg ha^{-1}) from the treatment for which weed index is being calculated.

Results and Discussion

At the experimental site, the common weeds were monocot weeds like *Commelina spp.*, *Cyperus rotundus*, and grasses, and dicot weeds like *Parthenium hysterophorus*, *Digera muricata*, and *Phyllanthus spp*. Compared to the weedy check, all weed control treatments were highly effective in reducing weed density.

Effect on weed index

Among the herbicides tested, the treatment of propaquizafop 2.5% + imazethapyr 3.75% ME (RM) at 125 g a.i. ha^{-1}, applied at 17 DAS, showed the lowest weed index. This was due to its strong ability to reduce weed competition. This treatment significantly reduced weed dry biomass and improved weed control efficiency. The combination of these factors reduced the negative impact of weeds on the crop, enabling better growth and higher yield. Treatments that result in a lower weed index indicate better weed control. These herbicides reduce competition for water, nutrients, and sunlight, leading to better seed yield in blackgram compared to the weedy check. The results match those of Reddy *et al.* (2023) [9].

Effect on yield attributes

Number of pods per plant

Among all treatments, the farmers' practice (hoeing at 15 DAS followed by hand weeding at 25 DAS) gave the highest number of pods per plant at 25.80, followed by the propaquizafop 2.5% + imazethapyr 3.75% ME (RM) treatment at 17 DAS. The lowest number of pods per plant was found in the weedy check at 12.05. These results are consistent with Malviya *et al.* (2024) [6].

Seed yield plant

As shown in Table 1, the farmers' practice gave the highest seed yield per plant. Among preemergence treatments, pendimethalin 30% + imazethapyr 2% EC (RM) at 800 g a.i. per hectare was effective. Among post-emergence treatments, imazethapyr 70% at 70 g a.i. ha^{-1}, propaquizafop 2.5% + imazethapyr 3.75% ME (RM) at 125 g a.i. ha^{-1}, and quizalofop-ethyl 7.5% + imazethapyr 15% EC (RM) at 98.43 g a.i. ha^{-1} also performed well and were similar to the farmers' practice. The similar results were found by Harshita *et al.* (2021) [4].

Seed index

The seed index (100 seed weight) did not vary much among all treatments (Table 1). Similar results were reported by Jagdesh *et al.*

Seed yield ha^{-1}

As shown in Table 1, the farmers' practice resulted in the highest seed yield at 1276 kg per hectare, followed by propaquizafop 2.5% + imazethapyr 3.75% ME (RM) at 1235 kg ha^{-1}. Next came quizalofop-ethyl 7.5% + imazethapyr 15% EC (RM) at 98.43 g a.i. ha^{-1} (1184 kg ha^{-1}), imazethapyr 10% SL at 75 g a.i. ha^{-1} (1087 kg ha^{-1}), and imazethapyr 70% at 70 g a.i ha^{-1} (1046 kg ha^{-1}). The weedy check recorded the lowest yield at 748 kg ha^{-1}. Similar outcomes were found by Dhayal *et al.* (2022) [2].

Biological yield ha^{-1}

Farmers practice (hoeing at 15 DAS fb hand weeding at 25 DAS) (3243 kg ha^{-1}) recorded highest biological yield which found to be at par with propaquizafop 2.5% + imazethapyr 3.75% ME (RM) @ 125 g a.i. ha^{-1} at 17 DAS (3207 kg ha^{-1}). Subsequent biological yield was recorded in quizalofopethyl 7.5% + imazethapyr 15% EC (RM) @ 98.43 g a.i. ha^{-1} at 17 DAS (3123 kg ha-1), imazethapyr 10% SL @ 75 g a.i. ha^{-1} at 17 DAS (3081 kg ha^{-1}) and Imazethapyr 70% @ 70 g a.i. ha-1 at 17 DAS (3008 kg ha^{-1}). Significantly lowest biological yield has recorded in weedy check (2833 kg ha^{-1}) (Table 1). Similar results were also recorded by Rathika *et al.* (2023) [8] and Patel *et al.* (2024) [7].

Table 1: Yield attributes and weed index (%) as influenced by different treatments in Blackgram

Treatments		Yield attributes					
	Weed index (%)	No. of Pods plant^{-1}	Seed yield plant $^{-1}$ (g)	Seed index (g)	Seed yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index
T1: Pendimethalin 38.7% CS @ 678 g a.i ha^{-1} as PE	27.20	19.30	4.78	4.13	924	2897	31.83
T2: Pendimethalin 30% + imazethapyr 2% EC RM @ 800 g a.i. ha^{-1} as PE	24.29	19.88	5.41	4.14	955	2965	32.01
T3: Imazethapyr 10% SL @ 75 g a.i. ha-1 at 17 DAS	14.41	22.48	4.93	4.16	1087	3081	35.28
T4: Imazethapyr 70% @ 70 g a.i. ha^{-1} at 17 DAS	18.02	21.46	5.61	4.21	1046	3008	34.90
T5: Propaquizafop 2.5% + imazethapyr 3.75 ME (RM) @ 125 g a.i. ha^{-1} at 17 DAS	3.22	24.41	6.18	4.22	1235	3207	38.53
T6: Quizalofop-ethyl 7.5% + imazethapyr 15% EC (RM) @ 98.43 g a.i. ha^{-1} at 17 DAS	7.42	24.11	6.09	4.21	1184	3123	37.88
T7: Farmers Practice (hoeing at 15 DAS fb hand weeding at 25 DAS)	0.00	25.80	6.55	4.23	1276	3243	39.40
T8: Weedy check	33.32	12.05	4.14	4.09	748	2833	29.88
S.E (m±)	5.12	0.54	0.41	0.02	26	22	0.39
C.D. at 5%	15.53	1.65	1.26	NS	78	67	1.18
GM	15.98	21.91	5.49	4.17	1057	3032	34.96

Harvest index

The highest harvest index was observed in farmers practice (hoeing at 15 DAS *fb* hand weeding at 25 DAS) (39.40) which followed by propaquizafop 2.5% + imazethapyr 3.75% ME (RM) @ 125 g a.i. ha^{-1} at 17 DAS (38.53). The significantly lowest harvest index was recorded in weedy check (29.88) (Table 1). The results are also similar with findings of Dhayal *et al.* (2022) [2].

Effect on economics

The treatment farmers practice (hoeing at 15 DAS fb hand weeding at 25 DAS) has recorded highest gross monetary returns while propaquizafop 2.5% + imazethapyr 3.75% ME (RM) @ 125 g a.i. ha^{-1} treatment recorded highest net monetary returns (61899 Rs.ha^{-1}) and B:C ratio (3.10). In contrast, the weedy check treatment recorded lowest net monetary returns (36915 Rs.ha^{-1}) and B:C ratio (2.35) (Table 2).The similar results were recorded by Reddy *et al.* (2023) [9].

Table 2: Economics of blackgram influenced by different weed control treatments.

Treatment	Total cost of cultivation (Rs.ha^{-1})	GMR (Rs.ha^{-1})	NMR (Rs.ha^{-1})	B:C
T1: Pendimethalin 38.7% CS @ 678 g a.i ha^{-1} as PE	28602	68357	39755	2.39
T2: Pendimethalin 30% + imazethapyr 2% EC RM @ 800 g a.i. ha^{-1} as PE	30072	70704	40632	2.43
T3: Imazethapyr 10% SL @ 75 g a.i. ha-1 at 17 DAS	27843	80462	52619	2.89
T4: Imazethapyr 70% @ 70 g a.i. ha^{-1} at 17 DAS	27569	77414	49844	2.81
T5: Propaquizafop 2.5% + imazethapyr 3.75% ME (RM) @ 125 g a.i. ha^{-1} at 17 DAS	29486	91385	61899	3.10
T6: Quizalofop-ethyl 7.5% + imazethapyr 15% EC (RM) @ 98.43 g a.i. ha^{-1} at 17 DAS	29255	87580	58326	2.99
T7: Farmers Practice (hoeing at 15 DAS fb hand weeding at 25 DAS)	35280	94423	59143	2.68
T8: Weedy check	25815	62730	36915	2.35
S.E (m±)	-	5059	4854	-
C.D. at 5%	-	15347	14725	-
GM	29240	79132	49892	2.70

Conclusion

Weed index in blackgram using the herbicidal application of propaquizafop 2.5% + imazethapyr 3.75% ME (RM) @ 125 g a.i. ha^{-1} at 17 DAS was found to be equally effective as farmers practice (hoeing at 15 DAS fb hand weeding at 25 DAS). A herbicidal treatment of propaquizafop 2.5% + imazethapyr 3.75% ME (RM) @ 125 g a.i. ha^{-1} at 17 DAS recorded the maximum yield attributes in blackgram. Also, propaquizafop 2.5% + imazethapyr 3.75% ME (RM) @ 125 g a.i. ha^{-1} at 17 DAS recorded highest gross monetary returns (91385 Rs.ha^{-1}), net monetary returns (61899 Rs.ha^{-1}) and B:C ratio (3.10) which is followed by quizalofop-ethyl 7.5% + imazethapyr 15% EC (RM) @ 98.43 g a.i. ha^{-1} at 17 DAS and the lowest gross monetary returns (62730 Rs.ha^{-1}), net monetary returns (36915 Rs.ha^{-1}) and B:C (2.35) ratio was recorded by weedy check treatment. Similar results were recorded by Reddy *et al.* (2023) [9].

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