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RESEARCH NOTE

Effect of herbicides on associated weeds and growth of blackgram

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ABSTRACT

A field study was conducted at Research Station in Kota, Rajasthan during rainy *(Kharif)* season of 2020 to identify suitable herbicides including pre-emergence (PE) and post-emergence herbicides (PoE) for managing weeds and improve productivity of blackgram [*Vigna mungo* (L.) Hepper]. Among weed control treatments tested, the lowest weed density, weed index and highest crop growths parameters like plant population, plant height, dry matter accumulation, nodules/ plant, dry weight of nodules was recorded with hand weeding twice at 20 and 40 days after sowing (DAS), pre-emergence application (PE) of pendimethalin 1.0 kg/ha followed by (*fb*) post-emergence application (PoE) of propaquizafop 2.5% w/w 33.3 g/ha + imazethapyr 3.75% w/w (pre-mix) ME 50 g/ha at 20 DAS and pendimethalin 1.0 kg/ha PE *fb* fomesafen 11.1% w/w 220 g/ha + fluazifop-p-butyl 11.1% w/w 220 g/ha (pre-mix) PoE at 20 DAS.

Keywords: Blackgram, Fluazifop-p-butyl, Imazethapyr, Pendimethalin, Propaquizafop, Weed management

Blackgram [*Vigna mungo* (L.) Hepper] is one of the important pulse crops cultivated worldwide in tropical and subtropical regions of the world. The crop is resistant to adverse climatic conditions and improves the soil fertility by fixing atmospheric nitrogen in the soil. It has wide adaptability and can be grown round the year in different agroecological regions of the country. It contains 48.0% carbohydrates, 22.3% protein, 154 mg calcium, 9.1 mg iron, 1.4 g fat, 0.37 g riboflavin and 0.42 mg thiamine in per 100 g (Asaduzzaman *et al.* 2010). Blackgram is usually accompanied by luxuriant weed growth during the rainy (*Kharif*) season owing to abundant rainfall received during monsoons leading to serious crop losses. Unchecked weeds have been reported to cause a considerable reduction in the grain yield of blackgram ranging from 35.2 to -87% (Chand *et al.* 2004, Singh 2011, Sukumar *et al.* 2018) and critical period for crop weed competition is around 15 to 45 DAS (Khot *et al.* 2016). Blackgram is not a very good competitor against weeds (Choudhary *et al.* 2012) and is mostly susceptible to weed infestation during the first four weeks of its growth period (Randhawa *et al.* 2002). Therefore, adequate weed management is essential, particularly during critical period of crop weed competition, to ensure optimal crop growth.

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The majority of farmers use hand weeding, which requires a lot of labours, time and is also less cost effective under rainfall condition. Pre-emergence herbicides only control weeds for a short period and there after late-emerging weeds begin to compete with crops. Hence, in order to keep free from weed competition, the use of pre-emergence herbicides to manage early emerging weeds and post-emergence herbicides in sequence to manage late emerging weeds may be essential. Thus, the current study was conducted to determine the weed management effectiveness of herbicides including a ready-mix herbicide combination of pre- and post-emergence herbicides for season long broad-spectrum weed management in *Kharif* (rainy season) blackgram.

A field study was conducted during rainy *(Kharif)* season of 2020 at Research Station, Ummedganj, Kota, Rajasthan. The soil of the experimental site was clay loam, having 0.53% organic carbon, 206.10, 30.50 and 480.10 kg/ha available N, P and K, respectively. The mean maximum and minimum temperature recorded were in the range of 36.7°C to 29.3°C and 18.2°C to 26.1°C, respectively (mean of one years). The mean sunshine hours among different weeks were 0.7 to 9.1 h in a day. The total evaporation observed was 0.6 to 3.1 mm/day, while total rainfall recorded 650 mm to 1000 mm during the cropping season. The relative humidity in morning (RH_1) and evening (RH_2) were recorded in the range of 67.1 to 92 and 53.6 to 85%, respectively. Experiments consisted of 10 treatments

with three replications arranged in a randomized block design. Blackgram (cultivar: '*Mukundra Urd 2*') was sown at 30 cm row-to-row spacing using 20 kg seed/ha. Recommended dose of fertilizers (20 kg N + 30 kg P/ha) was applied to blackgram crop at the time of sowing through di-ammonium phosphate (DAP) and urea. Pre-emergence application (PE) of pendimethalin 1.0 kg/ha was done on next day of sowing and post-emergence application (PoE) of other herbicides (propaquizafop 2.5% w/w 33.3 g/ha + imazethapyr 3.75% w/w ME 50 g/ha (ready-mix), acifluorfen-sodium 16.5% EC 140 g/ha + clodinafop-propargyl 8% EC 70 g/ha (ready mix), fomesafen 11.1% w/w 220 g/ha + fluazifop-p-butyl 11.1% w/w 220 g/ha (ready-mix) and fluazifop-p-butyl 13.4% w/w 250 g/ha was done at 20 day after sowing (DAS) by using 375 l/ha of water with knapsack sprayer fitted with a flat fan nozzle. Weed density was recorded by using 0.5 m^2 quadrat at 60 DAS in all the treatments and then converted into number of weeds per m^2. Growth parameters like plant height, branches/plant, dry matter accumulation/meter row length, nodules/plant and dry weight of nodules/plant of blackgram were recorded at 30, 60 DAS and at harvest. The data on total weeds density was subjected to square root transformation $\sqrt{x+0.5}$ to normalize their distribution (Blackman and Roberts 1950). Weed index is the decrease in yield due to different treatments in comparison with recommended cultivation practices or the treatment which has the highest yield. It was calculated by using the formula by Gill and Kumar (1969).

$$WI\ (\%) = \frac{X-Y}{X} \times 100$$

Where,

X = Yield of plot with minimum weed competition

Y = Yield of treated plot

All the data were subjected to analysis of variance (ANOVA) as per the standard procedures. The comparison of treatment means was made by critical difference (RBD) at p=0.05.

Effect on weeds

The common weeds at the experimental site were monocot weeds: *Cynodon dactylon*, *Echinochloa crus-galli, Eleusine indica, Commelina bengalensis*; dicot weeds: *Parthenium hysterophorus, Digera arvensis, Trianthema* spp. and *Celosia argentea* and the sedge weed: *Cyperus rotundus.* All weed control treatments significantly reduced the monocot, dicot and sedge weeds density compared to weedy check. The hand weeding twice at 20 and 40 DAS recorded lowest weed density of monocots [*Cynodon dactylon* (3.18/m^2), *Echinochloa crus-galli* (4.2/m^2), *Eleusine indica* (3.32/m^2), *Commelina benghalensis* (3.12/m^2)]; dicot [*Digera arvensis* (3.32/m^2), *Celosia argentea* (3.26/m^2), *Trianthema* spp. (3.16/m^2), *Parthenium hysterophorus* (3.7/m^2)}; sedge {*Cyperus rotundus* (4.24/m^2)]; others (6.48/m^2) and total weeds (11.66/m^2) than the rest of treatments (**Table 1** and **2**). However, the density of *Commelina benghalensis* was at par with pendimethalin 1.0 kg/ha (PE) *fb* propaquizafop 33.3 g/ha + imazethapyr (pre mix) 50 g/ha PoE at 20 DAS, pendimethalin 1.0 kg/ha (PE) *fb* fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS and pendimethalin 1.0 kg/ha (PE) *fb* acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre-mix) PoE at 20 DAS.

The sequential application of pendimethalin 1.0 kg/ha PE *fb* propaquizafop 33.3 g/ha + imazethapyr (pre-mix) 50 g/ha PoE at 20 DAS has recorded the lowest total weed density (14.64/m^2). It was at par with the pendimethalin 1.0 kg/ha PE *fb* fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS and pendimethalin 1.0 kg/ha (PE) *fb* acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre-mix) PoE at 20 DAS. The high selectivity of herbicides to blackgram and non-selectivity to weeds was the reason for better management of weeds. Pendimethalin PE reduced emerging weed germination during initial period of growth and sequential post-emergence application of imazethapyr has suppressed the late emerging sedges and broad-leaved weeds. Imazethapyr inhibits the plastid enzyme acetolactate synthase (ALS) in plants which catalyses the first step in the biosynthesis of vital branched chain amino acids (valine, leucine, isoleucine). The ALS inhibitors thus limit cell division and reduce carbohydrate transport in the vulnerable plants (Das 2008). Imazethapyr was also recommended for usage in legumes by Papiernik *et al.* (2003). Hence, the sequential application of pendimethalin PE *fb* propaquizafop + imazethapyr or fomesafen + fluazifop-p-butyl PoE, acifluorfen-sodium + clodinafop-propargyl was more effective than sole application of pendimethalin PE, propaquizafop 33.3 g/ha + imazethapyr (pre-mix) 50 g/ha PoE and fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE in controlling weeds. These results were in conformity with the Sahu *et al.* (2019), Reddy *et al.* (2021) Jagadesh *et al.* (2021) and Singh *et al.* (2019).

Table 1. Effect of weed control treatments on dicot and sedge weeds density (no./m²) at 60 DAS

Treatment	Dicot				Sedge
	Parthenium hysterophorus	*Digera arvensis*	*Trianthema* spp.	*Celosia argentea*	*Cyperus rotundus*
Pendimethalin 1.0 kg/ha PE	5.68(15.14)	5.56(14.46)	4.4(8.66)	6.04(17.2)	6.74(8.00)
Propaquizafop 33.3 g/ha + imazethapyr 50 g/ha (pre-mix) PoE at 20 DAS	5.14(12.2)	5.12(12.06)	3.82(6.34)	5.58(14.54)	6.2(7.44)
Acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre-mix) PoE at 20 DAS	5.18(12.4)	5.18(12.4)	3.9(6.6)	5.64(14.94)	6.24(7.66)
Fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS	5.16(12.26)	5.16(12.26)	3.86(6.46)	5.6(14.66)	6.22(7.54)
Pendimethalin 1.0 kg/ha PE *fb* propaquizafop 33.3 g/ha + imazethapyr (pre-mix) 50 g/ha PoE at 20 DAS	4.7(10.06)	4.56(9.4)	3.42(4.86)	4.78(10.4)	5.8(6.14)
Pendimethalin 1.0 kg/ha PE *fb* acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre-mix) PoE at 20 DAS	4.8(10.54)	4.64(9.74)	3.46(5.00)	4.84(10.74)	5.86(6.4)
Pendimethalin 1.0 kg/ha PE *fb* fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS	4.76(10.34)	4.6(9.6)	3.44(4.94)	4.8(10.54)	5.84(6.26)
Fluazifop-p-butyl 250 g/ha PoE at 20 DAS	5.24(12.74)	5.18(12.46)	4.1(7.4)	5.34(13.26)	5.96(16.86)
Two hand weeding at 20 and 40 DAS	3.7(5.86)	3.32(4.54)	3.16(4.00)	3.26(4.34)	4.24(4.06)
Weedy check	7.26*(25.34)	7.8(29.46)	5.66(15)	7.34(26.02)	9.08(16.14)
LSD (p=0.05)	0.16	0.16	0.22	0.18	0.28

*$\sqrt{x+0.5}$ Subjected to square root transformation values and data in parentheses are original values; PE = pre-emergence application; PoE= post-emergence application; *fb* = followed by; DAS = days after seeding

Table 2. Effect of weed control treatments on monocot, other and total weeds density (no./m²) at 60 DAS

Treatment	Monocot				Other weeds	Total weeds
	Echinochloa crus galli	*Eleusine indica*	*Cynodon dactylon*	*Commelina benghalensis*		
Pendimethalin 1.0 kg/ha PE	5.94(16.7)	4.74(10.3)	4.24(8.0)	4.52(9.3)	9.44(43.6)	18.22(165.0)
Propaquizafop 33.3 g/ha + imazethapyr 50 g/ha (pre-mix) PoE at 20 DAS	4.76(10.3)	4.36(8.5)	4.1(7.4)	4.12(7.5)	8.42(34.4)	16.28(131.6)
Acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre-mix) PoE at 20 DAS	6.88(10.9)	4.42(8.7)	4.16(7.7)	4.16(7.7)	8.48(35.0)	16.48(134.8)
Fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS	4.84(10.7)	4.38(8.6)	4.14(7.5)	4.14(7.6)	8.44(34.6)	16.38(133.0)
Pendimethalin 1.0 kg/ha PE *fb* propaquizafop 33.3 g/ha + imazethapyr (pre-mix) 50 g/ha PoE at 20 DAS	4.54(9.3)	3.84(6.4)	3.78(6.1)	3.36(4.7)	7.76(29.1)	14.64(106.1)
Pendimethalin 1.0 kg/ha PE *fb* acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre-mix) PoE at 20 DAS	4.62(9.7)	3.94(6.7)	3.84(6.4)	3.5(5.14)	8.14(32.1)	15.06(112.3)
Pendimethalin 1.0 kg/ha PE *fb* fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS	4.58(9.5)	3.88(6.5)	3.82(6.3)	3.48(5.1)	7.82(29.6)	14.8(108.4)
Fluazifop-p-butyl 250 g/ha PoE at 20 DAS	4.68(10.0)	4.02(7.1)	3.88(6.5)	4.18(7.9)	9.34(42.6)	16.6(136.8)
Two hand weeding at 20 and 40 DAS	4.2(7.9)	3.32(4.5)	3.18(4.1)	3.12(3.9)	6.48(20.0)	11.66(67.1)
Weedy check	7.54*(27.5)	6.22(18.3)	5.86(16.1)	5.1(12.0)	12.8(81.0)	24.16(291.1)
LSD (p=0.05)	0.24	0.28	0.16	0.42	0.38	0.32

*$\sqrt{x+0.5}$ Subjected to square root transformation values and data in parentheses are original values; PE = pre-emergence application; PoE= post-emergence application; *fb* = followed by; DAS = days after seeding

Effect on blackgram

Weedy check recorded the lowest grain yield (395 kg/ha) and crop growth attributes at 30 DAS, 60 DAS and at harvest like plant height (16.72, 27.00 and 32.00 cm), branches/plant (2.17, 4.62 and 7.72), dry matter accumulation (5.37, 28.57 and 39.29 g/m row length), nodules/plant at 40 DAS (21.57) and dry weight of nodules/plant at 40 DAS (24.53 mg/plant). The higher grain yield (859 kg/ha) and growth parameters like plant height (21.76, 33.83 and 48.41 cm), branches/plant (3.53, 6.40 and 10.53), dry matter accumulation (10.17, 58.67 and 77.44 g/m row length), nodules/plant at 40 DAS (28.33) and dry weight of nodules/plant at 40 DAS (49.33 mg/plant) were observed with hand weeding twice at 20 and 40 DAS and was found at par with pendimethalin 1.0 kg/ha PE *fb* propaquizafop 33.3 g/ha + imazethapyr (pre mix) 50 g/ha PoE at 20 DAS, pendimethalin 1.0 kg/ha PE *fb* fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre mix) PoE at 20 DAS and pendimethalin 1.0 kg/ha PE *fb* acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre mix) PoE at 20

Table 3. Effect of weed control treatments on weed index, plant height, no. and dry weight of nodules/plant of blackgram

Treatment	Weed index (%)	Plant height (cm)			No. of nodules/ plants	Dry weight of nodules (mg)/plant
		30 DAS	60 DAS	At harvest	40 DAS	40 DAS
Pendimethalin 1.0 kg/ha PE	41.43	18.83	29.00	37.19	28.00	49.00
Propaquizafop 33.3 g/ha + imazethapyr 50 g/ha (pre-mix) PoE at 20 DAS	26.65	19.76	30.67	41.44	24.60	44.60
Acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre mix) PoE at 20 DAS	34.16	19.04	30.53	39.23	23.00	43.00
Fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS	29.01	19.28	30.57	40.45	23.73	43.73
Pendimethalin 1.0 kg/ha PE *fb* propaquizafop 33.3 g/ha + imazethapyr (pre-mix) 50 g/ha PoE at 20 DAS	3.66	21.20	32.50	46.13	27.33	48.33
Pendimethalin 1.0 kg/ha PE *fb* acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre-mix) PoE at 20 DAS	22.98	20.56	31.67	44.71	25.23	47.13
Pendimethalin 1.0 kg/ha PE *fb* fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS	9.69	21.12	32.07	45.88	26.87	47.87
Fluazifop-p-butyl 250 g/ha PoE at 20 DAS	43.71	18.84	29.93	37.49	24.67	27.30
Two hand weeding at 20 and 40 DAS	0.00	21.76	33.83	48.41	28.33	49.33
Weedy check	54.00	16.72	27.00	32.00	21.57	24.53
LSD (p=0.05)	-	1.69	1.48	2.97	3.12	2.30

*PE = pre-emergence application; PoE= post-emergence application; *fb* = followed by; DAS = days after seeding

Table 4. Effect of weed control treatments on branches/plant, dry matter accumulation and grain yield of blackgram

Treatment	Branches/ plant			Dry matter accumulation (g/m row length)			Grain yield (kg/ha)
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	
Pendimethalin 1.0 kg/ha PE	2.37	5.77	7.70	7.60	46.43	53.00	503
Propaquizafop 33.3 g/ha + imazethapyr 50 g/ha (pre-mix) PoE at 20 DAS	2.73	5.83	8.90	8.77	51.87	64.08	630
Acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre-mix) PoE at 20 DAS	2.28	5.53	8.69	8.10	50.97	60.64	565
Fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS	2.50	5.87	8.63	8.23	51.34	62.96	610
Pendimethalin 1.0 kg/ha PE *fb* propaquizafop 33.3 g/ha + imazethapyr (pre-mix) 50 g/ha PoE at 20 DAS	3.20	6.37	9.60	9.83	57.27	73.20	827
Pendimethalin 1.0 kg/ha PE *fb* acifluorfen-sodium 140 g/ha + clodinafop-propargyl 70 g/ha (pre-mix) PoE at 20 DAS	2.90	5.57	8.93	9.23	55.20	71.04	661
Pendimethalin 1.0 kg/ha PE *fb* fomesafen 220 g/ha + fluazifop-p-butyl 220 g/ha (pre-mix) PoE at 20 DAS	3.07	6.23	9.20	9.60	56.67	72.96	775
Fluazifop-p-butyl 250 g/ha PoE at 20 DAS	2.31	5.38	8.04	6.93	43.67	51.28	483
Two hand weeding at 20 and 40 DAS	3.53	6.40	10.53	10.17	58.67	77.44	859
Weedy check	2.17	4.62	7.72	5.37	28.57	39.29	395
LSD (p=0.05)	0.42	0.85	1.06	0.86	2.72	7.60	95

*PE = pre-emergence application; PoE= post-emergence application; *fb* = followed by; DAS = days after seeding

DAS (**Table 3** and **4**). This could be owing to better weed management and minimizing the competition of weeds with main crop for resources, *viz.* light, nutrients and moisture with those effective weed control treatments. Thus, reduced crop-weed competition resulted into overall improvement of crop growth as measured by plant height and dry matter accumulation, which led to better reproductive structure and translocation of photosynthates to the sink. The results corroborated with the findings of Yadav *et al*. (2014). Among different treatments, sequential application of pendimethalin 1.0 kg/ha PE *fb* propaquizafop 33.3 g/ha + imazethapyr (pre-mix) 50 g/ha PoE at 20 DAS recorded higher grain yield with 52.23% yield advantages over weedy check. The reduced crop weed competition, with hand weeding twice and all herbicidal weed control methods, resulted in a considerable increase in growth and yield characters ultimately led to higher grain yield of blackgram. In a weedy condition, weeds take a bigger portion of the resources available in the soil and environment for their growth during the early stages of crop growth. The results confirmed the finding of Tiwari *et al.* (2018), Harisha *et al.* (2021).

Thus, it was concluded that application of pendimethalin 1.0 kg/ha PE *fb* propaquizafop 33.3 g/ha + imazethapyr (pre-mix) 50 g/ha PoE at 20 DAS results in broad-spectrum weed management and higher crop growth parameters and grain yield in *Kharif* blackgram on sandy loam soils.

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