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Efficacy of pre and post emergence herbicides on phytotoxicity, control of weeds and weed dynamics in blackgram (*Vigna mungo* L.)

Mahendra Pratap Singh, Jai Dev Sharma, Amit Kumar, Pradeep Kumar Kanaujiya and Ankit Kumar

Abstract
The experiment was conducted at Agronomy Research Farm of N.D. University of Agriculture and Technology, Acharya Narendra Nagar (Kumarganj), Ayodhya (U.P.) during *Kharif* season of 2015-16, to study the Effect of pre and post emergences herbicide on phytotoxicity, management of weeds and weed dynamics in blackgram (*Vigna mungo* L.). Twelve weed management treatments comprised *viz*., Imazethapyr 70 g ha^{-1} PRE, Imazethapyr 80 g ha^{-1} PRE, Imazethapyr 70 g ha^{-1} POE (3-4 leaf stage of weeds), Imazethapyr 80 g ha^{-1} POE (3-4 leaf stage of weeds), Imazethapyr + imazamox (RM) 70 g ha^{-1} PRE, Imazethapyr + imazamox (RM) 80 g ha^{-1} PRE, Imazethapyr + imazamox (RM) 70 g ha^{-1} POE (3-4 leaf stage of weeds), Imazethapyr + imazamox (RM) 80 g ha^{-1} POE (3-4 leaf stage of weeds), Pendimethalin 1000 g ha^{-1} PRE, Imazethapyr + Pendimethalin (RM) 1000 g ha^{-1} PRE, Hoeing (20&40 DAS), Weedy check. Results revealed that pre-emergence application of imazethapyr + pendimethalin 1000 g ha^{-1} proved superior over rest of the treatments with respect to weed density of blackgram followed by imazethapyr + imazamox (RM) 80 g ha^{-1}, imazethapyr + imazamox (RM) 70 g ha^{-1} and pendimethalin 1000 g ha^{-1}. Post emergence application of imazethapyr + imazamox (RM) 80 g ha^{-1} was produced significantly more grin yield as compared to rest of the treatments.

Keywords: RM: ready mixed formulation, PRE – pre- emergence, POE – post emergence, DAHA - day after herbicide applied, WCE – weed control efficiency

Introduction
Urdbean or Blackgram (*Vigna mungo* L.) is one of the very important short-duration pulse crops grown in many parts of the country. This crop is grown in cropping systems as mixed crop, catch crop, sequential crop besides as a sole crop under residual moisture conditions after the harvest of rice and also before and after the harvest of other summer crops under semi-irrigated and dryland conditions. Its seeds are highly nutritive having protein (25-26%), carbohydrates, minerals and vitamins.

The acreage of blackgram is mostly restricted to wet tropics. It is grown in India, Pakistan, Sri Lanka, and some countries of south-east Asia, Africa and America. India produced 17.21 million tonnes of pulses from an area of 24.78 million hectares (Anonymous, 2012), major contributors are Madhya Pradesh (4.16 million tonnes), Uttar Pradesh (2.43 million tonnes) and Rajasthan (2.36 million tonnes). However, about 2-3 million tonnes of pulses are imported annually to meet the domestic consumption requirement (Chaturvedi, *et al* 2010) [3].

The productivity of Urdbean in India with special reference to Uttar Pradesh is very low might be attributed due to different biotic and abiotic factors. Among them, invasion of crop by the weeds is one of the major causes of concern. A large number of weeds emerge in black gram fields. The grassy weeds cause the greatest potential damage, closely followed by sedges and BLWS. Besides directly competing with the crop, the weeds also harbour many pest and pathogens of blackgram.

Urdbean is less competitive against many weeds during early age of the crop and the most sensitive period of crop weed competition is in between 15 to 45 days after sowing.When intercropped with tall cereals or pigeonpea it smothers weed flora appreciably (20-45%) and consequently minimize the cost incurred on weed control. Various methods like cultural, mechanical, biological and chemicals are used for weed control (Fand *et al*., 2013) [4]. I view of this the present investigation was undertaken to see the efficacy of pre and post emergence herbicides on phytotoxicity control of weeds and weed dynamic in blackgram (*Vigna mungo* L.)

Methods and Materials

The experiment was conducted at Agronomy Research Farm of A.N.D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) India during *Kharif* season 2015-16 to study the efficacy of pre and post emergence herbicides on phytotoxicity control of weeds and weed dynamics in blackgram. Twelve weed management treatments comprising of Imazethapyr 70 g ha^{-1} PRE, Imazethapyr 80 g ha^{-1} PRE, Imazethapyr 70 g ha^{-1} POE (3-4 leaf stage of weeds), Imazethapyr 80 g ha^{-1} POE (3-4 leaf stage of weeds), Imazethapyr + imazamox (RM) 70 g ha^{-1} PRE, Imazethapyr + imazamox (RM) 80 g ha^{-1} PRE, Imazethapyr + imazamox (RM) 70 g ha^{-1} POE (3-4 leaf stage of weeds), Imazethapyr + imazamox (RM) 80 g ha^{-1} POE (3-4 leaf stage of weeds), Pendimethalin 1000 g ha^{-1} PRE, Imazethapyr + Pendimethalin (RM) 1000 g ha^{-1} PRE, Hoeing (20&40 DAS), Weedy check were evaluated in tried under randomized block design with three replications. The herbicides were applied as pre-emergence (0-2 DAS) and post emergence (25 DAS) at 3-4 leaf stage of weeds with the help of manually operated Knapsack sprayer fitted with flat fan nozzle using 500 litres of water per hectare. The sowing of blackgram was done on 7 July, 2015 in rows at 45 cm apart with a depth of 5-7. The fertilizer dose of 20 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied as basal dressing in the field at the time of sowing in furrows. The observations on crop and weeds were recorded at different stages of crop growth. Samples from each plot were collected randomly. Few crop plants were tagged for further studies. The data on population of individual weed species and their dry matter were analyzed after square root transformation ($r = \sqrt{x + 0.5}$). The treatment comparisons were made at 5% level of significance. A quadrate of 0.5 m x 0.5 m size was used for recording the weed density, and the weeds within the quadrate were identified counted and expressed in no. m^{-2}. After counting, weeds were cut close to the ground surface and sun dried for two days. After that the samples were dried in hot air oven at 70 ± 1 ^{0}C for 48 hours till constant weight attained and then weed dry weight was recorded in g m^{-2}. Weed control efficiency of different weed control treatments was calculated on weed dry weight basis with the help of following formula.

$$\text{W.C.E. (\%)} = \frac{W_0 - W_1}{W_0} \text{x}100$$

Where,

W_0 = Weed dry weight in weedy plot

W_1 = Weed dry weight in treated plot

Results and Discussion

Weed flora

Numbers of weed species were recorded in the weedy check treatment of the experimental field. Among them, *Solanum nigrum*, *Trinthema monogyna and Celosia argentia* belong the BLWs; *Echinochlova colona* and *Cynodon dactylon* belong the grassy, *cyperus rotundus* belong the sedge and some weed species *e.g. Digera arvensis, Phyllanthus niruri* and *Commelina benghalensis* were included in the group of other weeds.

As far as the relative per cent contribution of these weed species in total weed density was concerned, it was recorded almost same at all the crop growth stages. However, dominancy varied from species to species in the range of 54.4% (*Cyperus rotundus*) to 2.0% (*Cynodon dactylon*). Among the different weed species, dominancy of BLWs e.g. *Celosia argentia* (49.3-54.4%) and *Trianthema monogyna* (17.9-19.6%) followed by grassy *e.g. E. colona* (11.2-13.5%), *Cynodon dactylon* (1.0-2.0%) and some other weeds (12.9-15.7%) observed. overall, BLWs caused the severe damage to the crop as compared to rest of the weed species. Similar type of weed flora in blackgram under normal conditions has also been reported by Buttar *et al.*, 2008.

Weed density

The weed density of all the weed species and total weeds was affected significantly due to different weed control treatments. Regarding the different treatments, application of imazethapyr + pendimethalin (RM) 1000 g ha^{-1} PRE recorded significantly lower weed density (72.3) of all the weeds as compared to rest of the pre-emergence herbicides. Reduced weed density (94.5) of different weed flora was recorded with T_5 treatment than the other pre-emergence herbicides. Minimum weed density (95.1) of different weed flora was recorded with application of imazethapyr + imazamox (RM) 80 g ha^{-1} followed by T_5, T_2 and T_1. As a as post-emergence herbicides is concerned, application of imazethapyr + imazamox (RM) 80 g ha^{-1} POE applied at 3-4 leaf weed stage was recorded significantly lower weed density (120.0) of different weed species as compared to rest of the post-emergence herbicides, however, it was at par with imazethapyr + imazamox (RM) 70 g ha^{-1}. Significantly more weed density (128.4) of different weed flora was recorded with the application of imazethapyr 80 g ha^{-1} POE. Significant decrease in weed density in blackgram with the application of herbicides have also been reported by several workers (Punia *et al.*, 2009 and Jamin *et al.*) [8, 6].

Table 1: Effect of weed treatments on density of different weed species at harvest stage in blackgram

Treatments	*T. monogyna*	*E. colona*	*C. argentia*	*Solanum nigrum*	*Cyperus rotundus*	Other weeds	Total
T_1: Imazethapyr 70 g ha^{-1} PRE	2.58 (6.2)	2.79 (7.3)	3.06 (8.9)	2.46 (5.6)	10.17 (102.8)	3.41 (11.2)	12.57 (158.0)
T_2: Imazethapyr 80 g ha^{-1} PRE	3.52 (11.9)	3.83 (14.2)	3.25 (10.1)	2.86 (7.7)	10.22 (104.3)	3.99 (15.5)	12.46 (155.2)
T_3: Imazethapyr 70 g ha^{-1} POE (3-4 leaf weeds stage)	2.81 (7.4)	2.80 (7.4)	3.11 (9.2)	2.19 (4.3)	9.84 (96.6)	3.76 (13.7)	12.68 (160.6)
T_4: Imazethapyr 80 g ha^{-1} POE (3-4 leaf weeds stage)	3.00 (8.5)	2.95 (8.2)	3.18 (9.7)	2.60 (6.3)	10.4 (110.6)	3.52 (11.9)	12.63 (159.1)
T_5: Imazethapyr + imazamox (RM) 70 g ha^{-1} PRE	2.19 (4.3)	1.97 (3.4)	2.62 (6.4)	2.23 (4.5)	8.60 (73.9)	3.56 (12.3)	10.65 (113.7)
T_6: Imazethapyr + imazamox (RM) 80 g ha^{-1} PRE	2.58 (6.2)	3.14 (9.4)	2.12 (4.0)	2.02 (3.6)	8.72 (76.1)	3.86 (14.4)	10.25 (104.80)

T_7: Imazethapyr + imazamox (RM) 70 g ha^{-1} POE (3-4 leaf weeds stage)	3.49 (11.7)	3.34 (10.7)	2.96 (8.3)	2.79 (7.3)	10.10 (101.7)	3.76 (13.7)	11.89 (142.0)
T_8: Imazethapyr + imazamox (RM) 80 g ha^{-1} POE(3-4 leaf weeds stage)	2.44 (5.5)	2.21 (4.4)	2.88 (7.8)	2.32 (4.9)	9.08 (82.2)	3.69 (13.2)	10.87 (118.0)
T_9: Pendimethalin 1000 g ha^{-1} PRE	2.27 (4.7)	2.38 (5.2)	1.63 (2.2)	2.19 (3.5)	8.23 (68.9)	3.71 (13.4)	10.00 (99.9)
T_{10}: Imazethapyr + Pendimethalin (RM) 1000 g ha^{-1} PRE	2.21 (4.4)	2.58 (6.2)	2.46 (2.6)	2.00 (3.5)	8.31 (69.1)	3.79 (13.9)	10.00 (99.7)
T_{11}: Hoeing (20&40 DAS)	2.83 (7.5)	2.02 (3.6)	1.95 (3.3)	1.61 (2.1)	8.86 (78.0)	2.02 (3.6)	9.92 (98.1)
T_{12}: Weedy check	3.68 (13.1)	5.80 (33.2)	4.44 (19.2)	3.74 (13.5)	12.27 (150.6)	3.88 (14.6)	15.64 (244.2)
S.Em±	0.10	0.12	0.12	0.10	0.42	0.16	0.46
CD at 5%	0.30	0.37	0.35	0.29	1.23	0.49	1.36

Note: Fig. in parenthesis are the original value, x = $\sqrt{x+0.5}$ transformation

Table 2: Visual observation on phytotoxicity on blackgram due to different herbicides (Score 0-10)

Treatments	Crop discolouration on DAHA						Chlorosis on DAHA					
	1	**3**	**5**	**7**	**10**	**15**	**1**	**3**	**5**	**7**	**10**	**15**
T_1: Imazethapyr 70 g ha^{-1} PRE	0	0	0	0	0	0	0	0	0	0	0	0
T_2: Imazethapyr 80 g ha^{-1} PRE	0	0	0	0	0	0	0	0	0	0	0	0
T_3: Imazethapyr 70 g ha^{-1} POE (3-4 leaf weeds stage)	0	0	1	2	0	0	0	1	1	3	0	0
T_4: Imazethapyr 80 g ha^{-1} POE (3-4 leaf weeds stage)	0	1	2	4	1	0	0	1	1	5	6	6
T_5: Imazethapyr + imazamox (RM) 70 g ha^{-1} PRE	0	0	0	0	0	0	0	0	0	0	0	0
T_6: Imazethapyr + imazamox (RM) 80 g ha^{-1} PRE	0	0	0	0	0	0	0	0	0	0	0	0
T_7: Imazethapyr + imazamox (RM) 70 g ha^{-1} POE (3-4 leaf weeds stag)	0	2	3	2	0	0	0	1	4	5	0	0
T_8: Imazethapyr + imazamox (RM) 80 g ha^{-1} POE(3-4 leaf weeds stage)	0	2	4	3	1	0	0	1	5	6	0	0
T_9: Pendimethalin 1000 g ha^{-1} PRE	0	0	0	0	0	0	0	0	0	0	0	0
T_{10}: Imazethapyr + Pendimethalin (RM) 1000 g ha^{-1} PRE	0	0	0	0	0	0	0	0	0	0	0	0
T_{11}: Hoeing (20&40 DAS)	0	0	0	0	0	0	0	0	0	0	0	0
T_{12}: Weedy check	0	0	0	0	0	0	0	0	0	0	0	0

DAHA-Day after herbicide applied

Table 3: Effect of various treatments on dry matter of weeds (gm^{-2}) at various crop growth stages and weed control efficiency (%) at harvest stage.

Treatments	Dry matter of weeds (gm^{-2}) at harvest	WCE (%)	Grain yield (q ha^{-1})
T_1: Imazethapyr 70 g ha^{-1} PRE	10.62 (112.68)	26.02	8.99
T_2: Imazethapyr 80 g ha^{-1} PRE	10.51 (110.19)	27.66	9.09
T_3: Imazethapyr 70 g ha^{-1} POE (3-4 leaf weeds stage)	11.63 (135.12)	11.29	7.72
T_4: Imazethapyr 80 g ha^{-1} POE (3-4 leaf weeds stage)	11.36 (128.95)	15.34	7.95
T_5: Imazethapyr + imazamox (RM) 70 g ha^{-1} PRE	10.43 (109.1)	28.37	11.66
T_6: Imazethapyr + imazamox (RM) 80 g ha^{-1} PRE	9.24 (85.12)	44.12	12.06
T_7: Imazethapyr + imazamox (RM) 70 g ha^{-1} POE (3-4 leaf weeds stage)	11.14 (123.84)	18.70	9.22
T_8: Imazethapyr + imazamox (RM) 80 g ha^{-1} POE(3-4 leaf weeds stage)	10.65 (113.18)	25.70	9.56
T_9: Pendimethalin 1000 g ha^{-1} PRE	8.78 (77.12)	49.37	10.16
T_{10}: Imazethapyr + Pendimethalin (RM) 1000 g ha^{-1} PRE	8.37 (70.64)	53.62	12.36
T_{11}: Hoeing (20&40 DAS)	8.32 (68.98)	54.71	11.9
T_{12}: Weedy check	12.35 (152.33)	0	5.67
S.Em±	0.41	-	0.37
CD at 5%	1.20	-	1.09

Note: Fig. in parenthesis are the original values, x = $\sqrt{x+0.5}$ transformation

Dry matter accumulation of weeds

Pre-emergence application of herbicides declined the dry matter weeds significantly at all the physiological stages of crop growth. As far as 60 days after sowing stage is concerned, application of imazethapyr + pendimethalin (RM) 1000 g ha^{-1} recorded significantly lower dry matter of weeds (59.31 g m^{-2}) being at par with pendimethalin (RM) 1000 g ha^{-1}, however it was at par with T_6 (64.72 g m^{-2}) (Table-3). Application of imazethapyr + imazamox (RM) 80 g ha^{-1} also recorded lower dry matter of weeds (64.72) followed by T_5 (71.69). Application of imazethapyr 80 g ha^{-1} also recorded less dry matter of weeds (70.86 g m^{-2}) than imazethapyr 70 g ha^{-1} (71.69 g m^{-2}), however, it was on par with each other. As far as post-emergence herbicides is concerned, application of imazethapyr + imazamox (RM) 80 g ha^{-1} (3-4 leaf weeds stage) recorded lower dry matter of weeds (73.38 g m^{-2}) as compared to rest of the post-emergence herbicides. Application of imazethapyr + imazamox (RM) 70 g ha^{-1} POE also recorded minimum dry matter of weeds (74.91 g m^{-2}) followed by imazethapyr 80 g ha^{-1} (83.86 g m^{-2}) and imazethapyr 70 g ha^{-1} (89.53 g m^{-2}). Significantly lower dry matter of weeds (155.05 g m^{-2}) was recorded with hoeing treatment (20 and 40 DAS) as compared to rest of the treatments. Almost similar trend of dry matter accumulation of weeds was recorded at harvest stage of blackgram due to different weed control treatments. These findings are in the conformity as reported by Nandan *et al.*, (2011) [7].

Phytotoxicity

The ready mixed application of Imazethapyr + imazamox (RM) 80 g ha^{-1} as post emergence at 3-4 leaf weeds stage or Imazethapyr + imazamox (RM) 70 g ha^{-1} as post emergence at 3-4 leaf weeds stage or Imazethapyr 80 g ha^{-1} post emergence at 3-4 leaf weeds stage or Imazethapyr 70 g ha^{-1} post emergence at 3-4 leaf weeds stage or showed phytotoxicity symptom on crop plants within 1-15 DAHA (Table-2). The phytotoxic symptoms observed from 3rd day after herbicide application (DAHA) in case of post-emergence herbicides and maximum toxicity observed at 7th day of application in case of T_7 and T_8 treatments. However, in case of pre emergence treatments there was no any phytotoxicity recorded.

Grain yield

Among the different weed control treatments, application of imazethapyr + pendimethalin (RM) 1000 g ha^{-1} recorded significantly more grain yield (12.36 g ha^{-1}) as compared to rest of the herbicide application, except T_6 and T_5 (Table-3). Non-significant differences were also recorded with imazethapyr 80 g ha^{-1} on grain yield (9.09 q ha^{-1}) of blackgram than imazethapyr 70 g ha^{-1} (8.99 q ha^{-1}). Among the different post-emergence herbicides, application of imazethapyr + imazamox (RM) 80 g ha^{-1} POE was recorded significantly more grain yield (9.56 q ha^{-1}) as compared to T_3 and T_4 but it was at par with T_7. Highest grain yield (12.36 q ha^{-1}) of Blackgram was recorded due to hoeing (20 and 40 DAS) treatment, while lowest (5.67 q ha^{-1}) in weedy check. The increase in grain yield of blackgram due to different weed control treatments might be due to the fact that increase in growth and yield attributing characters of blackgram and declined the weed density and dry meter. Similar results are in close conformity with the findings of Jakhar *et al.*, (2015) [5].

Conclusion

On the basis of the experiment conducted during *kharif* 2015, it may be concluded that pre-emergence application of imazethapyr + pendimethalin 1000 g ha^{-1} proved superior over rest of the treatments with respect to weed density of blackgram followed by imazethapyr + imazamox (RM) 80 g ha^{-1}, imazethapyr + imazamox (RM) 70 g ha^{-1} and pendimethalin 1000 g ha^{-1}. However post emergence herbicides treatments, eg.

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