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Weed management effect in blackgram under acidic soils of Manipur

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ABSTRACT

A field experiment on effect of different weed management practices in blackgram under acidic soils of Manipur was conducted at C.A.U. research farm, Andro, Imphal East of Central Agricultural University, Manipur during *Kharif* season 2013, 2014 and 2015. It was laid out in randomized block design with nine different weed management treatments, *viz.* pre-emergence application of pendimethalin 1.0 kg/ha, pendimethalin + imazethapyr 1.0 kg/ha, pendimethalin 1.0 kg/ha + quizalofop-ethyl 75 g as post-emergence application, pendimethalin + imazethapyr 1.0 kg/ha + quizalofop-ethyl 75 g as post-emergence application, pendimethalin 1.0 kg/ha + imazethapyr 55 g/ha, pendimethalin 1.0 kg/ha + hand weeding at 30 DAS, pendimethalin + imazethapyr 1.0 kg/ha + hand weeding at 30 DAS and twice hand weeding at 20 and 40 DAS. Pendimethalin1.0 kg/ha with hand weeding twice at 20 and 40 DAS recorded significant reduction in weed density, weed biomass and weed control efficiency followed by pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha, + hand weeding at 25 DAS. Significantly higher number of pods per plant, seed and stover yield and growth attributes like plant height and number of branches per plant were recorded under twice hand weeding followed by integrated treatment of pendimethalin + imazethapyr 1.0 kg/ha + hand weeding.

INTRODUCTION

Grain legumes are inseparable ingredients of vegetarian diet, and one of the cheapest weapons for combating the malnutrition problem by supplying dietary protein to the people. India, contributes 27.65% to the global grain legume production and holds 35.2% of the world's pulse acreage (Kundu *et al*. 2009). Surprisingly, about 80% of the area under pulses is currently grown in rainfed land of the country. Blackgram [*Vigna mungo* (L.) Hepper] is one of the important grain legumes grown throughout the country during both in summer and rainy seasons. It fits well in various multiple and intercropping systems due to its rapid growth, shorter duration and nitrogen fixing capacity. The crop can be grown on all types of soils ranging from sandy loam to heavy clay except the alkaline and saline soil. Blackgram contributes about 13% of total area in pulses and 10% of their total production in our country. This crop was cultivated on an area of about 5.44 million hectares (*Kharif* + *Rabi*) and recorded a production of 3.56 million tonnes at a productivity level of 655 kg/ha during 2017 (Anonymous 2018). It is extensively grown in the states of Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu and Uttar Pradesh. In Manipur, it is grown during *Kharif* season on an area of 1300 ha with a production of 1072 tonnes with a productivity of 825 kg/ha, which is above the national average (Shashidhar and Samuel 2017).

Blackgram is susceptible to weed competition (Balyan *et al*. 2016) with yield reduction of 42-51% (Malliswari *et al*. 2008, Begum and Rao 2006). Thus, weed management has become imperative to sustain productivity of this crop (Kumar *et al*. 2018). Higher weed density is seen mainly in the rainy season due to ample presence of moisture in the soil and limited field work days (Ramamoorthy *et al*. 2004). The most intensive period for weed competition is around 3 and 6 weeks after sowing which needs control measures for achieving yield targets (Asaduzzaman *et al*. 2010).Weeds can be checked by adopting various methods like eco-physical, biological, chemical and recently through combining direct and indirect approach *i.e.* integrated weed management.

Increasing in labour cost and constraints in availability on time, manual weed control is less economical practice for most of the agricultural crops (Kumar *et al*. 2016), which make us to explore the possibility of herbicidal weed control in blackgram. Chemical measures though become cost-effective; their efficiencies are greatly reduced during *Kharif* due to uncertain rainfall. Application of selective herbicides may control certain species or group of weeds but may not be effective on other weed species. In such situation, while one group of weeds is effectively eliminated, other group takes over and offers severe competition to the crop. High dose of herbicides may leave residue in the soil to injure the subsequent crops and also create the pollution (Pahwa and Prakash 1996).

Very few farmers follow chemical weed control in pulses like blackgram. Pendimethalin, a pre-emergence herbicide is used 0.75 to 1.0 kg/ha to control initial flush of weeds in most of pulses including blackgram. This alone is not sufficient to control the diverse weed flora of the blackgram. Singh *et al*. (2014) discussed the need of post-emergence herbicide to control the second flush of weeds in pulses and to reduce human labour. Kumar (2010) stressed the importance of identifying the broad spectrum effective group of pre- and post-emergence herbicides to be identified to sustain the productivity of the blackgram. Thus, keeping these points in view, an experiment was conducted with the objective of evaluating the relative efficacy of different weed control practices in blackgram in high rainfall areas like Manipur.

MATERIALS AND METHODS

A field investigation was conducted during wet seasons of 2013, 2014 and 2015 at Central Agricultural University Farm, Andro, Imphal East, Manipur, India (latitude of 24^{o} 45' 89'' N, longitude 94^{o} 03' 46'' E with an altitude of 875 m above MSL) to identify the best combination of herbicide and management practices to increase the efficacy of weed control in blackgram under sub-tropical conditions of Manipur. The soils of experimental site was clay loam in texture having acidic pH of 5.2, bulk density 1.39 g/cc and with a high organic carbon content (0.98%). The soil was medium in nitrogen (293.87 kg/ha), low in phosphorus (20.42 kg/ha) and medium in potassium (315.85 kg/ha) contents at the time of initiation of the experiment. The climate of the area is subtropical, received annual average rainfall of 1549 mm and means maximum and mini-mum temperature is were 29.2^{o}C and 21.5^{o}C, respectively.

The experiment comprising of nine treatments was laid out in randomized complete block design. Treatments comprised of pre-emergence application of pendimethalin 1.0 kg/ha, pendimethalin + imazethapyr 1.0 kg/ha, pendimethalin 1.0 kg/ha + quizalofop-ethyl 75 g/ha as post-emergence application, pendimethalin + imazethapyr 1.0 kg/ha + quizalofop-ethyl 75 g/ha as post-emergence application, pendimethalin 1.0 kg/ha + imazethapyr 55 g/ha, pendimethalin 1.0 kg/ha + hand weeding at 30 DAS, pendimethalin + imazethapyr 1.0 kg/ha + and weeding at 30 DAS and twice hand weeding at 20 and 40 DAS. The blackgram variety '*IPU-94-1*' (*Uttara*) having duration of 70-80 days was sown with 30 cm spacing using seed rate of 20 kg/ha. Fertilizer dose of 40:20:20 kg as, NPK per ha using urea (43 kg/ha), single super phosphate (250 kg/ha) and murite of potash (33 kg/ha) was incorporated into the soil well before sowing. A knapsack sprayer fitted with flat-fan nozzle was used to apply the pre-emergence herbicides on the first day after sowing (DAS) and post-emergence herbicides at 20 DAS with a spray volume of 600 l/ha as per the treatments. Suitable plant protection chemicals were sprayed in all the plots to check the incidence of pests and diseases. In the plots ear marked for hand weeding, the operation was done at 20 and 40 days after sowing as per the treatments.

Weed population was recorded by using 0.25 m^2 (side 0.5 m) iron square quadrate at 20 and 40 DAS in all the treatments by random sampling in each plot. Weeds were dried under the sun and then in an oven at 70^{0}C for 72 h, weighed and converted into g/m^2. The data was analysed after subjecting the original data to transformation using square root of ($\sqrt{x+0.5}$). Weed control efficiency (WCE) was calculated as per formula suggested by Patil and Patil (1983).

Five random plants were selected from each plot at 30 DAS to record observations on nodulation and plant growth and yield parameters, *viz*. plant height (cm), no. of branches per plant at maturity, no. of pods per plant, number of seeds per pod, test weight (g), seed and stover yield (kg/ha) were recorded at harvest.

Statistical analysis of the data was done as per the Fisher's analysis of variance technique for the experimental designs and treatment means were compared using least significant difference test at 5% probability level using t-test and calculating LSD values. The economics of treatments was computed on the basis of prevailing market prices of inputs and outputs (₹ 4500/- per quintal of blackgram as per

minimum support price) under each treatment. Analysis of variance was performed on all the collected data. Pooling was made over the years as similar trend was noticed during both the years (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Weed studies

The common weeds in the experimental site were *Cyperus rotundus, Cyperus iria* among sedges and *Echinochloa colona*, *Echinochloa crus-galli, Cynodon dactylon*, *Digitaria sanguinalis*, *Dactyloctenium aegyptium*, *Setaria glauca*, *Eleusine india* among grasses and *Commelina benghalensis*, *Ageratum conyzoides*, *Euphorbia hirta*, *Amaranthus spinosus, Phyllanthus niruri and Trianthema monogyna*, *Ipomoea pestigridis*, *etc*. were the commonly seen broad-leaved weeds in the experimental site. The weed intensity was in the order of sedges>grasses> broad-leaved weeds during all the years of cropping seasons.

The critical period of weed infestation in blackgram is 4-7 weeks after sowing. Weed infestation during this period reduces productivity of the crop. It is apparent from the results that all the treatments significantly reduced the density and dry weight of weeds at all the growth stages of crop in comparison to un-weeded control that was observed to be the most severely infested by weeds. The highest weed density of 122.6 per m^2 was noted in weedy check plot at 30 DAS that increased to 172.8 at 45 DAS (**Table 1**).

Significantly lower weed intensity and weed dry weight which reflected the best control of weeds was recorded with pre-emergence application of pendimethalin + imazethapyr plus hand weeding at 20 DAS (43.3/m^2 and 32.0 g/m^2). This could be ascribed to the competition of weeds for moisture, nutrients, space and shadiness and short life cycle of weeds resulting in extermination of the some species. Among the herbicide applications, the pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha (48.4 g/m^2 and 37.2 g/m^2) was effective reducing the weed population at 30 DAS, which was at par with pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha + hand weeding at 30 DAS (43.3 and 32 g/m^2) at 30 DAS. The pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha (66.0 g/m^2 and 48.2 g/m^2), the combination of the pre-emergence application of pendimethalin+ imazethapyr 1.0 kg/ha + post-emergence application of quizalofop-ethyl 100 g/ha at 20 DAS (66.5 g/m^2 and 44.5 g/m^2) and pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha + imazethapyr 55 g/ha as PoE at 20 DAS (67.4 g/m^2 and 55.6 g/m^2) did not differ significantly with respect to weed density but differed significantly with respect to weed dry weight at 45 DAS. The combination of pre-emergence pendimethalin + hand weeding at 30 DAS (70.3 g/m^2 and 60 g/m^2) and pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha + hand weeding at 30 DAS (57.3g/m^2 and 44 g/m^2) differed significantly even at 45 DAS. This indicated that effectiveness of herbicide pendimethalin + imazethapyr was very effective in controlling weeds. Similar trend was recorded with weed control efficiency at 30 and 45 DAS (**Table 1**). The increase in density and dry weight of weeds in different treatments was attributed to uninterrupted growth of weeds with greater competitive ability than crop that was utmost suppressed due to profuse growth of weeds.

Efficacy of the herbicidal treatments that were subsequently followed by HW at 30 DAS was better in weed control than sole application of these herbicides (**Table 1**). Pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha + HW at 30 DAS was found effective than application of pendimethalin 1.0 kg/ha + HW at 30 DAS. It was equally effective with HW twice and pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha. The superiority of these treatments could mainly be ascribed to the fact that application of herbicide alone inhibited the germination and emergence of weeds during initial growth stage of crop only but at later stages, these herbicides dissipated and deactivated in the soil and next flush of weeds appeared in such plots. The hand weeding done at 30 DAS effectively controlled the subsequent flush of weeds and thus kept the field weed free for a longer duration. Accelerated growth of crop due to looseness of soil and aeration in root zone incurred due to hand weeding could be assigned as another reason of lower density and dry matter of weeds obtained under these treatments.

By removing two initial flushes of weeds, two HW at 20 and 40 DAS reduced the weed growth effectively during most of the growth phases of crop. On the other hand, inhibition of germination and growth of weeds following application of different herbicides might have reduced the weed growth through arresting different metabolic activities and HW done at 30 DAS controlled the second flush of weeds efficiently. These seem to be the most spectacular reason of accumulating lesser

dry weight of weeds and consequently higher weed control efficiencies.

The variation in crop-weed competition under different treatments is associated with variation in weed dry production and the corresponding nutrient depletion by weeds that were eventually reflected in weed completion indices. Results indicated that the pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha + HW at 30 DAS treatment recorded the lowest weed competition index of 0.92 per cent, only as against in the maximum of 55.3% observed under weedy check. Samant and Mishra (2014) in groundnut reported the post-emergence application of quizalofop-ethyl at 20 DAS followed HW for effective control of grassy weeds, and Vyas and Jain (2003) reported higher weed control efficiency, seed yield with application of imazethapyr over quizalofop-p-ethyl in soybean crop. Similarly, pendimethalin + imazethapyr 1.0 kg/ha as pre-emergence application and pendimethalin+ imazethapyr 1.0 kg/ha + quizalofop-ethyl at 20 DAS were found to be the next best treatments that represented the significantly lower weed intensity and weed dry weight by increasing the weed control efficiency. The treatments with hand weeding components registered higher weed competition indices which incurred higher cost for hand weeding leading the treatments to be less remunerative.

The increased dry matter accumulation of weeds corresponding to reduction in grain yield seemed to be responsible for variation in weed competition indices among different treatments.

Growth and yield of blackgram

On the basis of mean data of three (3) years, two HW at 20 and 40 DAS recorded the highest (820 kg/ha) grain yield in *Kharif* seasons, which was followed by pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha + HW 30 DAS (812 kg/ha) (**Table 2**). This provided effective control of weeds and high grain yield of blackgram (Rathi *et al*. 2004). The two HW done on 20 and 40 DAS provided as high grain yield as the weed free treatment (Chand *et al*. 2004, Singh 2011). Several reports on application of pendimethalin 1.0-2.0 kg, pendimethalin 1.0 kg/ha + HW 25 DAS and fluchloralin 0.5-1.5 kg/ha have been reported to provide better grain yield of summer blackgram (Bhandari *et al*. 2004). Similar outcomes have also been reported by Vaishya *et al.* (2003), Gupta 2014 and Jhakar *et al*. 2015. The yield attributing characters like number of pods per plant, number of seeds per pod recorded similar trend as that of seed and stover yield which helped in increasing the yield of these treatments as compared to two HW 20 and 40 DAS, the uncontrolled weeds caused, on an average, 38% reduction in grain yield.

Net returns and B:C ratio were the highest with the application of pendimethalin + imazethapyr 1.0 kg/ha as pre-emergence spray + post-emergence

Table 1. Influence of different herbicides and weed management practices on growth and weed intensity, dry weight and weed control efficiency of blackgram during 2013-2015 (mean of 3 years)

Treatment	Plant height (cm)	No. of branches	No. of pods/ plant	No. of seeds/ pod	Weed intensity (no./m^2)		Weed dry weight (g/m^2)		Weed control efficiency (%)	
					30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Pendimethalin 1.0 kg/ha as PE	27.4	4.20	17.8	4.10	8.6 (74.1)	9.3 (87.5)	7.7 (50.9)	8.1 (65.2)	44.59	57.81
Pendimethalin + imazethapyr 1.0 kg/ha as PE	30.4	4.72	20.9	4.19	7.0 (48.4)	8.1 (66.0)	6.1 (37.2)	7.0 (48.2)	65.44	69.23
Pendimethalin 1.0 kg/ha as PE+ quizalofop-ethyl 100 g/ha as PoE at 20 DAS	29.5	4.44	20.0	3.96	8.0 (63.4)	8.0 (63.9)	7.0 (48.6)	7.5 (55.6)	54.98	64.16
Pendimethalin + imazethapyr 1.0 kg/ha as PE + quizalofop-ethyl 100 g/ha as PoE at 20 DAS	30.9	4.60	21.6	4.19	7.2 (52.7)	8.1 (66.5)	6.3 (39.6)	6.7 (44.5)	63.26	71.56
Pendimethalin 1.0 kg/ha as PE + imazethapyr 55 g/ha as PoE at 20 DAS	29.4	4.51	20.9	3.82	8.6 (74.3)	8.2 (67.4)	7.7 (60.2)	7.5 (55.6)	44.86	63.89
Pendimethalin 1.0 kg/ha as PE+ manual weeding at 30 DAS	29.9	4.40	18.8	4.05	8.3 (68.5)	8.4 (70.3)	7.6 (57.4)	7.9 (63.0)	46.69	60.03
Pendimethalin+ imazethapyr1.0 kg/ha as PE + manual weeding at 30 DAS	32.2	5.20	23.2	4.18	6.6 (43.3)	7.6 (57.3)	5.7 (32.0)	6.6 (44.0)	70.19	72.00
Two manual weeding at 20 and 40 DAS	33.6	5.83	24.7	4.12	4.7 (21.9)	5.3 (28.3)	4.4 (19.5)	4.7 (21.5)	81.90	86.03
Weedy check	23.2	3.50	11.2	3.63	11.1 (122.6)	13.1 (172.8)	10.4 (108.8)	12.5 (157.0)	0.00	0.00
LSD (p=0.05)	2.2	0.31	1.9	0.36	0.41	0.50	0.45	0.45	6.42	4.54

* Data in parentheses are original values; PE – Pre-emergent application; PoE – Post-emergent application

Table 2. Influence of different herbicides and weed management practices on yield economics and weed index of black gram during 2013-2015

Treatment	Seed yield (kg/ha)				Stover yield (t/ha)				Gross returns (x10³ ₹/ha)	Net returns (x10³ ₹/ha)	B:C ratio	Weed index (%)
	2013	2014	2015	Pooled	2013	2014	2015	Pooled				
Pendimethalin 1.0 kg/ha as PE	511	664	668	614	1.18	1.59	1.78	1.52	27.65	6.89	1.33	22.12
Pendimethalin+ imazethapyr 1.0 kg/ha as PE	524	689	753	655	1.31	1.67	1.86	1.61	29.50	8.45	1.40	17.49
Pendimethalin 1.0 kg/ha as PE+ quizalofop-ethyl 100 g/ha as PoE at 20 DAS	522	654	753	643	1.26	1.61	1.80	1.56	28.94	8.93	1.45	19.35
Pendimethalin+ imazethapyr 1.0 kg/ha as PE + quizalofop-ethyl 100 g/ha as PoE at 20 DAS	538	692	839	690	1.30	1.64	1.83	1.59	31.04	12.49	1.67	14.30
Pendimethalin 1.0 kg/ha as PE+ imazethapyr 55 g/ha as PoE at 20 DAS	513	691	827	677	1.24	1.60	1.79	1.54	30.48	7.54	1.33	18.16
Pendimethalin 1.0 kg/ha as PE+ manual weeding at 30 DAS	509	695	963	722	1.22	1.66	1.85	1.58	32.51	3.40	1.12	13.00
Pendimethalin+ imazethapyr1.0 kg/ha as PE + manual weeding at 30 DAS	576	779	1080	812	1.32	1.72	1.91	1.65	36.52	8.55	1.31	0.91
Two manual weeding at 20 and 40 DAS	580	791	1090	820	1.37	1.77	2.07	1.74	36.91	6.49	1.21	0.00
Weedy check	251	355	328	311	1.08	1.43	1.62	1.38	14.01	-5.06	0.73	55.28
LSD (p=0.05)	31.4	39.8	79.9	51.8	0.06	0.07	0.07	0.06	-	-	-	5.64

Note: The data on economics is mean of three years; PE – Pre-emergent application; PoE – Post-emergent application

spray of quizalofop-ethyl 100 g/ha at 20 DAS (₹ 12489/ha and 1.67, respectively) followed by pre-emergence spray of pendimethalin 1.0 kg/ha + quizalofop-ethyl 100 g/ha as post-emergence spray at 20 DAS (₹ 8927 and 1.45) and pendimethalin + imazethapyr 1.0 kg/ha as pre-emergence spray + HW at 20 DAS (₹ 8554 and 1.31). Weedy check though involved the lowest cost of cultivation yet it provided the lowest net returns (Singh 2011) (**Table 2**).

It is reflected from results that different weed control treatments evaluated for their efficacy in present investigations differed significantly in their effect on plant height, branches per plant in blackgram (**Table 1**). The variation in treatments and their effect on growth attributes has been found to be directly associated with almost similar variation in weed control. All the treatments significantly enhanced the growth parameters of crop at most of the stages over weedy check plots. The maximum plant height and number of branches per plant were recorded with the treatment with hand weeding at 20 and 40 DAS at harvest (33.6 and 5.83 cm). This treatment was at par with pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha + HW at 30 DAS (32.3 cm and 5.2) at harvest stages. However, the plant height did not differ significantly among rest of the treatments except weedy check. Further, the number of branches did not differed significantly among rest of the treatments except the pre-emergence application of pendimethalin 1.0 kg/ha and weedy check (4.2 and 3.5).

Conclusion

Pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha + HW at 30 DAS was found the most effective with regard to grain yield (812 kg/ha), net returns (₹ 8454/ha) and B:C ratio (1.31). Two hand weeding done at 20 and 40 DAS also produced grain yield of 820 kg/ha with net returns of ₹ 6491/ha and thus proved equally effective and remunerative weed management treatment in blackgram.

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