

Bioefficacy of herbicides against weeds of blackgram grown under rainfed conditions

S. RAJU, PANDIT S. RATHOD, B. M. DODAMANI, N. ANANDA AND R.P. PATIL

Department of Agronomy, College of Agriculture
University of Agricultural Sciences, Raichur - 584 104, Karnataka, India
E-mail: psrathoduasr@gmail.com

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Abstract: A field experiment was conducted at Agricultural Research Station, Kalaburagi, University of Agricultural Sciences, Raichur during *kharif* 2015 to evaluate the effect of pre and post emergent herbicides on weeds and productivity of blackgram [*Vigna mungo* (L.) Heppler] under rainfed conditions. Fifteen treatments were tested in randomized block design with three replications. Among the weed control treatments, pendimethalin 30 EC @ 0.75 kg a.i ha⁻¹ fb imazethapyr 10 SL @ 75 g a.i ha⁻¹ at 20 DAS recorded significantly lower total weed density (2.19/0.25 m²), weed dry weight (1.38 g/0.25 m²) and weed control efficiency (92.1%) than rest of the treatments including weedy check but it was on par with that of pendimethalin 30 EC @ 0.75 kg a.i ha⁻¹ fb quizalofop ethyl 5 EC @ 75 g a.i ha⁻¹ at 20 DAS, intercultivation at 20 and 40 DAS, tank mix application of imazethapyr 10 SL and quizalofop ethyl 5 EC each @ 75 g a.i ha⁻¹ at 20 DAS and pendimethalin 30 EC @ 0.75 kg a.i ha⁻¹ fb one hand weeding at 25-30 DAS as compared to weedy check. The same treatments also noticed significantly maximum growth and yield attributing characters.

Key words: Black gram, Herbicides, Productivity, Weed dry weight, Yield

Introduction

Blackgram [*Vigna mungo* (L.) Heppler] is one of the most important pulse crop grown throughout the country during *kharif* season. It contributes about 13 per cent of total pulse area and 10 per cent of their total production in our country. In India, this crop was cultivated over an area of about 30.6 lakh hectares with a production of 17 lakh tonnes and productivity of 555 kg ha⁻¹ during 2013-14 (Anon., 2014). It is extensively grown in the states of Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka and Uttar Pradesh. The crop can be grown on all types of soils ranging from sandy loam to heavy clay except the alkaline and saline soil. However, it does well on heavier soils such as black cotton soils which retain moisture for longer period. In Karnataka, it is cultivated over an area of 1.28 lakh hectares with a production of 0.45 lakh tones and lower productivity of 352 kg ha⁻¹. The lower productivity of blackgram is mainly due to weed infestation during early stages of crop growth ends up in yield reduction up to 43.2-64.1 per cent in blackgram (Rathi *et al.*, 2004). Therefore, removal of weeds at appropriate time using a suitable method is essential to obtain high yields of blackgram. In blackgram, weeds could be controlled by hand weeding (Chand *et al.*, 2004). However, hand weeding is laborious, time consuming, costly and tedious. Moreover, many times labour is not available at the critical period of weed removal. Furthermore, weather conditions do not permit timely hand weeding due to wet field conditions. Use of herbicides offers an alternative for possible effective control of weeds. Therefore, in the present study, effect of various herbicides was compared with weed free check and weedy check for evaluating the reduction in weed dry weight and obtaining high yields of blackgram grown during *Kharif* season.

Material and methods

A field experiment was conducted during *Kharif* season of 2015 at Agricultural Research Station, Kalaburagi,

University of Agricultural Sciences, Raichur, situated at North Eastern Dry Zone of Karnataka at a latitude of 17° 34' North, longitude of 76° 79' East and an altitude of 478 meters above mean sea level. The experimental soil was black clay in texture belonging to the order *Vertisol* and pH was slightly alkaline (8.30) with an electrical conductivity of 0.41 ds/m besides having a content of low soil organic carbon (0.49 %), soil was low in available nitrogen (232 kg ha⁻¹), medium in available phosphorus (29 kg ha⁻¹) and high in available potassium (430 kg ha⁻¹). The experiment was laid out in randomized block design with three replications having fifteen treatments, viz., (T₁) Weedy check, (T₂) Weed free check, (T₃) Intercultivation at 20 and 40 Days after sowing (DAS), (T₄) Pendimethalin 30 EC @ 0.75 kg a.i ha⁻¹, (T₅) Pendimethalin 30 EC @ 0.75 kg a.i ha⁻¹ fb one hand weeding at 25-30 DAS, (T₆) Imazethapyr 10 SL @ 50 g a.i ha⁻¹ at 20 DAS, (T₇) Imazethapyr 10 SL @ 75 g a.i ha⁻¹ at 20 DAS, (T₈) Imazethapyr 10 SL @ 100 g a.i ha⁻¹ at 20 DAS, (T₉) Imazethapyr 10 SL @ 125 g a.i ha⁻¹ at 20 DAS, (T₁₀) Imazethapyr 10 SL @ 150 g a.i ha⁻¹ at 20 DAS, (T₁₁) Propaquizafop ethyl 10 EC @ 50 g a.i ha⁻¹ at 20 DAS, (T₁₂) Quizalofop ethyl 5 EC @ 75 g a.i ha⁻¹ at 20 DAS, (T₁₃) Pendimethalin 30 EC @ 0.75 kg a.i ha⁻¹ fb imazethapyr 10 SL @ 75 g a.i ha⁻¹ at 20 DAS, (T₁₄) Pendimethalin 30 EC @ 0.75 kg a.i ha⁻¹ fb quizalofop ethyl 5 EC @ 75 g a.i ha⁻¹ at 20 DAS and (T₁₅) Tank mix application of imazethapyr 10 SL and quizalofop ethyl each 5 EC @ 75 g a.i ha⁻¹ at 20 DAS. The quantities of herbicides as per treatments were sprayed by knapsack sprayer with flat fan nozzle with 600 litre of water per ha. The pre and post emergence herbicide treatments were imposed as per schedule. The blackgram variety 'DU-1' was sown at 30 cm apart rows with a seed rate of 12 kg ha⁻¹ on 15th July and harvested on 10th of October during 2015. The crop was fertilized with 25 kg N and 50 kg P₂O₅ through urea, single super phosphate respectively.

The rainfall received during crop season was 351.9 mm as against the normal rainfall of 555.6 mm. There were no major pests and diseases during the year of experimentation. Weeds were counted at 25, 50 DAS and at harvest. Monocot and dicot weeds present within 0.5 m x 0.5 m random quadrant in each net plot were counted separately and expressed as number of weeds per 0.25 m². Weed dry weight was recorded at 25, 50 DAS and at harvest. Weeds in 0.5 m x 0.5 m quadrant in the net plot were cut close to the ground level and were dried at 70 °C to a constant weight and the weight was recorded. Based on this data, dry weight of weeds per 0.25 m² were worked out and expressed in g per 0.25 m². The data on dry weight were subjected to arcsine transformation before statistical analysis to normalize their distribution.

Weed control efficiency (WCE) was calculated by the following formula.

$$\text{WCE}(\%) = \frac{\text{WCE} - \text{WCT}}{\text{WCC}} \times 100$$

Where,

WCC= Dry weight of weeds in unweeded control plot

WCT= Dry weight of weeds in treated plot

Regarding agronomic characters, ten competitive plants were randomly selected from each plot and observations were recorded for growth and yield attributes. Whereas, seed yield obtained from the net plot area was recorded at physiological maturity and expressed in kg ha⁻¹.

Results and discussion

Effect on weeds

Table 1. Effect of different treatments on total weed density, dry weight of weeds and WCE at 50 DAS and at harvest in blackgram

Treatments	Total weed density			Total weed dry weight			Weed control efficiency (%)		
	25 DAS	50 DAS	At harvest	25 DAS	50 DAS	At harvest	25 DAS	50 DAS	At harvest
T ₁ : Weedy check	5.43 (29.00)	6.26 (38.67)	6.72 (44.67)	4.00 (15.49)	4.44 (19.23)	4.69 (21.47)	0.0	0.0	0.0
T ₂ : Weed free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	100.0	100.0	100.0
T ₃ : Intercultivation at 20 and 40 DAS	2.46 (5.56)	3.06 (8.84)	3.49 (11.67)	2.06 (3.76)	2.19 (4.28)	2.42 (5.37)	75.8	77.6	74.9
T ₄ : Pendimethalin 30 EC @ 0.75 kg a.i/ha	4.30 (18.00)	4.69 (21.50)	4.52 (19.95)	2.62 (6.36)	2.91 (7.95)	3.08 (8.98)	58.9	58.4	58.0
T ₅ : Pendimethalin 30EC @ 0.75 kg a.i/ha fb one hand weeding at 25-30 DAS	2.80 (7.33)	3.24 (10.00)	3.58 (12.33)	1.89 (3.08)	2.20 (4.35)	2.48 (5.65)	80.1	77.3	73.7
T ₆ : Imazethapyr 10 SL @ 50 g a.i/ha at 20 DAS	3.44 (11.33)	3.83 (14.17)	4.16 (16.79)	2.29 (4.73)	2.53 (5.92)	2.81 (7.40)	69.4	69.4	65.6
T ₇ : Imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS	3.85 (14.33)	4.13 (16.55)	4.36 (18.48)	2.52 (5.83)	2.76 (7.09)	2.93 (8.07)	62.3	63.1	62.4
T ₈ : Imazethapyr 10 SL @ 100 g a.i/ha at 20 DAS	2.97 (8.33)	3.43 (11.27)	3.58 (12.33)	2.18 (4.24)	2.41 (5.33)	2.50 (5.75)	72.6	72.2	73.1
T ₉ : Imazethapyr 10 SL @ 125 g a.i/ha at 20 DAS	3.94 (15.00)	4.34 (18.32)	4.42 (19.08)	2.49 (5.68)	2.66 (6.55)	2.93 (8.10)	63.3	65.6	61.9
T ₁₀ : Imazethapyr 10 SL @ 150 g a.i/ha at 20 DAS	4.12 (16.50)	3.79 (13.89)	4.55 (20.17)	2.45 (5.50)	2.65 (6.50)	2.94 (8.15)	64.4	66.2	62.2
T ₁₁ : Propaquizafop ethyl 10 EC @ 50 g a.i/ha at 20 DAS	3.39 (11.00)	3.88 (14.57)	4.10 (16.33)	2.41 (5.30)	2.58 (6.13)	2.83 (7.51)	65.8	68.1	65.1
T ₁₂ : Quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS	3.54 (12.00)	3.97 (15.24)	4.23 (17.41)	2.22 (4.41)	2.33 (4.93)	2.59 (6.23)	71.5	74.4	71.0
T ₁₃ : Pendimethalin 30 EC @ 0.75 kg a.i/ha fb imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS	2.20 (4.33)	2.61 (6.33)	3.03 (8.67)	1.38 (1.40)	1.33 (1.28)	1.48 (1.70)	90.9	93.4	92.1
T ₁₄ : Pendimethalin 30 EC @ 0.75 kg a.i/ha fb quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS	2.37 (5.11)	2.92 (8.00)	3.14 (9.33)	1.57 (1.96)	1.56 (1.94)	1.74 (2.52)	87.3	89.9	88.3
T ₁₅ : Tank mix application of imazethapyr 10 SL and quizalofop ethyl 5EC each @ 75 g a.i/ha at 20 DAS	2.64 (6.44)	3.21 (9.82)	3.44 (11.33)	2.01 (3.55)	2.20 (4.33)	2.43 (5.43)	77.0	77.5	74.7

DAS: Days After Sowing a.i.: Active Ingredient fb : Followed by EC : Emulsifiable Concentrate SL : Soluble liquids

*Figures in parentheses indicate original values

Total weed count (x) data were transformed to (x+0.5)^{1/2}

The experimental field was mainly colonized by *Cynodon dactylon* (L.) Pers., *Dactyloctenium aegyptium* and *Digitaria marginata* Link., *Cyperus rotundus* L. was dominant one and common broad leaved weeds observed were *Commelina benghalensis*, *Phyllanthus niruri* L., *Portulaca oleracea* L. and *Amaranthus viridis* L. All the weed species were effectively controlled by sequential application of Pendimethalin 30 EC @ 0.75 kg a.i ha⁻¹ followed by imazethapyr 10 SL @ 75 g a.i ha⁻¹ at 20 DAS compared to alone application of pendimethalin as PE and post emergent herbicides were equally effective as weed free check after sowing. Among different weed control treatments, the treatment which received pendimethalin 30 EC @ 0.75 kg a.i/ha followed by imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS was significantly superior over weedy check with respect to reduced weed population (2.61 and 3.03 per 0.25 m² respectively) and dry weight (1.33 and 1.48 g per 0.25 m²) at 50 DAS and at harvest of crop growth. The next best treatment which recorded lower weed population and dry weight was pendimethalin 30 EC @ 0.75 kg a.i/ha followed by quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS. The lower weed density and dry weight in these treatments was mainly due to effective control of annual weeds by pendimethalin upto 25 day and at later stage, new flushes of annual and perennial weeds were effectively controlled by post-emergent application of imazethapyr and quizalofop ethyl. Significantly, higher weed control efficiency was recorded in pendimethalin 30 EC @ 0.75 kg a.i/ha followed by imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS and pendimethalin 30 EC @ 0.75 kg a.i/ha followed by quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS. Various earlier workers (Khot *et al.*, 2012b; Dwivedi *et al.*, 2012 and Choudhary *et al.*, 2012) also reported higher weed population and dry weight in

unweeded check. Similar observation was earlier reported by Yadav *et al.* (2015).

Effect on crop growth and yield

All the growth and yield attributes were significantly higher under sequential application of pre and post-emergent herbicides as compared to their single application. The weed free check recorded significantly superior growth and yield attributes as compared to all other treatments including weedy check. However, among the herbicidal treatments, higher plant height (36.73 cm), number of branches (7.6 plant⁻¹), number of pods (43.0 plant⁻¹) and number of seeds (7.0 pod⁻¹) were recorded in the treatment receiving pendimethalin 30 EC @ 0.75 kg a.i/ha fb imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS and pendimethalin 30 EC @ 0.75 kg a.i/ha fb quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS, respectively. This was due to better control of both grassy as well as broad leaved weeds during early crop growth period. The minimum values were recorded under weedy check treatment.

DAS: Days After Sowing a.i.: Active Ingredient fb : Followed by

EC : Emulsifiable Concentrate SL : Soluble liquids

Significantly higher seed and haulm yield was recorded in pendimethalin 30 EC @ 0.75 kg a.i/ha fb imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS (833 kg ha⁻¹ and 1697 kg ha⁻¹ respectively), and it was on par with pendimethalin 30 EC @ 0.75 kg a.i/ha fb quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS (813 kg ha⁻¹ and 1658 kg ha⁻¹ respectively), intercultivation at 20 and 40 DAS (806 kg ha⁻¹ and 1651 kg ha⁻¹ respectively), tank mix application of

Table 2. Effect of weed control treatments on growth and yield attributes of blackgram

Treatments	Plant height (cm)	No. of pods plant ⁻¹	No. of seeds pod ⁻¹	Haulm yield(kg ha ⁻¹)	Harvest index (%)
T ₁ : Weedy check	21.17	24.6	3.77	1013	27.76
T ₂ : Weed free check	37.57	45.2	8.00	1746	33.11
T ₃ : Intercultivation at 20 and 40 DAS	36.13	42.0	7.73	1651	32.80
T ₄ : Pendimethalin 30 EC @ 0.75 kg a.i/ha	28.27	26.8	5.71	1297	27.91
T ₅ : Pendimethalin 30EC @ 0.75 kg a.i/ha fb one hand weeding at 25-30 DAS	35.03	41.6	7.27	1540	31.98
T ₆ : Imazethapyr 10 SL @ 50 g a.i/ha at 20 DAS	32.23	31.2	6.17	1465	29.87
T ₇ : Imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS	31.50	29.4	6.05	1448	29.36
T ₈ : Imazethapyr 10 SL @ 100 g a.i/ha at 20 DAS	33.40	38.8	7.17	1534	31.49
T ₉ : Imazethapyr 10 SL @ 125 g a.i/ha at 20 DAS	31.17	31.0	6.04	1451	29.19
T ₁₀ : Imazethapyr 10 SL @ 150 g a.i/ha at 20 DAS	30.00	28.0	5.90	1337	28.65
T ₁₁ : Propanil 10 EC @ 50 g a.i/ha at 20 DAS	32.87	35.4	6.85	1518	31.18
T ₁₂ : Quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS	32.73	32.6	6.30	1513	30.66
T ₁₃ : Pendimethalin 30 EC @ 0.75 kg a.i/ha fb imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS	36.73	43.0	7.90	1697	32.92
T ₁₄ : Pendimethalin 30 EC @ 0.75 kg a.i/ha fb quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS	36.30	42.2	7.76	1658	32.90
T ₁₅ : Tank mix application of imazethapyr 10 SL and quizalofop ethyl 5EC each @ 75 g a.i/ha at 20 DAS	35.47	42.0	7.31	1588	32.24
S.E.m.±	0.79	1.3	0.41	76	0.82
C.D. at 5 %	2.29	3.7	1.19	220	2.4

DAS: Days After Sowing a.i.: Active Ingredient fb : Followed by
EC : Emulsifiable Concentrate SL : Soluble liquids

Table 3. Yield and economic analysis of blackgram as influenced by different weed management practices

Treatments	Seed yield (kg ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B:C Ratio
T ₁ : Weedy check	389	34806	18634	16172	1.87
T ₂ : Weed free check	864	77271	23614	53657	3.27
T ₃ : Intercultivation at 20 and 40 DAS	806	72056	22564	49492	3.19
T ₄ : Pendimethalin 30 EC @ 0.75 kg a.i/ha	502	44879	21389	23490	2.10
T ₅ : Pendimethalin 30EC @ 0.75 kg a.i/ha fb one hand weeding at 25-30 DAS	724	64726	22889	41837	2.83
T ₆ : Imazethapyr 10 SL @ 50 g a.i/ha at 20 DAS	624	55786	20214	35572	2.76
T ₇ : Imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS	602	53819	20689	33130	2.60
T ₈ : Imazethapyr 10 SL @ 100 g a.i/ha at 20 DAS	705	63027	21164	41863	2.98
T ₉ : Imazethapyr 10 SL @ 125 g a.i/ha at 20 DAS	598	53461	21639	31822	2.47
T ₁₀ : Imazethapyr 10 SL @ 150 g a.i/ha at 20 DAS	537	48008	22114	25894	2.17
T ₁₁ : Propaquizafop ethyl 10 EC @ 50 g a.i/ha at 20 DAS	688	61507	21064	40443	2.92
T ₁₂ : Quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS	669	59809	22309	37500	2.68
T ₁₃ : Pendimethalin 30 EC @ 0.75 kg a.i/ha fb imazethapyr 10 SL @ 75 g a.i/ha at 20 DAS	833	74470	22314	52156	3.34
T ₁₄ : Pendimethalin 30 EC @ 0.75 kg a.i/ha fb quizalofop ethyl 5 EC @ 75 g a.i/ha at 20 DAS	813	72682	22689	50523	3.28
T ₁₅ : Tank mix application of imazethapyr 10 SL and quizalofop ethyl 5EC each @ 75 g a.i/ha at 20 DAS	759	67855	21889	45966	3.10
S.Em.±	52	4659	-	16172	1.87
C.D. at 5 %	151	13498	-	53657	3.27
DAS: Days After Sowing EC : Emulsifiable Concentrate	a.i.: Active Ingredient SL : Soluble liquids	fb : Followed by			

imazethapyr 10 SL and quizalofop ethyl each 5 EC @ 75 g a.i/ha at 20 DAS (759 kg ha⁻¹ and 1588 kg ha⁻¹ respectively) and pendimethalin 30 EC @ 0.75 kg a.i/ha fb one hand weeding at 25-30 DAS (724 kg ha⁻¹ and 1540 kg ha⁻¹ respectively). In *kharif* blackgram the weed free treatment reduced the crop-weed competition by providing no weed situation in blackgram field. Thus, the crop plants being vigorous by efficiently utilization of nutrients, moisture, sunlight with space and gave better growth and yield. The weedy check plot gave significantly minimum yield due to heavy competition for nutrient, moisture

and light between the crop and weeds. Similar findings were also reported by Rao *et al.* (2010).

Conclusion

It can be inferred from the present investigation that, application of pendimethalin 30% EC 0.75 kg a.i ha⁻¹ PE fb imazethapyr 75 g a.i./ha or quizalofop p ethyl 75 g a.i./ha at 20 DAS was the most effective for controlling weeds, obtaining higher seed yield, net returns and B:C ratio in blackgram under rainfed conditions of Karnataka.

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