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Yield and weed density of Blackgram (*Vigna mungo* (L.) Hepper) as influenced by weed control methods

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Abstract: The study conducted with pre-emergent herbicides alone and with sequential application of post-emergent herbicides at All India Co-ordinated Research Project (AICRP) on weed management, Gandhi Krishi Vignyan Kendra (GKVK), Bangalore in late *rabi* season of 2013 revealed the predominance of grasses over broad leaved weeds in blackgram. Interculture @ 20 days after sowing (DAS) and hand weeding @ 40 DAS resulted in higher yield (1182 and 5873 kg ha^{-1} seed and haulm yield, respectively) and least weed density of 41.33 m^{-2} during harvest. Uncontrolled weed growth recorded maximum population (70.00 m^{-2}). During initial days pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} and alachlor 50 EC @ 1.0 kg a.i. ha^{-1} recorded significantly least weed population of 29.33 m^{-2} at p< 0.05 level of significance. Uncontrolled weed growth resulted in maximum reduction in yield of 65.64 per cent.

Keywords: Broad spectrum herbicide, Herbicide sequence, Yield reduction

INTRODUCTION

Blackgram is especially an unnoticed crop because of its cultivation as *paira* crop in rice fallows and as catch crop for catching the season where the main crop fails. Weeds, due to their competition with crop plants for nutrients, moisture, light and space cause yield reduction in pulses to greater extent. Unchecked weeds have been reported to cause a considerable reduction in the grain yield of black gram, which in case of summer and kharif blackgram could be 41.2 and 41.6 per cent, respectively (Singh, 2011). Therefore, removal of weeds at appropriate time using a suitable method is essential to obtain high yields of black gram.

Pre-emergent application of herbicide may allow the emergence of weeds, especially grasses after a few days. Due to which requirement of post-emergent herbicides for managing weeds is unavoidable. This investigation was planned and implemented to find out the influence of various weed control methods on yield as well as weed population of blackgram. For which the experiment was devised taking into account of the pre- as well as post-emergent herbicides so that weeds can be controlled throughout the crop growth period. Effect of various herbicides was compared with interculture followed by hand weeding and untreated check.

MATERIALS AND METHODS

The investigation was conducted at the field unit of Main Agricultural Research Station, Hebbal, during late *rabi* season of 2013. The region comes under the agro climatic zone southern plateau and hills with an elevation of 914 m Mean Sea Level. The soil textural class of the experimental site is sandy clay loam with low nitrogen, medium available phosphorus and available potassium status.

Type-9 cultivar of black gram was sown in line with a distance of 30 cm from row to row and 10 cm from plant to plant. The experiment comprised of 14 treatments which were replicated thrice. The treatments T_1 to T_{14} (Table 1) included pre-emergent herbicides alone and in combination with post-emergent herbicides along with interculture in combination with hand weeding and weedy check. Pre-emergent herbicides were sprayed 3 days following the date of sowing and similarly post-emergent herbicide spray was given 30 days following the date of sowing. Weed count was taken using a weed quadrant of 0.25 m^2 at 15 DAS, 45 DAS and during harvest.

The yields from the net plots were taken in to account for yield estimation and were converted to hectare. The weed count values were subjected to square root transformation to make it normal distribution. The values obtained were subjected to Fisher's method of "Analysis of variance" (ANOVA) as outlined by Gomez and Gomez (1984) and data were compared with critical differences at a probability level of 0.05 per cent.

RESULTS AND DISCUSSION

Seed yield, haulm yield and weed index: Significant difference (P 0.05 %) was observed for seed as well as

haulm yield (Table 2). Significantly higher seed and haulm yield was observed in interculture followed by hand weeding 1181.6 and 5873.3 kg ha $^{-1}$, respectively and it was statistically on par with pendimethalin followed by quizalofop (T_{10}) with seed and haulm yield of 1120.6 and 5194.3 kg ha^{-1}, respectively. Seed and haulm yield was significantly reduced under unweeded check (405.4 kg of seed yield and 2700 kg ha^{-1}). The better performance of mechanical weeding was earlier reported by Brij *et al.* (2011) and Chhodavadia (2014) in greengram which might be due to nearly complete removal of weeds resulting in reduced crop weed interference thus crop growth was better which lead to more pod bearing branches and ultimately more haulm and seed yield. Among the herbicidal treatments the combination of pre- and post-emergent herbicides (T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, T_{11} and T_{12}) yielded more than single application of pre-emergent herbicides (T_1, T_2, T_3). The reproductive sink depends on the vegetative source available due to which harvest index was moreover not influenced by weed control measures (Table 2). No control of weeds (T_{14}) resulted in yield reduction of nearly 65.55 percent, similar findings were reported by Gogoi *et al.* (1991) where yield reduction ranged from 60 to 65 per cent in summer blackgram. Singh (2011) after conducting experiment for four years in blackgram reported that the yield reduction due to weed interference is 41.2 and 41.6 percent in summer and kharif season respectively.

Weed density: In the experimental plots population of grasses were maximum followed by broad leaved weeds with the least population being taken by sedges. Grasses and broad leaved weeds population differed significantly at 5 per cent level of significance throughout the crop growth period whereas, in sedges the influence of weed control practices were not effective.

At 15 DAS (Table 3) sedge and broad leaved weed population did not differ significantly. Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} controlled grasses effectively and recorded least grass population of 6.67 m$^{-2.}$ Weedy check (T_{14}) recorded significantly higher grass density of 31.33 m^{-2}at 5 per cent significance level. In summer season blackgram De and Modak (1993) also found that any weed control measures resulted in less population of weeds over the control. For total weed density

Table 1. Treatment details, dosage and time of application of herbicides.

Treatments	Dosage (kg ha^{-1})	Time of application (DAS)
T_1-Pendimethalin 30 EC	0.75	3
T_2-Alachlor 50 EC	1.0	3
T_3-Oxyfluorfen 23.5 EC	0.075	3
T_4-T_1fbimazethapyr 10 SL	0.75 fb0.063	3 fb 30
T_5-T_2fbimazethapyr 10 SL	1.0 fb0.063	3 fb 30
T_6-T_3fbimazethapyr 10 SL	0.075 fb0.063	3 fb 30
T_7-T_1fb fenoxaprop-p-ethyl 9 EC	0.75 fb 0.054	3 fb 30
T_8-T_2fb fenoxaprop-p-ethyl 9 EC	1.0 fb 0.054	3 fb 30
T_9-T_3 fb fenoxaprop-p-ethyl 9 EC	0.075 fb 0.054	3 fb 30
T_{10}-T_1fb quizalofop-p-ethyl 5 EC	0.75 fb0.03	3 fb 30
T_{11}-T_2fb quizalofop-p-ethyl 5 EC	1.0 fb0.03	3 fb 30
T_{12}-T_3fb quizalofop-p-ethyl 5 EC	0.075 fb0.03	3 fb 30
T_{13}-Interculture @ 20 DAS and hand weeding @ 40 DAS	-	-
T_{14}-Weedy check	-	-

DAS- Days after sowing, fb- Followed by

Table 2. Seed yield, haulm yield, harvest index and weed index of blackgram as influenced by weed control practices.

Treatments	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index	Weed index (%)
T_1-Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1}, [PE]	719.3	4203.0	0.15	39.04
T_2-Alachlor 50 EC @ 1.0 kg a.i. ha^{-1}, [PE]	759.3	4516.4	0.15	35.66
T_3-Oxyfluorfen 23.5 EC @ 0.075 kg a.i. ha^{-1}, [PE]	734.0	4266.7	0.15	37.80
T_4-T_1fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	767.9	4434.0	0.15	34.92
T_5-T_2fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	868.8	4583.6	0.16	26.37
T_6-T_3fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	1053.2	4787.5	0.18	10.75
T_7-T_1fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	1078.2	4856.8	0.18	8.63
T_8-T_2fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	1096.9	4719.3	0.19	7.04
T_9-T_3 fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	1078.6	4976.8	0.18	8.59
T_{10}-T_1fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	1120.6	5194.3	0.18	5.03
T_{11}-T_2fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	853.9	4279.2	0.17	27.64
T_{12}-T_3fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	985.9	4948.2	0.17	16.45
T_{13}-Interculture @ 20 DAS and hand weeding @ 40 DAS.	1181.6	5873.3	0.17	0.00
T_{14}-Weedy check.	405.4	2700.0	0.13	65.64
S.Em ±	63.7	437.7	0.03	NA
CD($P \leq 0.05$)	185.1	1377.2	NS	NA

Table 3. Weed density (Number m^{-2}) at 15 DAS in blackgram as influenced by weed control practices.

Treatments	Sedge	Grasses	Broad leaved weeds	Total
T_1-Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1}, [PE]	2.18 (4.67)	3.37 (10.67)	3.86 (14.00)	5.50 (29.33)
T_2-Alachlor 50 EC @ 1.0 kg a.i. ha^{-1}, [PE]	1.77 (3.33)	3.15 (10.00)	5.01 (24.67)	6.20 (38.00)
T_3-Oxyfluorfen 23.5 EC @ 0.075 kg a.i. ha^{-1}, [PE]	1.00 (0.00)	4.01 (16.00)	3.84 (14.67)	5.58 (30.67)
T_4-T_1fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	2.59 (7.00)	2.76 (6.67)	4.59 (20.33)	5.91 (34.00)
T_5-T_2fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	1.00 (0.00)	3.60 (12.00)	4.27 (17.33)	5.51 (29.33)
T_6-T_3fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	1.67 (2.67)	4.82 (22.67)	4.80 (22.00)	6.93 (47.33)
T_7-T_1fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	2.37 (6.00)	4.20 (16.67)	2.95 (8.67)	5.68 (31.33)
T_8-T_2fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	1.96 (3.33)	3.83 (14.00)	3.73 (13.33)	5.60 (30.67)
T_9-T_3 fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	2.08 (4.00)	4.85 (22.67)	3.65 (12.67)	6.34 (39.33)
T_{10}-T_1fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	1.55 (2.00)	3.46 (11.33)	4.41 (19.33)	5.79 (32.67)
T_{11}-T_2fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	1.41 (1.33)	3.91 (14.67)	3.93 (16.00)	5.73 (32.00)
T_{12}-T_3fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	2.99 (10.00)	4.31 (18.67)	2.60 (6.00)	5.96 (34.67)
T_{13}-Interculture @ 20 DAS and hand weeding @ 40 DAS.	1.41 (1.33)	5.54 (30.00)	3.77 (13.33)	6.75 (44.67)
T_{14}-Weedy check.	1.00 (0.00)	5.67 (31.33)	3.66 (12.67)	6.68 (44.00)
S.Em ±	0.62	0.44	0.47	0.31
CD($P \leq 0.05$)	NS	1.27	NS	0.91

PE- Pre emergence at 3 DAS, POE- Post emergence at 30 DAS, fb- Followed by, DAS- Days after sowing, NS- Non significant, Figures in the parenthesis are original values; data analysed after square root(X+1) transformation

Table 4. Weed density (Number m^{-2}) at 45 DAS in blackgram as influenced by weed control practices.

Treatments	Sedge	Grasses	Broad leaved weeds	Total
T_1-Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1}, [PE]	1.96 (3.33)	4.57 (22.67)	4.27 (18.00)	6.55 (44.00)
T_2-Alachlor 50 EC @ 1.0 kg a.i. ha^{-1}, [PE]	1.96 (4.67)	4.25 (17.33)	5.55 (30.00)	7.27 (52.00)
T_3-Oxyfluorfen 23.5 EC @ 0.075 kg a.i. ha^{-1}, [PE]	1.55 (2.00)	5.50 (30.00)	4.97 (24.67)	7.58 (56.67)
T_4-T_1fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	1.55 (2.00)	3.93 (18.00)	5.85 (34.67)	7.37 (54.67)
T_5-T_2fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	1.55 (2.00)	4.73 (22.67)	4.85 (22.67)	6.93 (47.33)
T_6-T_3fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	1.00 (0.00)	5.62 (30.67)	4.43 (18.67)	7.08 (49.33)
T_7-T_1fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	2.37 (6.00)	4.25 (20.00)	5.88 (35.33)	7.88 (61.33)
T_8-T_2fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	1.41 (1.33)	4.13 (16.67)	5.79 (32.67)	7.16 (50.67)
T_9-T_3 fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	1.67 (2.67)	5.09 (25.33)	3.93 (15.33)	6.60 (43.33)
T_{10}-T_1fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	1.55 (2.00)	3.13 (11.33)	5.91 (34.00)	6.90 (47.33)
T_{11}-T_2fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	1.00 (0.00)	3.98 (18.00)	5.79 (32.67)	7.14 (50.67)
T_{12}-T_3fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	1.67 (2.67)	4.63 (22.00)	4.53 (21.33)	6.78 (46.00)
T_{13}-Interculture @ 20 DAS and hand weeding @ 40 DAS	2.27 (7.33)	5.38 (28.00)	4.24 (17.33)	7.31 (52.67)
T_{14}-Weedy check	1.24 (0.67)	6.33 (40.00)	4.37 (18.67)	7.68 (59.33)
S.Em ±	0.66	0.87	0.65	0.65
CD($P \leq 0.05$)	NS	2.52	1.61	1.63

PE- Pre emergence at 3 DAS, POE- Post emergence at 30 DAS, fb- Followed by, DAS- Days after sowing, NS- Non significant, Figures in the parenthesis are original values; data analysed after square root(X+1) transformation.

pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} and alachlor 50 EC @ 1.0 kg a.i. ha^{-1} recorded significantly least value of 29.33 m^{-2}. While significantly higher total weed population was observed in oxyfluorfen 23.5 EC @ 0.075 kg a.i. ha^{-1}(47.33 m^{-2}) and was statistically on par with interculture @ 20 DAS and hand weeding @ 40 DAS (44.67 m^{-2}) as well as (T_{14}) weedy check (44.00 m^{-2}). Superior performance of pendimethalin due to its broad spectrum control was earlier reported by Jain and Jain (1987) in blackgram and Reddy *et al.* (2000) in rice-blackgram cropping sequence.

At 45 DAS (Table 4) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} followed by quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1} (T_{10}) recorded least grass population of 11.33m^{-2}. During initial days pendimethalin controlled weeds and after 30 days where grasses start to emerge vigorously quizalofop being grass killer controlled grasses. The combination effect of pendimethalin and quizalofop were also reported by Kumar and Tewari (2004) in summer blakgram. Due to no control measures taken weedy check (T_{14}) recorded highest grass population of 40.00 m^{-2}. Owing to physical removal of weeds twice, interculture @ 20 DAS and hand weeding @ 40 DAS (T_{13}) resulted in least population of broad leaved weeds (17.33 m^{-2}). Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} followed by fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1} (T_7) recorded highest broad leaved weed population of 35.33 m^{-2}. During later part of crop growth dominance of grassy weeds are more and fenoxaprop being a grass killer controlled the grasses due to which broad leaved weeds were more which was not the case in weedy check where broad leaved weeds did not got a chance to grow freely due to dominance of grasses.When total

Table 5. Weed density (Number m^{-2}) at harvest in blackgram as influenced by weed control practices.

Treatments	Sedge	Grasses	Broad leaved weeds	Total
T_1-Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1}, [PE]	1.00 (0.00)	1.29 (18.00)	1.48 (28.67)	6.90 (46.67)
T_2-Alachlor 50 EC @ 1.0 kg a.i. ha^{-1}, [PE]	1.00 (0.00)	1.46 (28.00)	1.39 (22.67)	7.18 (50.67)
T_3-Oxyfluorfen 23.5 EC @ 0.075 kg a.i. ha^{-1}, [PE]	1.00 (0.00)	1.45 (26.67)	1.36 (22.00)	7.04 (48.67)
T_4-T_1fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	1.41 (1.33)	1.33 (20.00)	1.55 (34.00)	7.47 (55.33)
T_5-T_2fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	1.00 (0.00)	1.53 (32.00)	1.31 (18.67)	7.19 (50.67)
T_6-T_3fbimazethapyr 10 SL @ 0.063 kg a.i. ha^{-1}, [POE]	1.77 (3.33)	1.52 (31.33)	1.38 (22.00)	7.59 (56.67)
T_7-T_1fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	1.00 (0.00)	1.27 (16.67)	1.53 (32.67)	7.09 (49.33)
T_8-T_2fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	1.00 (0.00)	1.28 (17.33)	1.49 (28.67)	6.85 (46.00)
T_9-T_3 fb fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1}, [POE]	1.00 (0.00)	1.39 (22.67)	1.49 (30.00)	7.31 (52.67)
T_{10}-T_1fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	1.00 (0.00)	0.93 (10.67)	1.55 (33.33)	6.70 (44.00)
T_{11}-T_2fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	1.00 (0.00)	1.47 (28.00)	1.37 (21.33)	7.08 (49.33)
T_{12}-T_3fb quizalofop-p-ethyl 5 EC @ 0.03 kg a.i. ha^{-1}, [POE]	2.22 (4.67)	1.45 (26.00)	1.42 (24.67)	7.51 (55.33)
T_{13}-Interculture @ 20 DAS and hand weeding @ 40 DAS	1.00 (0.00)	1.39 (22.67)	1.31 (18.67)	6.49 (41.33)
T_{14}-Weedy check	1.00 (0.00)	1.74 (55.33)	1.21 (14.67)	8.39 (70.00)
S.Em ±	0.29	0.1	0.06	0.29
CD($P \leq 0.05$)	NS	0.29	0.16	0.85

PE- Pre emergence at 3 DAS, POE- Post emergence at 30 DAS, fb- Followed by, DAS- Days after sowing, NS- Non significant, Figures in the parenthesis are original values; data analysed square root(X+1) transformation for sedge and total weed density, log(X+2) transformation for grasses and broad leaved weed density.

weed population was considered oxyfluorfen 23.5 EC @ 0.075 kg a.i. ha^{-1} followed by fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1} (T_9) recorded least weed density of 43.33 m^{-2}. Oxyfluorfen is known for its residual effect due to which its effect was there for more duration than other herbicides and being a broad spectrum herbicide it controlled all three types of weeds and above that fenoxaprop being a grass killer controlled grasses more effectively which were dominant in the later part of crop growth. The better performance of grass killers along with a pre-emergent herbicides in blackgram were reported by Rao (2008), Tomar (2011), Mundra and Maliwal (2012) and Chhodavadia (2014) in summer green gram .While, pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} followed by fenoxaprop-p-ethyl 9 EC @ 0.054 kg a.i. ha^{-1} (T_7) recorded highest weed density of 61.33 m^{-2} which was solely due to more population of broad leaved weeds.

During harvest (Table 5), Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} followed by quizalofop-p-ethyl 5 EC @ 0.030 kg a.i. ha^{-1} (T_{10}) recorded least grass density of 10.67m^{-2} which was due to effective control of grasses during the earlier periods.Similar results were obtained by Kumar and Tewari (2004) where application of pendimethalin (1.0 kg a.i. ha^{-1}) pre-emergence followed by fluazifop-p-butyl (0.375 kg a.i. ha^{-1}) post-emergence caused reduced weed growth as well as it resulted in 100 per cent mortality of *Trianthema monogyna* in summer blackgram. Whereas (T_{14}) weedy check resulted in highest grass population of 15.33 m^{-2}.Broad leaved weeds least density was obtained in (T_{14}) weedy check (1.21 m^{-2}) where grasses smothered broad leaved weeds. While pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} followed by imazethapyr 10 SL @ 0.063 kg a.i. ha^{-1} (T_4) recorded highest weed density of 34.00 m^{-2}. Interculture @ 20 DAS and hand weeding @ 40 DAS (T_{13}) resulted in lower weed density of 41.33 m^{-2} and the highest population of weeds were observed in (T_{14}) weedy check 70.00 m^{-2}. Earlier works done by Kundu *et al.* (2011) and Chhodavadia (2014) in summer green gram are also in agreement with the superior performance of mechanical weeding in combination of manual weeding over other control measures.

Conclusion

It can be inferred that weeds cause 65.64 per cent yield loss if no weed control method is adopted. With abundant labour availability hand weeding at 20 DAS and intercultural at 40 DAS may be recommended for obtaining higher yield (1182 and 5873 kg ha^{-1} seed and haulm yield, respectively) and reduced population of weeds41.33 m^{-2}. With the current trend of increased cost and reduced availability of manpower pendimethalin followed by quizalofop is the best option available for harvesting higher yield (seed and haulm yield of 1120.6 and 5194.3 kg ha^{-1}) as well as for controlling weeds 44.00 m^{-2}.

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