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Original Research Article

Weed Management on Direct Seeded Finger Millet (*Eleusine coracana* L.) Under Rainfed Condition of Jharkhand

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A B S T R A C T

The experiment comprising 12 weed management practices with different herbicidal doses and inter-culture was conducted on sandy loam textured soil of Agronomical Research Farm, Birsa Agricultural University, Ranchi during *Kharif* 2016 under rainfed upland condition. The predominant weed floras observed in the experimental plot were among grasses, *Echinocloa crusgalli*, *Dactyloctenium aegyptium* and *Eleusine indica*, amonog broad leaved weeds, *Commelina bengalensis*, *Ageratum conyzoides*, *Commelina nodifolia* and *Oldenlandia corymbosa* and among sadges, *Cyperus rotundus* and *Cyperus esculentus*. Irrespective of weed management practices, total density, total dry weight of weeds and weed control efficiency were higher in weed free plot which was on par with pre-emergence application of bensulfuron methyl + pretilachlor @ 3 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS and also with pre-emergence application of bensulfuron methyl + pretilachlor @ 3 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS over weedy check. Grain and straw yield (3496 and 6164 kg/ha, respectively) were significantly higher with weed free plot as compared to weedy cheak. However, the net return and B:C ratio (Rs 45,274 per ha and 2.29, respectively) were significantly higher with pre-emergence application of bensulfuron methyl (0.6 % G) + pretilachlor (6.0 % GR) @ 3 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS which was on par with pre-emergence application of bensulfuron methyl (0.6 % G) + pretilachlor (6.0 % GR) @ 2 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS (Rs 43,118 per ha and 2.21, respectively). The weedy check recorded significantly minimum net returns (Rs. 2,781 per ha) and benefit: cost ratio (0.17).

Keywords

Weed management, Finger millet, bensulfuron methyl + pretilachlor

Introduction

Finger millet is an important cereal crop for subsistence agriculture in dry areas of Eastern Africa, India and Sri Lanka. Finger millet offers enormous advantages such as early maturity, wide adaptability, low input cost and high nutritious value of both grain and fodder. The grain of finger millet is high in amino acid, lacking in the diets of the poor who live on starchy foods. It is grown on an area of 1.19 million hectare in India with a total production of 1.98 million tonnes and productivity of 1661 kg ha^{-1} (Anonymous, 2013). The production and productivity of finger millet is low because of inefficient nutrient management, heavy weed infestation, incidence of blast disease etc. Among these, weed infestation is a serious threat to its production. The critical period for crop-weed competition is five weeks after planting. Finger millet is a high statue crop with slower initial growth which remains under smothering due to the

infestation of weeds at early stages of growth. This situation causes higher competition and may result in drastic reduction in yield (Kushwaha *et al.,* 2002). Uncontrolled weed growth during crop period reduced the grain yield ranging from 34 to 61% (Ramachandra Prasad *et al.*, 1991).

Since single method is not able to control all weeds upto desired level, therefore, integration of chemical and mechanical methods might be an answer to achieve greater weed control efficiency, which in turn, may increase over all benefit of finger millet cultivation. Information on weed management in finger millet is limited, therefore, present experiment was carried out to study the effect of herbicides and their integration on growth and productivity of finger millet.

Materials and Methods

A field experiment was conducted during *Kharif* 2016 at Agronomical Research Farm, Birsa Agricultural University, Ranchi, Jharkhand. The soil of the experimental field was sandy loam soil in texture with low in available organic carbon (3.13 g/kg soil) and available nitrogen (142.17 kg/ha) but medium in available phosphorus (18.55 kg/ha) and potassium (148.21 kg/ha) with a pH of 5.56. The experiment consisting of twelve treatments was laid out in a randomized block design with three replications. The experiment was conducted in randomized block design replicated thrice with twelve different weed management practices viz., Pendimethalin (30 EC) @ 0.5 kg a.i./ha as pre-emergence (T_1), Pendimethalin (30 EC) @ 0.75 kg a.i/ha as pre-emergence (T_2), Bensulfuron methyl (0.6% G) + Pretilachlor (6.0% G) @ 2 kg/ha (pre-mix formulation) as pre-emergence (T_3), Bensulfuron methyl (0.6% G) + Pretilachlor (6.0% G) @ 3 kg/ha (pre-mix formulation) as pre-emergence (T_4), Isoproturon (50 WP) @ 0.5 kg a.i./ha as pre-emergence (T_5), Pendimethalin (30 EC) @ 0.5 kg a.i./ha (PE) *fb* one inter-culture at 45 DAS (T_6), Pendimethalin (30 EC) @ 0.75 kg a.i/ha as pre-emergence *fb* one inter-culture at 45 DAS (T_7), Bensulfuron methyl (0.6% G) + Pretilachlor (6.0% G) @ 2 kg/ha (pre-mix formulation) as pre-emergence *fb* one inter-culture at 45 DAS (T_8), Bensulfuron methyl (0.6% G) + Pretilachlor (6.0% G) @ 3 kg/ha (pre-mix formulation) as pre-emergence *fb* one inter-culture at 45 DAS (T_9), Isoproturon (50 WP) @ 0.5 kg a.i./ha as pre-emergence *fb* one inter-culture at 45 DAS (T_{10}), Weed free plot by one hand weeding at 20 DAS *fb* two inter-culture at 30 & 45 DAS (T_{11}) and Weedy check (T_{12}). The variety used for the experiment was A-404 with a spacing of 30 x 10 cm. A recommended dose of fertilizers (50:30:25 N: P_2O_5: K_2O kg/ha) was applied equally to each plot. Nitrogen was applied in two splits. Half dose of N (25 kg/ha) along with full dose of P_2O_5 and K_2O (30 and 25 kg/ha) were applied as basal and remaining N (25 kg/ha) was applied as top dressing after 30 days of sowing.

The source for nitrogen, phosphorous and potassium were urea, single super phosphate and muriate of potash, respectively. Weed counts (number/m^2) and dry weight (g/m^2) were recorded by putting a quadrate (25 x 25 cm) at two random spots in each plot at 60 days after sowing (DAS) of crop. Weed control efficiency (WCE) was also calculated on the basis of dry matter production of weeds. The experimental data recorded for growth, yield attributes and yield were statistically analyzed. Data on weed density and dry weight of weeds were transformed using square root transformation ($\sqrt{X+0.5}$) before statistical analysis.

Results and Discussion

Effects on weed

The predominant weed flora observed in the experimental field in association with the direct sown finger millet were among grasses *viz., Echinocloa crusgalli*, *Dactyloctenium aegyptium* and *Eleusine indica*, broad leaved weeds *Commelina bengalensis*, *Ageratum conyzoides*, *Commelina nodifolia* and *Oldenlandia corymbosa* and among sedges *Cyperus rotundus* as reported by Madhu kumar *et al.,* (2013). All the weed control treatments significantly reduced the weed growth over weedy check up to 60 DAS (Table 1).

Weed free plot significantly reduced the density of grassy, broad leaved and sedge weeds (15.33/m^2, 21.33/m^2 and 0.00/m^2, respectively) at 60 DAS which was on par with pre-emergence application of bensulfuron methyl + pretilachlor @ 2 or 3 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS as compared to other treatment. Among weed management practices, weed free plot had significantly reduced dry weight of grassy, broad leaved and sedges (0.36 g/m^2, 2.05 g/m^2 and 0.00 g/m^2, respectively) at 60 days after sowing which was on par with pre-emergence application of bensulfuron methyl + pretilachlor @ 2 or 3 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS as compared to other treatments. Whereas, weedy check recorded significantly higher weed population and weed dry weight, respectively. The reduction in the weed population and weed dry weight in these treatments was mainly due to effective control of weeds at all stages of crop growth period. These results are in conformity with the findings of Sanjoy Saha (2005) and Madhu Kumar *et al.,* (2013). However, the weed control efficiency (98.87%) was also highest with weed free plots (Table 1). This was mainly due to better control of weeds right from sowing to 60 DAS, which is the critical period for crop weed competition. These results are in conformity with the findings of Prashanth Kumar *et al.,* (2015).

Effect on crop growth and yield attributes

All weed management practices significantly improved the growth and yield attributes of finger millet over weedy check (Table 2). The highest values of plant height (129.21 cm at maturity), leaf area index (3.21 at 90 DAS), number of effective tillers (115.67 per m^2 at maturity), ear weight (11.65 g at maturity), ear length (8.74 cm at maturity) and grains per ear (1031.67) were recorded under weed free plot which was on par with pre-emergence application of bensulfuron methyl + pretilachlor @ 2 or 3 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS. The enhancement of crop growth and yield attributes components could be due to less competition by the weeds for crop these factors throughout the crop growth period due to control of early emerged weeds before sowing through pre-emergence application of herbicides and late emerged weeds through inter-culture. Similar results were reported by Prashanth Kumar *et al.,* (2015) and Prithvi *et al.,* (2015).

Effect on yield

Among different weed management practices, weed free plot recorded significantly higher grain and straw yield (3496 kg/ha and 6164 kg/ha, respectively) of direct sown finger millet as compared to weedy check. However, it was on par with pre-emergence application of bensulfuron methyl + pretilachlor @ 2 or 3 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS (Table 3).

Table.1 Effect of weed control treatments on weed density, weed dry weight and weed control efficiency (WCE) in direct sown finger millet

Treatments	Weed density (no/m^2) at 60 DAS			Total weed dry weight (g/m^2) at 60 DAS			WCE (%) at 60 DAS
	Grasses	Broad Leaved	Sedges	Grasses	Broad Leaved	Sedges	
T1: Pendimethalin @ 0.50 kg a.i./ha PE	9.96 (98.67)	15.47 (240.00)	9.61 (92.33)	9.11 (83.00)	10.36 (107.28)	4.50 (19.85)	25.76
T2: Pendimethalin @ 0.75 kg a.i/ha PE	9.45 (89.00)	13.88 (192.33)	9.15 (83.67)	8.62 (74.00)	8.87 (78.28)	4.21 (17.32)	42.86
T3: Bensulfuron methyl + pretilachlor @ 2 kg a.i/ha PE	7.49 (55.67)	10.50 (110.00)	8.19 (66.67)	7.23 (52.00)	5.96 (35.09)	3.21 (9.80)	73.79
T4: Bensulfuron methyl + pretilachlor @ 3 kg a.i/ha PE	6.91 (47.33)	9.14 (83.33)	7.03 (49.00)	6.22 (38.33)	4.81 (22.67)	2.55 (6.03)	82.60
T5: Isoproturon @ 0.50 kg a.i./ha PE	8.64 (74.33)	12.06 (145.67)	8.42 (70.33)	7.77 (60.00)	7.72 (59.43)	3.50 (11.75)	56.07
T6: Pendimethalin @ 0.50 kg a.i./ha PE *fb* 1 IC at 45 DAS	6.03 (36.00)	7.14 (50.67)	6.08 (36.67)	9.30 (86.00)	2.62 (6.38)	1.63 (2.16)	95.32
T7: Pendimethalin @ 0.75 kg a.i./ha PE *fb* 1 IC at 45 DAS	5.81 (33.33)	6.65 (44.00)	5.54 (30.33)	8.95 (79.67)	2.42 (5.37)	1.46 (1.64)	96.05
T8: Bensulfuron methyl + pretilachlor @ 2 kg a.i/ha PE *fb* 1 IC at 45 DAS	4.69 (21.67)	5.80 (33.33)	4.10 (16.33)	7.00 (49.67)	2.07 (3.81)	1.17 (0.87)	97.43
T9: Bensulfuron methyl + pretilachlor @ 3 kg a.i/ha PE *fb* 1 IC at 45 DAS	4.29 (18.00)	5.36 (28.33)	3.45 (11.67)	5.86 (34.00)	1.88 (3.03)	1.08 (0.67)	98.03
T10: Isoproturon @ 0.50 kg a.i./ha PE *fb* 1 IC at 45 DAS	5.58 (30.67)	6.32 (39.67)	4.89 (23.67)	8.03 (64.67)	2.38 (5.19)	1.26 (1.09)	96.45
T11: Weed free plot	3.97 (15.33)	4.65 (21.33)	0.71 (0.00)	2.60 (6.33)	1.59 (2.05)	0.71 (0.00)	98.87
T12: Weedy check	13.10 (172.33)	21.23 (450.67)	10.67 (113.67)	12.49 (156.00)	12.32 (151.42)	4.78 (22.39)	0.00
SE m ±	0.31	0.43	0.33	0.38	0.24	0.12	1.89
CD (P = 0.05)	**0.91**	**1.26**	0.96	**1.11**	**0.69**	**0.34**	**5.53**
CV%	7.52	7.55	8.71	8.45	7.81	8.01	4.54

Note: Data in parenthesis (original value) was subjected to $\sqrt{X + 0.5}$ transformation.

Table.2 Effect of weed control treatments on growth and yield attributes parameters of direct sown finger millet

Treatments	Plant height (cm) at maturity	Leaf area index at 90 DAS	Effective tillers (no/m^2) at maturity	Weight of ear (g)	Ear length (cm)	Grains per ear
T1: Pendimethalin @ 0.50 kg a.i./ha PE	98.38	2.29	80.33	7.33	7.51	794.33
T2: Pendimethalin @ 0.75 kg a.i/ha PE	99.49	2.33	83.33	7.52	7.60	803.00
T3: Bensulfuron methyl + pretilachlor @ 2 kg a.i/ha PE	103.30	2.47	87.67	8.01	7.79	832.00
T4: Bensulfuron methyl + pretilachlor @ 3 kg a.i/ha PE	106.78	2.56	90.67	8.25	7.82	843.67
T5: Isoproturon @ 0.50 kg a.i./ha PE	101.82	2.39	85.33	7.78	7.69	817.67
T6: Pendimethalin @ 0.50 kg a.i./ha PE *fb* 1 IC at 45 DAS	111.46	2.68	94.67	8.52	7.95	851.33
T7: Pendimethalin @ 0.75 kg a.i./ha PE *fb* 1 IC at 45 DAS	114.18	2.73	97.00	8.78	7.99	859.33
T8: Bensulfuron methyl + pretilachlor @ 2 kg a.i/ha PE *fb* 1 IC at 45 DAS	121.33	3.01	107.67	10.40	8.50	941.67
T9: Bensulfuron methyl + pretilachlor @ 3 kg a.i/ha PE *fb* 1 IC at 45 DAS	125.30	3.12	112.00	10.90	8.63	983.33
T10: Isoproturon @ 0.50 kg a.i./ha PE *fb* 1 IC at 45 DAS	116.44	2.85	99.67	9.23	8.04	883.00
T11: Weed free plot	129.21	3.21	115.67	11.65	8.74	1031.67
T12: Weedy check	86.02	1.74	63.33	5.21	6.77	534.33
SE m ±	3.95	0.11	4.31	0.44	0.23	41.03
CD (P = 0.05)	**11.59**	**0.32**	**12.64**	**1.29**	**0.68**	**120.33**
CV%	6.25	7.12	8.02	8.81	5.06	8.38

Table.3 Effect of weed control treatments on yield and economics of direct sown finger millet

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation* (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T1: Pendimethalin @ 0.50 kg a.i./ha PE	1868	3421	17385	35946	18561	1.07
T2: Pendimethalin @ 0.75 kg a.i/ha PE	1955	3575	17697	37625	19928	1.13
T3: Bensulfuron methyl + pretilachlor @ 2 kg a.i/ha PE	2443	4346	17157	46825	29668	1.73
T4: Bensulfuron methyl + pretilachlor @ 3 kg a.i/ha PE	2523	4423	17387	48263	30876	1.78
T5: Isoproturon @ 0.50 kg a.i./ha PE	2041	3664	17277	39175	21898	1.27
T6: Pendimethalin @ 0.50 kg a.i./ha PE *fb* 1 IC at 45 DAS	2686	4938	19759	51733	31974	1.62
T7: Pendimethalin @ 0.75 kg a.i./ha PE *fb* 1 IC at 45 DAS	2728	4966	20071	52465	32394	1.61
T8: Bensulfuron methyl + pretilachlor @ 2 kg a.i/ha PE *fb* 1 IC at 45 DAS	3281	5676	19531	62649	43118	2.21
T9: Bensulfuron methyl + pretilachlor @ 3 kg a.i/ha PE *fb* 1 IC at 45 DAS	3412	5828	19761	65035	45274	2.29
T10: Isoproturon @ 0.50 kg a.i./ha PE *fb* 1 IC at 45 DAS	2852	5150	19651	54782	35131	1.79
T11: Weed free plot	3496	6164	29281	66927	37646	1.29
T12: Weedy check	983	1858	16222	19003	2781	0.17
SE m ±	117.15	228.62	-	2206.53	2206.53	0.12
CD (P = 0.05)	**343.56**	**670.47**	-	**6470.96**	**6470.96**	**0.35**
CV%	8.04	8.80	-	7.90	13.13	13.86

The minimum Grain and straw yield in weedy check could be due to the severe weed competition as evidenced by the maximum weed density, weed dry matter which resulted in less number of tillers, lower plant dry matter and plant height. Reduction in grain yield of finger millet to an extent of 35 to 61% due to weed competition was reported by Prashanth Kumar *et al.,* (2015) and Prithvi *et al.,* (2015).

Effect on economics

A critical analysis of data on economics revealed that the highest gross returns (Rs 66927 per ha) was obtained with weed free plot. But higher cost of cultivation in weed free plot (one hand weeding and twice inter-culture) due to engagement of more labourers for weeding. This confirms the finding of Tuti *et al.,* (2016). Bensulfuron methyl + pretilachlor @ 3 kg/ha (pre-mix

formulation) as pre-emergence application *fb* one inter-culture at 45 DAS had reduced cost of cultivation (73.74%) compared to weed free plot. Maximum net return (Rs. 45,274 per ha) and benefit: cost ratio (2.29) were obtained with pre-emergence application of bensulfuron methyl + pretilachlor @ 3 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS, was comparable to pre-emergence application of bensulfuron methyl + pretilachlor @ 2 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS (Table 3). The higher net returns in this treatments when compared to weed free plot was not because of higher yield but because of lower cost involved in herbicide application and inter-culture than weed free plot. This confirms the finding of Prithvi *et al.*, (2015).

On the basis of result obtained, it can be concluded that pre-emergence application of pre-mix formulation of bensulfuron methyl (0.6% G) + pretilachlor (6.0% G) @ 2 Kg/ha *fb* one inter-culture at 45 DAS was found to be best as integrated weed management practice for better weed control efficiency, crop growth, higher productivity and profitability in direct sown finger millet production under rainfed condition.

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