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Effect of weed management practices on crop weed competition for nutrients uptake by weeds and direct sown finger millet in Jharkhand

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Abstract
A field experiment was conducted on weed management practices in direct sown finger millet at Agronomical farm, Birsa Agricultural University, Ranchi during *kharif* season of 2016. The objective of the study was to determine the effect of weed management practices on weed dynamics, crop growth, crop yield and economics of finger millet. *Commelina bengalensis* L. was found to be the most dominant weed species affecting finger millet yield. Significant differences were observed at 5% probability among weed control practices on total weed density, weed biomass and crop yield. The study indicated that 71.79% yield reduction was recorded from weedy check plot. The results revealed that pre-emergence application of Bensulfuron methyl (0.6% G) + Pretilachlor (6.0 % G) @ 3 kg/ha *fb* one inter-culture at 45 days after sowing recorded significantly lower total weed density at 45 (100.67 per m^2) and nutrient uptake by weeds (8.51, 3.03 and 7.36 kg/ha NPK, respectively) as compared to weedy check plot. However, pre-emergence application of bensulfuron methyl (0.6% G) + pretilachlor (6.0 % G) at 3 kg/ha recorded significantly higher grain and straw yield (3412 and 5828 kg/ha, respectively) and nutrient uptake by plant (72.8, 19.0 and 65.1 kg/ha NPK, respectively) by direct sown finger millet. Whereas, the net returns (Rs. 45274 ha^{-1}) was higher with the pre-emergence application of bensulfuron methyl (0.6 % G) + pretilachlor (6.0 % GR) at 2 kg/ha as compared to weedy check plot (Rs.2781 ha^{-1}). From the studies it can be concluded that pre-emergence application of Bensulfuron methyl (0.6% G) + Pretilachlor (6.0 % G) @ 3 kg/ha reduced the weed competition for nutrients as a result of this the grain yield and nutrient uptake by crop was more.

Keywords: Nutrient uptake, crop weed competition, direct swon and finger millet.

Introduction
Finger millet (*Eleusine coracana* (L.) Gaertn.) is an important dry land crop due to its resilience and ability to withstand aberrant weather conditions and generally grown in soils having poor water supplying capacity and nutrients. Moreover, the crop has high impact on the poor in world for food security and source of energy and protein for millions of people. Finger millet ranks 6th important crop of India after rice, maize, wheat, sorghum and barley. It comprises of 5% of the total land devoted to cereals (Shinggu *et al*., 2009) [8]. 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}. The major finger millet producing states are Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Jharkhand, Gujarat, Maharashtra and the hilly regions of Utara Pradesh and Himachal Pradesh. The maximum area is covered in Karnataka 7.88 lakh hectare with a total production of 12.72 lakh tonnes and an average productivity of 1671 kg ha^{-1} (Anonymous, 2013) [1]. It is grown in an area of 13914 hectare in Jharkhand with a total production of 10412 tonnes and with an average yield of 748 kg ha^{-1} (Anonymous, 2013) [1]. The yield potential of finger millet in Jharkhand state is much lower than the national average. Weeds are considered as one of the major problems the farmer is faced with in the production of the crop. Finger millet has very poor competitive ability with weeds due to its initial slow

growth. Since single method is not able to control all weeds up to desired level, integration of weed control practice and cropping system can be an effective weed control strategy. Weeds that grow with the crop deplete considerable amount of plant nutrients, which results in lower crop yields. Nutrient depletion by weeds, besides other factors, depends on soil type and composition of weeds. Management of weeds in direct sown finer millet is a very difficult task. In order to check the losses caused by weeds it is vital to control all types of weeds during crop growth period to enhance growth and yield. With this context, the experiments entitled the effect of chemical weed management practices and inter culture on nutrient uptake by weeds and direct sown finger millet under rainfed conditions in Jharkhand was formulated.

Materials and Methods

Experimental area

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.

Treatments and Experimental Design

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: P2O5: K2O 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 P2O5 and K2O (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.

Finger millet grains, straw and weed samples were collected from experimental plots at harvest were oven dried and grounded into fine powder using Wiley mill were analyzed for nutrient uptake (N, P and K, respectively). Nitrogen, phosphorus and potassium content of the samples were estimated by MicroKjeldhal method, Vanadomolybdo phosphoric yellow colour method and flame photometer method, respectively and subsequently the uptake per hectare was computed both in weeds, grain and straw. The data collected were subjected to statistical analyses in the randomized complete block design following the method of Gomez and Gomez (2003) [3].

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) [4].

Weed free plot significantly reduced the total weed density (31.33/m^2) at 45 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. Whereas, weedy check recorded significantly higher weed density. 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) [7] and Madhu Kumar *et al.*, (2013) [4]. However, the weed control efficiency (98.87%) was also highest with weed free plots (Table 1).

Nutrient uptake by weeds

Weedy check plot recorded maximum uptake of nutrients by weeds. This was mainly due to no control of weeds which has facilitated the weeds to utilize nutrients to maximum extent. Similarly increase in nutrient uptake by increase in weed competition also reported by Prashanth Kumar *et al.*, (2015) **[5].** However, pre-emergence application of weed free plot recorded significantly lower Nutrient uptake by weeds and was being on par with bensulfuron methyl + pretilachlor @ 2 or 3 kg/ha (pre-mix formulation) *fb* one inter-culture at 45 DAS (Table 1).

Table 1: Effect of weed management practices on weed parameters and nutrient uptake by weeds

Treatments	Total weed density (no/m^2) at 45 DAS	Weed control efficiency (%)at 45 DAS	Nutrient uptake by weed (kg/ha)		
			N	P	K
T_1	18.54 (343.67)	25.11	36.71	13.67	28.10
T_2	16.70 (278.33)	43.49	35.15	13.01	26.98
T_3	12.26 (150.00)	78.47	27.83	10.40	19.02
T_4	10.31 (106.00)	84.79	26.50	10.21	18.16
T_5	14.26 (203.00)	63.95	32.68	12.09	24.64
T_6	18.68 (349.00)	23.89	20.51	8.56	15.01
T_7	16.92 (286.33)	40.83	18.94	7.94	14.40
T_8	12.32 (152.00)	78.81	10.57	3.28	8.26
T_9	10.05 (100.67)	85.95	8.51	3.03	7.36
T_{10}	14.55 (211.33)	62.34	17.46	7.05	13.38

T_{11}	5.63 (31.33)	94.91	5.25	2.25	6.45
T_{12}	24.72 (611.67)	0.00	44.13	17.02	34.02
SE m ±	0.41	2.95	2.35	1.11	0.77
CD(P=0.05)	**1.20**	**8.66**	**6.88**	**3.26**	**2.26**

Note: Data in parenthesis (original value) was subjected to √X + 0.5 transformation.

Effect on yield and nutrient uptake by finger millet

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 2). 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) [5] and Prithvi *et al.,* (2015) [6]. Similar trend was observed with NPK uptake by grain and straw of direct sown finger millet as compared to weedy check plot (Table 2). Higher nutrient uptake was due to lesser phytotoxicity, lower weed population and lower weeds dry weight which helped the crop to grow well and absorbed more nutrient from the soil. These results were in line with Madhu Kumar *et al*. (2013) [4] and Prashanth Kumar *et al.,* (2015) [5].

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) [9]. 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) 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 2). 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) [6].

Table 2: Effect of weed management practices on grain and straw yield, net return and nutrient uptake by crop at harvest

Treatmants	Grain yield (kg/ha)	Straw yield (kg/ha)	Net return (Rs./ha)	Nutrient uptake (kg/ha)								
				N			P			K		
				Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T1	1868	3421	18561	19.8	10.5	30.3	5.1	2.9	8.0	10.9	30.0	40.9
T2	1955	3575	19928	22.1	12.4	34.5	5.5	3.2	8.7	11.2	30.7	41.9
T3	2443	4346	29668	26.5	13.7	40.2	6.7	4.5	11.2	12.3	32.2	44.4
T4	2523	4423	30876	28.2	14.5	42.7	7.1	4.8	11.9	12.9	32.9	45.8
T5	2041	3664	21898	23.8	12.3	36.1	6.0	3.9	9.9	11.5	31.4	42.8
T6	2686	4938	31974	36.0	18.5	54.5	8.1	5.9	14.0	16.2	36.0	52.2
T7	2728	4966	32394	38.3	19.8	58.1	8.3	6.2	14.5	16.8	36.9	53.7
T8	3281	5676	43118	46.7	24.1	70.8	10.4	8.1	18.5	18.1	43.9	62.0
T9	3412	5828	45274	48.1	24.8	72.8	10.5	8.4	19.0	18.8	46.3	65.1
T10	2852	5150	35131	38.7	20.6	59.3	9.0	6.9	15.8	17.3	37.4	54.6
T11	3496	6164	37646	49.2	25.3	74.5	11.5	9.3	20.8	21.0	48.5	69.5
T12	983	1858	2781	11.1	8.0	19.1	3.4	2.1	5.5	7.9	23.8	31.7
SE m ±	117.15	228.62	2206.53	1.8	1.0	2.7	0.5	0.3	0.7	0.8	1.7	1.9
CD(P=0.05)	**343.56**	**670.47**	**6470.96**	**5.2**	**2.9**	**7.8**	**1.3**	**0.8**	**1.9**	**2.2**	**4.9**	**5.6**

Conclusion

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 for Jharkhand.

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