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Influence of Weed Management Practices on Nutrient Removal and Performance of Transplanted Finger Millet (*Eleusine coracana* L.)

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ABSTRACT

Background: Finger millet production and productivity is lowering in India due to the growth of different weed species. Weeds are the prime yield limiting biotic constraints in finger millet. Therefore, the present investigation has been carried out to find out the suitable weed management practices on the performance of finger millet.

Methods: In this regard, a field experiment was carried out during *kharif*, 2018 at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli, Tamil Nadu, India to evaluate the different weed management practices for transplanted finger millet under sodic soil. The experiment comprised of ten weed management practices with different herbicidal treatments *viz.,* pre emergence (PE) application of pendimethalin at 750 g/ha, oxyfluorfen at 50 g/ha, bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha, early post emergence (EPOE) application of bispyribac sodium at 25 g/ha, PE pendimethalin at 750 g/ha *fb* EPOE bispyribac sodium at 25 g/ha, PE oxyfluorfen at 50 g/ha *fb* EPOE bispyribac sodium at 25 g/ha, PE bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha, PE oxyfluorfen at 50 g/ha *fb* hand weeding (HW) at 30 DAT, HW at 15 and 30 DAT and unweeded control (UWC) in transplanted finger millet.

Result: The results revealed that lower nutrient removal by weeds, higher nutrient uptake by crop and yield parameters *viz.,* productive tillers/m^2, earhead weight and total grains/earhead were registered in application of PE bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha. The highest grain and straw yields were also registered in application of PE bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha and it was on par with hand weeding at 15 and 30 DAT.

Key words: Crop nutrient uptake, Nutrient removal, Transplanted finger millet, Yield, Yield attributes.

INTRODUCTION

Finger millet (*Eleusine coracana* L.) commonly known as ragi, is one of the important staple food crop next to rice, wheat and maize for majority of people in South Asia and Africa and for those who depend on subsistence farming. Finger millet is grown as a transplanted crop under irrigated condition and as a drill sown crop under rainfed conditions. It can be grown in poor water supplying capacity and nutrient deficient soils due to its resilience and ability to withstand aberrant weather conditions. So, it is called as Climate Change Compliant Crop (Ferry, 2014). In many places where it is grown, it is looked upon as a poor man's crop or a famine food. In India, the area under finger millet cultivation is 1.19 M ha with a production of 1.99 M tonnes and an average productivity of 1.66 tonnes/hectare (Indiastat, 2017-18).

In transplanted finger millet, heavy weed competition causes yield loss ranging about 33 to 50 per cent (Patro and Das, 1972). Competition begins when crop and weeds require same resources and grow in close proximity to each other. Once this occurs, the other factors necessary for plant growth cannot be used effectively even though they will be present in abundance. The reduction in grain yield due to weed competition varies from 34 to 61 per cent in finger millet (Ramachandra Prasad *et al.*, 1991).

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Nutrient addition through fertilizers is one of the costlier inputs in crop production, which may greatly influence the cost of cultivation. If proper weed management practices are not adopted, the weeds can make use of the inputs leaving the crop deprived which ultimately results in poor yield (Lall and Yadav, 1982). The integration of chemical and cultural methods increased the weed control and enabled that herbicide rate to be reduced (Reddy *et al.*, 1990). Kumara *et al.* (2007) opined that the advantage of

using herbicides are many folds which include effective control of wide spectrum of weeds and are economical in operation. Satish *et al.* (2018) reported that lower weed dry weight and higher WCE were resulted under HW at 20 DAS *fb* inter cultivation at 30 and 45 DAS and it was comparable with PE bensulfuron methyl + pretilachlor at 3 kg/ha *fb* inter cultivation at 45 DAS in direct seeded finger millet. A more possible way for controlling weeds is by manipulating the cropping system and making conditions more favourable for crop growth and unfavourable for weed growth. Right time and right method employed to remove weeds ensure a higher yield in any crop. No weed competition during critical stages results in good crop establishment. Keeping this in view, the present investigation was carried out to evaluate different weed management practices for transplanted finger millet.

MATERIALS AND METHODS

Field experiment was conducted during *Kharif,* 2018 at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, Tamil Nadu, India. The experimental site is located at 10°45′N latitude, 78°36′E longitude and at an altitude of 85 m above MSL.

The weather condition prevailed in the experimental location during the course of investigation is briefed here under. The rainfall received during the cropping season (June 2018 - September 2018) was 177.8 mm in 9 rainy days. The mean temperature recorded during the cropping season was 36.6°C (max.) and 26.3°C (min.), respectively. The mean relative humidity was 75.1 and 40.4 per cent during 7.16 hrs and 14.16 hrs, respectively. The mean bright sunshine hours per day were 5.8 hrs. The mean evaporation per day was 9.2 mm day^{-1}. The mean wind velocity was 11.0 km hr^{-1}. The soil of the experimental field was sandy loam in texture, moderately drained and classified as *Vetric Ustropept.*

The field experiment was laid out in randomized block design (RBD) with three replications and ten treatments. The treatments details comprised of pre emergence (PE) application of pendimethalin at 750 g/ha, oxyfluorfen at 50 g/ha, bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha, early post emergence (EPOE) application of bispyribac sodium at 25 g/ha, PE pendimethalin at 750 g/ha *fb* EPOE bispyribac sodium at 25 g/ha, PE oxyfluorfen at 50 g/ha *fb* EPOE bispyribac sodium at 25 g/ha, PE bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha, PE oxyfluorfen at 50 g/ha *fb* hand weeding (HW) at 30 DAT, HW at 15 and 30 DAT and unweeded control (UWC). The finger millet variety TRY 1 was used during the course of investigation.

Observations recorded during the course of investigation were NPK removal by weeds (20, 40 and 60 DAT), NPK uptake by crops (vegetative, flowering and harvest stage). Plant and weed samples were collected from the sampling area of individual plots for analysis. The collected samples were oven dried, ground in a willey mill and analyzed for nutrient contents. Nutrient uptake and removal were computed from their respective NPK concentration and dry matter production (DMP) and denoted as kg/ha. For estimating, Nitrogen - Microkjeldhal method (Humphries, 1956), Phosphorus - triple acid digestion with colorimetric estimation (Jackson, 1973) and Potassium - flame photometer (Jackson, 1973) methods were used, respectively. The productive tillers/m^2, earhead length, earhead weight, no. of grains/earhead and test weight were recorded during the harvest stage of crop. The grain and straw yield were recorded from the net plot at harvest stage and expressed in kg/ha.

The observed data on weeds and crops was statistically analyzed based on the procedure (Gomez and Gomez, 1984). Critical difference (CD) at five per cent level of probability was calculated for comparison. Non significant comparison was indicated as 'NS'.

RESULTS AND DISCUSSION

Nutrient removal by weeds

The extent of weed competition in transplanted finger millet was assessed through nutrient removal by weeds. Nutrient depletion is a function of dry weight and nutrient content in weeds. Removal of nutrients by weeds was significantly influenced by different weed management practices at all the stages of observation (Table 1). Lower nutrient (NPK) removal was registered with PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha. This might be due to the effective control of first and second flush of weeds by the application of pre emergence herbicide along with early post emergence herbicide. This could be attributed due to reduced crop weed competition for nutrients, light, moisture and space throughout the crop growth which results in lower NPK removal by weeds. This is in agreement with the findings of Uma *et al.* (2014). In unweeded control, maximum removal of nutrients by weeds was recorded throughout the crop period. This was mainly due to continuous growth of weeds which resulted in higher weed dry matter accumulation and thereby higher nutrient (NPK) removal. This is in conformity with the findings of Mishra *et al.* (2012) and Kumar *et al.* (2015).

Nutrient uptake by crops

Nutrient uptake by finger millet was increased due to reduced weed density as well as weed biomass which helped the crop to grow well and absorb more nutrients from the soil. Higher nutrient (NPK) uptake in finger millet was recorded with PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha and it was comparable with HW at 15 and 30 DAT (Table 2). There was significant increase in NPK uptake by finger millet due to reduced weed density as well as weed biomass and overall less competition by weeds. Application of different herbicides did not show any phytotoxicity symptoms on finger millet which helped the crop to grow well and absorb more

Table 1: Effect of weed management practices on nitrogen, phosphorus and potassium removal by weeds in transplanted finger millet.

Treatments	Nitrogen (kg/ha)			Phosphorus (kg/ha)			Potassium (kg/ha)		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
T_1: PE Pendimethalin at 750 g/ha	7.83	11.36	14.37	2.60	3.38	4.51	10.31	14.58	19.22
T_2: PE Oxyfluorfen at 50 g/ha	5.28	11.07	14.09	2.23	3.24	4.45	7.94	14.21	18.85
T_3: PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha	4.22	10.85	13.67	1.21	3.17	4.33	5.59	13.82	18.03
T_4: EPOE Bispyribac sodium at 25 g/ha	10.17	6.01	13.40	4.93	2.02	4.20	18.75	9.49	17.80
T_5: PE Pendimethalin at 750 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	7.69	5.89	11.69	2.54	1.99	3.10	10.24	9.37	15.66
T_6: PE Oxyfluorfen at 50 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	5.22	5.43	10.31	2.20	1.81	2.61	7.91	9.14	13.18
T_7: PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	4.13	4.58	6.94	1.48	1.30	1.32	5.55	7.58	7.77
T_8: PE Oxyfluorfen at 50 g/ha *fb* HW at 30 DAT	5.11	4.31	9.92	2.17	1.01	2.33	7.86	7.14	11.76
T_9: HW at 15 and 30 DAT	1.42	4.07	8.37	0.29	0.91	1.73	3.91	7.05	9.61
T_{10}: UWC	10.24	22.50	35.57	4.97	7.50	10.80	18.83	29.89	37.40
SEm±	0.17	0.25	0.42	0.07	0.08	0.12	0.29	0.37	0.53
CD (P=0.05)	0.49	0.72	1.21	0.20	0.22	0.33	0.84	1.05	1.51

Table 2: Effect of weed management practices on nitrogen, phosphorus and potassium uptake by crops in transplanted finger millet.

Treatments	Nitrogen (kg/ha)			Phosphorus (kg/ha)			Potassium (kg/ha)		
	Veg.	Fl.	Har.	Veg.	Fl.	Har.	Veg.	Fl.	Har.
T_1: PE Pendimethalin at 750 g/ha	13.15	19.05	23.99	2.72	3.56	5.11	11.24	14.81	21.58
T_2: PE Oxyfluorfen at 50 g/ha	14.11	19.78	24.87	2.80	3.61	5.27	11.74	15.22	22.12
T_3: PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha	14.24	20.73	25.23	2.85	3.72	5.43	11.93	15.76	22.61
T_4: EPOE Bispyribac sodium at 25 g/ha	13.71	21.07	26.19	2.76	3.85	5.59	11.57	16.04	23.14
T_5: PE Pendimethalin at 750 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	16.04	23.75	28.71	3.23	4.89	7.27	13.55	17.53	25.97
T_6: PE Oxyfluorfen at 50 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	18.76	24.69	29.48	3.87	4.91	7.33	15.25	17.95	26.73
T_7: PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	19.97	28.94	33.40	4.02	5.52	8.26	15.56	20.92	30.27
T_8: PE Oxyfluorfen at 50 g/ha *fb* HW at 30 DAT	14.33	25.61	30.75	2.90	5.09	7.64	12.17	18.72	37.56
T_9: HW at 15 and 30 DAT	17.13	27.42	32.00	3.35	5.38	7.97	14.18	19.66	28.90
T_{10}:UWC	6.59	13.41	19.80	1.74	1.44	1.83	4.70	6.73	11.30
SEm±	0.44	0.69	0.86	0.09	0.13	0.18	0.37	0.51	0.75
CD (P=0.05)	1.26	1.93	2.43	0.26	0.36	0.53	1.04	1.43	2.12

Veg. - Vegetative, Fl. - Flowering, Har, - Harvest.

nutrients from the soil. These results were in line with Madhu Kumar *et al.* (2013) and Pavithra *et al.* (2019). The uncontrolled weed growth in unweeded control resulted in increase in competition of weeds with the crops throughout the crop period for the growth resources which results in lower NPK uptake by finger millet.

Application of either pre emergence (PE) or early post emergence (EPOE) herbicide alone has not completely controlled the weed growth resulting in maximum nutrient removal by weeds and lower nutrient uptake by crop. This is because, the PE herbicide controlled only the first flush of weeds and EPOE herbicide alone was not effective in controlling the later emerging weeds. Combined application of PE and EPOE has resulted in better weed control in transplanted finger millet due to the effective control of first and second flush of weeds. This is in line with the findings of Dahiphale *et al.* (2015).

Yield parameters

Yield parameters *viz.,* productive tillers/m^2, earhead weight and total grains/earhead were altered significantly by the adoption of weed management practices (Table 3). PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha registered more number of productive tillers/m^2, earhead weight and total grains/earhead and was at par with HW at 15 and 30 DAT. The effective control of weeds in these treatments resulted in lesser competition by weeds for nutrients, space and light ultimately resulting in increased number of productive tillers/m^2. Pre emergence herbicide application controlled weeds at early stage and supplemental early post emergence herbicide controlled weed growth at later stage which resulted in higher yield attributes. This is in agreement with the findings of Prithvi *et al.* (2015) and Rathika and Ramesh (2019). Earhead length and test weight was not significantly influenced by different weed management practices.

Yield attributes were lower under unweeded control. This might be due to interception of light by tall growing *Echinochloa sp.* and *Cyperus sp.,* resulting in poor photosynthesis and photo-chemical energy supply which ultimately affected the translocation of photosynthates to the developing grains (Mandhata and Singh, 2010). This might have reflected on the lesser number of filled grains with lesser percentage in the UWC. This is in line with the findings of Banu *et al.* (2016).

Yield

Adoption of different weed management practices produced distinct variations in grain and straw yields of transplanted finger millet (Table 3). Higher grain and straw yields were recorded with PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha and was comparable with HW at 15 and 30 DAT. This might be due to cumulative effect of increased levels of yield attributes which was due to lesser crop weed competition, better light transmission for photosynthesis, reduced nutrient removal by weeds and increased nutrient uptake by crop. These results are in conformity with the findings of Tuti *et al.* (2016). Application of pre-emergence herbicide controlled the weeds at early stage and early post emergence herbicide controlled weed growth at later stage

Table 3: Effect of weed management practices on yield parameters in transplanted finger millet.

Treatments	Yield parameters					Yield (kg/ha)	
	Productive tillers (No./m^2)	Earhead length (cm)	Earhead weight (g)	No. of grains/ earhead	Test weight (g)	Grain	Straw
T_1: PE Pendimethalin at 750 g/ha	110	6.0	3.7	1297	2.7	2556	4796
T_2: PE Oxyfluorfen at 50 g/ha	113	6.0	3.9	1325	2.8	2720	4924
T_3: PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha	118	6.0	4.0	1381	2.8	2862	5065
T_4: EPOE Bispyribac sodium at 25 g/ha	121	6.0	4.1	1404	2.7	2741	5160
T_5: PE Pendimethalin at 750 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	135	6.1	4.7	1535	2.8	3022	5727
T_6: PE Oxyfluorfen at 50 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	148	6.1	5.0	1567	2.9	3140	5838
T_7: PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	174	6.3	5.7	1794	2.9	3560	6617
T_8: PE Oxyfluorfen at 50 g/ha *fb* HW at 30 DAT	157	6.1	5.2	1649	2.9	3222	6137
T_9: HW at 15 and 30 DAT	166	6.3	5.5	1733	2.9	3443	6353
T_{10}:UWC	94	5.9	3.1	1151	2.7	1256	3144
SEm±	4	0.2	0.1	44	0.1	90	166
CD (P=0.05)	11	NS	0.4	124	NS	256	469

which resulted in lesser competition by weeds promoting higher yield (Rathika and Ramesh, 2018).

CONCLUSION

From the above finding, application of PE bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha can effectively increase the crop nutrient uptake, yield attributes and yield of transplanted finger millet with reduced nutrient removal by weeds under sodic soil conditions.

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