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Research Article

Response of transplanted finger millet to weed management practices under sodic soil condition

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Abstract
Weeds are the major biotic constraints in finger millet production and account for 41 to 63% yield loss. Weed management through herbicides plays a major role in increasing productivity. The field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli during *Kharif*, 2018, to evaluate the weed management practices on the growth and yield of transplanted finger millet under sodic soil conditions. The experiment was laid out in Randomized Block Design (RBD) with ten treatments and three replications. The treatment comprised weed management practices with different herbicides and their combinations. The results revealed that the highest plant height, total number of tillers/m^2, dry matter production, leaf area index and crop growth rate were registered in PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE application of bispyribac sodium at 25 g/ha. The highest grain and straw yield was also registered in PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE application of bispyribac sodium at 25 g/ha, and it was on par with hand weeding at 15 and 30 DAT. Hence, in transplanted finger millet under sodic soil, the application of PE bensulfuron methyl at 60 g ha^{-1} + pretilachlor at 600 g ha^{-1} *fb* EPOE bispyribac sodium at 25 g ha^{-1} was found to be the most viable option for effective weed control besides increased productivity and profitability.

Keywords: Growth, Transplanted finger millet, Weed management practices, Yield

INTRODUCTION

Finger millet (*Eleusine coracana*) is grown in many dry regions, mainly in Asia and Africa. It is the staple food crop for most people in South Asia and Africa and for those who depend on subsistence farming. Among the millets, finger millet is ranked fourth globally in importance, after sorghum, pearl millet and foxtail millet. The finger millet grain is a rich source of carbohydrate (76.3%), protein (9.2%), fat (1.29%), ash (3%), calcium (0.33%), minerals (2.24%), vitamin A, B and small quantities of phosphorus. 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 a Climate Change Compliant Crop (CCCC) (Ferry, 2014).

In many places where it is grown, it is looked upon as a poor man's crop or a famine food. In developing countries like India, dietary diversification must be followed to manage food security and malnutrition; otherwise, the biofortification of staple food grains or consumption of nutri-cereals or millets may be adapted (Jena *et al.,* 2018). In our country, it is grown in the states of Karnataka, Andhra Pradesh, Odisha and Tamil Nadu. The area under finger millet cultivation in India is 1.19 m.ha with a production of 1.99 mt and an average productivity of 1.66 tonnes/hectare. In Tamil Nadu, finger millet is the major traditional millet crop cultivated under 0.86

L.ha, with a production of 3.21 L.t and a productivity of 3.71 tonnes/hectare (www.indiastat.com).

In finger millet cultivation, weed menace has become a major threat for production and productivity. Lall and Yadav (1982) also reported that its slow growth habit during initial stages favours weed growth and causes more competition for sunlight, nutrients, and water, leading to lower crop productivity. Madhu Kumar *et al.* (2013) observed that *Cynodon dactylon* L., *Dactyloctenium aegyptium* L., *Digitaria marginata* L., *Eleusine indica* L., *Echinochloa colona* L., *Panicum miliacea* L., among grasses; *Achyranthes aspera* L., *Aegeratum conyzoides* L., *Alternanthra sp*., *Amaranthes viridis* L., *Bidens pilosa* L., *Commelina benghalensis* L., *Mullugo disticha* L., *Mimosa pudica* L., *Parthenium hysterophorus* L. and *Sida cardifolia* L. among broad leaved weeds (BLW) and *Cyperus rotundus* L. were the major sedge in transplanted finger millet. However, finger millet production requires much labour, particularly weed management practices. Kumara *et al.* (2007) reported that herbicides are more cost-effective in controlling these weeds during the initial stages than hand weeding (HW). Prashanth Kumar *et al.* (2015) opined that herbicides for controlling weeds are now gaining importance in Indian agriculture due to the labor scarcity at critical stages of crop growth and increased wages. The advantages of using herbicides are many folds that effectively control a wide range of weed flora. The increase in yield provided higher monetary returns. Similarly, when compared to unweeded control, considering the gross return and cost of weed management practices, the benefits accrued from weed management were considerably higher. Thus, there is a need to develop profitable weed management strategies. Hence, the present investigation has been carried out to evaluate the different weed management practices on transplanted finger millet growth and yield under sodic soil.

MATERIALS AND METHODS

The field experiment was conducted during *Kharif,* 2018, at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, Tamil Nadu. The experimental site was located at 10°45'N latitude, 78° 36'E longitude, and 85m above MSL. A total of 177.8 mm of rainfall was received during the cropping period on 9 rainy days. The mean maximum and minimum temperature recorded during the cropping season were 36.6 °C and 26.3 °C, respectively and the mean relative humidity ranged from 75.1 and 40.4 per cent. 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 clay loam in texture, moderately drained and classified as *Vetric Ustropept* with pH of 8.9 and EC of 0.94 dS/m. The experimental soil was low in available nitrogen (196.0 kg/ha), medium in available phosphorus (11.4 kg/ha) and medium in available potassium (242.7 kg/ha). The field experiment was laid out in randomized block design (RBD) with three replications and ten treatments. The treatments 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 at 30 DAT, hand weeding at 15 and 30 DAT and unweeded control (UWC). The finger millet variety used for the experiment was TRY 1.

The observations recorded during the investigation were plant height (cm), total number of tillers/m^2 (Nos./m^2), dry matter production (kg/ha), leaf area index (LAI), crop growth rate (CGR) (g/m^2/day), relative growth rate (RGR) (g/g/day) and net assimilation rate (NAR) (g/cm^2/day) during vegetative, flowering and harvest stages by adopting standard procedure. The grain and straw yield was recorded from the net plot at the harvest stage and expressed in kg/ha. Visual observation recorded the days to 50% flowering in each treatment.

RESULTS AND DISCUSSION

Growth parameters

Adoption of different weed management practices improved the growth parameters *viz.,* plant height (Fig.1), the total number of tillers/m^2 (Fig.2), and dry matter production (Fig.3) of transplanted finger millet. The increased plant height (43.8, 90.9 and 98.1 cm), higher number of total tillers/m^2 (137, 181 and 198/m^2) and dry matter production (1112, 6036 and 9822 kg/ha) at vegetative, flowering and harvest stages were recorded in 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. This was due to better control of weeds during critical stages of crop weed competition which results in higher nutrient availability for crop growth. This is in line with the findings of Banu (2014) found that PE bensulfuron methyl + pretilachlor at 660 g/ha registered the tallest plants in transplanted finger millet and Prithvi *et al.* (2015) opined that pre emergence application of oxadiargyl 100 g/ha fb inter-cultivation at 20 DAT recorded higher plant height and crop dry weight. They reported that the weed management practices adopted in transplanted finger millet improved the growth parameters by eliminating weed competition. This might be due to reduced weed competition and increased availability of resources like nutrients, soil moisture and light which resulted in maximum LAI, thereby increasing the photosynthetic activity, ultimately resulting in increased growth of crops.

The combination of pre and early post-emergence herbicides maintained the superiority over other treatments and UWC. Weed control at the early stages by pre-emergence herbicide application and late emerged weeds controlled by early post-emergence herbicide application created a conducive crop environment by reducing weed competition, thereby enhancing the plant height, tiller number and DMP as reported by Uma *et al.* (2014) stated that in transplanted rice, bensulfuron methyl + pretilachlor 660 g/ha *fb* HW on 40 DAT registered taller plants and higher DMP and it was comparable with bensulfuron methyl + pretilachlor at 660 g/ha *fb* bispyribac sodium at 25 g/ha. This is in consonance with the findings of Kujur (2016) revealed that PE oxyfluorfen at 75 g/ha *fb* HW at 40 DAS registered the tallest plants in finger millet and Rathika and Ramesh (2019) stated that PE pretilachlor + safener at 0.45 kg/ha + EPOE metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS was found to be an ideal weed management options for controlling weeds, higher productivity and profitability of direct wet seeded rice.

Physiological parameters

Leaf area index (LAI) was significantly influenced by various weed management practices (Table 1). The results showed that the highest LAI (2.24, 4.26 and 3.64 at vegetative, flowering and harvest stages, respectively) 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 and it was comparable with HW at 15 and 30 DAT. The earliness (51 DAT) in 50% flowering (Table 1) was also recorded in the same treatment but not significantly different from the rest of the treatments. The leaf area index (LAI) of transplanted finger millet is closely related to grain production because it increases the translocation of photosynthates sufficient to the sink needs. This is in line with the findings of Satish *et al.* (2018) that higher plant height, LAI and number of productive tillers were recorded under HW at 20 DAS *fb* inter cultivation at 30 and 45 DAS in direct-seeded finger millet..

The results on CGR indicated that it increased from the vegetative stage to the flowering stage and then declined (Table 2). The CGR was higher (16.41 and 12.62 g/m^2/day at 30-60 and 60-90 DAT, respectively) with PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha. Relative growth rate (RGR) and Net assimila-

Table 1. Effect of weed management practices on leaf area index (LAI) and days to 50% flowering in transplanted finger millet

Treatments		LAI			Days to 50% flowering (days)
		Vegetative Stage	Flowering stage	Harvest stage	
T_1	PE Pendimethalin at 750 g/ha	1.62	2.93	2.32	54
T_2	PE Oxyfluorfen at 50 g/ha	1.69	3.06	2.41	53
T_3	PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha	1.71	3.17	2.37	53
T_4	EPOE Bispyribac sodium at 25 g/ha	1.65	3.20	2.54	53
T_5	PE Pendimethalin at 750 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	1.92	3.66	2.97	52
T_6	PE Oxyfluorfen at 50 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	2.15	3.45	3.01	52
T_7	PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	2.24	4.26	3.64	51
T_8	PE Oxyfluorfen at 50 g/ha *fb* HW at 30 DAT	1.75	3.83	3.19	52
T_9	HW at 15 and 30 DAT	1.99	4.00	3.42	51
T_{10}	Unweeded control	1.40	2.55	1.64	56
CD (P=0.05)		0.15	0.28	0.25	NS

Table 2. Effect of weed management practices on CGR, RGR and NAR in transplanted finger millet

Treatments		CGR (g/m^2/day)		RGR (g/g/day)		NAR (g/cm^2/day)	
		30-60 DAT	60-90 DAT	30-60 DAT	60-90 DAT	30-60 DAT	60-90 DAT
T_1	PE Pendimethalin at 750 g/ha	12.07	9.12	0.083	0.023	0.00024	0.00018
T_2	PE Oxyfluorfen at 50 g/ha	12.56	9.30	0.083	0.023	0.00024	0.00018
T_3	PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha	12.69	9.61	0.084	0.023	0.00025	0.00018
T_4	EPOE Bispyribac sodium at 25 g/ha	13.22	9.81	0.084	0.023	0.00026	0.00018
T_5	PE Pendimethalin at 750 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	14.42	10.94	0.085	0.023	0.00031	0.00019
T_6	PE Oxyfluorfen at 50 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	14.40	11.08	0.085	0.023	0.00032	0.00019
T_7	PE Bensulfuron methyl at 60 g/ha + Pretilachlor at 600 g/ha *fb* EPOE Bispyribac sodium at 25 g/ha	16.41	12.62	0.090	0.024	0.00036	0.00019
T_8	PE Oxyfluorfen at 50 g/ha *fb* HW at 30 DAT	15.50	11.78	0.085	0.023	0.00034	0.00019
T_9	HW at 15 and 30 DAT	16.29	11.89	0.086	0.023	0.00035	0.00019
T_{10}	Unweeded control	10.43	7.37	0.083	0.023	0.00019	0.00018
CD (P=0.05)		1.17	0.89	0.007	NS	0.00003	NS

CGR – Crop Growth Rate, RGR – Relative Growth Rate, NAR – Net assimilation Rate

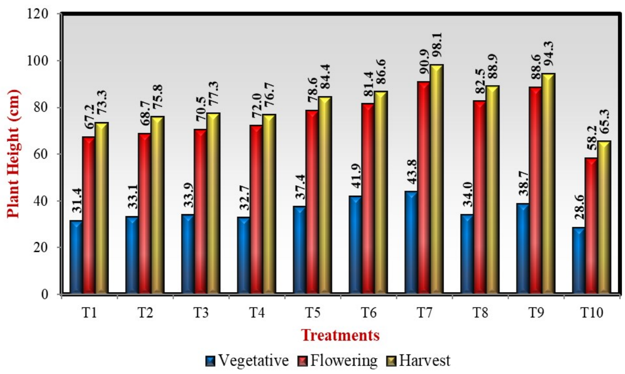

Fig. 1. *Plant height (cm) as influenced by weed management practices in transplanted finger millet*

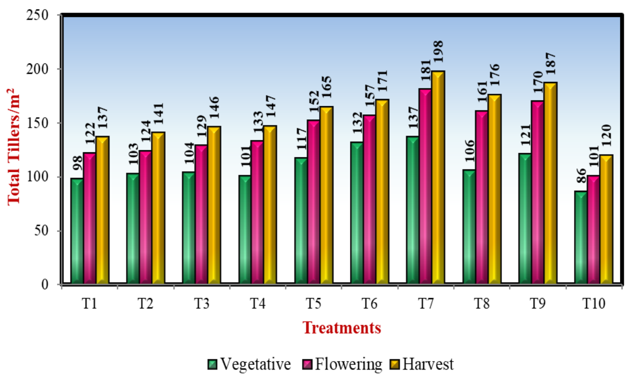

Fig 2. *Total tillers/m² as influenced by weed management practices in transplanted finger millet*

tion rate (NAR) (Table 2) was significantly influenced by different weed management practices only between 30-60 DAT. The data between 60-90 DAT was not significantly influenced by different weed management practices. The highest RGR (0.090 g/g/day between 30 -60 DAT) and NAR (0.00036 g/cm^2/day between 30-60 DAT) were recorded in 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 and PE application of oxyfluorfen at 50 g/ha *fb* HW at 30 DAT.

Grain and straw yield

The grain and straw yields were significantly influenced by different weed management practices (Fig.4). The highest grain and straw yields of 3560 and 6617 kg/ha were recorded by PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE application of bispyribac sodium at 25 g/ha and it was on par with hand weeding at 15 and 30 DAT (3443 and 6353 kg/ha). This might be due to reduced weed competition and increased availability of resources like nutrients, soil moisture, and light, resulting in maximum LAI,

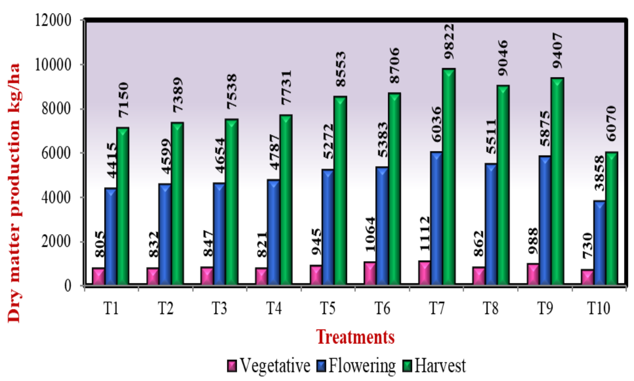

Fig. 3. *Dry matter production (kg/ha) of transplanted finger millet as influenced by weed management practices*

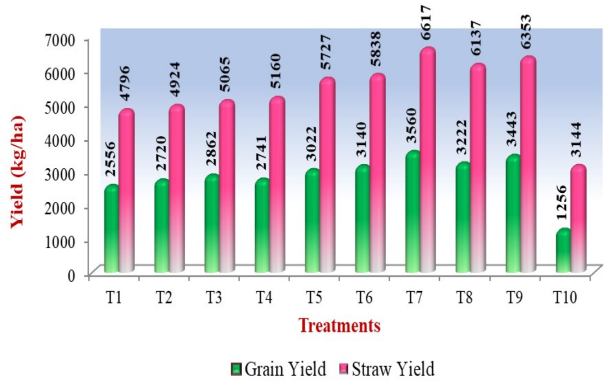

Fig. 4. *Yield (kg/ha) of transplanted finger millet as influenced by weed management practices*

thereby increasing the photosynthetic activity and ultimately resulting in higher yield. Application of pre-emergence herbicide (bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha) controlled the weeds at an early stage and early post-emergence herbicide controlled the weed growth (bispyribac sodium at 25 g/ha) at the later stage which resulted in lesser competition by weeds and higher yield This is in conformity with the findings of Uma *et al.* (2014) opined that Bensulfuron-methyl + Pretilachlor at 10 kg/ ha^{-1} + Bispyribac Sodiumat 25 g/ha as post-emergence at 20 DAT or the same pre-emergence herbicide + one hand weeding at 40 DAT may be suggested for higher yield in transplanted rice and Rathika and Ramesh, (2018) found that bensulfuron methyl 60 g/ha + pretilachlor at 600 g/ ha on 3 days after transplanting (DAT) fb early post-emergence application of bispyribac sodium at 25 g/ha on 20 DAT registered higher grain and straw yields in rice.

The outcome of the study clearly indicated that weed free environment created by the application of pre and early post emergence herbicides combination favoured finger millet plants to produce taller plants, increased LAI, productive tillers/m^2 and DMP by utilizing all available resources effectively. Higher DMP, a major determinant of yield coupled with enhanced productive tillers/m^2, earhead weight and number of total grains/ earhead resulted in higher productivity. Though manual weeding was found better, it cannot be practicable and feasible due to escalating costs besides non-availability of labour in time.

Conclusion

From this field experiment, it was concluded that PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE application of bispyribac sodium at 25 g/ha was found to be the best method to attain increased growth and yield of transplanted finger millet under sodic soil. Though HW at 15 and 30 DAT were significantly comparable in terms of growth and grain yield of finger millet, the present scenario of acute labour scarcity and escalating cost of labour, resorting to chemical weed management practice including pre and early post- emergence herbicide are best practice for achieving efficient and economic weed control besides obtaining higher monetary returns in transplanted finger millet.

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Conflict of interest

The authors declare that they have no conflict of interest.

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