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Screening of Herbicides in Transplanted Finger Millet [*Eleusine coracana* (L.) Gaertn]

Jangam Bhavana[1], R. Krishnan[2], P. Murali Arthanari[1], R. Kalpana[1], C.N. Chandrasekhar[3], R. Ravikesavan[4]

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ABSTRACT

Background: Weeds smother the finger millet due to crop's slow growth during the initial stages which reduces the yield substantially by 5-70%. Intensive use of herbicides is gaining popularity among the farmers now a days due to its effectiveness in controlling weeds, timeliness and reduced cost.

Methods: The current field experiment was conducted at Tamil Nadu Agricultural university during *kharif* season, 2021 under irrigated condition with twelve herbicide treatments laid out in randomized complete block design (RCBD) with three replications.

Result: Pre-emergence application of pyrazosulfuron ethyl 15 g ha^{-1} significantly reduced the total weed density and total weed dry weight at 90 days after transplanting over all the other herbicides used. This treatment also considerably improved the plant parameters such as plant height, total number of tillers, plant dry matter production, Grain and stover yield and yield parameters such as productive tillers, ear head weight of transplanted finger millet which was statistically followed by the application of pendimethalin 750 g ha^{-1} as pre-emergent spray. Similar trend was followed in case of net returns and B: C ratio. while lower plant parameters were observed with the application of tembotrione 12 g ha^{-1}.

Key words: *Eleusine coracana*, Herbicides, Pyrazosulfuron ethyl, Weed management, Yield.

INTRODUCTION

Finger millet is one of the worlds important staple food crops which usually grown in arid and semiarid regions and it is the sixth most produced crop in India after wheat, rice, maize, sorghum and bajra. It is popularly known as ragi in south India. Finger millet crop is a highly productive crop that can thrive well even under various harsh environmental conditions. According to Indian statistics the crop occupies a share 11.5 lakh hectares in terms of area with a production and productivity of 19.9 lakh tonnes and 1724 kg ha^{-1}, respectively. Whereas, in case of Tamil Nadu, it occupies an area of 82.9 thousand hectares with a production of 2.8 lakh tonnes and a productivity 3481 kg ha^{-1} (Anonymous, 2021).

Though the crop is vital for its nutritional quality, the productivity is decreasing due to several factors like improper nutrient management, incidence of blast disease and weeds infestation. Critical period of crop weed competition is five weeks after planting of ragi (Nanjappa, 1980). As the crop growth is slow during the initial stages, the weeds pose drastic reduction in yield due to higher competition between weeds and crop. The yield reduction was ranged from 34 to 61% due to uncontrolled weed growth (Ramachandra Prasad *et al*., 1991). Though manual weeding is effective for management, it is considered as non-feasible due to scarcity of labour, higher labour wages and it is time consuming. Under such situations appropriate technology with less labour will be of more helpful to control the weeds efficiently. According to Rathore *et al*., (2010), applying post-emergence herbicide for weed control resulted in reduced labour requirements compared to intercultural operations. Farmers are also seeking for the selective pre- or post-emergence herbicides, which are less expensive than manual weeding for timely weed control in finger millet crop. Hence an experiment was conducted to screen suitable pre-emergence, early post emergence and post emergence herbicides for effective weed management in transplanted finger millet.

[1]Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
[2]Nammazhvar Organic Farming Research Centre, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
[3]Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
[4]Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.

Corresponding Author: Jangam Bhavana, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India. Email: j.bhavana6870@gmail.com

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MATERIALS AND METHODS

A field study was conducted at Eastern Block Farm of Tamil Nadu Agricultural University, Coimbatore during *kharif*

season of 2021 to find out the suitable herbicides for efficient weed control in transplanted finger millet. The experiment comprising three replications was laid out in randomized complete block design (RCBD). Finger millet variety ATL 1 was used as an experimental material.

Twelve herbicides were considered to study the efficiency of the herbicides in weed management of transplanted finger millet. During the field trial, N, P and K were provided at 60:30:30 ratio in the form of urea, SSP and MOP where P, K and half of the N dose was applied basally and the remaining half of N was applied in two equal split doses at 30 DAT and 45 DAT. All other agronomic procedures remained standard across all treatments of the experiment.

Data analysis

The data regarding plant biometric observations, yield and weed observations were recorded and analysed by using ANOVA (Analysis of Variance) and mean of the treatments were compared with LSD at 5% probability level using the statistical analysis software AGRESS and Correlation co efficient was analyzed using PATH software.

RESULTS AND DISCUSSION

Effect of herbicides on weeds

The most prevalent weeds in the finger millet crop that have been observed at various growth stages were broadleaved weeds such as *Trianthema portulacastrum, Parthenium hysterophorous, Amaranthus viridis, Digera arvensis,* grasses such as *Cynodon dactylon, Echinochloa colona, Dactyloctenium aegyptium* and sedges like *Cyperus rotundus*. Weed management methods led to substantial differences in weed density at 90 DAS (Table 1) at 5% level of significance. The weed density was considerably lower in treatments applied with pyrazosulfuron ethyl @15 g ha^{-1}. The result demonstrated a significant decline in weed density as a result of the post-emergence application of pyrazosulfuron ethyl 15 g ha^{-1} which was followed by pendimethalin 750 g ha^{-1}. whereas higher weed density was observed with the application of topramezone 20 g ha^{-1}. Similar trend was followed with the weed dry weight at 90 DAT. The lesser weed density and weed dry weight at 90 DAT by the application of pyrazosulfuron ethyl 15 g ha^{-1} was due to the inhibition of ALS enzyme activity in the meristematic tissues of weed species that ultimately lead to the poor growth of weeds. These findings are in line with Ramadevi *et al.,* (2021) in finger millet, Ramesha *et al.,* (2017); Pal *et al.* (2012); Saini *et al.,* (2008); Angiras and Kumar, (2005) and Chopra and Chopra, (2003) in transplanted rice.

Effect of herbicides on crop growth

The growth of crop was significantly influenced using herbicides in transplanted finger millet which was depicted in Table 1. Among all the herbicides, PE application of pyrazosulfuron ethyl 15 g ha^{-1} (T_2) exerted significant influence on the growth parameters such as plant height

Table 1: Effect of weed management treatments on weed and crop growth parameters in transplanted finger millet.

Treatments	Weed density (no/m^2) at 90 DAT*	Weed dry weight (g/m^2) at 90 DAT*	Plant height (cm) harvest	No.of tillers (no./m^2) at harvest	Productive tillers (no./m^2) harvest	Crop dry weight at harvest (g/m^2)
T_1: PE bensulfuron methyl 60 g ha^{-1} + Pretilachlor @ 600 g ha^{-1}	10.7 (113.7)	9.69 (93.34)	96.42	93	90	5386
T_2: PE pyrazosulfuron ethyl 15 g ha^{-1} at 3 DAT	7.9 (61.7)	6.98 (48.36)	118.78	120	117	7172
T_3: PE application of atrazine 0.25 kg ha^{-1} at 3 DAT	10.4 (107.3)	9.22 (84.45)	97.46	95	92	5570
T_4: PE application butachlor @ 0.75 kg ha^{-1} at 3 DAT	11.9 (141.7)	10.92 (118.75)	85.34	85	80	4931
T_5: PE application pendimethalin 30 EC @ 750 g ha^{-1} at 3 DAT	9.2 (83.3)	8.17 (66.18)	108.67	102	99	6546
T_6: PE application of isoproturon 0.5 kg ha^{-1} at 3 DAT	12.2 (149.3)	11.26 (126.38)	82.41	82	78	4797
T_7: EPOE of bispyribac sodium 25 g a.i. ha^{-1} at 15 DAT	11.6 (134.3)	10.35 (106.53)	87.56	87	83	5070
T_8: POE application of tembotrione 12 g ha^{-1} at 20 DAT	13.3 (175.3)	12.16 (147.42)	64.35	66	62	3637
T_9: POE application of 2,4-D Na salt 0.5 kg ha^{-1} at 20 DAT	10.9 (117.3)	9.95 (98.47)	94.65	89	85	5248
T_{10}: POE ethoxy sulfuron 18.75 g a.i ha^{-1} at 20 DAT	13.0 (168.7)	11.84 (139.65)	74.51	75	71	4152
T_{11}: POE application of almix 4 g a.i. ha^{-1} at 20 DAT	12.9 (164.7)	11.49 (131.46)	77.63	78	74	4257
T_{12}: COE application of topramezone 20 g ha^{-1} at 20 DAT	14.5 (209.3)	13.24 (174.83)	0.00	0	0	0
SEm±	0.56	0.50	4.18	4.25	3.99	244
LSD (P=0.05)	1.16	1.05	8.67	8.81	8.29	506

DAT- Days after transplanting; PE- Pre-emergence; EPOE- Early post-emergence; POE- Post-emergence.
* Data in parentheses are original values that were transformed to $(\sqrt{X + 0.5})$ and analysed statistically.

(118.78 cm), total number of tillers (120) and dry matter production (7172 kg ha^{-1}) at harvest which was followed by PE application of pendimethalin 30 EC @ 750 g ha^{-1} (T_5) with 108.67 cm, 102, 6546 kg ha^{-1} at harvest respectively. The increased growth parameters were the consequence of effective weed control, which reduced competition for finger millet and enhanced nutrient availability, which increased the number of tillers and plant height, which in turn increased the dry matter production in finger millet crop. These results were corroborated with the findings of Ramadevi *et al*., (2021). Complete death was observed in ragi plants that were treated with POE application of topramezone 20 g ha^{-1} which might be due to 4 - Hydroxyphenyl-pyruvate dioxygenase (HPPD) enzyme inhibition in finger millet (Ramadevi *et al*., 2021). Lower growth of the plant parameters was observed with the POE application of tembotrione 12 g ha^{-1} (64.35 cm plant height, 66 number of total tillers and 3637 kg ha^{-1} DMP at harvest). The main cause of the growth slowdown was severe weed competition for the available resources.

Effect of herbicides on yield and yield parameters

The herbicides provided positive influence on the yield (Fig 1) and yield parameters of fingermillet (Table 2). Among different herbicides, pyrazosulfuron ethyl 15 g ha^{-1} (T_2) which was applied as pre-emergent herbicide recorded significantly improved yield *i.e.,* grain yield (2685 kg ha^{-1}) and stover yield (4563 kg ha^{-1}) and the yield attributes such as number of productive tillers (117), ear head weight (5.4 g). The next best treatment is PE application of pendimethalin 30 EC @ 750 g ha^{-1} (T_5). The improved yield might be due to the result of improved weed control at the early stages using pre-emergence herbicides, that might have improved the dry matter production and better translocation, partitioning of photosynthates for sink requirements which ultimately showed in better expression of yield and yield parameters. The other yield parameters such as ear length, fingers per ear and test weight are failed to show the significant interaction between the treatments. Complete yield loss was observed with the application of topramezone 20 g ha^{-1} as Post emergence herbicide. Lower yield was observed with the POE application of tembotrione 12 g ha^{-1} with a grain yield 1369 kg ha^{-1} of and stover yield of 2326 kg ha^{-1}. Similarly superior yield and yield attributes with pyrazosulfuron ethyl was reported by Rajendra Kumar *et al.,* (2018), Ramesha *et al.,* (2017) and Saini *et al.,* (2008) in transplanted rice.

Effect of herbicides on economics

Economic analysis of the herbicides tested indicated that higher gross returns (` 88202), net returns (` 52376) and B: C ratio (2.46) were recorded with the PE application of pyrazosulfuron ethyl 15 g ha^{-1} (T_2) which was closely followed by PE application of pendimethalin 750 g ha^{-1} (T_5) with gross returns, net returns and B: C ratio of ` 80349, ` 43524 and 2.18 respectively. Higher net returns could be due to higher grain yield, straw yield and efficient control of the weeds combined with lower cost weed control using herbicides.

Table 2: Effect of different treatments on yield, yield parameters and economics of transplanted finger millet.

Treatments	Ear length (cm)	Ear weight (g)	Fingers per ear (no.)	Test weight (g)	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	Returns per rupee investment
T_1: PE bensulfuron methyl 60 g ha^{-1} + Pretilachlor @ 600 g ha^{-1}	6	8.7	7.4	2.7	68466	30840	1.82
T_2: PE pyrazosulfuron ethyl 15 g ha^{-1} at 3 DAT	6.2	9.4	7.4	2.8	88202	52376	2.46
T_3: PE application of atrazine 0.25 kg ha^{-1} at 3 DAT	6	8.7	7.3	2.8	72140	36494	2.02
T_4: PE application butachlor @ 0.75 kg ha^{-1} at 3 DAT	6.1	8.6	7.1	2.8	59491	23395	1.65
T_5: PE application pendimethalin 30 EC @ 750 g ha^{-1} at 3 DAT	6.1	9.2	7.1	2.8	80349	43524	2.18
T_6: PE application of isoproturon 0.5 kg ha^{-1} at 3 DAT	6	8.8	7.2	2.7	56995	20545	1.56
T_7: EPOE of bispyribac sodium 25 g a.i. ha^{-1} at 15 DAT	6	8.6	7.3	2.7	61658	25082	1.69
T_8: POE application of tembotrione 12 g ha^{-1} at 20 DAT	6	8.7	7.0	2.6	44683	8776	1.24
T_9: POE application of 2,4-D Na salt 0.5 kg ha^{-1} at 20 DAT	6.2	8.9	7.0	2.8	65562	29786	1.83
T_{10}: POE ethoxy sulfuron 18.75 g a.i ha^{-1} at 20 DAT	6	8.9	7.3	2.6	51775	15199	1.42
T_{11}: POE application of almix 4 g a.i. ha^{-1} at 20 DAT	5.9	8.8	7.0	2.8	53656	17656	1.49
T_{12}: POE application of topramezone 20 g ha^{-1} at 20 DAT	0	0	0.0	0	0	-38810	0.00
SEm±	0.28	0.44	0.32	0.14	*	*	*
LSD (P=0.05)	0.58	0.91	0.67	0.29	*	*	*

DAT- Days after transplanting; PE- Pre-emergence; EPOE- Early post-emergence; POE- Post-emergence.
*Data statistically not analyse.

Table 3: Correlation co efficient between grain yield, Weed density and weed dry matter at 90 DAT, productive tillers.

Parameter	Grain yield	Weed density	WDW	Productive tillers
Grain yield	1			
Weed density	-0.733**	1		
WDW	-0.722**	0.905**	1	
Productive tillers	0.905**	-0.858**	-0.857**	1

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
WDW- Weed dry weight.

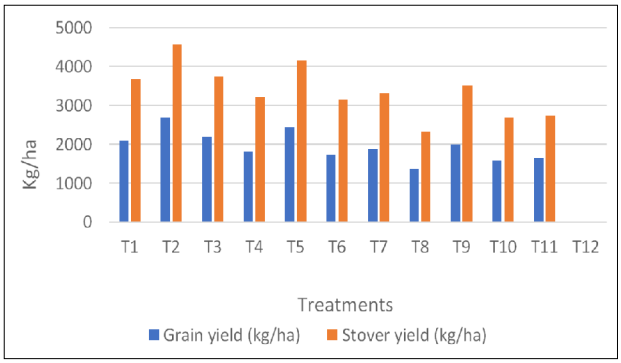


Fig 1: Effect of herbicides on the grain yield (kg/ha) and stover yield (kg/ha) of transplanted finger millet.

Similar trend was observed with Bhatt *et al.,* (2017); Kumar *et al*., (2017) and Rana *et al.,* (2018) in transplanted rice.

Correlation study

In the past, growth in any experimentation was compared using variance analysis. After the 1970s, data interpretation diverged toward quantitative and qualitative analysis, with various criss-cross view tools supporting the conventional variance technique. The current study tries to use correlation to explain the variation among two or more variables using PATH software.

Simple correlation studies of crop grain yield, productive tillers, weed density and weed dry matter were worked out from the data. Correlation coefficient between grain yield and productive tillers, plant height and dry matter production showed positive significance among the treatments while negative relationship was observed with weed density and weed dry weight which was depicted in Table 3.

CONCLUSION

From the results, it can be concluded that Pyrazosulfuron ethyl 15 g ha^{-1} as pre-emergence application at 3 DAT can be recommended for an efficient weed control in transplanted finger millet at times of labour shortage.

Conflict of interest: None.

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