



INFLUENCE OF WEED MANAGEMENT PRACTICES ON NUTRIENT UPTAKE AND PRODUCTIVITY OF HYBRID PEARL MILLET UNDER DIFFERENT HERBICIDES APPLICATION

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Abstract

A field experiment was conducted in the farmer's field, Semmangudi village, Sirgali taluk, Nagapattinam district, Tamil Nadu during summer, 2018 to study the productivity and profitability enhancement of hybrid pearl millet (*Pennisetum glaucum* L. R. Br.) through weed management. The experiment was laid out in Randomized Block Design (RBD) with three replications. The treatments of unweeded control (T_1), hand weeding twice at 15 and 30 DAS (T_2), pre-emergence application of atrazine (750 g ha^{-1}) on 3 DAS (T_3), pre-emergence application of pretilachlor (450 g ha^{-1}) on 3 DAS (T_4), early post-emergence application of fenoxaprop-p-ethyl (56.25 g ha^{-1}) on 10 DAS (T_5), early post emergence application of metsulfuron methyl + chlorimuron ethyl (4 g ha^{-1}) on 10 DAS (T_6), pre-emergence application of atrazine (750 g ha^{-1}) on 3DAS + one hand weeding on 30 DAS (T_7), pre-emergence application of pretilachlor (450 g ha^{-1}) on 3DAS + one hand weeding on 30 DAS (T_8), early post-emergence application of fenoxaprop-p-ethyl (56.25 g ha^{-1}) on 10 DAS + one hand weeding on 30 DAS (T_9), early post-emergence application of metsulfuron methyl + chlorimuron ethyl (4 g ha^{-1}) on 10DAS + one hand weeding on 30 DAS (T_{10}). Among the different weed management practices in hybrid pearl millet, pre-emergence application of pretilachlor (450 g ha^{-1}) on 3DAS + one hand weeding on 30 DAS (T_8) significantly recorded the highest nutrient uptake by crop and growth and yield parameters such as plant height, LAI, DMP, number of tillers plant⁻¹, ear head length, ear head girth, number of grains ear head⁻¹ and lowest nutrient removal by weeds. Hence from the results, it is revealed that pre-emergence application of pretilachlor (450 g ha^{-1}) on 3DAS followed by one hand weeding on 30 DAS (T_8) was an efficient and economically feasible practice to manage the weeds in hybrid pearl millet with better returns.

Keywords: weed management, pearl millet, early pre-emergence, early post emergence, pretilachlor, hand weeding, nutrient uptake

Introduction

Pearl millet (*Pennisetum glaucum* L. R. Br.) is the world's hardiest warm season cereal crop (Reddy *et al.*, 2011). Globally, it ranks sixth after rice, wheat, maize, barley and sorghum in terms of area, production and productivity (Khairwal *et al.*, 2007). Pearl millet is an indispensable arid and semi-arid crop of India (Ramesh *et al.*, 2006) cultivated as multiple purpose (food, feed, green and dried forages) crop (Yadav *et al.*, 2011). Pearl millet belongs to family Poaceae and popularly known as candle millet, cat tail millet, cumbu, bulrush millet or bajra. Pearl millet accounts for about 50 percent of the total global production of millets. India is the largest single producer of the crop, both in terms of area (7.47 million hectares) and production (9.80 million tonnes) with an

average productivity of 1312 kg ha^{-1} (Anon, 2017; Divya *et al.*, 2017). In Tamil Nadu, pearl millet is extensively grown in Villupuram, Thoothukudi, Madurai, Theni, Thiruvannamalai, Virudhunagar, Dindigul and Dharmapuri districts with an area of 0.5 lakh ha with a production of 1.2 lakh tonnes and productivity of 2241 kg ha^{-1} (Anon, 2017). Among the millets, pearl millet occupies 95% of the production (Yadav *et al.*, 2012; Yadav and Rai, 2013; Agricultural Statistics, Government of India, 2014; Nedumaran *et al.*, 2014). On an average 55 percent yield reduction due to heavy weed infestation in pearl millet crop was observed by Banga *et al.*, (2000).

The pre-emergence herbicides are effective only for about initial 30 days and thereafter weeds may threaten pearl millet crop. Sometimes due to unavoidable

circumstances, it is not possible to spray pre-emergence herbicides and later on it becomes very difficult to control the weeds manually. Under such circumstances, the best possible means to control new flush of weeds are through combined use of pre and post emergence or early post emergence herbicides (Guriqbal Singh and Sekhon, 2013). With this in view, the present investigation was undertaken to evaluate the efficacy of some promising herbicides on hybrid pearl millet.

Materials and methods

Field experiment was conducted in the farmer's field, Semmangudi village, Sirgali taluk, Nagapattinam district, Tamil Nadu during summer, 2018 to evaluate the effect of weed control measures on the growth and yield of pearl millet. The experimental site is situated at 11°24' N latitude and 79°44' E longitude at an altitude of +5.79 m above the mean sea level. The climate of Semmangudi village is moderately warm with hot summer months. The maximum temperature ranges between 33.8°C and 38.0°C with a mean of 35.9°C while the minimum temperature ranges between 22.3°C and 27.4°C with a mean of 24.85°C. The relative humidity ranges from 78 to 89 per cent with a mean of 83.5 percent. The soil of the farmer's field was clay loam in texture with a pH of 7.5. The soil was low in available nitrogen, medium in available phosphorus and high in available potassium.

The experiment was laid out in Randomized Block Design (RBD) with three replications. The treatments of unweeded control (T_1), hand weeding twice at 15 and 30 DAS (T_2), pre-emergence application of atrazine (750g ha⁻¹) on 3 DAS (T_3), pre-emergence application of pretilachlor (450g ha⁻¹) on 3 DAS (T_4), early post-emergence application of fenoxaprop-p-ethyl (56.25 g ha⁻¹) on 10 DAS (T_5), early post emergence application of metsulfuron methyl + chlorimuron ethyl (4 g ha⁻¹) on 10 DAS (T_6), pre-emergence application of atrazine (750g ha⁻¹) on 3DAS+one hand weeding on 30 DAS (T_7), pre-emergence application of pretilachlor (450 g ha⁻¹) on 3 DAS + one hand weeding on 30 DAS (T_8), early post-emergence application of fenoxaprop-p-ethyl (56.25g ha⁻¹) on 10 DAS + one hand weeding on 30 DAS (T_9), early post-emergence application of metsulfuron methyl + chlorimuron ethyl (4g ha⁻¹) on 10DAS + one hand weeding on 30 DAS (T_{10}).

Biometric observations on weed count, weed dry weight, weed control efficiency at 30, 60, and 90DAS and nutrient removal by weeds were recorded. Observations on growth components of pearl millet *viz.*, Plant height, LAI, DMP and Number of tillers plant⁻¹ yield components like earhead length, earhead girth, test

weight, no of grains earhead⁻¹, nutrient uptake were recorded. Yield parameters of grain and stover yield from each net plot was recorded and expressed in Kg ha⁻¹. The expenditure incurred from sowing to harvest was worked out as cost of cultivation and expressed as Rs ha⁻¹. Total income obtained from grain stover yield was calculated for individual treatments. Gross and net returns were worked out and presented.

Chemical analysis of crop and weed samples for nitrogen, phosphorous, and potassium content was carried out for the computation of nutrient uptake by crops and nutrient removed by weeds. The values were expressed in Kg ha⁻¹. The expenditure incurred from sowing to harvest was worked out as cost of cultivation and expressed as Rs ha⁻¹. Total income obtained from grain stover yield was calculated for individual treatments. Gross and net returns were worked out and presented.

Results and Discussion

Studies on Weeds

Regarding the total weed count, the highest weed population of *Cyperus rotundus* (48.20 m⁻²) in 30 DAS and (59.65 m⁻²) in 60 DAS was recorded with unweeded control. This might be due to enrichment of soil seed bank in experimental field followed by *Cleome viscosa*, *Echinochloa colonum*, *Euphorbia maculata*, *Cynodon dactylon*, *Echinochloa crusgalli* and *Commelina benghalensis*. Among the weed control treatments, pre-emergence application of pretilachlor (450g ha⁻¹) on 3 DAS and one hand weeding on 30 DAS was found to significantly record the lowest number of individual weeds and also total weed count. The pre-emergence herbicide has an ability to control the perennial, annual grasses and certain broad leaved weeds when combined with hand weeding. Similar results were also reported by Khizarhayat (2004).

Pretilachlor is a Chloroacetanilide group of herbicide, having a moderate solubility and persistence. This pre-emergence herbicide which inhibits the photosynthesis (Davinder Pal Singh *et al.*, 2016) reduces cell division (Vimal Raj yadhav *et al.*, 2018) and growth. It offers reliable pre-emergence to early post emergence control of annual grasses, some sedges and broad leaved weeds. Regarding this experiment, pre-emergence application of pretilachlor (450g ha⁻¹) on 3 DAS and one hand weeding on 30 DAS registered the least weed count, weed biomass and highest weed control efficiency. The pre-emergence herbicide controlling the weed seed emergence and initial establishment and reduce the weed competition during early stages of crop growth and leave only very few for late emergence. Regarding the cultural

practices by repeated hand weeding, infestation of weeds was controlled in an effective manner. The least values of all the weed parameters in hybrid pearl millet was observed in twice hand weeding. This result was similar with (Ashish Kiroriwal *et al.*, 2012).

The response of weed control measures on weed biomass was almost similar to that of weed count. Among that pre-emergence application of pretilachlor (450g ha^{-1}) on 3 DAS and one hand weeding on 30 DAS significantly recorded the least weed biomass. This is due to less weed count and less competition by weeds during the crop period and it was on par with hand weeding twice. Higher weed count resulted in highest weed biomass was observed in unweeded plots. Lower densities of weeds coupled with lowest weed biomass in pre-emergence application of pretilachlor (450g ha^{-1}) on 3 DAS and one hand weeding on 30 DAS. This treatment recorded the highest weed control efficiency of 92.40 percent at 60

DAS. Similar result was found by Satish Kumar Pandey *et al.*, (2018). Among the different weed control measures, the minimum nutrient removal by weeds was recorded in pre-emergence application of pretilachlor (450g ha^{-1}) on 3 DAS and one hand weeding on 30 DAS and was on par with twice hand weeding. It may be due to less weed population and weed biomass. Depletion of nutrients by weeds was restricted in superior treatments because weeds are effectively controlled during weed infestations as well as weed competition. Unweeded check recorded the maximum nutrient removal by weeds. It is due to high weed density and more biomass accumulation. Similar result was observed by Ashish Kiroriwal (2013) in hybrid pearl millet. It was on par with two hand weeding treatments. These results are in accordance with Singh *et al.*, (2001) in pearl millet.

The lowest weed control efficiency (66.72 percent) was observed in pre-emergence application of

Table 1: Effect of weed management on total weed count at 30 & 60 DAS, biomass of total weeds at 30 & 60 DAS (g m^{-2}) and WCE at 30 & 60 DAS (%) of hybrid pearl millet.

Treatments	Total weed count at 30 & 60 DAS		Biomass of total weeds at 30 & 60 DAS (g m^{-2})		WCE at 30 & 60 DAS (%)	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T ₁ - Unweeded control.	(174.66)* 13.23	(214.31) 14.65	142.99	159.81	-	-
T ₂ - Hand weeding twice at 15 and 30 DAS.	(30.41) 5.55	(57.68) 7.62	11.13	14.43	92.21	90.97
T ₃ Pre-emergence application of atrazine (750g ha^{-1}) on 3DAS.	(104.02) 10.22	(130.33) 11.43	34.48	38.58	75.88	75.85
T ₄ Pre-emergence application of pretilachlor (450g ha^{-1}) on 3DAS	(78.32) 8.87	(106.28) 10.33	26.13	29.74	81.72	81.39
T ₅ Early post emergence application of fenoxaprop-p-ethyl (56.25 g ha^{-1}) on 10 DAS	(150.38) 12.28	(182.84) 13.54	49.58	53.18	65.32	66.72
T ₆ Early post emergence application of metsulfuron methyl+ chlorimuron ethyl (4g ha^{-1}) on 10 DAS	(100.87) 10.06	(127.05) 11.29	33.13	36.47	76.83	77.17
T ₇ Pre emergence application of atrazine (750 g ha^{-1}) on 3 DAS + one hand weeding on 30 DAS.	(56.22) 7.53	(88.58) 9.43	19.23	23.04	86.55	85.58
T ₈ Pre emergence application of pretilachlor (450g ha^{-1}) on 3DAS + one hand weeding on 30 DAS	(28.43) 5.37	(53.98) 7.38	9.63	12.13	93.26	92.40
T ₉ Early post emergence application of fenoxaprop-p-ethyl (56.25g ha^{-1}) on 10 DAS + one hand weeding on 30 DAS.	(127.17) 11.29	(158.50) 12.60	41.98	45.38	70.64	71.60
T ₁₀ Early post emergence application of metsulfuron methyl+ chlorimuron ethyl(4g ha^{-1}) on 10 DAS+ one hand weeding on 30 DAS.	(52.81) 7.30	(84.46) 9.21	17.83	20.94	87.53	86.89
S.Ed	0.18	0.20	0.99	1.09	-	-
CD (P=0.05)	0.38	0.42	2.08	2.31	-	-

*Figures in the parenthesis indicates original values

fenoxaprop-p-ethyl alone. The yield reduction up to 68 per cent was recorded in unweeded control. This might be due to severe weed competition of pearl millet crop with the obnoxious weed species and led to inferior yield attributing traits, hence had minimum grain and stover yields. The data's regarding the weed parameters are presented in table 1.

Studies on Pearl millet

Regarding the growth characters, the effect of weed competition was reflected on growth performance of crop. The vegetative characters such as highest plant height, LAI and dry matter of the crop was recorded in weed free environment at critical stages of crop growth. The highest plant height (80.46, 157.74, 190.80 cm) @ 30,60 and harvest), LAI (7.53 at 60 DAS) and highest dry matter production (3395, 7721, 11374 kg ha⁻¹) @ 30,60 and Harvest) was recorded in pre-emergence application of pretilachlor (450g ha⁻¹) on 3 DAS and one hand weeding on 30 DAS. Among the weed control measures pre-emergence application of pretilachlor (450g ha⁻¹) on 3 DAS and one hand weeding on 30 DAS and hand

emergence application of pretilachlor (450g ha⁻¹) on 3 DAS and one hand weeding on 30 DAS as the treatment enabled the crop with better crop growth and yield attributes. Hand weeding twice at 15 and 30 DAS obtained a good satisfactory control of weeds in hybrid pearl millet. A similar finding was observed by Ravendra singh *et al.* (2017).

The highest yield and yield attributes was mainly due to maintenance of weed free environment especially from initial stages as well as during critical growth stages of crop growth. Hence, the pearl millet crop produced highest ear head length, ear head girth and more number of grains ear head⁻¹ resulted in higher grain yield. The data's regarding the yield and yield attributes are presented in Table 3

Economics

Regarding the economics, the highest net return (55915 Rs ha⁻¹) and cost benefit ratio (3.37) was observed in pre-emergence application of pretilachlor (450g ha⁻¹) on 3 DAS and one hand weeding on 30 DAS and was on

Table 2: Effect of weed management on grain and stover yield (kg ha⁻¹) and economics of crop cultivation on hybrid pearl millet

Treatment	Grain yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	Cost of cultivation (Rs. ha ⁻¹)	Gross income (Rs. ha ⁻¹)	Net income (Rs. ha ⁻¹)	Benefit cost ratio
T ₁ -Unweeded control.	1101	4117.00	19,319	26,137	6818	1.35
T ₂ - Hand weeding twice at 15 and 30 DAS.	3520	7428.52	25,319	77,841	52,522	3.07
T ₃ -Pre-emergence application of atrazine (750g ha ⁻¹) on 3DAS.	2201	5920.77	20,596	49,940	29,344	2.42
T ₄ -Pre-emergence application of pretilachlor (45-10g ha ⁻¹) on 3DAS	2,649	6632.71	20,554	59,612	39,058	2.90
T ₅ Early post emergence application of fenoxaprop-p-ethyl (56.25 g ha ⁻¹) on 10 DAS	1,482	4654.64	20,439	34,294	13,855	1.67
T ₆ Early post emergence application of metsulfuron methyl+ chlorimuron ethyl (4g ha ⁻¹) on 10 DAS	2,296	6176.32	20,839	52,096	31,257	2.49
T ₇ Pre emergence application of atrazine (750 g ha ⁻¹) on 3 DAS + one hand weeding on 30 DAS.	3,125	7057.47	23,596	69,557	45,961	2.94
T ₈ Pre emergence application of pretilachlor (450g ha ⁻¹) on 3DAS + one hand weeding on 30 DAS	3,595	7569.59	23,554	79,469	55,915	3.37
T ₉ Early post emergence application of fenoxaprop-p-ethyl (56.25g ha ⁻¹) on 10 DAS + one hand weeding on 30 DAS.	1,864	5397.39	23,439	42,677	19,238	1.82
T ₁₀ Early post emergence application of metsulfuron methyl+ chlorimuronethyl (4g ha ⁻¹) on 10 DAS+ one hand weeding on 30 DAS.	3,180	7130.29	23,839	70,730	46,891	2.96
S.Ed	59.69	122.91	-	-	-	-
CD (P=0.05)	125.41	258.23	-	-	-	-

Table 3: Nutrient removal by weeds at 60 DAS and Nutrient uptake by crop as influenced by weed management practices Kg ha⁻¹

Treatment		Nutrient removal by weeds at 60 DAS			Nutrient uptake by crop		
		Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
T ₁	Unweeded control.	47.73	31.19	39.89	105.47	24.86	117.53
T ₂	Hand weeding twice at 15 and 30 DAS.	17.82	7.90	14.8	154.13	37.21	172.17
T ₃	Pre-emergence application of atrazine (750g ha ⁻¹) on 3DAS.	33.53	20.10	26.89	126.25	29.75	140.68
T ₄	Pre-emergence application of pretilachlor (450g ha ⁻¹) on 3DAS.	27.93	15.74	22.58	136.08	32.07	151.63
T ₅	Early post emergence application of fenoxaprop-p-ethyl (56.25 g ha ⁻¹) on 10 DAS.	42.98	27.46	35.59	111.97	26.39	124.76
T ₆	Early post emergence application of metsulfuron methyl+ chlorimuron ethyl (4g ha ⁻¹) on 10 DAS.	32.63	19.39	26.28	129.68	30.56	144.50
T ₇	Pre emergence application of atrazine (750 g ha ⁻¹) on 3 DAS + one hand weeding on 30 DAS.	23.33	12.14	18.93	142.42	33.57	158.69
T ₈	Pre emergence application of pretilachlor (450g ha ⁻¹) on 3DAS + one hand weeding on 30 DAS.	16.72	7.15	14.15	159.23	37.53	177.43
T ₉	Early post emergence application of fenoxaprop-p-ethyl (56.25g ha ⁻¹) on 10 DAS + one hand weeding on 30 DAS.	38.25	23.77	31.09	119.79	28.23	133.48
T ₁₀	Early post emergence application of metsulfuron methyl + chlorimuron ethyl(4g ha ⁻¹) on 10 DAS + one hand weeding on 30 DAS.	22.32	11.4	18.3	146.95	34.63	163.74
S.Ed		0.60	0.36	0.48	2.52	0.59	2.81
CD (P=0.05)		1.26	0.77	1.01	5.30	1.25	5.92

weeding twice at 15 and 30 DAS proved its superiority over the other treatments. The reason attributed for higher uptake of nutrients may be due to reduced weed competition, resulted in increased growth, yield attributing characters and yield which revealed that the higher nutrient uptake by crop. These results are in similar with hybrid pearl millet reported by (Hari Singh *et al.*, 2017). The least nutrient uptake was observed in unweeded control, because weeds compete heavily from the beginning of germination of crop for nutrients and made lesser amount of nutrients available to the crop. The data's regarding nutrient removal presented in Table 3

The reason for the better growth characters of pearl millet under these treatments might be due to the effective control of weeds which might have reduced the competition of nutrients, moisture, space and radiant energy providing favourable conditions for higher uptake of nutrients and better utilization of other resources by the crop. The plots with unweeded registered the least

plant height, LAI and crop dry matter production because of severe weed competition from the beginning of crop growth and critical stages of crop growth and resulted in greater amount of nutrients and moisture were removed by weeds. Hand weeding twice was next in order and recorded the comparatively higher plant height, LAI and dry matter production.

The growth of pearl millet in early stages is very slow. The fast growing weeds were higher during the initial stages of crop and uncared growth of these weeds up to 45 DAS caused adequate damage to the crop growth. Regarding the herbicide, contact action of pre-emergence herbicide like pretilachlor performed better causing chlorosis and necrosis in weed species significantly reducing the weed competition, there by recording the maximum increase in growth parameters like increase in plant height, highest LAI and DMP.

Regarding the yield attributes and yield, significantly higher yield and yield attributes was recorded under pre-

par with hand weeding twice on 15 and 30 DAS. This may be due to utilize the nutrients and moisture effectively. These findings were substantiating with the results of (Prithvi *et al.*, 2015). The least return rupee⁻¹ invested was recorded in unweeded control. This might be due to unrestricted weed growth resulting in poor performance of the crop.

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