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CHEMICAL WEED MANAGEMENT IN PEARL MILLET (*Pennisetum americanum* L.) THROUGH PRE AND POST EMERGENCE HERBICIDES

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ABSTRACT

An experiment was conducted during *kharif*, 2023 on sandy loam soils of dryland farm of S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh, in a randomized block design with eleven treatments and three replications. Among the weed management practices, hand weeding (HW) twice at 20 and 40 DAS (T_{10}) recorded significantly lowest weed density and biomass, higher weed control efficiency, growth parameters, yield attributes, grain and stover yield of pearl millet, but it was equally effective with PE application of pendimethalin 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_2) and PE application of atrazine 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_1). At 75 DAS, yield attributes of pearl millet *viz*., number of panicles m^{-2}, panicle length, panicle diameter, number of grains panicle^{-1} and test weight and grain and stover yield were significantly higher with hand weeding twice at 20 and 40 DAS (T_{10}), which was at par with pre emergence application of pendimethalin 0.5 kg ha^{-1}*fb* HW at 30 DAS (T_2) and pre emergence application of atrazine 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_1). The next best treatment was pre emergence application of pendimethalin 0.5 kg ha^{-1} *fb* post emergence application of carfentrazone ethyl 20 g ha^{-1} at 25 DAS (T_8), which was on par with pre emergence application of pendimethalin 0.5 kg ha^{-1} *fb* post emergence application of pyrithiobac sodium 0.05 kg ha^{-1} at 25 DAS (T_4). Significantly lower yield attributes and yield were registered with weedy check (T_{11}).

KEYWORDS: Pearl millet, Herbicide, Weed control efficiency, Weed density, Weed management, Yield.

INTRODUCTION

Pearl millet (*Pennisetum americanum*) is the sixth most economically important cereal in the world and stands fourth, in order of importance as a food grain in India. Pearl millet is a drought tolerant, warm weather coarse cereal grown in semi-arid and arid climatic conditions of tropical and sub-tropical regions of our country and has the potential to contribute substantially to food, fodder and nutritional security. Because of its drought tolerance, pearl millet can be cultivated in areas that are often too hot and dry for other crops to be grown. It provides staple food for poor in relatively dry tracts even under adverse weather conditions. Pearl millet has excellent nutritional properties *viz.,* 378 calories of energy, magnesium (114 mg), calcium (8 mg), iron (3 mg), zinc (1.7 mg) and dietary fibre (8.5 g) per 100 g of edible grain. It is rich in amino acids (methionine), vitamins (niacin, thiamine and riboflavin) and minerals (magnesium). Niacin reduces blood cholesterol, while magnesium is essential for maintaining healthy life, as it lowers the blood pressure and reduces the risk of heart attack. Further, the nutritional value of this crop offers much scope for development of value added products in new health conscious consumer segments as it contains more fibre so good for diabetic and heart patients. Weed management is one of the main constraint in achieving the desired yield in pearl millet, as weeds have better competing ability than the crop and they can survive in adverse conditions too. Different categories of weeds *i.e.,* grasses, sedges and broad leaved weeds compete combinedly or individually with pearl millet for various growth factors and may reduce the grain yield from 16 to 94 percent depending upon different growing conditions. The predominant method of weed management in pearl millet is hand weeding. Hand weeding generally requires more labour for timely completion of the operation. During the early stages of crop growth pearl millet is highly susceptible to weed competition, so effective weed management with PE and PoE herbicides is a viable alternative. Sequential application of pre followed by PoE herbicides helps to suppress wide variety of weeds that are actively growing, besides maintaining crop performance at its best throughout the growing season. Ready-mix herbicides are formulated by combining different group of herbicides with different mode of action to target specific weed species for broadspectrum weed control. There is no suitable post emergence selective herbicides in controlling grassy weeds in pearl

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millet. Hence, the present study was undertaken to find out the suitable pre and post herbicides for effective weed control and for high net returns in pearl millet.

MATERIAL AND METHODS

An experiment was conducted during *kharif ,* 2023 at dryland fram of S. V. Agricultural college, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh which is geographically situated at 13.5°N latitude and 79.5°E longitude with an altitude of 182.9 m above the mean sea level in the Southern Agro-Climatic Zone of Andhra Pradesh. The soil was sandy loam in texture, neutral in soil reaction, low in organic carbon (0.26 %) and available nitrogen (212 kg ha^{-1}), medium in available phosphorus (26.6 kg ha^{-1}) and potassium (234 kg ha^{-1}). The experiment was conducted using Randomized Block Design with eleven treatments and three replications. The treatments taken in the investigation were PE application of atrazine 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_1), PE application of pendimethalin 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_2), PE application of atrazine 0.5 kg ha^{-1} *fb* PoE application of pyrithiobac sodium 0.05 kg ha^{-1} at 25 DAS (T_3), PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of pyrithiobac sodium 0.05 kg ha^{-1} at 25 DAS (T_4), PE application of atrazine 0.5 kg ha^{-1} *fb* PoE application of metsulfuron methyl + chlorimuron ethyl 4 g ha^{-1} at 25 DAS (T_5), PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of metsulfuron methyl + chlorimuron ethyl 4 g ha^{-1} at 25 DAS (T_6), PE application of atrazine 0.5 kg ha^{-1} *fb* PoE application of carfentrazone ethyl 20 g ha^{-1} at 25 DAS (T_7), PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of carfentrazone ethyl 20 g ha^{-1} at 25 DAS (T_8), PoE application of tembotrione 60 g ha^{-1} at 25 DAS (T_9), hand weeding twice at 20 and 40 DAS (T_{10}) and weedy check (T_{11}). Pearl millet variety *'ABV-04'* was sown at a spacing of 45 cm x 15 cm, on 2nd July 2023, blackgram variety *'TBG-104'* was sown in field as a succeeding crop after ploughing, at a spacing of 30 cm x 10 cm to study the residual effect of pre and PoE herbicides applied to pearl millet on the weeds and on blackgram. Recommended doses of 80 kg N, 40 kg P_2O_5 and 30 kg K_2O ha^{-1} was applied through urea, single super phosphate and muriate of potash, respectively to all the plots uniformly. The entire dose of phosphorus, potassium and half of the dose of nitrogen was applied at the time of sowing and the remaining half of the dose of nitrogen was top dressed at 25 DAS.

All the herbicides alone or in combination were applied uniformly in the experimental plots with the help of knapsack sprayer fitted with flat fan nozzle using a spray volume of 500 l ha^{-1}. The PE application of herbicide was done within 24 hours after sowing and PoE herbicide application was done at 25 DAS of pearl millet. The data on weed density and dry weight as well as growth parameters of pearl millet was recorded at 75 DAS. Five randomly selected plants were tagged in each treatment, from each replication in the net plot area and used for making observations on yield parameters of pearl millet. The number of weeds associated with pearl millet was recorded by placing a quadrat of 0.5 m x 0.5 m inside the net plot area and expressed as weed density (no. m^{-2}). While recording weed density, weeds were harvested from each quadrat for estimating weed dry weight. The weeds collected from the sampling area were dried under shade for 24 hours followed by oven drying at 60°C, till a constant weight was obtained and expressed as weed biomass (g m^{-2}). Weeds were categorized into grasses, sedges and broad leaved weeds for both density and dry weight of weeds. These were subjected to square root transformation to normalize their distribution and the corresponding transformed values were used for statistical analysis as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect on weeds

The predominant weed species in the experimental site were *Dactyloctenium aegyptium* and *Digitaria sanguinalis* among grasses; *Cyperus rotundus* a sedge; *Boerhavia erecta, Cleome gynandra, Commelina benghalensis* and *Euphorbia hirta* among the broad leaved weeds. Similar type of weed flora were also reported by Mishra *et al*. (2014). However, narrow leaved weeds were dominated over broad leaved weeds. Significantly lower density and biomass of grasses was recorded with hand weeding twice at 20 and 40 DAS (T_{10}) at 75 DAS. The next best treatment with lower density and biomass of grasses were reported with PE application of atrazine 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_1), which was at par with PoE application of tembotrione 60 g ha^{-1} at 25 DAS (T_9). Grasses count was not recorded in treatments with pendimethalin due to the greater efficacy of PE application of pendimethalin 0.5 kg ha^{-1} in controlling the grasses by inhibiting cell division, causes mitotic aberrations which inturn inhibits the root growth

Table 1. Weed density (No. m^{-2}) and biomass (g m^{-2}) at 75 DAS of pearl millet as influenced by weed management practices

Treatments	Weed density (No. m^{-2})				Weed biomass (g m^{-2})				WCE (%)
	Grasses	Sedges	BLW	Total	Grasses	Sedges	BLW	Total	
T_1 : PE application of atrazine 0.5 kg ha^{-1} *fb* hand weeding at 30 DAS	5.05 (25.00)	7.45 (55.00)	0.71 (0.00)	9.20 (84.33)	2.84 (7.57)	4.27 (17.74)	0.71 (0.00)	5.08 (25.32)	62.5 (78.7)
T_2 : PE application of pendimethalin 0.5 kg ha^{-1} *fb* hand weeding at 30 DAS	0.71 (0.00)	7.28 (53.00)	4.56 (20.33)	8.57 (73.33)	0.71 (0.00)	4.16 (16.99)	2.91 (8.03)	5.05 (25.01)	62.7 (78.9)
T_3 : PE application of atrazine 0.5 kg ha^{-1} *fb* PoE application of pyrithiobac sodium 0.05 kg ha^{-1} at 25 DAS	7.20 (51.33)	8.93 (79.33)	0.71 (0.00)	11.45 (130.67)	3.94 (15.45)	5.33 (28.07)	0.71 (0.00)	6.88 (46.85)	51.1 (60.5)
T_4 : PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of pyrithiobac sodium 0.05 kg ha^{-1} at 25 DAS	0.71 (0.00)	9.14 (83.00)	4.59 (20.67)	10.21 (103.67)	0.71 (0.00)	5.37 (28.57)	3.02 (8.63)	6.14 (37.20)	56.0 (68.7)
T_5 : PE application of atrazine 0.5 kg ha^{-1} *fb* PoE application of metsulfuron methyl 10% + chlorimuron ethyl 4 g ha^{-1} at 25 DAS	7.59 (57.33)	8.99 (80.33)	0.71 (0.00)	11.75 (137.67)	4.13 (16.57)	5.62 (31.33)	0.71 (0.00)	6.95 (47.90)	50.6 (59.6)
T_6 : PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of metsulfuron methyl 10% + chlorimuron ethyl 4 g ha^{-1} at 25 DAS	0.71 (0.00)	10.00 (99.50)	4.74 (22.00)	11.05 (121.50)	0.71 (0.00)	5.94 (34.83)	3.08 (9.02)	6.65 (43.85)	52.6 (63.1)
T_7 : PE application of atrazine 0.5 kg ha^{-1} *fb* PoE application of carfentrazone ethyl 20 g ha^{-1} at 25 DAS	7.40 (54.33)	9.06 (81.67)	0.71 (0.00)	11.68 (136.00)	4.02 (15.63)	5.50 (29.85)	0.71 (0.00)	6.78 (45.48)	51.9 (61.9)
T_8 : PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of carfentrazone ethyl 20 g ha^{-1} at 25 DAS	0.71 (0.00)	9.15 (83.33)	4.57 (20.47)	10.23 (103.80)	0.71 (0.00)	5.43 (29.00)	2.99 (8.43)	6.16 (37.43)	55.9 (68.5)
T_9 : PoE application of tembotrione SC 60 g ha^{-1} at 25 DAS	5.15 (26.00)	7.51 (56.00)	4.91 (23.67)	10.30 (105.67)	2.63 (6.44)	4.56 (20.35)	3.14 (10.55)	6.15 (37.34)	55.9 (68.6)
T_{10} : Hand weeding twice at 20 and 40 DAS	3.11 (9.33)	4.37 (20.67)	3.39 (11.00)	6.40 (41.00)	1.25 (1.07)	1.71 (2.43)	1.08 (0.67)	2.16 (4.17)	79.2 (96.5)
T_{11} : Weedy check (Control)	8.65 (74.33)	11.13 (123.33)	6.86 (46.66)	15.65 (244.33)	5.59 (30.80)	7.32 (53.11)	5.97 (35.23)	10.94 (119.14)	0.0
SEm±	0.150	0.373	0.131	0.249	0.163	0.216	0.086	0.131	0.82
CD (P = 0.05)	0.44	1.10	0.39	0.73	0.48	0.64	0.25	0.39	2.4

Data in parentheses are original values, which were square root transformed and analysed statistically; PE = PE; PoE = PoE; *fb* = followed by

Table 2. Growth and yield attributes and yield of pearl millet as influenced by different weed management practices

Treatments	Plant height (cm)	Leaf area index	Dry matter production (kg ha^{-1})	Number of tillers m^{-2}	Number of panicles m^{-2}	Panicle length	Test weight	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1 : PE application of atrazine 0.5 kg ha^{-1} *fb* hand weeding at 30 DAS	189	3.16	9107	35.0	33.0	28.1	9.70	3180	6973
T_2 : PE application of pendimethalin 0.5 kg ha^{-1} *fb* hand weeding at 30 DAS	195	3.18	9184	35.7	33.7	28.5	9.87	3332	6982
T_3 : PE application of atrazine 0.5 kg ha^{-1} *fb* PoE application of pyrithiobac sodium 0.05 kg ha^{-1} at 25 DAS	161	1.92	7341	26.0	24.3	22.8	7.24	1796	5788
T_4 : PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of pyrithiobac sodium 0.05 kg ha^{-1} at 25 DAS	176	2.56	8270	30.3	28.7	25.7	8.57	2579	6399
T_5 : PE application of atrazine 0.5 kg ha^{-1} *fb* PoE application of metsulfuron methyl 10% + chlorimuron ethyl 4 g ha^{-1} at 25 DAS	154	1.82	7147	25.0	23.7	22.2	7.16	1658	5718
T_6 : PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of metsulfuron methyl 10% + chlorimuron ethyl 4 g ha^{-1} at 25 DAS	162	2.00	7418	26.3	24.7	23.0	7.33	1923	5817
T_7 : PE application of atrazine 0.5 kg ha^{-1} *fb* PoE application of carfentrazone ethyl 20 g ha^{-1} at 25 DAS	156	1.88	7261	25.3	24.0	22.7	7.19	1682	5758
T_8 : PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of carfentrazone ethyl 20 g ha^{-1} at 25 DAS	177	2.60	8327	30.7	29.0	25.8	8.60	2745	6433
T_9 : PoE application of tembotrione SC 60 g ha^{-1} at 25 DAS	174	2.52	8148	29.7	28.3	25.1	8.44	2495	6371
T_{10} : Hand weeding twice at 20 and 40 DAS	198	3.21	9296	37.0	35.3	28.6	10.37	3457	7004
T_{11} : Weedy check (Control)	138	1.29	6532	19.0	17.0	19.0	6.03	1210	5149
SEm±	3.4	0.171	203.9	0.98	1.12	0.67	0.372	95.0	172.4
CD (P = 0.05)	10	0.50	601	3.0	3.3	1.9	1.09	280	508

of the germinating grasses. Significantly higher density and biomass of grasses were recorded with weedy check (T_{11}).

Lower density and dry weight of sedges was recorded with hand weeding twice at 20 and 40 DAS (T_{10}), which was significantly lower than rest of the chemical weed management practices. Post emergence application of tembotrione 60 g ha^{-1} at 25 DAS (T_9) with next best weed management practices in reducing density and dry weight of sedges which might be due to tembotrione had a considerable effect in reducing sedge count. Similar results were also reported by Yadav *et al*. (2018). Weedy check (T_{11}) recorded significantly higher density and dry weight of sedges than rest of the weed management practices.

Hand weeding twice at 20 and 40 DAS and treatments with PE application of atrazine 0.5 kg ha^{-1} were equally effective in lowering the broad leaved weed density and biomass. Broad leaved weeds were not observed in treatments with atrazine due to the greater efficacy of atrazine to inhibit the germination of broad leaved weeds by inhibiting the electron transfer during photosynthesis thereby reduces the density of broad leaved weeds. Significantly higher broad leaved weed density and biomass was reported in weedy check (T_{11}).

The total weed density and biomass was significantly lower with hand weeding twice at 20 and 40 DAS (T_{10}), which was significantly lower than PE application of pendimethalin 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_2) and PE application of atrazine 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_1). This might be attributed to effective weed control through manual weeding or due to greater efficacy of atrazine or pendimethalin in reducing broad leaved weed or grasses thereby reduced the total density and dry weight of weeds as reported by Bhuva and Detroja (2018).

Weed control efficiency was significantly higher with hand weeding twice at 20 and 40 DAS (T_{10}). The next best treatments were PE application of pendimethalin 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_2) and PE application of atrazine 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_1), which was significantly higher than weedy check (T_{11}). Reduced density and dry weight of total weeds from the initial stages of crop growth in this way resulted in higher weed control efficiency as observed by Girase *et al*. (2017).

Effect on crop

Among the weed control treatments, significantly higher values of growth parameters *viz*., plant height, leaf area index, dry matter production and number of tillers m^{-2} were recorded with hand weeding twice at 20 and 40 DAS (T_{10}), which was at par with PE application of pendimethalin 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_2) and PE application of atrazine 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_1) due to the tremendous growth and development of the crop in a weed free environment during a vital stage of crop growth leading to efficient utilization of light, space, moisture and nutrients thereby increased the all above said growth parameters. Weedy check (T_{11}) registered significantly lower values of all the above said growth parameters due to high degree of crop weed competition.

Yield attributes and yield of pearl millet differed significantly under different weed control treatments. Significantly higher yield attributes *viz*., number of panicles m^{-2}, length and diameter of panicle, number of grains panicle^{-1}, test weight, grain and stover yield were recorded with hand weeding twice at 20 and 40 DAS (T_{10}), which was comparable with PE application of pendimethalin 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_2) and PE application of atrazine 0.5 kg ha^{-1} *fb* HW at 30 DAS (T_1). This might be due to timely and effective weed control increased the nutrient availability that accelerated the photosynthates production as well as their translocation to sink leads to the production of higher yield attributes coupled with higher grain and stover yield as reported by Chaudhary *et al*. (2022) and Kumar *et al*. (2012). Significantly lower values of yield attributed and yield of pearl millet were reported with weedy check (T_{11}) due to greater competition for the growth resources among the crop and weeds as evident by the lowest crop stature, yield attributes and yield of pearl millet.

The present study has revealed that PE application of pendimethalin 0.5 kg ha^{-1} or atrazine 0.5 kg ha^{-1} *fb* HW at 30 DAS was considered as best weed management practice to increase the productivity and profitability of pearl millet, whenever labour scarcity prevailed, one can go for PE application of pendimethalin 0.5 kg ha^{-1} *fb* PoE application of carfentrazone ethyl 20 g ha^{-1} at 25 DAS (T_8) for obtaining broad spectrum weed control in pearl millet on sandy loam soil.

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