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Relative efficiency of pre and post-emergence herbicides on yield and economics of Pearl millet (*Pennisetum glaucum* L.)

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ABSTRACT

A field experiment was conducted at the Crop Research Centre, School of Agriculture, ITM University, Gwalior (M.P.) during the *Kharif* season in 2022. The experiment was conducted with Randomized Block Design and replicated thrice and comprised of ten treatments. The herbicides were used individually as well as in combinations viz; T_1 to T_{10} the crop was infested with the different types of weed flora. Ex; *Digitarias anguinalis* L. and *Echinochloa crusgalli* L. of grassy weeds, *Digera arvensis* L. and *Trianthema monogyna* L. of Broad-leaved weeds and *Cyperus rotundus* L. of the sedges group. Weed density of the different weed species and total weeds affected significantly due to different weed management practices, The result indicated that the total weed population and its dry weightand weed index were lower with Atrazine (50 % WP) at 750g ha^{-1}(PE)*fb* Topramezone (33.3%SC) at 25 gha^{-1}(PoE). However, the higher weed control efficiency was recorded with Atrazine (50 % WP) at 750 gha^{-1}(PE)*fb* Topramezone (33.3%SC) at 25 gha^{-1}(PoE), found at par with Atrazine (50%WP) at 750gha^{-1} (PE)*fb* Tembotrione (34.4% SC) at 20gha^{-1}. Yield attributes and yield like number of tillers per plant, ear head weight per plant, Test weight, Grain yield, Straw yield and Harvest Index were significantly higher with Atrazine (50 % WP) at 750 gha^{-1} (PE)*fb* Topramezone (33.3%SC) at 25g ha^{-1} (PoE). The maximum net returns and B:C ratio was recorded higher with Atrazine (50 % WP) at 750 gha^{-1} (PE)*fb* Topramezone (33.3%SC) at 25gha^{-1} (PoE).

Key words : *Weed Management, Atrazine, Pendimethalin, Topramezone, Tembotrion, Weed density and Pearl millet.*

Introduction

Pearl millet (*Pennisetum glaucum* L.) is an important cereal crop that is widely grown in arid and semi-arid regions of the world, including India. It is a staple food crop in many parts of India, particularly in the states of Rajasthan, Gujarat, Haryana, and Uttar Pradesh. Pearl millet is known for its high nutritional value, drought tolerance and suitability for low-input agriculture making it an important crop for food security and poverty reduction in these regions.

As Pearl millet is grown predominantly in warm rainy season, weeds of different kinds deprive the crop. Weed management is an important factor for enhancing the productivity of pearl millet. Weeds are self-perpetuating and appear simultaneously with crop plants during the early growth period creating severe competition with the main plants for light, space, Water and nutrients and in turn decrease overall land productivity of the system as a whole hence weeds are the main factor responsible for the yield declines in any ecosystem.

Almost all types of weeds viz., grassy, broad

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leaved weeds and sedges infested the pearl millet field. Some predominant weed species are *Cynodon dactylon*, *Dinebraretroflexa*, *Echinochloa colona*, *Brachiaria eruciformis*, *Cyperus rotundus*, *Parthenium hysterophorus*, *Commelina benghalensis*, *Amaranthus viridis* and *Trianthema portulacastrum* which cause heavy losses in pearl millet production. Atrazine and pendimethalin recommended as a pre-emergence herbicide are not effective against some of the weeds both grassy and non-grassy as well the sedges *Cyperus rotundas*. Hence there is a need for some alternate post- emergence herbicides which can be provide broad spectrum weed control in *kharif* pearl millet without affecting the crop growth and yield of crop. Use of herbicides would make weed control more acceptable to the farmers and control of weeds by using herbicides was a cheaper proposition than with manual methods.

Under scarcity of human Labouré, use of herbicide is the best option to reduce the weed menace during early stages of crop growth (Chaudhary *et al.* 2016).

Day by day, manual weeding being costly due to increasing Laboure rate and shortage of Labouré, therefore, use of herbicides for weed control is increasing.Information is lacking about efficacy ofnewly evolved pre- and post-emergence herbicides for weed management in pearl millet for Gwalior region. Weed control is one of the major input costs of crop production. Weed competition was observed maximum during the initial growth stage of pearl millet crop, because in early stage the growth of pearl millet is very slow. Therefore, weed control in pearl millet during the early growth period of crop is more important. If weed infestation is minimize during critical period of crop weed competition the yield can be equivalent to that of weed free condition. Therefore, it is an essential to manage the weeds by any means during crop weed competition period to obtain potential yield of pearl millet.

Atrazine as pre-emergence is the most widely used herbicide for weed control in pearl millet. However, in case of continuous rainfall after sowing, spraying of pre-emergence herbicide may not be feasible. Furthermore, the efficacy of pre-emergence herbicides is moisture dependent. Too little or excessive moisture after herbicide application can result in poor weed control. Hence, there is a need to standardize the post- emergence dose of atrazine in pearl millet crop for safe and efficient weed control. Hence there is a need for some alternate post- emergence herbicides which can be provide broad spectrum weed control in *kharif* pearl millet without affecting the crop growth and yield of crop. Weed flora was categorized into narrow and broad-leaved grasses and sedges. Weed dry weight was calculated after two days of sun drying and 48 hours of Oven drying at 70±1 ^{o}C. Category-wise, weed was initially evaluated by counting.

Using a common equation, weed control efficiency (WCE) was calculated. The cost of cultivation was subtracted from the gross return to determine the net return. By dividing the net return by the cost of cultivation, the benefit-cost ratio was obtained.

On October 24, 2022, the crop was harvested. Statistical information on weeds and crops was examined using randomized block designs and analysis of variance (ANOVA) techniques. (Gomez and Gomez, 1984). The square root transformed data "x + 0.5 on weed density and dry matter were used in an ANOVA.

Materials and Methods

The field experiment was carried out at the crop research center, school of agriculture, ITM University, Gwalior (M.P.), during the *kharif* season of 2022. The research field is in the Indo-Gangetic plains region of the subtropics at an elevation of 196 m above sea level with coordinates of 26° 21' N latitude and 78° 17' E longitude. The experiment was laid out in RBD with Ten Treatments and consisting of three replications. The texture of the experimental soil was sandy loam in nature, having soil pH 7.64, organic carbon 0.44, available 16.50 kg ha^{-1} of N, available 15.2 kg ha^{-1} of P_2O_5 and available 23.60 kg ha^{-1} of K_2O. The treatments were: T_1-Atrazine (50% WP)@750gha^{-1} (PE); T_2-Pendimethalin(30%EC) @ 1000gha^{-1}(PE); T_3-Topramezone(33.3% SC) @25gha^{-1} (PoE); T_4-Tembotrion (34.4%SC)@20gha^{-1}(PoE); T_5-Atrazine (50%WP)@750gha^{-1} (PE)*fb* Topramezone (33.3%SC) @25 gha^{-1}(PoE); T_6-Pendimethalin (30%EC) @1000gha^{-1} (PE)*fb* Topramezone (33.3% SC)@25gha^{-1} (PoE); T_7-Atrazine (50% WP)@750gha^{-1} (PE)*fb* Tembotrion (34.4%SC)@20gha^{-1}(PoE); T_8-Pendimethalin (30%EC)@1000gha^{-1} (PE)*fb* Tembotrion (34.4% SC)@20gha^{-1}(PoE); T_9-weed Free check.; T_{10}- weedy check treatments.

Pearl millet variety "Raja HP-50Hybrid" was sown using seed rate of 5kg ha^{-1} with spacing of 45cm x 15cm and seeds were treated with carbendazim @2 g kg^{-1} seeds. At 90 DAS, Observations were made about the weed flora, weed density (No. m^{-2}), weed dry weight (g m^{-2}), number of tillers per plant, ear head weight per plant, and Test weight (1000 seed g^{-1}). Weed flora was categorized into narrow and broad-leaved weeds and sedges. Weed dry weight was calculated after two days of sun drying and 48 hours of Oven drying at 70±1 ^{o}C. Category-wise, weed was initially evaluated by counting. Pre and post-emergence applications were applied on the first day after sowing and post emergence application were applied 35 day after sowing using a knapsack sprayer with a flat-fan nozzle and a 500 L ha^{-1} spray volume. A common dose of 60 kg N, 30 kg P_2O_5 and 20 kg K_2O ha^{-1} was applied as the basal dose of nutrients at the time of sowing. Using a common equation, weed control efficiency (WCE) was calculated. The cost of cultivation was subtracted from the gross return to determine the net return. By dividing the net return by the cost of cultivation, the benefit-cost ratio was obtained.

Statistical information on weeds and crops was examined using randomized block designs and analysis of variance (ANOVA) techniques (Gomez and Gomez, 1984). The square root transformed data √x + 0.5 on weed density and dry matter were used in an ANOVA.

Formulae were used: Weed control efficiency & weed index.

Weed control efficiency (WCE%)

$$\text{WCE (\%)} = \frac{\text{DMC–DMT}}{\text{DMC}} \times 100$$

Where,

DMC = Dry matter of weeds in the un-weeded check (control)

DMT = Dry matter of weeds in the treated plot.

Weed Index (WI %)

$$\text{WI (\%)} = \frac{(\text{X– Y})}{\text{X}} \times 100$$

Where,

X = Grain yield from weed-free check or maximum yield treatment (Complete removal of weeds)

Y= Grain yield from treatment for which weed index is to be calculated

Results and Discussion

The experimental field was infested with narrow leaf weeds, broad leaf weeds, and Sedges. The important weed species at 90 DAS stages were, the main weed species were *Digitariasanguinalis* (11.27%), *Echinochloacrusgalli* (27.94%), *Digera arvensis (11.51%), Trianthemamonogyna* (13.23%), *Cyperus rotundus* (21.56%), and other weeds (14.58%). Other weeds include *Cynodondactylon L, Euphorbia hirta, Amaranthus ssp,* and *Portulacaoleracea*. In Table 1, data on density, dry weight of total weeds, and weed control efficiency (WCE) recorded at the 90-days stage of crop growth have been given below.

Effect on weeds

The effectiveness of weed control was determined by how successfully weed populations were managed and how well weed control techniques outperformed weedy checks. This was greatly altered by various weed control techniques. Among all weed control methods, the higher weed control efficiency recorded with $T_{9;}$ weed-free was found to be more effective, followed by T_5-Atrazine (50% WP)@ 750 gha^{-1} (PE)*fb* Topramezone (33.3%SC)@25 gha^{-1} (POE) followed by T_7-Atrazine (50% WP) @750gha^{-1} (PE)*fb* Tembotrion (34.4%SC)@20gha^{-1}(PoE) followed by T_6-Pendimethalin (30% EC) @ 1000gha^{-1}(PE)*fb* Topramezone (33.3% SC)@25gha^{-1} (PoE) followed by T_8-Pendimethalin (30%EC) @1000gha^{-1}(PE)*fb* Tembotrion (34.4%SC)@20 gha^{-1}(PoE), and T_1-Atrazine (50% WP)@750gha^{-1}(PE). The lower weed control efficiency (WCE) was recorded in the weedy check treatment. Among all weed control methods, the lower weed index was recorded with T_{11}-weed-free followed by T_3-Atrazine (50%WP)@750gha^{-1} (PE)*fb* Topramezone (33.3% SC) @25gha^{-1} (PoE)) applied on the first day after sowing and 35 days after sowing applied post emergence. The higher weed index (WI) was recorded in weedy check treatment.

Effect on pearl millet

A significantly higher yield was recorded in T_9-Weed-free which is at par with T_5-Atrazine (50% WP) @750gha^{-1}(PE)*fb* Topramezone (33.3%SC) @25 gha^{-1}(PoE) applied on the first day after sowing and 35 days after sowing *found*at par with the T_7-Atrazine (50% WP) @750gha^{-1}(PE)*fb* Tembotrion (34.4%SC)@ 20gha^{-1}(PoE) *found* at par with the, T_6-Pendimethalin (30%EC) @1000gha^{-1}(PE)*fb* Topramezone (33.3% SC)@25gha^{-1}(PoE), and T_9-Atrazine (50%WP) @750gha^{-1}(PE). On the weedy check treatment, a significantly greater yield was noted.

Table 1. Effect of different herbicidal treatments on yield & economics of Pearl Millet

S. No.	Treatment	Grain yield (Kg ha^{-1})	Straw Yield (Kg ha^{-1})	Harvest Index (%)	Net returns (Rs. ha^{-1})	B-C ratio (Rs. re^{-1} Invested)
T_1	Atrazine @750 g ha^{-1} (PE)	1316	2914	31.04	20147.99	0.73
T_2	Pendimethalin @1000 g ha^{-1} (PE)	1061	2568	29.25	31638.09	1.14
T_3	Topramezone @25 g ha^{-1} (PoE)	1430	3044	32.00	36702.99	1.33
T_4	Tembo Trion @20 g ha^{-1} (PoE)	1387	2992	31.68	34934.50	1.27
T_5	Atrazine @750 g ha^{-1} (PE) fb Topramezone @25 g ha^{-1} (PoE)	2000	3807	34.49	62011.54	2.21
T_6	Pendimethalin@1000 g ha^{-1}(PE) fb Topramezone @25 g ha^{-1}(PoE)	1896	3729	33.69	57483.16	2.06
T_7	Atrazine@750 g ha^{-1}(PE) fbTembotrion @20 g ha^{-1}(PoE)	1951	3790	33.99	59819.12	2.13
T_8	Pendimethalin @1000 g ha^{-1}(PE) fb Tembotrion @20 g ha^{-1} (PoE)	1654	3389	32.86	46574.68	1.67
T_9	Weed Free	2234	4156	34.98	70072.26	2.30
T_{10}	Weedy check	837	2216	27.40	10431.85	0.38
	SEm±	74	112	—	—	-
	C.D. (P=0.05)	219	334	NS	—	-

Economics

Among all the herbicide treatments, the highest net return was recorded with T_5-Atrazine (50%WP) @750gha^{-1}(PE)*fb* Topramezone (33.3%SC) @25gha^{-1}(PoE) applied on the first day after sowing and (PoE) 35 days after sowing *found* at par with the T_7-Atrazine (50%WP)@750gha^{-1}(PE)*fb* Tembotrion (34.4%SC) @20gha^{-1}(PoE) followed by T_6-Pendimethalin (30%EC) @1000 gha^{-1}(PE)*fb* Topramezone (33.3% SC) @25gha^{-1}(PoE), and T_9-Atrazine (50%WP)@750 gha^{-1}(PE). On the weedy check treatment, significantly greater net return was noted. The benefit-cost ratio recorded a higher T_3-Atrazine (50% WP) @750g ha^{-1} (PE)*fb* Topramezone (33.3%SC) @25 gha^{-1}(PoE) applied on the first day after sowing and (PoE) 35 days after sowing is at par with the T_7-Atrazine (50%WP) @750gha^{-1} (PE)*fb* Tembotrion (34.4%SC) @20gha^{-1}(PoE), followed by T_6-Pendimethalin (30%EC)@ 1000gha^{-1}(PE)*fb* Topramezone (33.3% SC)@25gha^{-1}(PoE), and T_9-Atrazine (50%WP) @750gha^{-1}(PE). On the weedy check treatment, a significantly greater benefit-cost ratio was noted.

Conclusion

The present experiment concluded that the application of T_5-Atrazin @ 750gha^{-1}(PE) followed by Topramezone @ 25 gha^{-1} performed well and produced significantly higher yield and higher net profit (Rs. 62011.54) and B-C ratio (2.21).

Conflict of interest : None

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