Eco. Env. & Cons. 30 (1) : 2024; pp. (181-185)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i01.035

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

Harish D.C. [1], Pradeep Kumar Kanaujiya[2], Pradeep Rajput[2], Jaidev Sharma[3] and Awadhesh Kishore[3]

School of Agriculture, ITM University, Gwalior 474 001 (M.P.) India

(Received 12 August, 2023; Accepted 29 September, 2023)

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 a Randomized Block Design and replicated thrice and comprised of twelve treatments. The herbicides were used individually as well as in combinations viz; T_1 to T_{12} the crop was infested with the different types of weed flora. Ex; *Digitarias anguinalis* L. and *Echinochloa crusgalli* L. of grassy, *Digera arvensis* L. and *Commelina benghalensis* L. of Broad-leaved 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 weight, and weed index were lower with Atrazine (50 % WP) at 1000 g ha^{-1} (PE).However, the higher weed control efficiency was recorded with Atrazine (50 % WP) at 1000 g ha^{-1} (PE), found at par with Atrazine (50% WP) at 750 g ha^{-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 1000 g ha^{-1} (PE). The maximum net returns and B:C ratio were recorded higher with Atrazine @ 1.0 g ha^{-1} (at 3 DAS).

Key words : *Weed management, Atrazine, Pendimethalin, Diuron, Metribuzin, Weed density, and Pearl millet.*

Introduction

Pearl millet (*Pennisetum glaucum* L.) is an important cereal crop that is widelygrown 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 (Charyulu *et al.*, 2019). Pearl millet is a significant crop in India, where it is cultivated on more than 10 million hectares of land, with an annual production of approximately 9.62 million tonnes. Rajasthan is the leading state for pearl millet production in India, responsible for more than half of the total production, followed by Gujarat, Haryana, and Uttar Pradesh. Other states that cultivate pearl millet include Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh, and Telangana. India is also the largest producer of pearl millet globally, accounting for nearly 50% of the total worldwide production. According to the latest data available from 2022, India produced approximately 8.99 million tonnes of pearl millet from an area of 9.14 mil-

([1]M.Sc. (Ag.) student, [2]Assistant Professor and [3]Professor)

lion hectares Kaur and Singh (2022). Madhya Pradesh produced around 2.16 million tonnes of pearl millet from an area of 2.51 million hectares and productivity of 860 kg ha^{-1}, which is lower than the national average of around 983 kg per hectare. However, there are certain areas in Madhya Pradesh where the productivity of pearl millet is higher than the state average, such as the Malwa region, where farmers have reported yields of up to 2,000 kg ha^{-1}. By integrating insights from a diverse range of studies, this research aims to present a comprehensive perspective on weed management in pearl millet cultivation Pandey and Singh (2021).

contributeinsight's into crop-weed competition studies and nutrient uptake.Explored weed dynamics in relation to planting methods, mulching, and weed control. One of the primary impediments in successful pearl millet cultivation pertains to weed management. Left unaddressed, weeds pose a considerable threat and can inflict substantial losses in yield. To mitigate this challenge, a repertoire of management strategies is available for effective weed control within pearl millet fields. These encompass diverse approaches spanning cultural, mechanical, chemical, and biological methods (Yadav *et al.,* 2020). Furthermore, the onslaught of pests and diseases, notably downy mildew, and stem borers, further compounds the detrimental effects on both yield and overall crop quality (Yadav *et al.,* 2021; Singh and Talukder, 2014). Weeds are a major threat in *kharif* season which adversely affect the yield. The extent of yield reduction depends upon the density of weed species, crop varieties, weather conditions and fertility of the soil. Losses due to weeds have been one of the major limiting factors in Pearl millet production because weeds compete with Pearl millet for light, moisture, and nutrients in the early season being the most critical. Most of the yield loss due to weed competition occurs during the 30 to 45 DAS, thus control should be prioritized at this time.

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 twelve 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) @ 500 g ha^{-1}(PE); T_2: Atrazine (50% WP) @ 750 g ha^{-1} (PE); T_3: Atrazine (50% WP) @ 1000 g ha^{-1} (PE); T_4: Pendimethalin (30% EC) @ 750 g ha^{-1}(PE); T_5: Pendimethalin (30% EC) @ 1000 g ha^{-1} (PE); T_6: Pendimethalin (30% EC) @ 1250 g ha^{-1} (PE) ; T_7: Metribuzin (30% WP) @ 250 g ha^{-1} (PE); T_8: Metribuzin (30% WP) @ 300 g ha^{-1} (PE); T_9: Metribuzin (30% WP) @ 350 g ha^{-1}; T_{10}: Diuron (80% WP) @ 1000 g ha^{-1}; $T_{11:}$ weed Free check.; $T_{12:}$ weedy check treatments.

Pearl millet variety "NBBH-20" was sown using seed rate of 5 kg 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 broadleaved weeds and sedges. Weed dry weight was calculated after two days of sun drying and 48 hours of Owen drying at 70±1 °C. Category-wise, weed was initially evaluated by counting.Pre-emergence applications were applied on the first 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 $\sqrt{x} + 0.5$ 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):

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

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

Weed flora

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* (22.5%), *Echinochloacrus galli* (10.86%), *Digeraarvensis (16.25%), Commelina benghalensis* (10%), *Cyperus rotundus* (26.32%), and other weeds (13.98%). Other weeds include *Cynodon dactylon* L, *Euphorbia hirta, Amaranthuss sp,* 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_{11}weed-free was found to be more effective, followed by T_3: Atrazine (50% WP) @ 1000g ha^{-1} (PE) *fb* T_2: Atrazine (50% WP) @ 750 g ha^{-1} (PE) *fb* T_6: Pendimethalin (30% EC) @ 1250 g ha^{-1} (PE) *fb* T_5: Pendimethalin (30% EC) @ 750 g ha^{-1} (PE) *fb* T_9*:* Metribuzin (30% WP) @ 350 g ha^{-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) @ 1000g ha^{-1} (PE) applied on the first day after sowing; T_2: Atrazine (50% WP) @750 g ha^{-1} (PE). The higher weed index (WI) was recorded in weedy check treatment.

Guggari *et al.* (1995) observed that weeds can be controlled up to 30–35 percent by pre-emergence applications of herbicides. This was caused by the pre-emergence herbicide's broad-spectrum activity, which can be seen in the roots and leaves of the affected plants. Pendimethalin is a selective and pre-emergence herbicide absorbed by roots and leaves. Affected plants die shortly after germination or following emergence from the soil and the timely

Table 1. Effect of different weed control treatments on weed density (no. m^{-2}), dry matter (g m^{-2}), Weed Control Efficiency (%) and weed index

S. No.	Treatment	Weed density (no. m^{-2})	Weed dry weight (g m^{-2})	WCE (%)	Weed Index (WI)
T_1	Atrazine(50% WP.)at 500 g ha^{-1} (PE)	12.89(165.64)	9.03(81.09)	70.15	29.90
T_2	Atrazine (50% W. P)at 750 g ha^{-1} (PE)	10.95(119.51)	7.46(55.16)	79.70	4.08
T_3	Atrazine(50% W. P) at 1000 g ha^{-1} (PE)	10.63(112.42)	7.10(49.90)	81.64	2.92
T_4	Pendimethalin (30% E. C) at 0.75 kg ha^{-1} (PE)	12.73(161.45)	9.08(81.87)	69.87	26.13
T_5	Pendimethalin (30% E. C) at 1 kg ha^{-1} (PE)	11.90(141.11)	8.18(66.47)	75.53	13.83
T_6	Pendimethalin (30% E. C) at1.25 kg ha^{-1} (PE)	11.60(133.97)	7.94(62.62)	76.95	10.24
T_7	Metribuzin (30% W. P)at .25 kg ha^{-1} (PE)	13.30(176.5)	9.40(87.88)	67.66	36.22
T_8	Metribuzin (30% W. P)at .30 kg ha^{-1} (PE)	13.07(170.21)	9.10(82.39)	69.68	33.54
T_9	Metribuzin(30% W. P) at .35 kg ha^{-1} (PE)	12.05(144.69)	8.23(67.23)	75.26	16.39
T_{10}	Diuron(80% W. P)at 1 kg ha^{-1} (PE)	12.20(148.36)	8.22(67.06)	24.68	19.64
T_{11}	Weed-Free check	0.71(0.00)	0.71(0.00)	100	0
T_{12}	Weedy Check	14.96(223.20)	16.48(271.71)	0	42.72
	SEm±	0.20	0.19		
	C.D.(P=0.05)	0.62	0.57		

Note: Fig. in parenthesis are the original values, X=√5e+ 0.5transformation weeding, which can reduce the population of weeds T_3; Atrazine (50% WP) 1000g ha^{-1} (PE). The crop canopy has restricted weed development as shown by plant height and the greater number of branches per plant, which cannot allow weeds to grow rapidly. This treatment combination reduced the weed population at harvest. Irrespective of weed-free treatment, significantly lower weed density (No. m^{-2}) and weed biomass at the 90-day stage were recorded with the application of T_3: Atrazine (50% WP) @ 1000g ha^{-1} (PE) applied on the first day after sowing *found* at par with the T_2: Atrazine (50% WP) @750 g ha^{-1} (PE) followed by $T_{6:}$ Pendimethalin (30% EC) @ 1250 g ha^{-1} (PE) found at par with the Pendimethalin @1000 g ha^{-1} (PE) *fb* T_9: Metribuzin (30% EC) @ 350 g ha^{-1} (PE) found at par with the Diuron (80% WP) @1000 g ha^{-1} (PE). On the weedy check treatment, significantly greater weed weight and density were noted.

Effect on pearl millet

A significantly higher yield was recorded in T_{11}: Weed-free which is at par with T_3: Atrazine (50% WP) @ 1000g ha^{-1} (PE) applied on the first day after sowing found at par with the T_2: Atrazine (50% WP) @ 750 g ha^{-1} (PE) *found* at par with the, $T_{6:}$ Pendimethalin (30% EC) @ 1250 g ha^{-1} (PE) *fb* Pendimethalin @ 1000 g ha^{-1} (PE) *fb* T_9: Metribuzin (30% EC) @350 g ha^{-1} (PE) *fb* Diuron (80% WP) @ 1000 kg ha^{-1} (PE). On the weedy check treatment, a significantly greater yield was noted.

Economics

Among all the herbicide treatments, the highest net return was recorded with T_3: Atrazine (50% WP) @ 1000g ha^{-1} (PE) applied on the first day after sowing found at par with the T_2: Atrazine (50% WP) @ 750 g ha^{-1} (PE) followed by $T_{6:}$ Pendimethalin (30% EC) @ 1250g ha^{-1} (PE) *fb* Pendimethalin @ 1000 g ha^{-1} (PE) *fb* T_9: Metribuzin (30% EC) @ 350 g ha^{-1} (PE) and Diuron (80% WP) @ 1000 g ha^{-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) @ 1000g ha^{-1} (PE) applied on the first day after sowing and it was at par with the T_2: Atrazine (50% WP) @ 750 g ha^{-1} (PE) followed by $T_{6:}$ Pendimethalin (30% EC) @ 1250g ha^{-1} (PE) *fb* Pendimethalin @1000 g ha^{-1} (PE) *fb* T_9: Metribuzin (30% EC) @ 350 g ha^{-1} (PE) *fb* Diuron (80% WP) @ 1000 g ha^{-1} (PE). On the weedy check treatment, a significantly greater benefit-cost ratio was noted.

Conclusion

Based on the experimental result, it can be concluded that among the herbicidal treatment, using Atrazine (50% WP) @ 1000g ha^{-1} *fb* Atrazine (50%WP) @ 750g ha^{-1} showed superior results in terms of reducing weed density and dry weight of weeds. It is regarded as an appropriate substitute for Pearl millet with a greater B-C ratio and broad-spectrum weed control.

Table 2. 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 (50% WP.)at 500 g ha^{-1} (PE)	1366.66	2931.24	31.79	27138	0.97
T_2	Atrazine (50% W. P)at 750 g ha^{-1} (PE)	1869.99	3823.59	32.35	46601	1.64
T_3	Atrazine (50% W. P) at 1000 g ha^{-1} (PE)	1892.66	3973.31	32.28	47393	1.65
T_4	Pendimethalin (30% E. C) at 0.75 kg ha^{-1} (PE)	1440.04	3011.70	32.16	30694	1.13
T_5	Pendimethalin (30% E. C) at 1 kg ha^{-1} (PE)	1679.99	3523.15	32.32	40121	1.46
T_6	Pendimethalin (30% E. C) at1.25 kg ha^{-1} (PE)	1749.99	3666.64	32.26	42679	1.54
T_7	Metribuzin (30% W. P)at .25 kg ha^{-1} (PE)	1243.33	2748.42	31.48	22959	0.84
T_8	Metribuzin (30% W. P)at .30 kg ha^{-1} (PE)	1295.66	2820.46	31.87	24812	0.90
T_9	Metribuzin (30% W. P) at .35 kg ha^{-1} (PE)	1629.99	3487.42	32.84	37961	1.37
T_{10}	Diuron (80% W. P)at 1 kg ha^{-1} (PE)	1566.66	3293.89	31.14	3539	1.28
T_{11}	Weed-Free check	1949.66	4292.54	32.75	40483	1.05
T_{12}	Weedy Check	1116.6	2530.47	30.61	12460	0.47
	SEm±	72.97	155.51	0.51	-	-
	C.D. (P=0.05)	214.01	456.10	NS	-	-

References

Ayub, M., Nadeem, M.A., Tanveer, A., Tahir, M. and Khan, R.M.A. 2017. Interactive effect of different nitrogen levels and seeding rates on fodder yield and quality of pearl millet. *International Journal of Agriculture Science.* 7(44): 138-140.

Aghav, V. D., Pagar, R. D. and Patel, J. C. 2019. Effect of herbicides on weeds and yield of rainy season pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. and Stuntz] *Crop Research*. 25(10): 729-891.

Charyulu, D. K., Shyam, D. M., Bantilan, C., Borikar, S. T., Gupta, S. K. and Rai, K. N. 2019. Pearl millet technology adoption and impact study in Maharashtra. *Research Report*. 71(8): 38(2).

Das, T. K. and Yaduraju, N. T. 2019. Crop weed competition studies in some kharif crops: nutrient uptake and yield reduction. *Ann. Plant Protection. Science*. 3(2).

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research*. John Wiley & Sons, 85(23): 1525-1592.

Guggari, A.K., Manjappa, K., Desai, B.K. and Chandranath, H.T. 1995. Integrated weed management in groundnut. J. *Oilseeds Research*. 12(1): 65-68.

Kaur, A. and Singh, V. P. 2022. Weed dynamics as influenced by planting methods, mulching, and weed control in rainfed hybrid pearl millet (*Pennisetum glaucum* L.). *Indian Jounral. Weed Science.* 38(1&2).

Mishra, P.S., Ramu, R.Y., Subramanyam, D. and Umamahesh, V. 2017. Impact of integrated weed management practices on weed dynamics, growth, and yield of pearl millet [*Pennisetum glaucum* (L). Br. emend. and Stuntz]. *International Journal of Agricultural Sciences*. 78(1&2).

Pandey, S., Singh, B., Kumar, A., Sharma, K. and Gupta, G. 2021 Weed dynamics, crop productivity and profitability of pearl millet as influenced by mechanized weed control under semi-arid agroecology ofIndia. *Agricultural Mechanization in Asia, Africa and Latin America*. 15(1).

Singh, S. D. and Talukder, S. K. 2014. Breeding pearl millet cultivars for resistance to downy mildew disease. *Euphytica.* 197(3): 285-295.

Yadav, R. L., Gupta, V. K., Hash, C. T. and Yadav, Y. P. 2020. Effective weed control practices for increasing crop yield in pearl millet. *Journal of Agronomy and Crop Science.* 192(6): 430-440.

Yadav, R. S., Yadav, S. R., Singh, D. and Verma, A. 2021. Pearl millet: a sustainable cereal for food security and nutritional security under climate change. *Environmental Science and Pollution Research*. 25(10): 8979-8988.