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# EFFECT OF WEED MANAGEMENT PRACTICES ON PEARL MILLET (*Pennisetum glaucum* L.) PRODUCTIVITY AND WEED DYNAMICS UNDER SEMI-ARID CONDITION OF RAJASTHAN INDIA

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**ABSTRACT**

A field experiment was conducted at Agronomy Research Farm, Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Rajasthan to study the effect of weed management practices on pearl millet productivity and weed dynamics under semi-arid condition of Rajasthan. Eight treatments of weed management were tested in randomized block design with three replications. The treatments consisted of $T_1$: Weedy check; $T_2$: Weed free; $T_3$: Two hand weeding 3& 5 weeks after sowing; $T_4$: PE application of Atrazine @ 500 g a.i./ha *fb* one HW at 3-4 WAS; $T_5$: Tembotrione 42% SC @ 90g a.i./ha at 3-4 leaf stage of weeds; $T_6$: Tembotrione 42% SC @ 100g a.i./ha at 3-4 leaf stage of weeds; $T_7$: PE application of Atrazine @ 500 g a.i./ha + Tembotrione 42% SC @ 90g a.i./ha at 3-4 leaf stage of weeds; $T_8$: PE application of Atrazine @ 500 g a.i./ha + Tembotrione 42% SC @ 100g a.i./ha at 3-4 leaf stage of weeds. Results on the pooled basis showed that weed free plot recorded significantly highest grain (3956 kg/ha) and stover (8827 kg/ha) yield of pearl millet followed by PE application of Atrazine @ 500 g a.i./ha *fb* one HW at 3-4 WAS, PE application of Atrazine @ 500 g a.i./ha + Tembotrione 42% SC @ 100g a.i./ha at 3-4 leaf stage of weeds and Two hand weeding 3& 5 weeks after sowing. From the results it is concluded that PE application of Atrazine @ 500 g a.i./ha followed by post emergence application of Tembotrione 42% SC @ 100g a.i./ha at 3-4 leaf stage of weeds significantly controlled the weed population and increased pearl millet productivity under rainfed condition with maximum net returns and B:C ratio.

***Keywords*:** Atrazine, Pearl millet, Tembotrion, Weed, Weed control efficiency.

## Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the most widely grown staple food of majority of poor and small land holders in Asia and Africa. It is also consumed as feed and fodder for livestock. It accounts for almost half of global millet production. It is the world's sixth and India's fourth important cereal food crop after rice, wheat and maize. Pearl millet is not only a quick growing short duration crop, but also a high drought tolerant and well adapted to different soil types. Pearl millet in India is being cultivated on an area of 7.47 million ha with a production of 9.80 million tonnes and the average productivity of 1312 Kg $ha^{-1}$ (Anonymous 2018-19) In India, the major pearl millet growing states are Rajasthan, Maharashtra, Uttar Pradesh, Gujarat and Haryana contributing 90% of total national production. In Rajasthan, pearl millet occupies 4.15 million ha area with the production of 4.15 million tonnes and average productivity of 1001 kg $ha^{-1}$. (Anonymous. 2018). Pearl millet is also called as the "Powerhouse of Nutrition" as it consists of most of the important nutrients in good quantity and quality which is required for maintaining healthy life. It has

high concentration of macronutrients and micronutrients such as iron, zinc, calcium, magnesium, copper, manganese, phosphorous, folic acid and riboflavin. It is rich source of unsaturated fatty acids (75%). Nutritional value of pearl millet is better in comparison to wheat, rice, maize and sorghum. It is a good source of energy, carbohydrate, fat (5-7%), ash, dietary fiber (1.2g/100g), α-amylase activity, quality protein (9-13%), vitamin A and B, minerals (2.3mg/100g), antioxidants such as ferulic acid and coumaric acids with better fat digestibility (Poshan, 2019). Pearl millet has special health benefiting properties for people suffering from life style diseases like diabetes, obesity etc. as it has high proportions of slowly digestible starch and resistant starch that contribute to low glycemic index. Pearl millet is gluten free and retains its alkaline properties even after being cooked which is ideal for people suffering from gluten allergy and acidity. Due to the excellent nutritional properties and resilience to climate change, pearl mill*et al*ong with other millets is renamed as nutri-cereals (Anonymous, 2018) for production, consumption, trade and was included in public distribution system.

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, as weeds compete for nutrient, water, light, and space; reduce crop yield and quality with crop during the early growth period. Weeds cause the lower grain and straw yields of *Kharif* pearl millet. Pearl millet grows slowly initially and is a relatively poor competitor with weeds during the first few weeks of growth. A heavy infestation of weed in pearl millet may reduce the yield by 40-55% (Banga, 2000; Sharma and Jain, 2003). The nutrient depletion by weeds in pearl millet is up to 61.8 kg N, 5.6 kg P and 57.6 kg K per hectare (Ram *et al.*, 2004). The critical period for weed competition in pearl millet is up to 30-45 days after sowing (Bhan *et al*., 1998). The predominant methods of weed management are inter-culturing and hand weeding. These are found effective, but they have certain limitations like unavailability of laborers during peak periods under intensive farming and high labour cost. Herbicides are as an effective tool for weed management and replacing conventional methods of weed management.

## Material and Method

A field experiment was conducted under on Pearl millet for three consecutive years during *Kharif* 2019 to *Kharif* 2021 at Agronomy Research Farm, Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Rajasthan to study the effect of weed management practices on pearl millet productivity and weed dynamics under semi-arid condition of Rajasthan. The experimental site was located at 26°512 N latitude and 75°472E longitude and at an altitude of 390 m above mean sea level. The mean maximum temperature was 31.62°C, 33.42°C, 34. 12°C and minimum temperature was 22.5°C, 23.1°C, 22.4 °C and total rainfall was 718.2 mm, 489.4 mm 510.0 mm, during the crop period in the year 2019, 2020 and 2021, respectively. The soil of the experimental site was well-drained loamy sand and coarse in texture. It was low in organic carbon (0.278 %) and available nitrogen (116.45kg/ha), medium in available phosphorus (34.0kg/ha) and available potassium (215.20 kg/ha) with pH 7.6 and EC 0.14dS $m^{-1}$. Eight weed management treatments were tested in randomized block design with three replications. The treatments consisted of $T_1$: Weedy check; $T_2$: Weed free; $T_3$: Two hand weeding 3& 5 weeks after sowing; $T_4$: Pre emergence application of Atrazine @ 500 g a.i./ha followed by *o*ne hand weeding at 3-4 weeks after sowing $T_5$: Tembotrione 42% SC @ 90g a.i./ha at 3-4 leaf stage of weeds; $T_6$: Tembotrione 42% SC @ 100g a.i./ha at 3-4 leaf stage of weeds; $T_7$: PE application of Atrazine @ 500 g a.i./ha + T5; $T_8$: . PE application of Atrazine @ 500 g a.i./ha + T6. Certified seeds of pearl millet variety RHB 173 were sown manually 2-3 cm deep at a recommended seed rate of 4.0 kg $ha^{-1}$. In all the years, crop was sown in first week of July and harvested in last week of September. The data on weed counts and dry matter were recorded with the help of a quadrate (0.5 m x 0.5 m) at two places per plot and then converted into per square meter. Weed control efficiency and weed index is calculated with the help of following formulas

$$\mathrm{WCE}(\%) = \frac{\text{Weed dry matter in weedy check plot} - \text{Weed dry matter in treated plot}}{\text{Weed dry matter in weedy check plot}} \times 100$$

Weed index is a derived parameter to measure crop yield loss accrued across treatments in comparison to a weed free plot and calculated with following formula:-

$$\text{Weed Index} = \frac{\text{Crop yield in weed free plots} - \text{Crop yield in the treated plot}}{\text{Crop yield in weed free plots}} \times 100$$

The economics was calculated as gross income based on prevailing market prices grain and stover and net returns were computed by deducting total cost from gross returns. B:C ratio was calculated for each treatment by dividing net return with cost. Data were analyzed statistically by applying the technique of analysis of variance (ANOVA) prescribed for the

design to test the significance of overall difference among treatments by the F test and conclusions were drawn at 5% probability level.

## Result and Discussion

### Weed flora

Experimental plot was infested with mixed flora of narrow and broad-leaved weeds *viz*., *Amaranthus viridis, Tribulus terristris, Digera arvensis, Corchorus trilocularis, Phyllanthus niruri, Celosia argentea* and *Portulaca oleracea* among broad-leaved weeds and *Eragrostis minor, Cyperus rotundus, Cynodon dactylon* and *Dactyloctenium aegyptium* were among narrow-leaved weeds. However, broad-leaved weeds were dominated over narrow-leaved weeds.

### Effect on weeds

The susceptibility and tolerance of different kinds of weeds to different applications of herbicides depend on their size and shape. There was a progressive increase in the population of individual weed species as well as total weeds. In the present investigation, weed dry weight was substantially reduced as opposed to weedy check due to specific weed management practices. At harvest the weed dry weight (both narrow and broadleaved weeds) was significantly lesser with the application of T4-atrazine 50% WP @ 500 g *a.i.* ha-1 (PE) *fb* one hand weeding at 3 – 4 WAS whereas, lowest dry weight of weeds was found in T…..-atrazine 50% WP @ 500 g *a.i.* $ha^{-1}$ (PE) *fb* tembotrione 42% SC @ 100 g *a.i.* $ha^{-1}$ at 3-4 leaf stage of weeds. Similar results were reported by Sunitha and Kalyani (2012) in maize and Guggari and Mallappa (2017) in pearl millet. The efficacy of herbicides can only be measured by measuring the weed control efficiency of a particular treatment and contrasting it with weedy check in terms of weed control. Lowest weed intensity and highest weed control efficiency was also recorded in T8.-atrazine 50% WP @ 500 g *a.i.* $ha^{-1}$ (PE) *fb* tembotrione 42% SC @ 100 g *a.i.* $ha^{-1}$ after weed free. The marked differences were obtained in weed control efficiency were due to different weed management treatments. Among herbicidal treatments, maximum weed control efficiency was achieved at 30 DAS by the sequential application of pre- and post-emergence herbicides *i.e.,* T8…..-atrazine 50% WP @ 500 g *a.i.* $ha^{-1}$ (PE) *fb* tembotrione 42% SC @ 100 g *a.i.* $ha^{-1}$ at 25 DAS. The results were in close conformity with the findings of Bhuva and Detroja (2018) and Samota (2019), Kumar and Choudhary (2022) in pearl millet. This might be due to broad spectrum nature of atrazine which killed weed by inhibiting electron transfer during photosynthesis, thereafter coinciding with tembotrione which acted as an inhibitor of enzyme 4-hydroxyphenylpyruvate dioxygenase (HPPD) resulted in lesser weed counts and ultimately produced lower weed dry weight (Table 1).

### Effect on crop growth and yield

Pooled data of three years (2019 to 2021) pertaining to growth, yield attributes and yield of pearl millet is given in Table 2 and 3. The plant population of pearl millet was found non- significant among different treatments over the years. Total and effective tillers/plant was found significantly higher in different weed management treatments as compared with weedy check. However, significantly higher total and effective tillers were found in weed free followed by two hand weeding, T4…..-atrazine 500 g a.i./ha as pre emergence f/b hand weeding and in $T_8$ - atrazine 50% WP @ 500 g *a.i.* $ha^{-1}$ (PE) *fb* tembotrione 42% SC @ 100 g *a.i.* $ha^{-1}$ . Similar trend was also recorded with respect to plant height. Test weight (1000- grains weight) also increased significantly under all treatments as compared with weedy check. The grain yield was computed based on treatments of inputs. It varied from 3956 kg/ha (Pooled mean) under weed free to 2309 kg/ ha (pooled mean) in weed check. Difference in yield was due to higher weed density in weed check treatment. Among other treatments, weed free has highest yield with 3956 kg/ha. Treatment $T_8$ recorded grain and stover yield of pearl millet which was significantly at par with the weed free. Lowest grain and stover yield were recorded under weedy check.

**Table 1 :** Performance of different weed management practices on weed intensity, weed control efficiency and weed index (Pooled data of 3 years)

| Treatments | Weed Intensity (%) | Weed Control Efficiency % | Weed index % | Weed dry weight ($g/m^2$)* |
|---|---|---|---|---|
| $T_1$ | 88 | 0.0 | 41.63 | 21.91 |
| $T_2$ | 0 | 100.0 | 0.00 | 1.0 |
| $T_3$ | 28 | 88.8 | 7.77 | 7.468 |
| $T_4$ | 30 | 88.0 | 4.51 | 7.738 |
| $T_5$ | 74 | 39.9 | 34.93 | 17.366 |
| $T_6$ | 72 | 43.1 | 29.94 | 17.11 |

| | | | | |
|---|---|---|---|---|
| $T_7$ | 26 | 89.7 | 9.80 | 18.999 |
| $T_8$ | 24 | 92.7 | 1.47 | 18.987 |
| SEm± | 1.0 | 3.6 | | 2.159 |
| CD at 5% | **3.1** | **10.9** | | 0.705 |
| CV% | 3.01 | 11.61 | | 0.997 |

*Square root transformation

**Table 2 :** Performance of different weed management practices on pearlmillet growth and yield attribute (Pooled data of 3 years)

| Treatments | Plant population 000'/ha | Total tillers/ plant | Effective tillers/plant | Plant height (cm) | Test wt. (g) |
|---|---|---|---|---|---|
| $T_1$ | 171 | 1.95 | 1.11 | 167.3 | 7.01 |
| $T_2$ | 174 | 3.61 | 2.78 | 197.4 | 8.18 |
| $T_3$ | 173 | 3.23 | 2.56 | 183.1 | 7.95 |
| $T_4$ | 173 | 3.77 | 2.72 | 194.7 | 8.07 |
| $T_5$ | 175 | 1.99 | 1.78 | 186.6 | 7.63 |
| $T_6$ | 177 | 1.94 | 1.78 | 178.0 | 7.35 |
| $T_7$ | 169 | 2.56 | 2.00 | 182.44 | 7.39 |
| $T_8$ | 174 | 3.22 | 2.44 | 175.44 | 7.81 |
| SEm± | 5.4 | 0.2 | 0.12 | 5.7 | 0.19 |
| CD at 5% | **NS** | 0.62 | 0.38 | **17.4** | 0.59 |
| CV% | 5.37 | 12.68 | 10.00 | 5.43 | 4.38 |

## Economics

Among economic parameters net returns and B:C ratio were worked out (Table 3). Maximum net returns were achieved in PE application of Atrazine @ 500 g a.i./ha + T6 (Rs. 51430/ha) followed by PE application of Atrazine @500 g a.i./ha *fb* one HW at 3-4 WAS (Rs. 48830/ha) and PE application of Atrazine @ 500 g a.i./ha + T5 (Rs.45835/ha). However, the economic viability of any treatment is judged on basis of net returns and B: C ratio. In the present study, PE application of Atrazine @ 500 g a.i./ha+ T6 was found most economical with highest net returns and B:C ratio (Rs. 51430/ha and 2.8) in comparison to PE application of Atrazine @500 g a.i./ha *fb* one HW at 3-4 WAS and PE application of Atrazine @ 500 g a.i./ha + $T_5$ fetching net returns (Rs.48830 and 45835/ha; and 2.7 and 2.6 under both treatments), respectively. Treatment $T_3$ and $T_4$ recorded significantly equal yields, but due to higher cost of labour employed for hand weeding and interculture, it fetched lower net returns and B:C ratio. This was mainly because of high cost of labour employed in weeding operations in comparison to chemical weed control (Nibhoria *et al*., 2021)

**Table 3 :** Performance of different weed management practices on pearlmillet yield and economics

| Treatments | Yield (kg/ha) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Grain | | | Pooled | Stover | | | Pooled | Net returns (Rs./ha) | B:C |
| | 2019 | 2020 | 2021 | | 2019 | 2020 | 2021 | | | |
| $T_1$ | 2922 | 2305 | 1699 | 2309 | 4979 | 5333 | 3578 | 4630 | 22704 | 2.0 |
| $T_2$ | 4588 | 4362 | 2917 | 3956 | 9671 | 10625 | 6186 | 8827 | 41850 | 2.1 |
| $T_3$ | 4362 | 3909 | 2706 | 3659 | 9156 | 10058 | 5738 | 8317 | 41278 | 2.2 |
| $T_4$ | 4506 | 4156 | 2808 | 3823 | 9053 | 10146 | 5944 | 8381 | 48830 | 2.7 |
| $T_5$ | 3539 | 2963 | 2343 | 2948 | 6543 | 7875 | 4936 | 6451 | 32561 | 2.2 |
| $T_6$ | 3189 | 3086 | 2382 | 2886 | 6399 | 7416 | 5039 | 6285 | 30878 | 2.1 |
| $T_7$ | 4033 | 3848 | 2840 | 3574 | 8971 | 9835 | 6033 | 8280 | 45835 | 2.6 |
| $T_8$ | 4469 | 4321 | 2905 | 3898 | 9185 | 10658 | 6153 | 8665 | 51430 | 2.8 |
| SEm± | 197 | 242 | 138 | 192.33 | 282 | 437 | 292 | 337.00 | - | - |
| CD at 5% | 597 | 734 | **419** | 583 | 856 | 1326 | **886** | 1023 | - | - |
| CV% | 9.29 | 11.58 | 9.29 | 10.21 | 6.11 | 8.42 | 9.28 | 8.24 | - | - |

## Conclusion

From the results, it is concluded that pre emergence application of Atrazine @ 500 g a.i./ha followed by post emergence application of Tembotrione 42% SC @ 100g a.i./ha at 3-4 leaf stage of weeds significantly controlled the weed population and increased pearl millet productivity under rainfed condition with maximum net returns and B:C ratio.

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