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# Integrated weed management in pearl millet

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## ABSTRACT

A field experiment was carried out during the rainy (*Kharif*) seasons of 2012 to 2014 in medium black soil at Bajra Research Scheme, Dhule, Maharashtra, to evaluate the effect of integrated weed management in rainfed pearl millet (*Pennisetum glaucum*) with pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS, four levels of post-emergence application of atrazine (0.1, 0.2, 0.3 and 0.4 kg/ha) along with one hand weeding at 35 DAS, two hand weeding and hoeing (at 20 and 40 DAS). The maximum grain yield was recorded with pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS, which was at par with two hand weeding and hoeing, and post-emergence application of atrazine 0.4 kg/ha + 1 HW at 35 DAS and increased the yield by 62.14% over weedy check. The higher grain yield may be owing to significantly lower weed dry weight, higher weed control efficiency which reflected in higher values of plant height, number of effective tillers/plant, earhead length and 1,000 grain weight. Maximum net returns (¹ 27,282/ha) and B:C ratio (2.73) were realized with pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS followed by post-emergence application of atrazine 0.4 kg/ha + 1 HW at 35 DAS which recorded net monetary returns of ¹ 25,404/ha and B:C ratio 2.62.

**Key words:** Herbicide, Pearl millet, Post-emergence, Pre-emergence, Weed control efficiency

Pearl millet (*Pennisetum glaucum* L.) is one of the important cereal crops globally after rice, wheat and maize. It is a unique crop among the major cereals and the staple food and fodder crop of the world's poor and most food insecure populations in the arid and semi-arid tropics. In India, the area and productivity of rainy (*Kharif*) season pearl millet during 2015-16 was 7.8 million hactares and 9.25 million tones, respectively with productivity of 1270 kg/ha. In Maharashtra, it is cultivated over an area of 0.80 million hactares with a production and productivity of 0.33 million tones and 416 kg/ha, respectively (GOI 2015-16). Weeds are a major obstacle in increasing the productivity of pearl millet especially during rainy season. Sharma and Jain (2003) reported upto 40% loss in grain yield due to weed competition in pearl millet. Under scarcity of human labour, use of herbicide is the best option to reduce the weed menace during early stages of growth. Some pre-mergence herbicides have been found effective against the weed of pearl millet (Das *et al*. 2013). However, neither herbicides nor mechanical cultivation are adequate for consistent and acceptable weed control. Therefore, present experiment was conducted to find out the effect of integrated weed management on productivity, weed dynamics and economics of rainy season pearl millet.

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## MATERIALS AND METHODS

Field experiment was carried out during the rainy (*Kharif*) seasons of 2012 to 2014 at Bajra Research Scheme Farm, College of Agriculture, Dhule (Maharashtra) under rainfed conditions on medium black soil. The soil of experimental field was clayey in texture, medium in organic carbon (0.51%), low in available nitrogen (213.0 kg/ha), with medium availability of phosphorus (15.8 kg/ha) and rich in potash (541.0 kg/ha). The soil was slightly alkaline in reaction (pH 8.1) with normal electrical conductivity (0.32 dS/m). The experiment was laid out in a randomized block design with four replications. Eight treatments comprised of weedy check, weed free, pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS, post-emergence application of atrazine 0.1 kg/ha + 1 HW at 35 DAS, post-emergence application of atrazine 0.2 kg/ha + 1 HW at 35 DAS, post-emergence application of atrazine 0.3 kg/ha + 1 HW at 35 DAS, post-emergence application of atrazine 0.4 kg/ha + 1 HW at 35 DAS and two hand weeding and hoeing at 20 and 40 DAS.

The pre-emergence herbicide was sprayed after sowing on wet soil and post-emergence herbicide was applied at 20 days after sowing (3rd leaf stage of weed) with the help of knapsack sprayer at a spray volume of 600 L/ha. Pearl millet hybrid *'86 M 64'* was sown at 45 x 15 cm spacing on 7 July 2012, 27 June 2013 and 20 July 2014. The delayed sowing

during 2014 was due to late onset of monsoon. The gross plot size was 5.0 x 3.6 m and crop was fertilized with 60 kg N and 30 kg P/ha through urea and single super phosphate. At sowing 50% N along with full dose of P were applied and remaining 50% N was applied 30 days after sowing. Total rainfall (678.6 mm) in 2013 during the cropping period was higher than 2012 (527.7 mm) and 2014 (469.3 mm). Weed population and weed dry matter were recorded 30 days after sowing and at harvest from pre-marked quadrants of 1 $m^2$ area. Weed control efficiency and weed index were worked out to assess the efficiency of different weed-control treatments. The data on growth and yield attributes were recorded from 5 randomly selected plants at harvest. The crop was harvested on 19 October 2012, 21 October 2013 and 5 November 2014. The economics were calculated based on prevailing market prices of inputs and out puts. The data were statistically analyzed and pooled data of three years were presented.

## RESULTS AND DISCUSSION

The major weed species observed in the experimental plot were grassy weeds like *Cynondon dactylon, Brachiaria eruciformis*; broad-leaf weeds like *Parthenium hysterophorus, Commelina benghalensis, Celosia argentea, Panicum isachmi, Amaranthus viridis, Euphorbia microphylla, Phyllanthus niruri, Alteranthera triandra;* and sedges *Cyperus rotundus.*

### Weed density and weed control efficiency

All the weed control measures reduced weed density and dry matter of weeds over weedy check (**Table 1**). The weed density and weed dry matter were significantly lowest in 2 hand weeding and hoeing at 20 and 40 DAS. Among the integrated weed management treatment dry matter, it was lower in pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS when compared with its other doses. In weed free treatment, there was no weed dry matter due to absence of weeds. The weedy check recorded the highest weed biomass. Similar results were reported by Ramakrishna (1994) and Sharma and Jain (2003).

Two hand weeding and hoeing at 20 and 40 DAS recorded significantly higher weed control efficiency (88.92% and 90.95% at 30 DAS and at harvest, respectively) and it was at par with pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS (79.21% and 83.25% at 30 DAS and at harvest, respectively) followed by post- emergence application of atrazine 0.4 kg/ha + 1 HW at 35 DAS (**Table 1**). The weed free treatment was found significantly superior by recording 100% weed control efficiency. The results were collaborating with the findings of Sharma and Jain (2003)

Among the weed control treatments, pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS recorded lower weed index (3.71%) and it was at par with two hand weeding and hoeing at 20 and 40 DAS (4.36%). Weed free treatment recorded the lowest weed index (0%) indicating that there was no reduction in grain and fodder yields due to weed infestation. The highest weed index (40.39%) was recorded in weedy check (control) as a result of uncontrolled weed growth which leads to higher competition with the crop. Similar results were obtained by Gautam and Kaushik (1984), Banga *et al.* (2000) and Sharma and Jain (2003).

**Table 1. Effect of weed management practices on weed intensity, weed biomass, weed control efficiency and weed index (pooled data of 3 years)**

| Treatment | Weed intensity (no./$m^2$) | | Weed dry matter (g/$m^2$) | | Weed control efficiency (%) | | Weed index at harvest (%) |
|---|---|---|---|---|---|---|---|
| | 30 DAS | At harvest | 30 DAS | At harvest | 30 DAS | At harvest | |
| Atrazine 0.5 kg/ha (PE) + 1 HW at 35 DAS | 6.15 (37.43) | 5.29 (27.50) | 5.08 (25.40) | 4.05 (15.96) | 79.21 | 83.25 | 3.71 |
| Atrazine 0.1 kg/ha (PoE) + 1 HW at 35 DAS | 8.83 (77.50) | 6.14 (37.25) | 7.16 (51.04) | 5.55 (30.37) | 58.85 | 71.93 | 19.25 |
| Atrazine 0.2 kg/ha (PoE) + 1 HW at 35 DAS | 8.02 (63.87) | 5.97 (35.25) | 6.41 (40.68) | 5.33 (27.94) | 66.01 | 74.29 | 15.44 |
| Atrazine 0.3 kg/ha (PoE) + 1 HW at 35 DAS | 7.88 (61.70) | 5.89 (34.17) | 6.25 (38.78) | 5.08 (25.33) | 68.92 | 75.39 | 13.78 |
| Atrazine 0.4 kg/ha (PoE) + 1 HW at 35 DAS | 7.83 (60.76) | 5.53 (30.16) | 5.91 (34.46) | 4.85 (23.04) | 71.00 | 78.01 | 7.88 |
| Two hand weeding and hoeing at 20 and 40 DAS | 5.23 (27.00) | 4.18 (17.08) | 3.85 (14.51) | 3.01 (8.62) | 88.92 | 90.95 | 4.36 |
| Control (weedy check) | 9.63*(92.33) | 8.23 (67.16) | 11.59 (134.0) | 10.17 (102.9) | 0.00 | 0.00 | 40.39 |
| Weed free | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 100 | 100 | 0.00 |
| LSD (p=0.05) | 0.24 (3.01) | 0.22 (1.90) | 0.69 (10.71) | 0.35 (5.79) | 9.76 | 8.21 | 3.19 |

Values are subjected to square root $\sqrt{x+0.5}$ transformation; original values are in parentheses**;** DAS- Days after sowing, HW- Hand weeding; PE- Pre-emergence; PoE- Post-emergence

**Table 2. Effect of weed management practices on growth and yield parameters of pearl millet (pooled data of 3 years)**

| Treatment | Plant height (cm) | No. of effective tillers/ plant | Earhead length (cm) | 1,000 grain weight (g) | Grain yield (t/ha) | Fodder yield (t/ha) | Gross returns (x10$^3$ `/ha) | Cost of cultivation (x10$^3$ `/ha) | Net returns (x10$^3$ `/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| Atrazine 0.5 kg/ha (PE) + 1 HW at 35 DAS | 214.0 | 1.80 | 26.11 | 11.48 | 3.10 | 5.70 | 43.01 | 15.73 | 27.28 | 2.73 |
| Atrazine 0.1 kg/ha (PoE) + 1 HW at 35 DAS | 208.4 | 1.44 | 24.49 | 10.91 | 2.59 | 4.79 | 35.98 | 15.38 | 20.61 | 2.34 |
| Atrazine 0.2 kg/ha (PoE) + 1 HW at 35 DAS | 209.5 | 1.49 | 24.88 | 11.03 | 2.70 | 5.00 | 37.59 | 15.55 | 22.04 | 2.42 |
| Atrazine 0.3 kg/ha (PoE) + 1 HW at 35 DAS | 210.9 | 1.50 | 25.20 | 11.15 | 2.76 | 5.13 | 38.43 | 15.62 | 22.81 | 2.46 |
| Atrazine 0.4 kg/ha (PoE) + 1 HW at 35 DAS | 212.2 | 1.63 | 25.43 | 11.26 | 2.96 | 5.49 | 41.08 | 15.68 | 25.40 | 2.62 |
| Two hand weeding and hoeing at 20 and 40 DAS | 214.8 | 1.84 | 26.00 | 11.49 | 3.07 | 5.68 | 42.58 | 18.47 | 24.11 | 2.31 |
| Control (weedy check) | 201.3 | 1.03 | 23.22 | 10.53 | 1.91 | 3.59 | 26.58 | 12.44 | 14.14 | 2.14 |
| Weed free | 216.4 | 1.98 | 26.38 | 11.73 | 3.22 | 5.96 | 44.71 | 20.62 | 24.09 | 2.17 |
| LSD (p=0.05) | 4.38 | 0.27 | 0.96 | 0.24 | 0.14 | 0.28 | 1.41 | - | 1.35 | 0.08 |

HW- Hand weeding; PE- Pre-emergence; PoE- Post-emergence

### Performance of pearl millet

All the weed control measures significantly increased the grain and fodder yield of pearl millet compared with weedy check (**Table 2**). The grain and fodder yields (3.22 and 5.96 t/ha, respectively) were recorded significantly higher in weed free treatment and were at par with pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS (3.10 and 5.70 t/ha, respectively). The next best treatment was two hand weeding and hoeing at 20 and 40 DAS and post-emergence application of atrazine 0.4 kg/ha + 1 HW at 35 DAS, which were at par with pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS. The lowest grain and fodder yield (1.91 and 3.59 t/ha, respectively) was recorded in weedy check because presences of more weeds interfered with growth and development of the crop and compete for nutrients, moisture, light and space. These results were in close conformity with those reported by Balyan *et al.* (1993), Ramakrishna (1994), Sharma and Jain (2003) and Deshveer (2005).

### Economics

The cost of cultivation (` 20,620/ha) and gross monetary returns (` 24,090/ha) were significantly higher in weed free treatment. It was followed by two hand weeding and hoeing at 20 and 40 DAS and pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS. While, net monetary returns (` 27,282/ha) and B:C ratio (2.73) was significantly higher in pre-emergence application of atrazine 0.5 kg/ha + 1 HW at 35 DAS than rest of the weed control treatments. It was closely followed by post-emergence application of atrazine 0.4 kg/ha + 1 HW at 35 DAS, which recorded net monetary returns of ` 25,404/ha and B:C ratio 2.62 (**Table 2**). Weed free treatment registered lower net monetary returns due to high cost involved in repeated weeding to keep crop weed-free despite having highest grain and fodder yield.

It was concluded that pre-emergence application of atrazine 0.5 kg/ha followed by hand weeding at 35 DAS and post-emergence application of atrazine 0.4 kg/ha at 20 DAS followed by hand weeding at 35 DAS appeared to be the best integrated weed management practice.

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