Effect of Integrated Weed Management on Yield, Yield Attributes and Economics of Pearl Millet \([\textit{Pennisetum glaucum} \text{ (L.)} \text{ R. Br. emend stuntz}]\)

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A B S T R A C T

A field experiment entitled “Effect of integrated Weed management on pearl millet \([\textit{Pennisetum glaucum} \text{ (L.)} \text{ R. Br. emend Stuntz}]\)” was conducted at Agricultural farm, Suresh GyanVihar University, Jagatpura, Jaipur, Rajasthan in Kharif 2018. The experiment consisted of nine weed management treatments involving three pre-emergence herbicides (Alachlor, Atrazine and Oxyfluorfen) in randomized block design with three replications. Among the treatments, 2 Hand weedings (HW) at 20 and 40 DAS(T2) attained higher grain, stover and biological yield (1987, 4935 and 6922 kg ha\(^{-1}\)) over other treatments. In case of earhead length and harvest index, Atrazine @ 750g ha\(^{-1}\) (PE) + 1 HW at 20 DAS (T6) recorded higher with 8.48g and 28.77% respectively. In case of economics, 2 HW at 20 and 40 DAS (T2) attained highest gross returns (₹49064 ha\(^{-1}\)) and Atrazine @ 750g ha\(^{-1}\) (PE) + 1 HW at 20 DAS (T6) attained higher net returns and BCR with (₹23332 ha\(^{-1}\)) and (1.91) respectively. Among all the yield attributes i.e. ear head length, test weight, grain yield, stover yield, biological yield and harvest index (20.5, 6.10, 863, 2836, 3698 and 23.33, respectively) attained the lowest values and economics i.e. net returns and BCR (2717 and 1.12, respectively) attained the lowest values.

Keywords
Pearl millet, Alachlor, Atrazine, Oxyfluorfen, Hand weeding

Introduction
Pearl millet \([\textit{Pennisetum glaucum} \text{ (L.)} \text{ R.Br. emend Stuntz}]\) is one of the important cereal crop of arid and semi-arid climatic conditions. Cultivation of pearl millet is mainly confined to the Southern Asia (India, Pakistan, Nepal, Bhutan and Afghanistan) and Africa (Nigeria, Niger, Mali, Tanzania, Sudan and Senegal). India is the largest producer of pearl millet having 7.47 m ha area with annual production of 9.86 million tonnes grain and productivity of 1319 kg ha\(^{-1}\) (Anonymous, 2018). As pearl millet is grown predominantly in warm rainy season, weeds of different kinds deprive the crop of vital nutrients, moisture, light and space. Das and Yaduraju (1995) have reported 72% or more yield loss in pearl millet due to its initial slow growth. It picks up growth, start tillering and increase in height after 25-30 days after sowing (DAS) and become more competitive against weeds. Weed management has been always a basic, indispensable integral part of agriculture. Manual weeding is a common practice adopted for weed control throughout the crop season is a labour and
cost-intensive affair. Therefore, integrated approach for weed management using chemical and non chemical methods have been in practice for achieving better management of weeds in field.

**Materials and Methods**

**Experimental details**

A field experiment was conducted during kharif, 2018 at Suresh Gyan Vihar University, Agricultural farm, Jagatpura, Jaipur, Rajasthan. The soil was sandy clay loam in texture, low in organic carbon (0.15 %), available N (0.40 kg ha\(^{-1}\)), medium in available P (42 kg ha\(^{-1}\)) and available K (290 kg ha\(^{-1}\)) with pH 8.48. Nine treatments of weed control were evaluated in randomized block design replicated thrice with hybrid RHB- 173. The recommended dose of 60 kg N, 30 kg P\(_2\)O\(_5\) and 0 kg K\(_2\)O ha\(^{-1}\) was applied. Entire quantity of nitrogen and phosphorous were applied as basal dose through urea and single super phosphate, respectively. The seeds were sown with a spacing of 45 × 15 cm. Thinning and gap filling were done at 15 DAS.

**Treatment details**

The treatments consisted of Control (T\(_0\)), 1 HW at 20 DAS (T\(_1\)), 2 HW at 20 and 40 DAS (T\(_2\)), Alachlor @ 1000 g ha\(^{-1}\) (PE) (T\(_3\)), Alachlor @ 1000 g ha\(^{-1}\) + 1 HW at 20 DAS (T\(_4\)), Atrazine @ 750 g ha\(^{-1}\) (PE) (T\(_5\)), Atrazine @ 750 g ha\(^{-1}\) + 1 HW at 20 DAS (T\(_6\)), Oxyfluorfen @ 150 g ha\(^{-1}\) (PE) (T\(_7\)) and Oxyfluorfen @ 150 g ha\(^{-1}\) + 1 HW at 20 DAS (T\(_8\)). Pre-emergence herbicides were applied 1 day after sowing (DAS), uniformly by using spray fluid @ 800 L ha\(^{-1}\) with the help of knapsack sprayer. Hand weedicings were carried out in the respective treatments at 20 and 40 DAS.

**Statistical analysis**

The observations on yield and yield attributes were recorded at harvest. The statistical analyses were done by using OP STAT.

**Results and Discussion**

**Weed flora**

Weed survey during the experimentation showed that the crop was heavily infested by weeds immediately after the emergence of the crop. The prominent annual dicot weed species noted to invade the crop were *Digera arvensis*, *Amaranthus viridis*, *Amaranthus spinosus*, *Phyllanthus niruri*, *Trianthema portulacastrum* etc. Whereas, *Cyperus rotundus*, *Dactyloctenium aegypticum*, *Digitaria sanguanalis*, *Cenchrus biflorus* and *Cynodon dactylon* were the major grassy and sedge species found to invade the crop.

**Yield and yield attributes**

Yield attributes showed a varied difference among the parameters. 2 HW at 20 and 40 DAS(T\(_2\)) recorded the highest yield attributes i.e. grain, stover, biological yield and test weight of pearl millet, which were statistically similar to pre-emergence application of atrazine @ 750 g ha\(^{-1}\)(PE) + 1 HW at 20 DAS(T\(_6\)). Other parameters i.e. Length of earhead and harvest index recorded highest in (T\(_6\)) atrazine @ 750 g ha\(^{-1}\)(PE) + 1 HW at 20 DAS, which was statistically similar to 2 HW at 20 and 40 DAS (T\(_2\)). The treatments associated with pre-emergence application of oxyfluorfen @ 150 g ha\(^{-1}\) resulted in reduced yield attributes and yield in pearl

**Economics**

The treatment (T\(_2\)) HW twice at 20 and 40 DAS resulted in the highest gross returns, which was in parity with treatment (T\(_6\)).
atrazine @ 750 g ha\(^{-1}\) (PE) + 1 HW at 20 DAS. However, the treatment T\(_6\) recorded the highest net returns and benefit-cost ratio (Table 2). The treatment with alachlor @ 1000 g ha\(^{-1}\) (PE) and alachlor @ 1000 g ha\(^{-1}\) (PE) + 1 HW at 20 DAS recorded lesser gross, net returns and benefit-cost ratio due to lower yield level and higher cost of cultivation. The lowest gross, net returns and benefit-cost ratio were observed in control (T\(_0\)) due to the uncontrolled growth of weeds which resulted in lowest yield associated with it.

**Table 1** Effect of integrated weed management practices on yield and yield attributes of pearl millet at harvest

| Treatments | Earhead length (cm) | Test weight (gm) | Grain yield (kg ha\(^{-1}\)) | Stover yield (kg ha\(^{-1}\)) | Biological yield (kg ha\(^{-1}\)) | Harvest index |
|------------|---------------------|------------------|------------------------------|-----------------------------|----------------------------------|---------------|
| T\(_0\) Control | 20.5 | 6.10 | 863 | 2,836 | 3,698 | 23.33 |
| T\(_1\) 1 HW at 20 DAS | 29.2 | 7.93 | 1,526 | 4,935 | 6,922 | 28.70 |
| T\(_2\) 2 HW at 20 and 40 DAS | 31.0 | 8.43 | 1,987 | 4,325 | 5,966 | 27.50 |
| T\(_3\) Alachlor @ 1000 g ha\(^{-1}\) (PE) | 25.9 | 7.16 | 1,036 | 3,212 | 4,248 | 24.38 |
| T\(_4\) Alachlor @ 1000 g ha\(^{-1}\) (PE) + 1 HW at 20 DAS | 26.4 | 7.36 | 1,339 | 4,855 | 5,284 | 27.57 |
| T\(_5\) Atrazine @ 750 g ha\(^{-1}\) (PE) | 28.6 | 8.26 | 1,641 | 4,325 | 5,966 | 27.50 |
| T\(_6\) Atrazine @ 750 g ha\(^{-1}\) (PE) + 1 HW at 20 DAS | 32.4 | 8.36 | 1,976 | 4,898 | 6,874 | 28.77 |
| T\(_7\) Oxyfluorfen @ 150 g ha\(^{-1}\) (PE) | 23.5 | 7.40 | 1,156 | 3,189 | 4,344 | 26.60 |
| T\(_8\) Oxyfluorfen @ 150 g ha\(^{-1}\) (PE) + 1 HW at 20 DAS | 24.6 | 7.13 | 1,456 | 4,911 | 5,726 | 29.63 |

SE(m)± 1.1 0.47 70 165 240 NS
CD at 5% 3.4 NS 212 501 726 NS

**Table 2** Effect of integrated weed management practices on economics of pearl millet

| Treatments | Yield (kg ha\(^{-1}\)) | Return | Gross returns (kg ha\(^{-1}\)) | Net returns | BCR |
|------------|------------------------|--------|-------------------------------|-------------|-----|
| Grain      | Grain                  | Stover | Stover                        |             |     |
| T\(_0\) Control | 863 | 2836 | 13808 | 9926 | 23734 | 2717 | 1.12 |
| T\(_1\) 1 HW at 20 DAS | 1526 | 3856 | 24416 | 13496 | 37912 | 13520 | 1.55 |
| T\(_2\) 2 HW at 20 and 40 DAS | 1987 | 4935 | 31792 | 17272 | 49064 | 21297 | 1.76 |
| T\(_3\) Alachlor @ 1000 g ha\(^{-1}\) (PE) | 1036 | 3212 | 16576 | 11242 | 27818 | 5026 | 1.22 |
| T\(_4\) Alachlor @ 1000 g ha\(^{-1}\) (PE) + 1 HW at 20 DAS | 1339 | 3516 | 21424 | 12306 | 33730 | 7563 | 1.28 |
| T\(_5\) Atrazine @ 750 g ha\(^{-1}\) (PE) | 1641 | 4325 | 26256 | 15137 | 41393 | 19341 | 1.87 |
| T\(_6\) Atrazine @ 750 g ha\(^{-1}\) (PE) + 1 HW at 20 DAS | 1976 | 4898 | 31616 | 17143 | 48759 | 23332 | 1.91 |
| T\(_7\) Oxyfluorfen @ 150 g ha\(^{-1}\) (PE) | 1156 | 3189 | 18496 | 11161 | 29657 | 7785 | 1.35 |
| T\(_8\) Oxyfluorfen @ 150 g ha\(^{-1}\) (PE) + 1 HW at 20 DAS | 1456 | 3456 | 23296 | 12096 | 35392 | 10145 | 1.40 |

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It is clear from the results that all the IWM treatments evaluated in present study varied widely in their effect on yield attributing characters like length of ear head, test weight, grain, stover and biological yields were found significantly superior in comparison to control treatment. The maximum test weight (8.43 g) was recorded under the treatment T2 (2 HW at 20 and 40 DAS). This result might be due to the fact that increased uptake of nutrients due to weed free environment and as a result there was more growth and development and thereby resulted in higher test weight (Singh et al. 2001). The highest ear head length was observed under Atrazine @ 750 g ha⁻¹ (PE) + 1 HW at 20 DAS (T6). Two HW at 20 and 40 DAS (T2) recorded grain and stover yield (1,339 and 3,516 kg ha⁻¹, respectively) kept the crop almost weed free environment which in turn resulted in significant reduction in competition for nutrients and other growth resources by weeds (Vanaja. 2007), Srividhya et al. (2011), Sandhyyarani and Karunasagar (2013) and Sunitha et al. (2011). Furthermore, the most severe competition throughout the crop season due to unrestricted weed growth under Control (T0) plots increased the depletion and moisture by weeds, thus adversely affecting the crop growth and ultimately resulted in the lowest yield of crop (Kaur and Singh. 2006), Kiroriwal et al. (2012) and Munde et al. (2013) in pearl millet.

All the integrated weed control treatments provided significantly higher net returns and B: C ratio in comparison to control. Atrazine @ 750 g ha⁻¹ (PE) + 1 HW at 20 DAS (T6) treatment fetched the maximum net returns (₹ 23332 ha⁻¹) with a BCR of 1.91. The higher net returns under superior treatment was the result of higher grain and stover yield due to effective control of weeds. The lowest grain yield achieved under control (T0) treatment was eventually reflected in the lowest net returns (₹ 2717 ha⁻¹) and B: C ratio (1.12).

Results of the present investigation corroborate with the findings of Arvadiya et al. (2012), Mathukia et al. (2015) and Mishra et al. (2017) in pearl millet.

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