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Effect of Pre and Post Emergence Herbicides Application on Economics of Pearl Millet (*Pennisetum glaucum* L.)

S. Mehetre [a*], P. Pawar [a], R. Pawar [a] and M. Gurav [a]

[a] Department of Agronomy, College of Agriculture, Dhule, Mahatma Phule Krishi Vidyapeeth, Rahuri. Maharashtra-424404, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted during *kharif* 2020 at Post Graduate Research Farm, Agronomy Section, College of Agriculture, Dhule to study the effect of pre and post emergent herbicides application on economics of pearl millet production. Experiment consisted of nine treatments namely weedy check (T_1), weed free (T_2), atrazine @ 500 g/ha PoE (T_3), 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE (T_4), 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE (T_5), atrazine @ 500 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE (T_6), atrazine @ 500 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE (T_7), pendimethalin 750 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE (T_8), pendimethalin 750 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE (T_9) laid out in randomized block design with three replications. Among the herbicidal treatments, grain yield (kg/ha) and straw yield (kg/ha) was observed better with application of pendimethalin @ 750 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE (T_9). Among the chemical weed management treatments, application of pendimethalin @ 750 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE (T_9) observed higher gross and net monetary returns (□/ha). However, the gross and net monetary returns (□/ha) were maximum under weed free treatment but lower B:C ratio as compared to sequential application of pendimethalin @ 750

**Corresponding author: E-mail: rushipawar99@gmail.com;*

g/ha PE fb 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE (T_9) and pendimethalin @ 750 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE (T_8) due to higher cost for labour weeding.

Keywords: Pearl millet; pre emergence; post emergence and herbicide.

1. INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.) is one of the major coarse grain crops and is considered to be a poor man's food. It belongs to gramineae family. It is widely grown in Africa and Asia since pre-historic times. In Asia it is an important cereal crop of India, Pakistan, China, and South Eastern Asia. In India, it is one of the important millet crops which flourishes well even under adverse conditions of weather. It provides staple food for the poor in a short period in the relatively dry tract of the country. It is the most drought tolerant crop among cereals and millets. In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat and maize. It occupies an area of 6.93 million hectares with an average production of 8.61 million tons and the productivity is 1243 kg/ha during 2018-19 (Directorate of Millets Development, 2020; Project Coordinator Review, 2020). Heavy weed infestation is one of the major constraints that limit the productivity of pearl millet crop. Weeds emerge fast and grow rapidly competing with the crop severally for growth resources *viz*., nutrients, moisture, sunlight and space during entire vegetative and early reproductive stages of pearl millet. The critical period for weed competition in pearl millet is up to 30-45 days after sowing [1]. Weeds cause lower grain and stover yield of pearl millet. On an average, 55% yield reduction due to heavy weed infestation in pearl millet crop [2] .Weeds emerge along with the crop causing serious competition during the initial growth period resulting in seed yield loss up to 40 % or more [3]. Hence, managing weeds during this period is most critical for obtaining higher yields. Atrazine as preemergence is the most widely used herbicide for weed control in pearl millet. At present, pre-emergence application of atrazine @ 1000 g a.i./ha was recommended to control the weeds in pearl millet [4]. Atrazine as preemergence 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.

2. MATERIALS AND METHODS

The field experiment was conducted in the *kharif* season of year 2020. Climatologically, this area falls in the sub-tropical region of North Maharashtra. Generally monsoon commences by third week of June and retreats at the end of September with the average annual rainfall of 607 mm. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction. The soil was very low in available nitrogen, low in phosphorus and very high in available potassium. The soil was free from any kind of salinity or sodicity hazards. Experiment consisted of nine treatments laid out in randomized block design with three replications. The treatments are represented in Table 1. The seed of pearl millet variety DHBH 9071 (Adishakti) was sown on 1st July 2020 at spacing of 45 cm x 15 cm using seed rate 3-4 kg/ha. The fertilizer was applied as per the recommended dose to pearl millet crop as 60:30:30 kg NPK/ha. Urea, Single Superphosphate and Muriate of potash were used as source for supply of N, P and K, respectively. The required quantity of herbicides *viz.,* atrazine, pendimethalin, 2,4-D (Na Salt) and 2,4-D (Dimethyl amine) was measured by weighing balance and measuring cylinder at the time of preparation of solution according to treatments. Handling, mixing and application of herbicides were done by taking all the precautionary measures to avoid exposure to chemicals, followed labels while and after the application, the unused herbicides were disposed without causing any environment hazards. The spraying was done by using knapsack sprayer with flat fan nozzle using 500 liters of water/ha. The crop was grown with recommended package of practices and was harvested at maturity on 5th October 2020.

Table 1. Treatment combinations

Tr. No.	Treatment combinations
T_1	Weedy check
T_2	Weed free
T_3	Atrazine @ 500 g/ha PoE
T_4	2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE
T_5	2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE
T_6	Atrazine @ 500 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE
T_7	Atrazine @ 500 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE
T_8	Pendimethalin 750 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE
T_9	Pendimethalin 750 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE

PE – Pre-emergence, PoE- post-emergenece

3. RESULTS AND DISCUSSION

3.1 Effect of Weed Management Treatments on Yield Attributes and Yield

The important yield contributing characters like weight of earhead/plant (g), grain weight/earhead (g) and test weight (g) were significantly more under weed free treatment. Among the different herbicidal treatments, application of pendimethalin @ 750 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE was significantly superior over other chemical weed management treatments but it was at par with pendimethalin @ 750 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE. The grain and straw yield (kg/ha) of pearl millet was found to be significantly higher (2896.92 and 5316.87 kg/ha, respectively) in treatment of weed free. Among the different chemical treatments, spraying of pendimethalin @ 750 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE which recorded significantly maximum grain and straw yield (2718.73 and 5099.12 kg/ha) as compared to other treatments of weed control and it was found at par with application of pendimethalin @ 750 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE (2548.76 and 4974.99 kg/ha). Among the herbicidal treatments tried in the experiment, application of PE herbicide followed by PoE herbicide treatment was found significantly better than application of PoE herbicide only in respect of grain and straw yield of pearl millet may probably be due to subsequent use of PE and PoE herbicides leading to no time for establishment of weeds in the field. The grain and straw yield was significantly lowest under weedy check treatment. These results correlate with the findings of Dobariya et al. [5], Kamble et al. [6] and Kumar and Chawla [7].

3.2 Effect of Different Weed Management Practices on Economics of Pearl Millet

The gross and net monetary returns were found maximum (136449 and 94695 /ha, respectively) in weed free treatment. Among chemical weed management treatments, application of pendimethalin @ 750 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE (128122 and 91909/ha, respectively) recorded more gross and net monetary returns than other chemical weed management treatments followed by pendimethalin @ 750 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE (120228 and 83980 /ha, respectively), atrazine @ 500 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE (111156 and 74937/ha, respectively) and atrazine @ 500 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE (104199 and 67945/ha, respectively). The benefit cost ratio was maximum for application of pendimethalin @ 750g/ha PE PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE (2.54) followed by pendimethalin @ 750 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE 30 DAS PoE (2.32) due to higher market price of atrazine herbicide as compared to 2,4-D (Na Salt). The gross and net monetary returns were maximum under weed free treatment but lower B:C ratio as compared to sequential application of pendimethalin @ 750 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE due to higher cost for labour weeding. These results corroborate with the findings of Kamble et al. [6], Dobariya et al. [5] and Sivamurugan [8].

Table 2. Weight of earhead/plant (g), grain weight/earhead (g) and test weight (g) as influenced by different herbicidal treatments

Tr. No.	Treatments	Weight of earhead/ plant (g)	Grain weight/ earhead (g)	Test Weight (g)
T_1	Weedy check	45.13	30.45	7.21
T_2	Weed free	69.12	52.27	12.87
T_3	Atrazine @ 500 g/ha PoE	54.67	43.78	8.70
T_4	2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE	56.08	44.07	9.08
T_5	2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE	57.16	44.21	9.31
T_6	Atrazine @ 500 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE	60.12	47.14	10.71
T_7	Atrazine @ 500 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE	63.26	48.26	10.81
T_8	Pendimethalin 750 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE	66.61	50.74	12.20
T_9	Pendimethalin 750 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE	68.89	51.84	12.25
	S. Em (±)	0.92	0.55	0.45
	CD (P=0.05)	2.76	1.66	1.35
	General mean	60.12	45.86	10.35

Table 3. Grain yield (kg/ha), straw yield (kg/ha), total cost of cultivation (□/ha), gross returns (□/ha), net returns (□/ha) and B:C ratio in pearl millet crop as influenced by different treatments

Tr. No.	Treatment Details	Grain yield (kg/ha)	Straw yield (kg/ha)	Total cost of cultivation (□/ha)	Gross returns (□/ha)	Net returns (□/ha)	B:C ratio
T_1	Weedy check	1180.35	2709.34	33754	45938	12184	1.36
T_2	Weed free	2896.92	5316.87	41754	136449	94695	2.27
T_3	Atrazine @ 500 g/ha PoE	1805.65	3911.23	35079	85407	50328	1.43
T_4	2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE DAS PoE	1834.29	3968.53	34929	86759	51830	1.48
T_5	2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE	1982.61	4165.23	34894	93700	58806	1.69
T_6	Atrazine @ 500 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS PoE	2205.05	4610.53	36254	104199	67945	1.87
T_7	Atrazine @ 500 g/ha PE *fb* 2,4-D (Na Salt) @ 500 g/ha at 25-30 DAS PoE	2356.02	4630.78	36219	111156	74937	2.07
T_8	Pendimethalin 750 g/ha PE *fb* 2,4-D (Dimethyl amine) @ 500 g/ha at 25–30 DAS PoE	2548.76	4974.99	36248	120228	83980	2.32
T_9	Pendimethalin 750 g/ha PE *fb* 2,4-D (Na Salt) 500 g/ha at 25-30 DAS PoE	2718.73	5099.12	36213	128122	91909	2.54
	S. Em (±)	63.64	114.35	-	-	-	-
	CD (P=0.05)	190.80	342.84	-	-	-	-
	General mean	2169.82	4376.29	-	-	-	-

Table 4. Price of grain, stover and inputs (□)

Particulars	Unit	Rate
Sell price of grain	□/kg	□46/kg
Sell price of stover	□/kg	□0.6/kg
Labour cost	labour unit	□200/labour
Atrazine	□/kg	□650/kg
Pendimethalin	□/lit	□425/lit
2,4-D (Na Salt)	□/kg	□280/kg
2,4-D (Dimethyl amine)	□/lit	□350/lit

4. CONCLUSION

Among the herbicidal treatments application of pre-emergence herbicide *i.e.* pendimethalin @ 750 g/ha followed by post-emergence herbicide *i.e.* 2,4-D @ 500 kg/ha at 25-30 DAS should be adopted for effective weed control and higher pearl millet production in the sub-tropical region of North Maharashtra. From the economic point of view application of pre-emergence spray of pendimethalin @ 750 g/ha followed by post-emergence herbicide 2,4-D (Na Salt) @ 500 kg/ha at 25-30 DAS 30 DAS PoE (T_9) and pre-emergence spray of pendimethalin @ 750 g/ha followed by post-emergence herbicide 2,4-D (Dimethyl amine) @ 500 g/ha at 25-30 DAS 30 DAS PoE (T_8) could be economical viable treatments based on B:C ratio.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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