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EFFECT OF CHEMICAL WEED MANAGEMENT AND BIOFERTILIZERS ON PEARL MILLET (*PENNISETUM GLAUCUM* L.)

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ABSTRACT

A field experiment entitled "Effect of Chemical Weed Management and Biofertilizers on Pearl Millet (*Pennisetum glaucum* was conducted during the *Kharif* season of 2023 & 2024 and *Rabi* seasons of 2023-24 & 2024-25 at the Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agriculture University, Bikaner. The field experiment comprised of 24 treatments combination having six herbicide treatment [weed free, weedy check, atrazine 500 g ha^{-1} (PE), 2,4-D 500g ha^{-1}at 21-25 DAS (PoE), tembotrione 120 g ha^{-1}at 21-25 DAS (PoE) and clodinafop propargyl 60 g ha^{-1}at 21- 25 DAS (PoE)] in main plot and four biofertilizer treatment (control, azotobactor 5 kg ha^{-1}, VAM 6 kg ha^{-1} and azotobactor 5 kg ha^{-1}+ VAM 6 kg ha^{-1}) in sub plots were laid out in split plot design and replicated thrice. Result indicated that the pre-emergence application of atrazine 500 g ha^{-1} and post-emergence application of tembotrione 120 g ha^{-1}, along with biofertilizers (azotobacter + VAM),

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Keywords: Atrazine, tembotrione, clodinafop propargyl, azotobacter and VAM.

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz] also known as candle millet, cattail millet, bulrush millet, or bajra, is an important crop of rainfed areas of Africa and India and serves as staple food for West African people. Pearl millet is one of the most important dryland crops, predominantly grown in arid and semi-arid regions of the world. The major pearl millet growing states are Rajasthan, Maharashtra, Uttar Pradesh, Gujarat, and Haryana, contributing 90% of national production. Rajasthan is the largest producer of pearl millet with an annual production of 5.89 million tons from 4.51 million hectares, exhibiting a productivity of 1261 kg ha^{-1} (Anonymous 2022). The major pearl millet-producing districts in Rajasthan are Jodhpur, Churu, Barmer, Sikar, Alwar, Bhartpur, SriGanganagar, Bikaner, Sawai Madhopur, Kota, Tonk, Jhunjhunu, Pali, and Jaisalmer. (Anonymous, 2022)

Weeds are plants that are undesirable, troublesome, and difficult to control, and they grow almost everywhere. As Pearl millet is grown predominantly in the warm rainy season, almost all types of weeds, viz., grassy, broad-leaved weeds and sedges, infest the Pearl millet field. Some predominant weed species are *Cynodon dactylon, Dinebra retroflexa, Brachiaria eruciformis, Cyperus rotundus, Parthenium hysterophorus, Commelina benghalensis, Amaranthus viridis, Digera arvensis,* and *Trianthema portulacastrum,* which cause heavy losses in pearl millet production. The critical period for weed competition in pearl millet is up to 30-45 days after sowing. Pearl millet grows slowly at first and is a relatively poor competitor with weeds during the first few weeks of development. Planting in wider rows to help inter-row cultivation and/or ditch furrow irrigation worsens the problems. Because the crop canopy forms slowly and provides little shading of

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weeds between the rows until midseason, by then, most weeds are well established.

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 plant during the early growth period (Bahadur *et al*., 2015), thereby may reduce yield to the extent of 40 % [Sharma and Jain, 2003], 55 % [Banga *et al*, 2000], 16-94 % [Balyan *et al*. 1993] and 41 % [Kaushik and Gautam, 1984]. The magnitude of losses depends on crop cultivars, the nature, and strength of weeds, spacing, duration of weed infestation, environmental conditions, and management exercises. The nutrient depletion by weeds in Pearl millet is up to 61.8 kg N, 5.6 kg P, and 57.6 kg K ha^{-1}, this was reported by Ram et al. (2004).

Most of the presently available herbicides provide only narrow spectrum of weed control in pearl millet. So, there is a need to test new herbicides alone or in combination, which are effective against complex weed flora in kharif pearl millet. The knowledge on the persistence and residual effects of herbicides in soil is essential to use them safely, effectively, and for non-hazardous chemical weed control schedules. So, it becomes imperative to work out safe combination and time of application of herbicides in pearl millet without affecting the growth and yield of succeeding chickpea crop.

2. MATERIALS AND METHODS

The present experiment, entitled Effect of Chemical Weed Management and Biofertilizers on Pearl Millet (*Pennisetum glaucum* L.) and their Residual Effects on Succeeding Chickpea, was conducted at the Instructional Farm, College of Agriculture, Bikaner, during the two consecutive *kharif* seasons 2023 &2024 and two *rabi* seasons of 2023-24 & 2024-25. The detailed information on location, soil, and experimental site, along with climatic conditions during the two crop seasons and methods and materials used in experimentation, is described here under.

2.1 Experimental site and location

The field experiment was conducted at the Instructional Farm, College of Agriculture, S.K. Rajasthan Agricultural University, Bikaner (Rajasthan), situated at 28° 10' N latitude and 73° 35' E. longtitude at an altitude of 235 meters above mean sea level. According to "Agro-ecological region map" brought out by the National Bureau of Soil Survey and Land Use Planning (JBSS & LUP), Bikaner falls under Agro-ecological region No. 2 (MgE1) under arid ecosystem (Hot Arid Eco-region with desert and saline soil), which is characterized by deep, sandy and coarse loamy, desert soils with low water holding capacity, hot and arid climate. According to NARP, Bikaner falls in Agro climatic zone Ic (Hyper-Arid, Partially Irrigated Western Plain Zone). According to the National Planning Commission, Bikaner falls under Agro-climatic zone XIV (Western Dry Region) of India.

2.2 Experimental details

2.2.1 Treatments

The field experiment comprised of 24 treatments combination having six herbicide treatment [Weed free, Weedy check, Atrazine (50% WP) 500 g ha^{-1} (PE), 2,4-D (38% EC) 500g ha^{-1}at 21-25 DAS (PoE), Tembotrione (42% SC)120 g ha^{-1}at 21-25 DAS (PoE) and Clodinafop propargyl (15%WP) 60 g ha^{-1}at 21-25 DAS (PoE)] in main plot and four biofertilizer treatment (control, Azatobactor 5 kg ha^{-1}, VAM 6 kg ha^{-1} and Azatobactor 5 kg ha^{-1} + VAM 6 kg ha^{-1}) in sub plots were laid out in split plot design and replicated thrice. The treatments, along with their symbols, are given in

Table 1: Details of treatment with their symbols.

	Treatments	Symbols
A. Main plot (Weed control measures)		
I.	Weed free	W^1
II.	Weedy check	W^1
III.	Atrazine (50% WP) 500 g ha^{-1} (PE)	W^1
IV.	2,4-D (38% EC) 500g ha^{-1} at 21-25 DAS (PoE)	W^1
V.	Tembotrione (42% SC) 120 g ha^{-1} at 21-25 DAS (PoE)	W^1
VI.	Clodinafop propargyl (15%WP) 60g ha^{-1} at 21-25 DAS (PoE)	W^1

B. Sub plot (Biofertilizers)		
I.	Control	B^1
II.	Azatobactor 5 kg ha^{-1} (soil application)	B^2
III.	VAM 6 kg ha^{-1} (soil application)	B^3
IV.	Azatobactor 5 kg ha^{-1}+ VAM 6 kg ha^{-1}	B^4

2.2.2 Experimental design and layout details
The experiment was laid out in a split-plot design and replicated thrice. The treatments were randomly allotted to different plots as shown in the plan of layout, and details of the experiments are as under:

Season	: Kharif (2023 & 2024): Pearl millet *Rabi* (2023 & 2024): Chickpea
Design	: Split plot design
Total No. of treatments	: 24
No. of replications	: 3
Total No. of plots	: 72
Plot size	: 3.6 m x 4.5 m = 22.5 m2
Crop geometry (row to row)	
Pearl millet	: 45 cmx 15 cm
Chickpea	: 30 cmx10cm
Variety	
Pearl millet	: BHB-1602
Chickpea	: GNG-1581
Seed rate ha^{-1}	
Pearl millet	: 4 kg ha^{-1}
Chickpea	: 60 kg ha^{-1}
Fertilizer kg ha^{-1}	
Pearl millet	: 60: 40:20 (N: P_2O_5: K_2O)
Chickpea	: 20: 32:20 (N: P_2O_5: K_2O)

3. RESULTS AND DISCUSSION

3.1 Total weed density
A perusal of the data presented in Table 3.1 showed that weed control measures exerted a significant influence on the total weed density at all stages of crop growth, while the impact of biofertilizers was found to be non-significant.

Weed Control Measures

At 20 DAS, the lowest total weed density was observed under the weed-free (W1) plot and followed by pre-emergence application of atrazine 500 k ha-1 (W3). In contrast, the weedy checek (W2) recorded the statistically highest weed density. At 40 DAS, an examination of the data indicated that total weed density remained significantly lower under the weed-free (W1) plot and followed by tembotrione 500 g ha-1 (W5) and atraziner 5400 g ha-1 (W3) treatments, both showing statistical parity and proving significantly better that all other treatments. At harvest, the final assessment confirmed that the total weed density was statistically lowest under the weed-free (W1) treatment, and among pre- and post-emergence herbicides, atrazine 500 g ha-1 (W3) and tembotrizone 500 g ha-1 (W5) respectively, recorded statistically lower weed densities that the weedy check. Percent reductions over the weedy check at harvest were: W1 (100%), W5 (85.4%), W3 (85.01%), and W4 (65.95%). Thus, a comprehensive evaluation across all stages clearly shows that the pre-emergence application of atrazine 500 g ha-1 (W3) was the most effective treatment in reducing total weed density, followed by post-emergence application of tembotrizone 500 g ha-1 (W5) and 2, 4-D (W4). Clodinafop-propargyl (W6) was the least effective, with weed densities remaining statistically higher throughout.

Biofertilizers
A perusal of the data further revealed that the application of biofertilizers had a non- significant effect on total weed density at 20 DAS, 40 DAS, and at harvest.

3.2 Grain yield, Stover yield, biological yield, and harvest index
Interpretation of the data presented in Table 3.2 revealed that both weed management practices and biofertilizer applications had a significant effect on grain yield, stover yield, and biological yield, whereas the effect on harvest index was non-significant.

Weed control measures
The weed-free treatment (W1) recorded the maximum grain yield (2303 kg ha-1), stover yield (5981 kg ha-1) and biological yield (8284 kg ha-1). Among herbicides,

Table 3.1: Effect of weed control measures and biofertilizers on total weed density (m^{-2}) in pearl millet.

Treatments (total weed density)	At 20 DAS			40 DAS			Harvest		
Weed Control Measures	**2023**	**2024**	**Pooled**	**2023**	**2024**	**Pooled**	**2023**	**2024**	**Pooled**
Weed-free (W1)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
Weedy check (W2)	12.40(154.03)	12.12(147.16)	12.26(150.59)	13.48(181.22)	13.29(176.22)	13.38(178.72)	9.31(86.80)	9.20(84.97)	9.26(85.88)
Atrazine 500 g ha-1 (W3)	2.81(7.41)	2.51(5.81)	2.66(6.61)	4.17(17.44)	4.04(15.83)	4.11(16.63)	3.73(13.38)	3.59(12.36)	3.66(12.87)
2,4-D 500g ha-1at 21-25 DAS (PoE) (W4)	12.16(147.39)	11.87(140.65)	12.01(144.02)	7.85(61.26)	7.69(58.68)	7.77(59.97)	5.56(30.54)	5.33(27.94)	5.45(29.24)
Tembotrione 120 g ha-1at 21-25 DAS (PoE) (W5)	12.05(144.97)	11.77(138.11)	11.91(141.54)	4.07(16.35)	3.86(14.73)	3.97(15.54)	3.68(13.02)	3.53(11.99)	3.61(12.51)
Clodinafop propargyl 60 g ha-1at 21-25 DAS (PoE) (W6)	12.22(149.13)	11.93(142.27)	12.08(145.70)	10.75(115.39)	10.61(112.77)	10.68(114.08)	9.94(98.43)	9.84(96.50)	9.89(97.46)
SEm+	0.22	0.28	0.17	0.18	0.17	0.12	0.12	0.15	0.09
CD(P=0.05%)	0.70	0.87	0.49	0.57	0.54	0.35	0.39	0.48	0.27
Biofertilizers									
Control (B1)	8.71(100.03)	8.47(95.22)	8.59(97.63)	6.94(67.03)	6.77(64.79)	6.86(65.91)	5.44(39.31)	5.30(37.63)	5.37(38.47)
Azotobactor 5 kg ha-1 (B2)	8.69(99.83)	8.45(95.06)	8.57(97.44)	6.79(63.94)	6.65(61.71)	6.72(62.82)	5.44(39.42)	5.30(37.74)	5.37(38.58)
VAM 6 kg ha-1 (B3)	8.73(100.55)	8.49(95.72)	8.61(98.14)	6.80(64.38)	6.67(62.15)	6.73(63.27)	5.51(40.69)	5.43(40.12)	5.47(40.41)
Azotobactor 5 kg ha-1+ VAM 6 kg ha-1 (B4)	8.78(101.55)	8.52(96.66)	8.65(99.10)	6.83(65.76)	6.70(63.52)	6.76(64.64)	5.56(42.02)	5.44(40.34)	5.50(41.18)
SEm+	0.10	0.13	0.08	0.13	0.13	0.09	0.12	0.11	0.08
CD(P=0.05%)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table: 3.2 Effect of weed control measures and biofertilizers on yield of pearl millet.

Treatments	Grain yield (kg ha^{-1})			Grain yield (kg ha^{-1})			Grain yield (kg ha^{-1})			Grain yield (kg ha^{-1})		
Weed Control Measures	**2023**	**2024**	**Pooled**	**2023**	**2024**	**Pooled**	**2023**	**2024**	**Pooled**	**2023**	**2024**	**Pooled**
Weed free (W1)	2399	2208	2303	6063	5898	5981	8462	8106	8284	28.59	27.25	27.92
Weedy check (W2)	1373	1303	1338	3084	3063	3073	4456	4365	4411	30.87	30.01	30.44
Atrazine 500 g ha-1 (W3)	2258	2218	2238	5488	5243	5366	7747	7461	7604	29.25	29.68	29.46
2,4-D 500g ha-1at 21-25 DAS (PoE) (W4)	2083	1960	2021	5348	5102	5225	7431	7061	7246	28.18	27.83	28.01
Tembotrione 120 g ha-1at 21-25 DAS (PoE) (W5)	2314	2149	2231	5735	5156	5445	8048	7304	7676	28.80	29.19	29.00
Clodinafop propargyl 60g ha-1at 21-25 DAS (PoE) (W6)	1921	1839	1880	5123	4961	5042	7044	6800	6922	27.33	27.17	27.25
SEm+	69	82	51	178	189	123	168	248	139	1.07	0.82	0.65
CD(P=0.05%)	219	259	149	562	595	362	529	781	410	NS	NS	NS
Biofertilizers												
Control (B1)	1834	1680	1757	4593	4570	4582	6427	6250	6339	28.46	26.99	27.73
Azotobactor 5 kg ha-1 (B2)	2113	2048	2081	5244	4942	5093	7357	6990	7174	28.93	29.54	29.23
VAM 6 kg ha-1 (B3)	2053	1905	1979	5252	4990	5121	7305	6895	7100	28.83	27.98	28.41
Azotobactor 5 kg ha-1+ VAM 6 kg ha- 1 (B4)	2232	2151	2192	5470	5114	5292	7703	7264	7484	29.12	29.58	29.35
SEm+	50	56	38	159	135	104	160	122	101	0.80	0.95	0.62
CD(P=0.05%)	145	162	107	454.99	388.61	294.07	458	351	284	NS	NS	NS

Atrazine (W3) and tembotrione 120 g ha-1 (W5) were statistically at par, with grain yields of 2238 kg ha-1 and 2231 kg ha-1), respectively. Their harvest indices were (29.46% and 29%), also significantly higher than other herbicidal treatments. 2,4-D (W4) and Tembotrione (W5) recorded moderate yields, while the weedy check (W2) showed the lowest productivity, with (1338 kg ha-1 grain yield), (3070 kg ha-1 Stover yield), (4411 kg ha-1 biological yield) and the lowest harvest index (27.92%). These were significantly lower that all other treatments.

Biofertilizers

Biofertilizer treatments significantly influenced yield attributes. The Azotobacter + VAM (B4) combination recorded the highest grain yield (2192 kg ha-1), stover yield (5292 kg ha-1), biological yield (7484 kg ha-1), and harvest index (29.35%), and was significantly superior to the control. Azotobacter (B2) and VAM (B3) recorded intermediate yields (2081 kg ha-1 and 1979 kg ha-1), and harvest index (27.73%), which were significantly lower than all other biofertilizer treatment.

4. CONCLUSION

From the above investigations, it can be inferred that the pre-emergence application of atrazine 500 g ha-1 and post-emergence application of tembotrione 120 g ha-1 reduced broad- leaved, grassy& sedges, and overall total weed density.

The pre-emergence application of atrazine 500 g ha-1 and post-emergence application of tembotrione 120 g ha-1, along with biofertilizers (azotobacter + VAM), gave significantly higher grain, stover, and biological yields compared to the weedy check.

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