Indian Journal of Weed Science (2026) **58**(1): 119–122
http://dx.doi.org/10.5958/0974-8164.2026.00017.7

RESEARCH NOTE

Weed management in summer pearl millet with non-chemical methods and herbicides at middle Gujarat region

Abhishek Inaniya*, Vinod B. Mor and D.D. Chaudhari

Received: 11 July 2025 | Revised: 7 December 2025 | Accepted: 11 December 2025

ABSTRACT

A field experiment was carried out to study the effect of pre- and post- emergence herbicides on weeds and pearl millet productivity at the Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat) during the summer season of 2023. The soil of the experimental field was loamy sand in texture. The inter cultivation (IC) followed by (*fb*) hand weeding (HW) at 15 and 30 days after sowing (DAS) caused maximum reduction in the weed density, dry biomass and weed index (WI), higher weed control efficiency (WCE) and pearl millet grain yield. All the tested herbicides significantly reduced the weed growth. The pre-emergence application (PE) of atrazine 750 g/ha and atrazine 500 g/ha + pendimethalin 250 g/ha (tank-mix) PE were found effective in managing weeds resulting in higher pearl millet grain yield, net returns and benefit-cost ratio.

Keywords: Atrazine, Non-chemical methods, Pearl millet, Pendimethalin, Weed management, Yield

Pearl millet (*Pennisetum glaucum* L.) is a major coarse grain crop mostly grown in arid and semi-arid climatic conditions. It is one of the most draught-tolerant crops, also known as bulrush millet, bajra, or candle millet and has been grown for food and fodder purposes. It is mostly cultivated in India, Pakistan, Nepal, Nigeria, Niger, Mali etc. In India, pearl millet is cultivated in 7.21-million-hectare area with an average production of 10.83 million tons and productivity of 2.72 t/ha (MoA&FW 2025). India is the largest producer of pearl millet in the world. Grains contain 67 g carbohydrates, 12 g protein, 5 g fat, 242 mg phosphorous, 42 mg calcium, 8 mg iron, and 1 g crude fiber per 100 g (Porwal *et. al.* 2023). Pearl millet is sensitive to weeds competition during the initial period of crop weed competition and weeds are the major constraints to attain higher pearl millet productivity as weeds compete for resources (Samota *et. al.* 2022). The critical period of competition for pearl millet is up to 35 days (Thanmai *et al.* 2018) and weeds uncontrolled during the critical period cause yield loss of 16 to 94% (Balyan *et al.* 1993, Banga *et al.* 2000; Rao *et al.* 2014). The prevailing methods of weed management are inter-culturing and hand-weeding, which are not economical due to labour scarcity and high labour wages. The chemical weed management practices proved which appears to be more economical as well as effective for management of weeds (Samota *et. al.* 2022; Rao 2022). Pre-emergence application (PE) of herbicides is effective in controlling weeds in pearl millet (Das *et al.* 2013). Atrazine and pendimethalin are broad-spectrum herbicides and are applied as pre-emergence for weed control. Tank mixing of both these herbicides effectively control most of the weeds. In pearl millet, the pre-emergence application of atrazine was reported to effectively control weeds (Kaur and Singh 2006). The post-emergence application (PoE) of tembotrione is recommended for reducing the density and dry biomass of narrow (including sedges) and broad-leaved weeds (Kumar *et al.* 2022). This study was conducted to assess the efficacy of pre- and post-emergence herbicides to manage complex weed flora in summer pearl millet.

A field study was conducted during the summer season of 2023 at the Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat. The soil of experimental field is loamy sand soil, low in available nitrogen (216 kg/ha), medium in available phosphorous (42.50 kg/ha) and high in available potassium (208.69 kg/ha) with pH of 8.19. The experiment was laid out on randomized completely block design (RCBD) with three replications and ten treatments having gross plot area of 3.60 x 5.00 m (18 m^2) and net plot area of 2.70 x 4.00 m (10.8 m^2). The tested treatments were: atrazine 50% WP (atrazine) 500 g/ha (PE); atrazine

Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat 388110, India

* Corresponding author email: abhishekinaniya2002@gmail.com

750 g/ha PE; pendimethalin 30% EC (pendimethalin) 500 g/ha PE, atrazine 500 g/ha + pendimethalin 250 g/ha (tank-mix) PE; early-post emergence application of (EPoE) atrazine 500 g/ha; tembotrione 42% SC (tembotrione) 84 g/ha EPoE, tembotrione 84 g/ha + atrazine 500 g/ha (tank-mix) EPoE, 2-4, D sodium salt 80% WP (2-4, D sodium salt) 400 g/ha PoE, inter-cultivation (IC) followed by (*fb*) hand weeding (HW) at 15 and 30 DAS and weedy check (control). Pearl millet cultivar *GHB 1129* was sown on 24th February 2023 and harvested on 30th May. Sowing was done by drilling method with the seed rate of 3.75 kg/ha at 45 cm spacing between the rows. Application of fertilizers was done at the recommended dose of 140-40-00 NPK kg/ha. Entire dose of phosphorus and half dose of nitrogen were applied as basal dose in furrows just before sowing and the remaining half dose of nitrogen was applied at 30 DAS. Herbicide spraying was done using battery operated knapsack sprayer fitted with a flat fan type of nozzle using 500 liters of water per hectare. The number of monocots, dicots, sedges and total weeds was counted by placing a 1m^2 quadrat at a random place in the net plot area. Weeds were dried and the dry weight of the weeds was recorded as weed dry biomass (g/m^2). Data on weed density (no./m^2) and dry biomass (g/m^2) were subjected to square root ($\sqrt{x+1}$) transformation. Weed control efficiency and weed index were calculated for each treatment using the formulas given below.

$$WCE = \frac{WDC - WDT}{WDT} \times 100$$

Where, WCE = Weed control efficiency (%)
WDC = Weed dry weight (g) in control plot
WDT = Weed dry weight (g) in treated plot

$$WI = \frac{X - Y}{X} \times 100$$

Where, WI = Weed index (%)
X = Maximum yield from the treatment
Y = Yield of plot from which weed index is to be calculated

Effect on weeds

The dominant weed flora at the experimental site include: among monocots, *Dactyloctenium aegyptium* (18.92%), *Eragrostis major* (13.51%), *Eleusine indica* (12.16%), *Digitaria sanguinalis* (8.11%) and *Setaria viridis* (4.73%); among dicots *Digera arvensis* (12.16%) was dominant followed by *Chenopodium album* (8.11%), *Phyllanthus niruri* (6.76%), *Amaranthus viridis* (4.05%), *Boerhavia erecta* (2.70%) and *Trianthema monogyna* (2.70%) and among sedges *Cyperus rotundus* (2.03%) and *Cyperus iria* (0.68%).

All the tested weed management treatments significantly lowered the density and dry biomass of weeds in comparison to weedy check at 30 DAS, 60 DAS and at harvest (Table 1 and 2). The dicots were effectively controlled by IC *fb* HW at 15 and 30 DAS. Among herbicides tested, atrazine 750 g/ha PE

Table 1. Effect of weed management treatments on weed density (no./m^2) at 30 DAS, 60 DAS and at harvest

Treatment	Weed density (no./m^2)											
	30 DAS				60 DAS				Harvest			
	Monocot	Dicot	Sedges	Total	Monocot	Dicot	Sedges	Total	Monocot	Dicot	Sedges	Total
Atrazine 500 g/ha PE	6.02 (36.00)	2.49 (5.33)	2.68 (6.33)	6.94 (47.66)	6.19 (39.00)	2.49 (5.33)	2.15 (3.66)	6.88 (48.00)	4.27 (17.33)	1.96 (3.00)	2.41 (5.00)	5.12 (25.33)
Atrazine 750 g/ha PE	5.22 (26.66)	1.52 (1.33)	2.15 (3.66)	5.68 (31.66)	5.32 (27.66)	1.73 (2.00)	1.82 (2.33)	5.71 (32.00)	3.55 (12.00)	1.41 (1.00)	1.82 (2.33)	4.01 (15.33)
Pendimethalin 500 g/ha PE	1.00 (0.00)	4.60 20.66)	2.41 (5.00)	5.13 (25.66)	2.22 (4.00)	4.61 (20.66)	2.53 (5.66)	5.58 (30.33)	2.22 (4.00)	2.76 (7.00)	2.69 (6.33)	4.24 (17.33)
Atrazine 500 g/ha + pendimethalin 250 g/ha (tank-mix) PE	1.00 (0.00)	2.23 (4.00)	2.94 (7.66)	3.55 (11.66)	1.91 (2.66)	2.15 (3.66)	2.82 (7.00)	3.78 (13.33)	2.13 (3.66)	2.64 (6.00)	2.37 (4.66)	3.91 (14.33)
Atrazine 500 g/ha EPoE	6.97 (48.00)	1.52 (1.33)	3.00 (8.00)	7.61 (57.33)	6.32 (39.66)	1.82 (2.33)	2.93 (7.66)	7.08 (49.66)	4.57 (20.00)	1.90 (2.66)	2.37 (4.66)	5.31 (27.33)
Tembotrione 84 g/ha EPoE	5.32 (28.66)	3.37 (10.66)	2.49 (5.33)	6.65 (44.66)	6.02 (36.00)	2.87 (7.33)	2.30 (4.33)	6.93 (47.66)	4.39 (18.66)	2.49 (5.33)	1.52 (1.33)	5.11 (25.33)
Tembotrione 84 g/ha + atrazine 400 g/ha (tank-mix) EPoE	5.19 (26.66)	1.41 (1.00)	2.15 (3.66)	5.64 (31.33)	5.61 (31.66)	1.98 (3.00)	1.71 (2.00)	6.07 (36.66)	4.26 (17.66)	1.68 (2.00)	2.50 (5.33)	5.08 (25.00)
2,4-D sodium salt 400 g/ha PoE	7.77 (60.00)	4.56 (20.00)	1.00 (0.00)	8.96 (80.00)	6.74 (46.66)	2.29 (4.66)	1.41 (1.00)	7.12 (52.33)	4.91 (23.33)	2.94 (7.66)	1.62 (1.66)	5.78 (32.66)
IC *fb* HW at 15 and 30 DAS	1.00 (0.00)	1.00 (0.00)	1.62 (1.66)	1.62 (1.66)	1.82 (2.33)	1.79 (2.33)	1.52 (1.33)	2.61 (6.00)	1.98 (3.00)	1.71 (2.00)	2.06 (3.33)	3.05 (8.33)
Weedy check (control)	9.40 (88.00)	7.52 (56.00)	2.23 (4.00)	12.18 (148.00)	7.13 (50.00)	3.53 (11.66)	2.23 (4.00)	8.15 (65.66)	4.81 (23.66)	3.82 (14.00)	2.13 (3.66)	6.47 (41.33)
LSD (p=0.05)	1.45	0.80	0.49	1.43	1.70	0.73	0.42	1.70	1.15	0.76	0.48	0.88

IC = intercultivation; HW = hand weeding; DAS = days after seedin; PE = pre-emergence; EPoE = early post-emergence

Table 2. Effect of weed management treatments on weed dry biomass (g/m²) at 30 DAS, 60 DAS and at harvest

Treatment	Weed dry biomass (g/m²)											
	30 DAS				60 DAS				Harvest			
	Monocot	Dicot	Sedges	Total	Monocot	Dicot	Sedges	Total	Monocot	Dicot	Sedges	Total
Atrazine 500 g/ha PE	3.89 (14.83)	1.04 (0.09)	1.92 (2.93)	4.29 (17.85)	6.61 (43.41)	3.52 (11.61)	2.14 (3.61)	7.69 (58.64)	7.90 (62.33)	4.40 (18.45)	1.81 (2.28)	9.12 (83.06)
Atrazine 750 g/ha PE	3.27 (9.84)	1.04 (0.08)	1.82 (2.40)	3.62 (12.33)	4.87 (23.08)	1.96 (2.97)	1.99 (3.07)	5.48 (29.13)	6.14 (39.37)	2.94 (7.77)	1.63 (1.67)	6.93 (48.81)
Pendimethalin 500 g/ha PE	1.00 (0.00)	2.70 (6.50)	1.63 (1.74)	3.01 (8.24)	2.36 (4.74)	4.93 (23.51)	2.51 (5.39)	5.87 (33.65)	4.89 (23.28)	5.19 (26.00)	2.31 (4.39)	7.37 (53.67)
Atrazine 500 g/ha + pendimethalin 250 g/ha (tank-mix) PE	1.00 (0.00)	1.26 (0.62)	2.18 (3.86)	2.31 (4.48)	2.02 (3.13)	3.12 (8.82)	2.48 (5.17)	4.25 (17.12)	4.38 (18.70)	3.91 (14.70)	2.05 (3.26)	6.08 (36.67)
Atrazine 500 g/ha EPoE	4.85 (22.65)	1.09 (0.19)	2.38 (4.90)	5.36 (27.75)	8.01 (63.83)	2.82 (7.02)	2.54 (5.47)	8.76 (76.33)	9.04 (81.88)	4.30 (17.65)	2.11 (3.49)	10.15 (103.02)
Tembotrione 84 g/ha EPoE	2.43 (4.98)	1.26 (0.60)	1.82 (2.4)	2.99 (8.05)	6.27 (39.11)	5.05 (24.67)	2.00 (3.02)	8.21 (66.81)	8.01 (64.00)	5.39 (28.21)	1.73 (2.02)	9.72 (94.24)
Tembotrione 84 g/ha + atrazine 500 g/ha (tank-mix) EPoE	2.20 (3.84)	1.07 (0.15)	1.42 (1.05)	2.45 (5.05)	6.09 (36.38)	2.74 (6.54)	1.79 (2.27)	6.77 (45.20)	6.79 (45.73)	3.54 (13.11)	1.77 (2.19)	7.81 (61.04)
2,4-D sodium salt 400 g/ha PoE	4.49 (19.70)	1.77 (2.17)	1.00 (0.00)	4.73 (21.87)	6.67 (44.12)	4.05 (15.77)	1.70 (1.91)	7.87 (61.81)	8.26 (67.57)	4.41 (18.87)	1.70 (1.95)	9.45 (88.39)
IC *fb* HW at 15 and 30 DAS	1.09 (0.22)	1.00 (0.00)	1.13 (0.28)	1.21 (0.50)	1.59 (1.57)	1.61 (1.62)	1.61 (1.62)	2.40 (4.81)	3.80 (13.70)	2.93 (7.87)	1.77 (2.17)	4.93 (23.75)
Weedy check (Control)	6.27 (39.11)	4.03 (15.40)	2.52 (5.41)	7.77 (59.92)	9.15 (84.07)	5.71 (31.91)	2.56 (5.61)	11.04 (121.59)	10.24 (103.98)	7.44 (54.66)	2.36 (4.63)	12.81 (163.29)
LSD (p=0.05)	0.96	0.39	0.63	0.83	1.46	0.77	0.40	1.19	1.85	1.20	0.32	1.77

*The means of original values are indicated by figures in parentheses. Data subjected to transformation ($\sqrt{x+1}$). PE = pre-emergence application, EPoE = early post-emergence application, IC = inter cultivation, HW = hand weeding, DAS = days after sowing, *fb* = followed by

Table 3. Effect of weed management treatments on weed control efficiency, weed index, grain yield and economics

Treatment	WCE (%)			WI (%)	Grain yield (t/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C
	30 DAS	60 DAS	Harvest					
Atrazine 500 g/ha PE	70.2	51.8	49.1	26.59	4.37	103276	62250	2.52
Atrazine 750 g/ha PE	79.4	76.0	70.1	12.10	5.24	122536	81255	2.97
Pendimethalin 500 g/ha PE	86.2	72.3	67.1	32.64	4.01	94850	53584	2.30
Atrazine 500 g/ha + pendimethalin 250 g/ha (tank-mix) PE	92.5	85.9	77.5	14.69	5.08	118098	76697	2.85
Atrazine 500 g/ha EPoE	53.7	37.2	36.9	19.87	4.77	110806	69780	2.70
Tembotrione 84 g/ha EPoE	86.6	45.1	42.3	20.39	4.74	109568	65574	2.49
Tembotrione 84 g/ha + Atrazine 500 g/ha (tank-mix) EPoE	91.6	62.8	62.6	25.56	4.43	103180	58676	2.32
2,4-D sodium salt 400 g/ha PoE	63.5	49.2	45.9	17.28	4.93	115836	75133	2.85
IC *fb* HW at 15 and 30 DAS	99.2	96.0	85.5	-	5.96	136978	88848	2.85
Weedy check (Control)	-	-	-	36.01	3.81	90530	50960	2.29
LSD (p=0.05)	-	-	-	-	0.84	-	-	-

*The means of original values are indicated by figures in parentheses. Data subjected to transformation ($\sqrt{x+1}$). IC = intercultivation; HW = hand weeding; DAS = days after seedin; PE = pre-emergence; EPoE = early post-emergence

significantly lowered weed density and dry biomass of dicots at 30 DAS, 60 DAS and at harvest as reported by Samota *et. al.* (2022). The density and dry biomass of sedges were significantly decreased with 2,4-D sodium salt 400 g/ha PoE at 30 DAS and harvest. The significant reduction in the sedge's density was recorded with tembotrione 84 g/ha EPoE. IC *fb* HW at 15 and 30 DAS significantly reduced total weed density and dry biomass at 30 DAS, 60 DAS and at harvest and recorded highest weed control efficiency (Table 3) as reported by Das *et al.* (2013). It was followed by atrazine 500 g/ha + pendimethalin 250 g/ha (tank mix) PE with lower density and dry biomass of monocot weeds and total weeds at 30 DAS, 60 DAS, at harvest and recorded highest weed control efficiency with lower value of weed index, which could be due to herbicide mixture of two herbicide having different modes of action as observed by Chaudhary *et al.* (2022). Weedy check registered the highest density and dry biomass of total weeds, lower weed control efficiency and higher weed index as no any weed management practice was adopted resulting in maximum growth of weeds during the entire crop growth period (Bhuva and Detroja 2018, Girase *et al.* (2017) and Samota *et al.* 2022).

Effect on pearl millet grain yield and economics

Among all weed control practices, significantly higher pearl millet yield was recorded with IC *fb* HW

at 15 and 30 DAS, atrazine 750 g/ha PE and atrazine 500 g/ha + pendimethalin 250 g/ha (tank-mix) PE with an increase in grain yield of 56%, 37% and 33% respectively as compared to weedy check as also observed by Das *et al*. (2013), Chaudhary *et al*. (2022) and Kumar *et al*. (2019). The highest gross return was recorded with IC *fb* HW at 15 and 30 DAS, followed by atrazine 750 g/ha PE and atrazine 500 g/ha + pendimethalin 250 g/ha (tank mix) PE. While both net return and B:C were higher with IC *fb* HW at 15 and 30 DAS and atrazine 750 g/ha PE respectively.

It was concluded that in case of scarcity of labour, atrazine 750 g/ha PE or atrazine 500 g/ha + pendimethalin 250 g/ha (tank-mix) PE provided better for efficient weed management, higher grain yield and economic returns in summer pearl millet.

REFERENCES

Balyan RS, Kumar S, Malik RK and Panwar RS. 1993. Post emergence efficacy of atrazine in controlling weeds in pearl millet. *Indian Journal of Weed Science* **25**: 7–11.

Banga RS, Yadav A, Malik RK, Pahwa SK and Malik RS. 2000. Evaluation of tank mixture of acetochlor and atrazine or 2,4-D Na against weeds in pearl millet (*Pennisetum glaucum*). *Indian Journal of Weed Science* **32**: 194–198.

Bhuva HM and Detroja AC. 2018. Pre- and post-emergence application of atrazine in integration with hand weeding for weed management in pearl millet. *Indian Journal of Weed Science* **50**(3): 273–277.

Chaudhary C, Hooda VS, Isha, Nagora Mehak, Kumar Shital and Nandal DP. 2022. Impact of integrated weed management practices on weed parameters and yield of pearl millet [*Pennisetum glaucum* L. Br. Emend. Stuntz.]. *The Pharma Innovation Journal* **11**(4): 693–700.

Das J, Patel BD, Patel VJ and Patel RB. 2013. Comparative efficacy of different herbicides in summer pearl millet. *Indian Journal of Weed Science*,**45**(3): 217–218.

Girase PP, Suryawanshi RT, Pawar PP and Wadile SC. 2017. Integrated weed management in pearl millet. *Indian Journal of Weed Science* **49**(1): 41–43.

Kaur A and Singh VP. 2006. Weed dynamics as influenced by planting methods, mulching and weed control in rainfed hybrid pearl millet (*Pennisetum glaucum*). *Indian Journal of Weed Science* **38**(1&2): 135–136.

Kumar Surendra and Chaudhary Rakesh. 2022. Efficacy and economic feasibility of different weed management practices in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *The Pharma Innovation Journal* **11**(7): 1591–1595.

Kumar YSR, Kumar Rabindra, Baba YA and Samruthi M. 2019. Effect of integrated weed management on yield, yield attributes and economics of pearl millet [Pennisetum glaucum (L). R. Br. Emend. Stuntz.]. *International Journal of Current Microbiology and Applied Sciences* **8**(10): 2629–2633.

MoA&FW. 2025. Third advance estimate of production of food grains. 2024-25. Ministry of Agriculture & Farmers Welfare Department of Agriculture & Farmers Welfare (MoA&FW), New Delhi, India.

Porwal A, Bhagwat G, Sawarkar J, Kamble P and Rode M. 2023. An overview of millets-the nutri-cereals: Its nutritional profile, potential health benefits and sustainable cultivation approach. *International Journal of Science and Research Archive* **10**(1): 841–859.

Rao AN. 2022. Weed management role in meeting the global food and nutrition security challenge. *Indian Journal of Weed Science* **54**(4): 345–356.

Rao A N, Wani SP and Ladha JK. 2014. Weed management research in India - an analysis of the past and outlook for future. Pp. 1-26. In: Directorate Of Weed Research, Souvenir (1989-2014). DWR Publication Number: 18. Directorate of Weed Research, Jabalpur, India.

Samota SR, Singh SP and Shivran Hansraj. 2022. Performance of pearl millet (*Pennisetum glaucum* L.) as affected by weed control measures. *Journal of Cereal Research* **14** (2): 211–214.

Samota SR, Singh SP, Shivran Hansraj, Singh Ranjeet and Godara, AS. 2022. Effect of weeds control measures on weeds and yield of pearl millet [*Pennisetum glaucum* L.] *Indian Journal of Weed Science* **54**(1): 95–97.

Thanmai PL, Srinivasulu K, Prasad PVN, and Babu PR. 2018. Evaluation of post-emergence herbicides in pearl millet (*Pennisetum typhoides*). *International Journal of Chemical Studies* **6**(3): 631–633.