

Research Article:**EFFECT OF DIFFERENT WEED MANAGEMENT PRACTICES ON RAINY SEASON MAIZE UNDER STALE SEEDBED CONDITION AT PURANCHUR, KASKI****Sansar Tandon^{a*} , Tulsi Parajuli^a  and Dinesh Marasini^b **^aCollege of Natural Resource Management, Agriculture and Forestry University, Puranchaur, Kaski, Nepal^bDepartment of Agronomy, Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal

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DOI: <https://doi.org/10.3126/jafu.v7i1.95397>**Received date:** 28 Feb 2026; **Revised date:** 07 May 2026; **Accepted date:** 16 May 2026; **Published date:** 10 Jun 2026**ABSTRACT**

A field experiment was conducted at Puranchaur, Kaski during April to August, 2023 to evaluate the effect of different weed management practices on weed dynamics and yield of maize. The experiment was laid out in Randomized Complete Block Design (RCBD) with five weed management practices (manual weeding, farmers practice, sunhemp-coculture, tembotrione, and atrazine fb tembotrione) and three replications. The cultivar used was Rampur Hybrid 10. Data was recorded and analyzed using R-Studio. The experimental findings indicated that the plant height (258.25) and Leaf Area Index (LAI) (3.90) of maize was highest in Farmers` practices. Atrazine followed by Tembotrione at 21 days after sowing was found most effective in lowering weed density and weed dry weight. Yield (5720.59 kg/ha) and yield attributing character was also found higher in Atrazine followed by Tembotrione among all weed management practices. Results revealed that no weed management in Maize in rainy season under stale seedbed at Puranchaur, Kaski leads to reduction of yield by 40.50%.

Keywords: Co-culture, ecological approach, mid-hills, *Zea mays***INTRODUCTION**

Maize is second most widely cultivated crop in the world. The production of Maize was approximately 1.218 Billion metric tons, 404.47 million Mt. and 3.19 million Mt. in World, Asia and Nepal respectively (FAOSTAT, 2024). Maize is also second most cultivated crop in Nepal with 940,256 ha area under production and average production of 2,976,490 Metric tonnes (MoALD, 2023). Majority of maize in Nepal is grown in rainy season as food, feed and staple (Dhakal et al., 2022). However, larger variation in maize production is present and yield is comparatively lower in rainy season due to higher weed infestation, higher pest and disease infestation, quantity and pattern of rainfall, soil fertility, plant population at harvest, seed quality, water management (KC et al., 2015). Being a rainy season crop, Maize is heavily affected by weeds from the moment it is seeded. This is due to increasing fertilizer use, wider row spacing, hot, humid weather that is conducive to the growth of weeds, and frequent rains that promote several weed flushes. Maize yield was reduced by 25 to 60% due to weed infestation (Barla et al., 2016). Therefore different weed management strategies has been used. Among such methods, herbicides are widely used due to their efficiency, cost-effectiveness, and ability to control wide range of weed species. Stale seedbed involves preparation of land and instead of sowing seed, weed just below soil surface are allowed to emerge following irrigation or rain and killed before sowing of crop seed with minimum soil disturbance by shallow cultivation or by using selective herbicides. Stale seed bed is based on principle that the majority of weeds

only emerge from seeds in the shallow layer of the soil (i.e., top 2.5 inches), and most typically only emerge in significant numbers from the top one inch of the soil. (*University of Maryland Extension, n.d.*), Therefore, this study aimed to evaluate impact of weed management on weed dynamics, crop growth and yields of maize, while also exploring the potential of stale seed bed technique as a sustainable weed control approach.

RESEARCH METHODS

A field experiment was conducted in farmer's field at Puranchaur, Nepal (28.3125° N latitude and 83.9691° E longitude). Stale seed bed was prepared by ploughing the field 3 times. Weeds were allowed to germinate under moisture in well prepared seed bed which were knocked down by using Glyphosate @0.75 kg a.i/ha at 15 Days after ploughing. Maize seeds were sown subsequently in weed-free seed bed with early competitive start on 13 May. Each plot was divided into 9 rows with 12 plants in each row and a total of 108 plants in each plot. The crop was planted after 1 month of stale seedbed preparation. Harvesting was done separately for each plot.

Table 1. Details of experiment

Particulars	Experimental details
Location	Pokhara metropolitan city-19, Puranchaur, Kaski
Variety	Rampur Hybrid-10
Number of treatments	5 weed management and 2 controls
Research design	RCBD with three replications
Plot size	5.4 × 3 m ²
Number of plots	21
Spacing	Row to Row 60 cm and Plant to Plant 25 cm
Manures	15 tons FYM/ha
Fertilizers	150 : 60 : 60 kg NPK /ha

Note: RCBD = Randomized Complete Block Design; FYM = Farmyard Manure; N:P:K = Nitrogen:Phosphorus:Potassium.

Treatments and application

The experiment comprises seven treatments.

Table 2. Treatment details

Name of Treatments	Treatments	Details
Weedy Check	T1	Unchecked growth of weeds
Weedy Free	T2	Weeding carried every 5 days interval
Manual weeding	T3	Manual weeding at 30 DAS and 45 DAS
Farmers practice	T4	One hoeing at 30DAS followed by earthing up at 45 DAS
Sun hemp coculture	T5	Sun hemp sown along with the Maize @ 80 kg/ha, and knocked down at 30 DAS using 2, 4-D@ 0.5 K.g a.i/ha
Tembotrione	T6	@ 120g a.i/ha at 21 DAS
Atrazine	fb	1 kg a.i/ha a pre emergence followed by Tembotrione @
Tembotrione	T7	120gm a.i/ha respectively at 21 DAS.

Note: DAS = Days After Sowing; a.i. = Active Ingredient; fb = followed by.

Data recorded

Among 12 plants, 5 plants were randomly selected from second row of each plot and plant height was measured as the distance from the soil surface to the top most visible portion at 30DAS, 45 DAS and 60 DAS. Non-destructive samples were taken to measure the length and breadth of the leaf at similar interval.

$$\text{Leaf Area Index (LAI)} = \frac{\text{Leaf Area}}{\text{Ground Area}} * \text{Correction factor (0.75)}$$

Out of cobs harvested from net plot area (5 rows), 5 sample cobs were chosen to record further yield attributing characters. Thousand grains from each plot were taken after shelling and were weighed on portable automatic electronic balance at particular moisture percent (14%) and expressed in gram (g). From net plot (5 rows) of each plot, the maize plant were harvested just above the ground and finally weighed to determine biological yield. The crop from the net plot was harvested and grain yield was recorded.

$$\text{Harvest index (HI)} = \frac{\text{Grain Yield}}{\text{Biological Yield}}$$

Sampling of weed was taken by making quadrant of 60cm*40cm on either side of plot. Weeds present inside that frame were uprooted, identified and categorized as narrow, broadleaf and sedges. The identified and categorized weeds were counted separately and expressed in number per square meter. Weed index was calculated to evaluate yield reduction due to weed competition.

$$\text{Weed Index (\%)} = \frac{\text{Yield in weed free plot} - \text{Yield in treatment plot}}{\text{Yield in weed free plot}} * 100$$

All the data from field experiments was first entered in MS-Excel in organized manner. These data were subjected to analysis of variance, Duncan test for mean separation using R studio.

RESULTS AND DISCUSSION

Weed flora in rainy season maize

17 different weeds belonging to 7 different families were found during experiment.

Table 3. Grasses observed in maize experiment at Puranchaur, Kaski, 2023

Scientific name	Common name	Local name	Family
<i>Cynodon dactylon</i> (L.) pers	Bermuda grass	Bubo	Poaceae
<i>Digitaria ciliaris</i> (Retz.) Koeler	Southern crabgrass	Chitre banso	Poaceae
<i>Digitaria sanuinalis</i> (L.)	Large crabgrass	Banso	Poaceae
<i>Eragrostis pilosa</i> (L.) P.Beauv	India lovegrass	Makai banso	Poaceae
<i>Commelina benghalensis</i> L.	Wandering jew	Ban Kane	Commelinaceae
<i>Eleusine indica</i> (L.) Gaertner	Goose grass	Kode jhar	Poaceae

Table 4. Broadleaf weeds observed in maize experiment at Puranchaur, Kaski, 2023

Scientific name	Common name	Local name	Family
<i>Drymaria cordata</i> (L.) Willd ex Roem. & Schult.	Tropical chickweed	Abhijjaalo	Caryophyllaceae
<i>Amaranthus spinosus</i> L.	Spiny pigweed	Kande latte	Amaranthaceae
<i>Persicaria nepalensis</i> (Meisner) H. Gross	Nepal persicaria	Ratnaulo	Polygonaceae
<i>Ageratum conyzoides</i> L.	Billy goat weed	Gandhe	Asteraceae
<i>Galinsoga parviflora</i> Cav.	Gallant soldier	Citlange jhar	Asteraceae
<i>Synedrella nodiflora</i> (L.) Gaertn.	Synedrella	Pahale jhar	Asteraceae
<i>Bidens pilosa</i> L.	Blackjack	Kalo Kuro	Asteraceae
<i>Crassocephalum crepidioides</i> (Benth.) S. Moore	Redflower ragleaf	Anikale jhar	Asteraceae

Table 5. Sedges observed in maize experiment at Puranchaur, Kaski, 2023

Scientific name	Common name	Local name	Family
<i>Cyperus</i> spp	Mothe		Cyperaceae
<i>Fimbristylis miliacea</i> (L.) Vahl	Lesser fimbristylis	Jwane jhar	Cyperaceae

Effect of different weed management practices on weed density and weed dry matter

Table 6. Weed density as influenced by different weed management practices under stale seed bed at Puranchaur, Kaski, 2023

Treatments	Weed density (number/m ²)								
	30 DAS			45 DAS			60 DAS		
	Grass	Broadleaf	sedges	Grass	Broadleaf	Sedges	Grass	Broadleaf	Sedges
Weedy check	19.15 ^a (495.55)	29.18 ^a (877.71)	8.83 ^a (77.70)	11.54 ^a (140.00)	20.32 ^a (446.67)	9.57 ^a (133.3)	9.43 ^{ab} (91.1)	15.97 ^{ab} (257.7)	9.35 ^{ab} (104.4)
Weed-free	0.70 ^b (0.0)	0.70 ^d (0.0)	0.70 ^c (0.00)	0.70 ^d (0.0)	0.70 ^c (0.0)	0.70 ^b (0.0)	0.70 ^b (0.0)	0.70 ^c (0.0)	0.70 ^d (0.0)
Manual weeding	11.79 ^{ab} (151.11)	18.42 ^b (340.0)	9.07 ^a (82.2)	3.68 ^{cd} (17.77)	5.91 ^{bc} (48.88)	2.20 ^{ab} (8.88)	14.07 ^a (277.78)	15.81 ^{ab} (255.5)	6.16 ^{bc} (37.77)
Farmers practice	11.01 ^{ab} (124.44)	20.62 ^b (433.33)	8.81 ^a (77.77)	5.29 ^{bc} (28.88)	8.45 ^b (73.33)	4.06 ^{ab} (24.44)	7.96 ^{ab} (64.4)	17.89 ^a (326.6)	6.14 ^{bc} (37.7)
Sunhemp coculture	13.57 ^{ab} (188.8)	16.29 ^{bc} (273.33)	8.02 ^a (64.44)	7.77 ^b (61.00)	3.71 ^{bc} (13.33)	5.21 ^{ab} (26.66)	13.62 ^a (248.89)	15.19 ^{ab} (248.88)	5.79 ^{bc} (33.3)
Tembotrione	10.65 ^{ab} (117.77)	16.88 ^b (286.66766)	5.09 ^b (26.60)	7.23 ^{bc} (60.00)	2.71 ^{bc} (8.8b)	8.65 ^{ab} (113.33)	10.69 ^{ab} (128.8)	8.46 ^c (17.7)	10.57 ^a (180.0)
Atrazine fb Tembotrione	8.32 ^{ab} (68.88)	12.31 ^c (151.11)	4.52 ^b (20.00)	4.72 ^{cd} (26.60)	4.68 ^{bc} (22.2)	5.53 ^{ab} (31.11)	12.7 ^{ab} (168.89)	8.46 ^{bc} (126.67)	4.84 ^c (24.4)
LSD (=0.05)	9.91	4.24	1.48	3.67	5.9	7.88	9.12	8.36	3.47
CV, %	51.84	14.6	12.95	35.3	49.96	86.25	51.8	42.1	31.35
SEm (±)	3.21	1.37	0.48	1.19	1.91	2.58	2.9	2.71	1.12
Grand Mean	10.74 (163.809)	16.34 (337.4)	6.43 (49.84)	5.85 (46.66)	6.64 (87.61)	5.13 (48.25)	9.89 (140.00)	11.18 (176.19)	6.22 (59.68)

Notes: Data subjected to square-root ($\sqrt{X+0.5}$) transformation; Trts: Treatments DAS: Days after sowing fb: followed by; SEm: Standard error of mean; CV: coefficient of variation; treatments followed by common letter(s) are not significantly different among each other based on DMRT at 0.05 level of significance, Mean separated by DMRT.

Table 7. Weed dry weight as influenced by different weed management practices under stale seed bed at Puranchaur, Kaski, 2023

Treatments	Weed dry weight (g/m ²)								
	30 DAS		45 DAS		60 DAS				
	Grass	Broadleaf	Sedges	Grass	Broadleaf	Sedges			
Weedy check	4.96ab (32.71)	6.67a (52.08)	1.65a (2.24)	8.52a (133.3)	16.25a (279.16a)	3.52a (13.43)	10.68a (91.82)	8.85a (91.8)	2.07b (4.10)
Weed-free	0.70c (0.0)	0.70c (0.0)	0.70c (0.0)	0.70c (0.0)	0.70b (0.0)	0.70b (0.0)	0.70d (0.0)	0.70b (0.0)	0.07b (0.0)
Manual weeding	5.93a (35.55)	5.78a (36.15)	1.75a (2.57)	3.04ab (8.88)	1.87b (3.72)	0.82b (0.2)	4.42bcd (25.5)	4.12b (25.55)	1.33b (1.28)
Farmers practice	2.98bc (8.74)	5.36ab (30.68)	1.29b (1.20)	3.76ab (24.4)	3.45b (13.49)	1.38b (1.71)	2.17cd (4.37)	3.83b (4.37)	1.045b (0.601)
Sunhemp coculture	3.34abc (11.41)	2.48bc (6.04)	1.22b (1.28)	4.49ab (26.6)	1.79b (2.71)	1.87b (3.0)	3.56cd (16.30)	2.51b (16.3)	1.048b (0.64)
Tembotrione	3.51abc (12.09)	5.40ab (29.78)	1.25b (1.11)	3.56ab (113.3)	1.44b (2.00)	1.98b (4.44b)	7.20abc (53.7)	1.57b (53.71)	4.41a (21.40)
Atrazine fb Tembotrione	1.22c (1.008)	1.36c (1.35)	1.06b (0.64)	2.93bc (31.1)	3.48b (13.72)	1.82b (3.16)	8.97ab (136.54)	4.13b (36.1)	1.51b (2.8)
LSD(=0.05)	2.68	3.065	0.35	5.031	3.15	1.47	4.82	3.18	3.081
CV, %	45.6	43.23	15.29	73.17	42.72	47.83	50.32	54.67	45.25
SEm (±)	0.85	0.994	0.1138	1.63	1.02	0.478	1.56	1.03	0.452
Grand Mean	3.24 (14.5)	3.98 (22.29)	1.28 (1.29)	3.86 (48.25)	4.14 (44.9)	1.73 (3.7)	5.38 (46.9)	3.26 (46.91)	1.73 (4.4)

Notes: Data subjected to square-root ($\sqrt{X+0.5}$) transformation; Trts: Treatments DAS: Days after sowing fb: followed by, SEm: Standard error of mean; CV: coefficient of variation; treatments followed by common letter(s) are not significantly different among each other based on DMRT at 0.05 level of significance, Mean separated by DMRT.

The weedy check consistently recorded the highest weed density and weed dry weight of grasses, broadleaf weeds, and sedges at 30, 45, and 60 DAS, indicating severe weed infestation and biomass accumulation under unmanaged conditions. In contrast, the weed-free treatment maintained the lowest weed density and dry weight throughout the crop growth period. Among the weed management practices, Atrazine fb Tembotrione was the most effective in suppressing weed population and reducing weed biomass across all weed categories, followed by Tembotrione alone. Manual weeding and farmers' practice provided moderate weed control, while sunhemp coculture also reduced weed density and dry matter accumulation compared to the weedy check but was generally less effective than herbicidal treatments. Across all treatments and observation periods, broadleaf weeds were the dominant weed group in terms of both density and dry weight, followed by grasses and sedges, highlighting the importance of effective broadleaf weed management in summer maize. Similar results were reported by (Sharma et al., 2018), Mali et al., (2020). The better results of these treatments can be explained by their broad-spectrum control and complementary mode of action. The sun hemp coculture showed moderate weed suppression which may be due to competition for light, water and space. Farmers practice and manual weeding resulted higher weed density and weed dry matter, indicating their lower effectiveness in controlling weed density and dry weight. Prevalence of broad leaf weeds in Rainy season resulted in higher weed density of broad leaf weeds compared to grasses (Ayana, 2022). Sedges density was lower due to lower prevalence of sedges in upland. Different weed management practices were practiced during 45 DAS so comparatively lower weed density was observed at 45 DAS. Similar result were obtained by SS et al.(2017) and Swetha et al. (2018). The superior performance of Atrazine fb tembotrione indicates its suitability as effective weed control measure in rainy season maize production.

Biometrical observation

Plant height and LAI

Table 8. Plant height and Leaf Area Index of maize as influenced by different weed management practices under stale seed bed at Puranchaur, Kaski, 2023

Treatments	Plant height (cm)				LAI		
	30 DAS	45 DAS	60 DAS	At Harvest	30 DAS	45 DAS	60 DAS
Weedy check	77.16 ^{ab}	173.5	196.50 ^c	247.5	0.61	2.59	2.20 ^d
Weed-free	55.83 ^c	160.66	210.00 ^{bc}	252.16	0.25	2.03	3.90 ^a
Manual weeding	65.00 ^{bc}	187.33	236.25 ^{ab}	260.16	0.43	2.44	3.35 ^{abc}
Farmers practice	65.33 ^{bc}	188.83	258.25 ^a	264.5	0.36	2.07	3.90 ^a
Sun hemp co culture	76.00 ^{ab}	179.16	232.50 ^{ab}	259.83	0.35	2.02	2.91 ^{cd}
Tembotrione	67.83 ^{bc}	177.83	252.00 ^a	272	0.38	1.77	3.75 ^{ab}
Atrazine fb Tembotrione	86.33 ^a	191.5	241.50 ^{ab}	281.5	0.57	2.62	2.07 ^{bcd}
LSD(p=0.05)	15.84	40.25	31.02	28.03	0.23	0.92	0.77
CV, %	12.63	12.58	7.55	6	31.16	23.26	13.17
SEm(±)	5.143	13.06	10.07	9.09	0.0762	0.298	0.25
Grand mean	70.5	179.83	232.42	262.52	0.42	2.22	3.29

Notes:LAI:Leaf Area index fb:followed by,SEm:Standard error of mean;CV:coefficient of variation;treatments followed by common letter(s) are not significantly different among each other based on DMRT at 0.05 level of significance, Mean separated by DMRT.

Plant height was significantly influenced by different weed management practices at different growth stages. Atrazine fb Tembotrione had significantly higher plant height at different stages of growth, however at 60DAS it was statistically at par with all other treatment except weedy

check and weed-free. Shrestha et al. (2023) also reported similar results. LAI was significantly influenced at 60 DAS which was highest at Weed-free and Farmers practice. Weed management practices had significant influence in Leaf area index at 60 DAS. At Early growth stage of crop, weed management practices did not have significant influence on LAI. Reduced weed density as a result of weed management practices at later stage of crop resulted in better nutrient utilization by the plant that resulted in increased photosynthesis that ultimately resulted in higher LAI (Ibade & Mohammed, 2020).

Yield attributes, yield and weed index

Table 9. Yield attributes of maize as influenced by different weed management practices under stale seed bed Puranchaur, Kaski, 2023

Treatments	Row per cob	Grain per row	Sterility	Thousand grain weight (g)
Weedy Check	12.20 ^c	17.21 ^b	15.01	237.33 ^c
Weed-free	14.26 ^a	30.43 ^a	9.99	312.18 ^b
Manual weeding	13.73 ^{ab}	30.97 ^a	11.53	305.68 ^b
Farmers practice	13.60 ^{ab}	30.80 ^a	13.63	348.41 ^a
Sun hemp co culture	13.06 ^b	32.17 ^a	10.82	322.97 ^{ab}
Tembotrione	14.00 ^a	32.32 ^a	7.92	310.98 ^b
Atrazine fb Tembotrione	14.40 ^a	30.70 ^a	14.5	297.43 ^b
LSD(=0.05)	0.74	6.74	7.57	31.19
CV (%)	3.06	12.74	35.7	5.74
SEm(±)	0.24	2.18	2.45	10.12
Grand mean	13.6	29.72	11.91	305.002

Notes: fb:followed by,SEm:Standard error of mean;CV:coefficient of variation;treatments followed by common letter(s) are not significantly different among each other based on DMRT at 0.05 level of significance, Mean separated by DMRT.

Table 10. Yield and Weed Index of maize as influenced by different weed management practices under stale seed bed Puranchaur, Kaski, 2023

Treatments	Grain Yield (kg/ha)	Straw Yield (kg/ha)	Harvest index	Weed index
Weedy Check	3375.79 ^d	6309.36 ^d	0.348	40.50 ^a
Weed-free	5693.04 ^a	8528.73 ^a	0.399	-
Manual weeding	4699.82 ^{bc}	7376.27 ^c	0.389	17.20 ^{bc}
Farmers practice	4903.67 ^{abc}	8392.86 ^{ab}	0.368	13.41 ^{bcd}
Sun hemp co culture	5242.59 ^{ab}	7111.91 ^{cd}	0.424	7.18 ^{cd}
Tembotrione	4124.10 ^{cd}	7621.31 ^{bc}	0.35	26.25 ^{ab}
Atrazine fb Tembotrione	5720.59 ^a	8873.73 ^a	0.392	-1.39 ^d
LSD(=0.05)	914.13	807.38	0.0797	17.01
CV (%)	10.65	5.85	13.06	54.35
SEm (±)	296.67	262.02	0.0258	5.39
Grand mean	4822.8	7744.88	0.343	17.19

Notes: fb:followed by,SEm:Standard error of mean;CV:coefficient of variation;treatments followed by common letter(s) are not significantly different among each other based on DMRT at 0.05 level of significance, Mean separated by DMRT

Different weed management practices had significant influence on yield and yield attributing characters. The weedy check performed worst with grain yield of 3375.79kg/ha and weed index of 40.50%. In contrast, the weed-free treatment produced 5693kg/ha. Among different weed management practices Atrazine fb Tembotrione performed better in terms of yield (5720.59) and other yield attributing characters, along with weed index of -1.39%. Similar results were observed by Shrestha et al.(2023), which was followed by sun hemp co-culture with yield of 5242.59kg/ha and weed index of 7.18. Farmers practice and manual weeding performed moderate with 4903.67kg/ha, 4699.8kg/ha of yield and 13.41%, 17.2% (weed index) respectively. Although tembotrione was effective in lowering weed density and weed dry weight, it was less efficient in improving grain yield (4124.10kg/ha) and weed index (26.25%) Overall, result demonstrated effectiveness of atrazine fb tembotrione in improving productivity under rainy season maize.

CONCLUSION

Weed management practices had significant influence on weed dynamics and productivity. Uncontrolled weed caused 40.50% yield loss. Overall result demonstrated atrazine fb tembotrione effectiveness in lowering weed density, weed dry weight and improving yield and yield attributing characters of summer season maize under stale seed bed condition.

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AUTHOR CONTRIBUTIONS

ST: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing; **TP:** Conceptualization, Methodology, Validation, Supervision; **DM:** Conceptualization, Methodology.

CONFLICT OF INTEREST

The authors agree in not having any conflict of interest regarding the published material. All the authors had gone through the document prior to the submission to the Journal of Agriculture and Forestry University.

ETHICAL APPROVAL AND PERMITS

No human participants or animals were involved during the study, and prior approvals were obtained where applicable.

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