

RESEARCH ARTICLE

EFFECT OF DIFFERENT WEED CONTROL METHODS ON GROWTH AND YIELD OF SPRING MAIZE (*ZEA MAYS* L.) IN CHITWAN, NEPAL

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ABSTRACT

In maize (*Zea mays* L.) cultivation, weed infestation is one of the crucial challenges for its production. To evaluate the impact of different weed control methods on growth, yield and yield attributes of maize and weed dynamics, a field experiment was carried out at research farm of Rampur campus, Chitwan, Nepal. The research was conducted in randomized complete block design (RCBD) with eight treatments viz: T₁ (Control), T₂ (Weed-free), T₃ (Plastic mulching), T₄ (Hand weeding), T₅ (Pendimethalin @ 1 kg a.i./ha), T₆ (Pendimethalin @ 1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture), T₇ (Pendimethalin @ 1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture fb 2,4-D @ 2.5 kg a.i./ha) and T₈ (Pendimethalin @ 1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture fb Laudis @ 200 ml/ha) replicated thrice during February,2024 to May,2024. Among different treatments, weed-free and plastic mulching were found to be the most effective in suppressing weed dry biomass, while the highest weed density was found consistently under control plot. Similarly, among different weed control treatments hand weeding showed the lowest weed index. The plant height, LAI, number of cobs per plant, test weight and grain yield was found higher under hand weeding and plastic mulching after weed free treatments. Manual and physical weed control methods are more effective in controlling weed and producing higher grain yield while chemical applications have moderate results under the field conditions of Khairahani, Chitwan.

KEYWORDS

Maize, Weed Control Efficiency, Weed Density, Yield

1. INTRODUCTION

Maize (*Zea mays*) also known as "Queen of grains" because of its higher genetic yield potential and adaptability to wide range of climatic conditions (Begam et al., 2018). It is the second most widely cultivated crop after rice in Nepal. In 2024, the total area under maize was 9,40,256 ha with the production of 29,69,222 MT and productivity of 3.15 MT/ha (MoALD, 2024). Globally, it is grown in approximately 205 million hectares, producing 1.21 billion tons, with an average yield of 5.9 tons per hectare (FAOSTAT, 2023).

The low productivity of maize in Nepal is largely attributed to several production challenges, with weed infestation being a significant issue. Weeds are serious competitors in taking up nutrients relative to crop plants; their share in the total uptake of macro-elements from the soil by the maize crop and weeds together was considerable and it averaged as follows: for K – 35%, Ca – 27.3%, Mg –27.4% (Glowacka, 2011). Weeds tend to be aggressive and fast-growing, with deep roots, allowing them to compete effectively with crops for essential resources, ultimately negatively impacting crop growth and productivity.

Globally, the yield losses of maize due to weeds are estimated at about 37% (Sharma and Rayamajhi, 2022). The wide spacing between plants and uniform early growth rate of maize crop is the reason for its susceptibility

to weed competition. The yield losses in maize may be attributed to several factors like spacing of rows, watering frequently and excessive use of chemical fertilizers that helps to create favorable environment for robust weed growth (Bajwa et al., 2014). Because of which the dry matter accumulation of crop reduces sharply impacting maize grain yield (Cerrudo et al., 2012).

The initial 4 to 6 weeks after sowing in maize is the critical period for crop-weed competition (Tehulie, 2021). During this period, weed management practices are required to be implemented to enhance grain yield. Various weed management practices viz: preventive, cultural, manual, mechanical, biological and chemical methods help to create unfavourable condition for weed growth and enhancing crop yield (Harker et al., 2013). Understanding and implementing best suited control measures is crucial for higher maize grain production. So, this research was intended to find out the best weed control methods in spring maize cultivation in Chitwan Nepal.

2. MATERIALS AND METHODS

An experiment was carried out from February 3 to May 30, 2024, in the agronomy farm of Rampur Campus, Chitwan. The soil was predominantly sandy loam. The research site was situated in central Nepal at 27.6198° N latitude and 84.5746° E longitude, with an elevation of 190 meters above

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sea level. A randomized complete block design (RCBD) was employed, comprising eight treatments replicated three times. Each individual plot measured 3.5 m in length and 1.8 m in width, resulting in a net plot area of 6.3 m². A spacing of 0.5 m was maintained between plots and between blocks. The experiment consists of the following treatments: T₁ (Control), T₂ (Weed-free), T₃ (Plastic mulching), T₄ (Hand weeding @ 30 and 45 DAS), T₅ (Pendimethalin @ 1 kg a.i./ha), T₆ (Pendimethalin @ 1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture), T₇ (Pendimethalin @ 1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture fb 2,4-D @ 2.5 kg a.i./ha) and T₈ (Pendimethalin @ 1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture fb Laudis @ 200 ml/ha). Maize seeds were treated with Bavistin @1.5gm/kg seed prior to sowing. Seeds of Rampur composite variety were sown on

February 10, 2024 at a spacing of 60 × 30 cm. In case of control plot (T₁), weeds were allowed to grow along with the maize crop throughout the crop cycle. In the weed free plot (T₂), weeding was done manually to keep the plots free from weeds throughout the crop cycle. The crop was raised under irrigated condition as per the recommended package of practices. The ANOVA was done using RStudio at 5 % level of significance and the analyzed data were subjected to DMRT for the mean separation.

3. RESULT AND DISCUSSION

3.1 Effect on weed density and dry biomass of weed

Table 1: Weed density and dry biomass of weeds as influenced by different weed control practices

Treatments	Weed Density (no. m ⁻²)		Weed Dry Biomass (g per m ⁻²)	
	30 DAS	45 DAS	30 DAS	45 DAS
T ₁ (Control)	513.00 ^a ±6.11	983.67 ^a ±14.80	107.06 ^a ±4.84	141.17 ^a ±4.35
T ₂ (Weed free)	85.00 ^c ±6.24	104.33 ^c ±7.06	5.36 ^d ±0.57	4.32 ^e ±0.44
T ₃ (Plastic mulching)	509.33 ^a ±5.78	931.00 ^b ±20.30	39.05 ^c ±1.89	55.79 ^d ±4.45
T ₄ (Hand weeding)	498.00 ^a ±12.1	199.33 ^d ±18.30	105.06 ^a ±6.62	85.38 ^c ±7.18
T ₅ (Pendimethalin)	374.67 ^b ±31.3	193.00 ^d ±15.00	66.65 ^b ±6.39	86.59 ^c ±9.69
T ₆ (Pendimethalin + Atrazine)	383.00 ^b ±29.5	213.67 ^d ±18.20	59.74 ^b ±1.91	91.12 ^c ±5.81
T ₇ (Pendimethalin + Atrazine fb 2,4-D)	360.33 ^b ±12.2	474.00 ^c ±21.40	66.08 ^b ±3.58	113.39 ^b ±4.31
T ₈ (Pendimethalin + Atrazine fb Laudis)	386.33 ^b ±41.6	493.00 ^c ±30.10	63.15 ^b ±5.30	119.18 ^b ±2.39
Grand Mean	388.70	449.00	64.02	87.12
CV, %	9.57	5.32	10.73	10.96
LSD (0.05)	65.15	41.88	12.03	16.72
F-test	***	***	***	***
SEm(±)	18.10	18.14	3.88	4.82

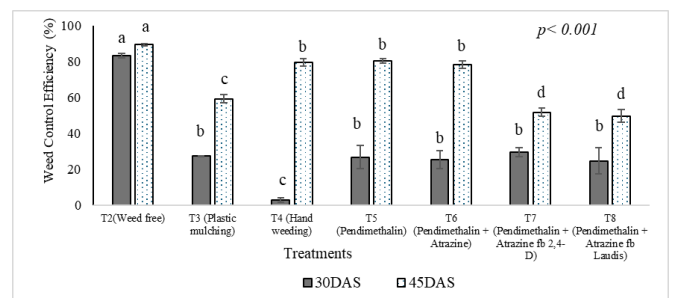
Note: Weed density data was subjected to Order-Norm transformation. Means with same letter in column shows non-significant difference at p=0.05 by DMRT; *** Significant at 0.001 level of significance (p<0.001). SEM = standard error of mean, LSD= Least significance difference, CV= Coefficient of variation, DAS= Days after sowing.

At 30 DAS, the lowest weed density was recorded in the weed-free treatment, followed by T₅, T₆, T₇, and T₈ (P < 0.001). In contrast, the control exhibited the highest weed density, which was statistically comparable to plastic mulch and hand weeding, indicating that these methods were ineffective at suppressing weeds during the early growth stages. Also, at 45 DAS, weed density differed significantly (P < 0.001). Weed free exhibited lowest weed density (104.33) followed by T₄, T₅ and T₆. Control recorded the significantly higher weed density followed by T₃, T₇ and T₈ respectively. Gurung et al. (2019) also reported that black plastic mulch reduced weed dry biomass dramatically.

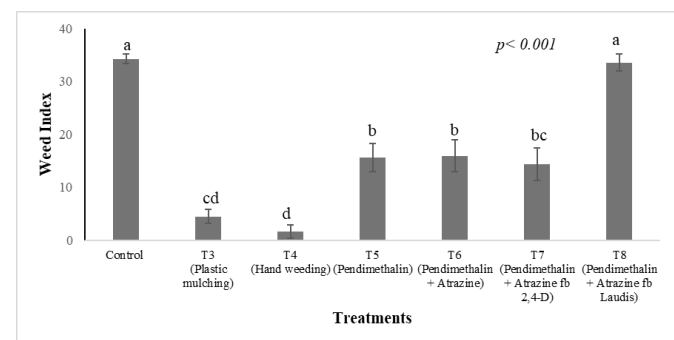
3.2 Effect on weed control efficiency and weed index

At 30 DAS, the highest weed control efficiency was recorded in the weed-free treatment, followed by T₇, T₅, T₆ and T₈ (p < 0.001). Also, at 45 DAS, weed control efficiency differed significantly (p < 0.001). A highly significant difference (P < 0.001) was observed for weed index. The treatment T₁ (34.28) recorded the highest weed index and was statistically at par with T₈ (33.59). In contrast, the treatment T₄ (1.64) recorded the lowest weed index, followed by T₃ (4.48). The very low weed control efficiency of hand weeding (2.94 %) at 30 DAS highlights the limitations of single, late interventions. By this stage, many weeds have already emerged, and one-time mechanical removal provides minimal suppression. This finding where 3-4 weeks post-sowing manual weeding gave significantly lower early-season weed control efficiency compared to repeated treatments or integrated methods (Mumtaz, 2022). Hand weeding (T₄) showed efficient weed control efficiency (~79.7 %) at later stages, who reported 76 % weed control efficiency at later days by

mechanical/manual weeding (Mastkar et al., 2022).



(a)



(b)

Figure 1: Weed control efficiency (a) and weed index (b) weeds as influenced by different weed control practices

3.3 Effect on growth attributes of maize

3.3.1 Plant Height

The weed control practices significantly influenced plant height of maize at all growth stages (Table 4). T₃ consistently produced the tallest plants, followed by T₂ and T₄, while control and T₇ recorded the shortest. The longest plant height under plastic mulch may be attributed to effective

weed suppression, moisture conservation, and soil temperature regulation due to plastic coverage of soil surface. Similar results were obtained also reported improved maize growth with plastic mulch (Sanwa et al., 2023 ; Timsina et al., 2025). The weed-free plots produced taller maize plants highlighting the negative impact of weed competition on crop development.

Table 2: Plant height of maize as influenced by different weed control practices

Treatments	Plant Height (cm)			
	30 DAS	45 DAS	60 DAS	75 DAS
T ₁ (Control)	22.79 ^{cd} ±2.99	44.68 ^d ±2.52	112.72 ^e ±14.9	152.70 ^e ±6.62
T ₂ (Weed free)	33.14 ^{ab} ±4.22	66.86 ^b ±1.81	180.52 ^{ab} ±12.1	208.77 ^a ±13.9
T ₃ (Plastic mulching)	40.96 ^a ±3.11	82.18 ^a ±1.91	190.18 ^a ±7.94	205.48 ^a ±11.6
T ₄ (Hand weeding)	28.02 ^{bc} ±1.85	63.20 ^{bc} ±2.08	161.18 ^{abc} ±4.77	186.25 ^{ab} ±5.74
T ₅ (Pendimethalin)	25.11 ^{bcd} ±0.28	50.58 ^d ±4.01	143.20 ^{cde} ±6.83	178.75 ^{abc} ±15.2
T ₆ (Pendimethalin + Atrazine)	25.92 ^{bcd} ±1.61	54.05 ^{cd} ±2.95	156.60 ^{bcd} ±16.5	182.48 ^{abc} ±7.80
T ₇ (Pendimethalin + Atrazine fb 2,4-D)	21.35 ^d ±2.40	42.68 ^d ±7.24	127.71 ^{de} ±17.6	166.46 ^{bc} ±6.76
T ₈ (Pendimethalin + Atrazine fb Laudis)	25.58 ^{bcd} ±1.36	47.69 ^d ±2.32	136.06 ^{cde} ±5.56	178.24 ^{abc} ±6.25
Grand Mean	27.86	56.49	151.02	182.39
CV, %	13.29	10.77	11.06	8.64
LSD (0.05)	6.48	10.65	29.25	27.59
F-test	**	***	***	*
SEm(±)	2.22	3.10	10.77	9.23

Note: The plant height at 30 days after sowing was subjected to Yeo-Johnson transformation. Note: '***' Significant at 0.001 level of significance (p<0.001), '**' Significant at 0.01 level of significance (p<0.01), '*'

Significant at 0.05 level of significance (p<0.05).

3.3.2 Leaf area index

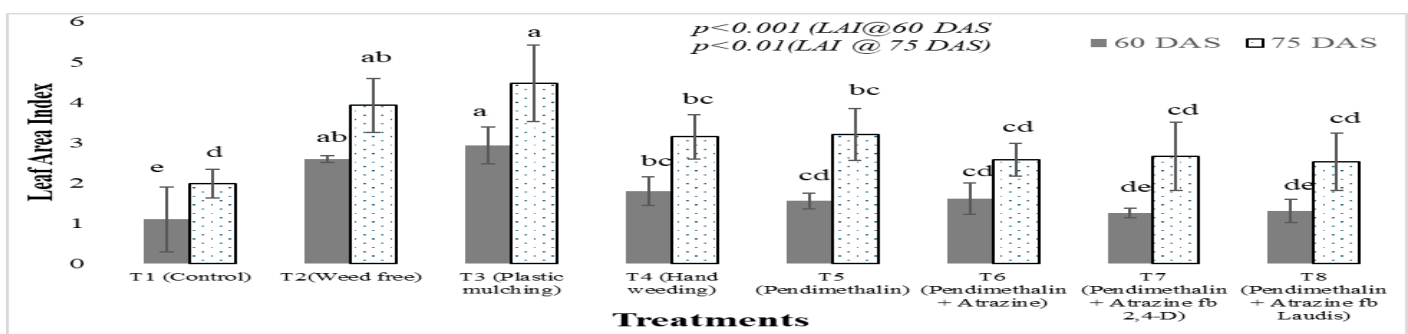


Figure 2: Leaf area index of maize as influenced by different weed control practices

The leaf area index (LAI) varied significantly among treatments across different growth stages of maize. At 60 and 75 DAS, plastic mulching

resulted in the highest LAI, which was statistically similar to the weed-free treatment but significantly higher than the other practices. Hand weeding

significantly improved the rate of leaf area expansion in maize compared to the control (Fakoor and Parsa, 2014).

3.4 Effect on yield and yield attributing traits of maize

Table 3: Yield and yield attributing traits of maize as influenced by different weed control practices.

Treatments	No. of cobs per plant		No. of kernels per cob	Test weight (g)	Grain yield (ton ha ⁻¹)
	75 DAS	90 DAS			
T ₁ (Control)	0.56 ^d ±0.02	1.69±0.03	338.78 ^d ±4.92	305.59 ^d ±1.47	3.81 ^d ±0.03
T ₂ (Weed free)	1.02 ^{abc} ±0.11	1.64±0.03	555.06 ^b ±6.92	337.01 ^a ±2.78	5.82 ^a ±0.04
T ₃ (Plastic mulching)	1.13 ^{ab} ±0.00	1.73±0.10	577.57 ^a ±2.48	322.38 ^c ±2.20	5.56 ^b ±0.11
T ₄ (Hand weeding)	0.98 ^{abc} ±0.20	1.55±0.04	562.19 ^b ±7.80	329.71 ^b ±2.70	5.73 ^{ab} ±0.04
T ₅ (Pendimethalin)	1.15 ^a ±0.02	1.90±0.06	441.81 ^c ±12.60	316.91 ^c ±1.61	4.91 ^c ±0.17
T ₆ (Pendimethalin + Atrazine)	1.00 ^{abc} ±0.06	1.69±0.03	433.62 ^c ±13.30	318.21 ^c ±2.46	4.89 ^c ±0.17
T ₇ (Pendimethalin + Atrazine fb 2,4-D)	0.82 ^{cd} ±0.02	1.73±0.11	435.27 ^c ±15.00	318.16 ^c ±1.64	4.98 ^c ±0.15
T ₈ (Pendimethalin + Atrazine fb Laudis)	0.85 ^{bc} ±0.10	1.48±0.17	349.21 ^d ±7.16	309.59 ^d ±2.34	3.87 ^d ±0.11
Grand Mean	0.94	1.67	461.69	319.65	4.95
CV, %	15.98	9.02	3.60	1.25	4.21
LSD (0.05)	0.26	0.26	29.16	7.03	0.36
F-test	**	ns	***	***	***
SEm(±)	0.06	0.07	8.77	2.15	0.10

Note: “***” Significant at 0.001 level of significance (p<0.001), “**” Significant at 0.01 level of significance (p<0.01), “*” Significant at 0.05 level of significance (p<0.05), ns- non-significant

At 75 DAS, the number of cobs per plant differed significantly (P < 0.01). T₅ recorded the highest number of cobs (1.15), which was statistically comparable to T₃ (1.13), T₂ (1.02), T₆ (1.00), and T₄ (0.98). In contrast, T₁ had the lowest cob number (0.56), similar to T₇ (0.82). At 90 DAS, no significant differences in number of cobs were observed among treatments.

A highly significant difference (P < 0.001) was observed in the number of kernels per cob. T₃ recorded the highest kernel count (577.57) which was statistically different than other treatments. likely due to effective weed control and lower weed biomass. This is in consistent with Sanwa et al. (2023), who reported that black plastic mulch significantly increased kernel counts. In contrast, T₁ (338.78) recorded the lowest number of kernels, statistically similar to T₈ (349.21), reflecting poor weed control during critical growth stages also lowering the kernel number. A highly significant difference (P < 0.001) was observed in test weight. T₂ recorded the highest test weight (337.01), which was statistically superior to all other treatments.

The highest grain yield was obtained under T₂ (5.82), statistically at par with T₄ (5.73). Similar results were obtained that weed-free plots produced higher gain yield compared to control (Shrestha et al., 2021). The higher yields in T₂ and T₄ followed by T₃ likely resulted from more kernels per cob and greater test weight. In contrast, control had the lowest yield, statistically similar to T₈, supported by poor weed control, lower kernels per cob and lower test weight.

This signifies the strong positive impact of manual and physical weed control on maize yield. The unchecked weed competition in control (T₁) resulted in lowest yield in the control. Moderate yields in herbicide treatments like T₆ and T₇ suggest that even herbicidal weed control was impactful, it was less effective than manual or physical methods, possibly due to application timing issues, diverse weed populations and narrow spectrum of herbicides.

4. CONCLUSION

Among different weed control practices, plastic mulching and hand weeding were the most effective in reducing weed dry biomass and weed

index while control consistently exhibited the highest weed biomass and low weed control efficiency. Moderate weed control under integrating pre and post-emergence herbicides indicates the need to optimize application rates and timing effectively. The results demonstrated that the weed-free conditions, hand weeding, and plastic mulching were the most effective control measures for enhancing grain number, grain weight and overall yield of maize. While herbicide-based treatments offered moderate weed controls and yield, manual and physical methods consistently achieved superior results under the field conditions of Chitwan.

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