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Effect of Different Weed Control Methods on Growth and Yield of Spring Maize (*Zea mays* L.) in Chitwan, Nepal

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ABSTRACT

Maize (*Zea mays* L.), an economically important cereal crop grown in temperate, tropical and subtropical parts of the world, faces significant productivity challenges due to weed infestation. A field experiment was carried out at research farm of Rampur campus, Chitwan to evaluate the effect of different weed control methods on growth and yield of spring maize. The research was conducted in randomized complete block design (RCBD) with eight treatments viz: T_1 (Control), T_2 (Weed-free), T_3 (Plastic mulching), T_4 (Hand weeding), T_5 (Pendimethalin @ 1 kg a.i./ha), T_6 (Pendimethalin @ 1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture), T_7 (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 T_8 (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 all treatments, weed-free and plastic mulching were the most effective in suppressing weed dry biomass, while control consistently recorded the highest weed density. Weed-free treatment had the highest weed control efficiency, while hand weeding showed the lowest weed index. The results clearly demonstrated that weed-free (T_2) and hand weeding (T_4) were the most effective practices for increasing the number of cobs per plant, test weight, and grain yield. While herbicide-based treatments provided moderate results, manual and physical methods were more consistent in delivering higher yields under the field conditions of Chitwan.

KEYWORDS

maize, yield, weed control efficiency, weed density

INTRODUCTION

Maize (*Zea mays*) is often referred as the "queen of grains" due to its adaptability to various environmental conditions and high yield potential (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 macroelements 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. Global maize yield losses attributed to weeds are estimated at around 37% (Sharma and Rayamajhi, 2022). The uniform growth rate of maize in its early stages and its wide row spacing, make it particularly susceptible to weed competition. Factors such as the spacing of maize rows, frequent watering, and excessive use of chemical fertilizers foster a favorable environment for weed growth, which in turn contributes to yield losses (Bajwa et al., 2014). If weeds interfere early in the growth stages of maize, it can lead to considerable variations in dry matter accumulation among plants, ultimately reducing grain yields at harvest (Cerrudo et al., 2012).

The critical period for crop-weed competition (CWC) in maize occurs from 4 to 6 weeks after sowing (Tehulie, 2021). During this time, it is essential to implement weed management practices to enhance crop yield. Various weed management strategies, including cultural, mechanical, biological, and chemical methods, aim to create conditions that are unfavorable for weed growth (Harker et al., 2013). While herbicides are commonly used to control weeds in maize, alternative cultural and mechanical methods are also effective. Implementing control measures is vital for enhancing maize production. Understanding the detrimental effects of weed competition and contamination, alongside effective control strategies, is crucial for successful maize cultivation. This research was aimed to find the best weed control method for spring maize cultivation in Chitwan.

MATERIALS AND METHODS

The field experiment was carried out on the lowland agronomy farm of Rampur Campus, Chitwan, Nepal, where the soil predominantly consists of sandy loam. The study took place from February 3 to May 30, 2024. The research site is situated in central Nepal at 27.6198° N latitude and 84.5746° E longitude, with an elevation of 190 meters above 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 m^2. A spacing of 0.5 m was maintained between plots and between blocks. The experiment consist of the following treatments.

Table 1: Different treatments applied in the research

Treatments	Treatment details
T_1	Control
T_2	Weed free
T_3	Plastic mulching
T_4	Hand weeding (30DAS & 45DAS)
T_5	Pre-emergence pendimethalin @1 kg a.i./ha
T_6	Pre-emergence pendimethalin @1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture
T_7	Pre-emergence pendimethalin @1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture followed by 2,4-D @2.5 kg a.i./ha as post emergence 30DAS
T_8	Pre-emergence pendimethalin @1 kg a.i./ha + Atrazine @1.5 kg a.i./ha tank mixture followed by Laudice @ 200 ml/ha as post-emergence 30 DAS

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 (T_1), weeds were allowed to grow along with the maize crop throughout the crop cycle. In the weed free plot (T_2), 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.

RESULT AND DISCUSSION Effect on weed density and dry biomass of weed Table 2: Weed density and dry biomass of weeds as influenced by different weed control practices

Treatments	Weed Density (no. per m^2)		Weed Dry Biomass (g per m^2)	
	30DAS	45DAS	30DAS	45DAS
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^e±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: The weed density was subjected to Order-Norm transformation. Superscript letters denote statistical groupings ($p \leq 0.05$) from Duncan's Multiple Range Test (DMRT) based on Order-Norm transformed data.

At 30 DAS, the lowest weed density was recorded in the weed-free treatment, followed by T_5, T_6, T_7, and T_8 ($P < 0.001$). 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 T_4, T_5 and T_6. Control recorded the significantly higher weed density followed by T_3, T_7 and T_8

respectively. Gurung et al. (2019) also reported that black plastic mulch reduced weed dry biomass dramatically.

Effect on weed control efficiency and weed index Table 3: Weed control efficiency and weed index weeds as influenced by different weed control practices

Treatments	Weed Control Efficiency (%)		Weed Index (%)
	30DAS	45DAS	
T_1 (Control)	0^{d}	0^{e}	$34.28^{a}\pm0.89$
T_2 (Weed free)	$83.42^{a}\pm1.24$	$89.38^{a}\pm0.73$	[illegible]^{e}
T_3 (Plastic mulching)	$0.70^{c}\pm0.05$	$5.31^{d}\pm2.30$	$4.48^{cd}\pm1.32$
T_4 (Hand weeding)	$2.94^{c}\pm1.32$	$79.68^{b}\pm2.08$	$1.64^{d}\pm1.30$
T_5 (Pendimethalin)	$26.86^{b}\pm6.54$	$80.40^{b}\pm1.24$	$15.63^{b}\pm2.64$
T_6 (Pendimethalin + Atrazine)	$25.45^{b}\pm4.90$	$78.24^{b}\pm2.01$	$15.96^{b}\pm3.02$
T_7 (Pendimethalin + Atrazine fb 2,4-D)	$29.73^{b}\pm2.54$	$51.79^{c}\pm2.20$	$14.37^{bc}\pm3.12$
T_8 (Pendimethalin + Atrazine fb Laudis)	$24.86^{b}\pm7.28$	$49.82^{c}\pm3.47$	$33.59^{a}\pm1.57$
Grand Mean	24.24	54.33	15.02
CV (%)	29.76	4.29	23.84
LSD (0.05)	12.64	4.08	6.27
F-test	***	***	***
SEM±	2.98	1.75	1.73

Note: The weed control efficiency at 30 days after sowing & 45 days after sowing and weed index was subjected to Order-Norm transformation.

At 30 DAS, the highest weed control efficiency was recorded in the weed-free treatment, followed by T_7, T_5, T_6 and T_8 ($p < 0.001$). Also, at 45 DAS, weed control efficiency differed significantly ($p < 0.001$). A highly significant difference ($P < 0.001$) was observed for weed index (WI) at 0.1 % level of significance. The treatment T_1 (34.28^{a}) recorded the highest weed index and was statistically at par with T_8 (33.59). In contrast, the treatment T_2 recorded the lowest weed index, followed by T_4 (1.64) and T_3(4.48).The very low weed control efficiency of plastic mulching (0.70 %) and 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 or mulch placement provides minimal suppression. This aligns with findings from Mumtaz (2022), where single hand weeding at 3 or 4 weeks post-sowing gave significantly lower early-season weed control efficiency compared to repeated treatments or integrated methods. Hand weeding (T_4) showed substantial late-season weed control efficiency (~79.7 %), similar to the weed-free treatment (89 %), consistent with Mastkar et al. (2022), who reported mechanical weeding achieved 76 % weed control efficiency at later days. **Effect on growth attributes of maize a. Plant Height**

Table 4: Plant height of maize as influenced by different weed control practices

Treatments	Plant Height (cm)			
	DAS	DAS	60 DAS	DAS
T_1 (Control)	22.79^{cd}±2.99	44.68^{d}±2.52	112.72^{e}±14.9	152.70^{c}±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.

Table 4 showed that weed control practices significantly influenced maize plant height at all growth stages. T_3 consistently produced the tallest plants, followed by T_2 and T_4, while control and T_7 recorded the shortest. The superior growth under plastic mulch was due to effective weed suppression, moisture conservation, and soil temperature regulation. These results align with Sanwa et al. (2023) and Timsina et al. (2025), who also reported improved maize growth with plastic mulch. The taller plants in weed-free plots highlight the negative impact of weed competition on maize development. **b. Plant canopy**

Table 5: Plant canopy of maize as influenced by different weed control practices

Treatments	Plant Canopy (cm)			
	30 DAS	45 DAS	60 DAS	75 DAS

T_1 (Control)	18.46±2.76	26.67^{d}±0.60	43.16^{d}±1.81	49.25^{d}±2.37
T_2(Weed free)	20.96±3.05	37.53^{bc}±0.62	73.08^{a}±5.74	79.04^{a}±6.17
T_3 (Plastic mulching)	24.89±2.94	45.91^{a}±4.10	69.72^{a}±6.17	75.28^{ab}±8.23
T_4 (Hand weeding)	22.28±1.38	41.85^{ab}±3.60	63.44^{ab}±4.67	68.58^{abc}±4.69
T_5 (Pendimethalin)	20.71±2.47	30.86^{cd}±2.03	54.02^{bcd}±0.71	60.69^{cd}±0.76
T_6 (Pendimethalin + Atrazine)	19.58±3.84	32.25^{cd}±1.40	55.47^{bc}±6.07	60.96^{cd}±5.33
T_7 (Pendimethalin + Atrazine fb 2,4-D)	17.09±0.86	24.01^{d}±3.02	50.77^{cd}±8.03	65.25^{bc}±11.7
T_8 (Pendimethalin + Atrazine fb Laudis)	19.40±2.61	29.22^{cd}±1.91	53.74^{bcd}±6.98	61.48^{cd}±5.67
Grand Mean	20.42	33.54	57.93	65.07
CV (%)	15.25	13.58	10.10	10.09
LSD (0.05)	5.45	7.97	10.25	11.50
F-test	NS	***	***	**
SEM±	2.48	2.16	5.02	5.61

Table 5 showed that weed management practices significantly affected maize canopy width at all stages except 30 DAS. T_3 and T_2 consistently produced the widest canopies, reaching 75.28 cm and 79.04 cm at 75 DAS, respectively. In contrast, T_7 and T_1 recorded the narrowest canopies. The increased canopy width under plastic mulch was due to reduced weed competition, better moisture retention, and improved nutrient availability, promoting vigorous leaf growth. These results are consistent with Sanwa et al. (2023), who found that black plastic mulch enhanced maize canopy development. The wider canopy in weed-free plots also highlights the benefits of effective weed control for optimal resource use. **c. Number of leaves**

Table 6: Number of leaves of maize as influenced by different weed control practices

Treatments	Number of leaves per plant			
	30 DAS	45 DAS	60 DAS	75 DAS
T_1 (Control)	6.46±0.59	8.80^{bc}±0.41	12.00±0.30	12.60±0.20
T_2(Weed free)	6.86±0.93	10.40^{ab}±0.61	13.13±0.29	13.26±0.67
T_3 (Plastic mulching)	6.93±0.06	11.20^{a}±0.46	13.33±0.76	12.60±0.64
T_4 (Hand weeding)	7.13±0.96	9.33^{abc}±0.06	13.06±0.52	13.86±0.65
T_5 (Pendimethalin)	7.00±0.60	9.26^{bc}±0.75	12.20±0.11	13.60±0.30
T_6 (Pendimethalin + Atrazine)	7.26±0.13	10.40^{ab}±0.11	12.60±0.90	12.33±1.23
T_7 (Pendimethalin + Atrazine fb 2,4-D)	5.46±0.57	8.53^{bc}±0.87	12.67±0.37	13.00±0.64
T_8 (Pendimethalin + Atrazine fb Laudis)	6.80±0.50	8.20^{c}±0.57	12.67±0.87	12.26±1.01
Grand Mean	6.74	9.51	12.71	12.94
CV (%)	17.03	10.43	6.64	7.85

LSD (0.05)	2.01	1.73	1.47	1.77
F-test	NS	*	NS	NS
SEM±	0.54	0.48	0.51	0.66

While most stages showed no significant differences on number of leaves, a notable effect was observed at 45 DAS ($p < 0.05$), highlighting the importance of early weed management. At 45 DAS, T_3 (11.20) had the highest leaf count which was statistically at par with T_2, T_4 and T_6. In contrast, T_8, T_7, and T_1 recorded the lowest leaf numbers, indicating that weed competition during early growth limits leaf development. Plastic mulching likely promoted leaf growth through weed suppression, moisture retention, and improved root conditions in early days as well. Similarly, manual weed removal in T_2 enhanced leaf number by ensuring better access to light, water, and nutrients. Lower leaf counts in T_8, T_7, and T_1 are attributed to resource competition and shading by weeds during crop establishment. Although differences were not significant at 30, 60, and 75 DAS, trends suggest that sustained weed control during early stages supports greater leaf production.

d. Leaf area index Table 7: Leaf area index of maize as influenced by different weed control practices

Treatments	Leaf Area Index			
	30 DAS	45 DAS	60 DAS	75 DAS
T_1 (Control)	0.10^{bc}±0.01	0.34^{abc}±0.02	1.09^{e}±0.08	1.98^{d}±0.36
T_2(Weed free)	0.14^{ab}±0.01	0.50^{ab}±0.12	2.59^{ab}±0.81	3.92^{ab}±0.67
T_3 (Plastic mulching)	0.20^{a}±0.06	0.64^{a}±0.17	2.93^{a}±0.46	4.47^{a}±0.95
T_4 (Hand weeding)	0.14^{ab}±0.02	0.46^{ab}±0.13	1.79^{bc}±0.36	3.14^{bc}±0.55
T_5 (Pendimethalin)	0.10^{bc}±0.01	0.36^{ab}±0.06	1.55^{cd}±0.20	3.20^{bc}±0.65
T_6 (Pendimethalin + Atrazine)	0.10^{bc}±0.01	0.28^{bc}±0.02	1.60^{cd}±0.39	2.57^{cd}±0.40
T_7 (Pendimethalin + Atrazine fb 2,4-D)	0.07^{c}±0.02	0.19^{c}±0.04	1.25^{de}±0.12	2.66^{cd}±0.85
T_8 (Pendimethalin + Atrazine fb Laudis)	0.09^{bc}±0.00	0.29^{bc}±0.03	1.30^{de}±0.29	2.52^{cd}±0.71
Grand Mean	0.12	0.38	1.76	3.06
CV (%)	38.33	44.69	25.20	18.46
LSD (0.05)	0.08	0.30	0.77	0.98
F-test	*	*	***	**
SEM±	0.01	0.07	0.34	0.64

Note: The leaf area index at 30 days after sowing, 45 days after sowing and 60 days after sowing was subjected to Yeo-Johnson transformation.

The leaf area index (LAI) varied significantly among treatments across all growth stages. 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. Fakoor and Parsa (2014) also reported that hand weeding significantly improved the rate of leaf area expansion in maize compared to the control.

Effect on yield and yield attributing traits of maize Table 8: 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

At 75 DAS, the number of cobs per plant differed significantly ($P < 0.01$). T_5 recorded the highest number of cobs (1.15), which was statistically comparable to T_3 (1.13), T_2 (1.02), T_6 (1.00), and T_4 (0.98). In contrast, T_1 had the lowest cob number (0.56), similar to T_7 (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. T_3 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, T_1 (338.78) recorded the lowest number of kernels, statistically similar to T_8 (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 (TW). T_2 recorded the highest test weight (337.01), which was statistically superior to all other treatments.

T_2 recorded the highest grain yield (5.82), statistically comparable to T_4 (5.73), This result aligns with Shrestha et al. (2021), who reported that weed-free plots nearly doubled maize yields compared to weedy controls, highlighting the importance of effective weed management. Plastic mulching (T_3) also produced comparable yields, consistent with Sanwa et al. (2023), who found that black plastic mulch significantly increased maize productivity. Similarly, Li et al. (2020) reported that plastic mulch significantly enhanced maize grain yield and improved water-use efficiency, promoting better kernel development. The higher yields in T_2 and T_4 followed by T_3 likely resulted from more kernels per cob and greater test weight. In contrast, T_1 had the lowest yield, statistically similar to T_8, reflecting poor weed control, fewer kernels per cob, and lower test weight. This highlights the strong positive impact of manual and physical weed control on maize yield. The lowest yield in the control (T_1), underscores significant losses from unchecked weed competition. Moderate yields in herbicide treatments like T_6 and T_7 suggest that while chemical control was beneficial, it was less effective than manual or physical methods, possibly due to timing issues, diverse weed populations, or limited herbicide persistence under field conditions.

CONCLUSION

Among all weed control methods, weed-free and plastic mulching were the most effective in reducing weed biomass, while control consistently exhibited the highest weed pressure. Integrating pre and post-emergence herbicides provided moderate control, indicating the need to optimize application rates and timing. Overall, these results underscore the importance of integrated weed management to limit weed competition during early maize growth, ultimately improving crop performance. The findings clearly demonstrated that weed-free conditions, hand weeding, and plastic mulching were the most effective practices for enhancing kernel number, grain weight, and overall maize yield. While herbicide-based treatments offered moderate benefits, manual and physical methods consistently achieved superior results under the field conditions of Chitwan.

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