Effect of weed control methods on the vegetative growth characteristics of maize cultivars (*Zea mays* L.)

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Abstract
This study was conducted in Atwaala village, Jalawla district, Diyala Governorate, from July1, 2025, to November1, 2025, to evaluate the effects of different weed control treatments, including hand weeding, mulching, chemical weed control using Amez herbicide, and an untreated control, The study was carried out as a factorial experiment in Randomized Complete Block Design (RCBD) with three replicates, and the obtained data were statistically analyzed to compare treatment means on vegetative growth characteristics for four maize cultivars: the American cultivar (DKC 6777), the Yugoslavian cultivar (ZP GLORYA), the Dutch cultivar (1F-110EB), and the cultivar Cardinia (1F CARDINA).

The results indicated that most cultivars did not differ significantly in several studied traits, except for the Yugoslavian cultivar (ZP GLORYA), which showed superiority in a number of growth indicators.
Weed control treatments, had a significant effect on the measured parameters. Hand weeding recorded the highest values for plant height (268.85 cm), leaf area (716.93 cm²), and ear height (90.25 cm), in addition to promoting earlier male and female flowering compared with the untreated control, which produced the lowest values due to severe weed competition. Mulching and chemical weed control treatments exhibited relatively similar and intermediate performance across most traits, suggesting that mulching could serve as a practical alternative to chemical weed management.
The interaction between cultivars and weed control methods revealed that the best performance was achieved when hand weeding was combined with either the Yugoslavian cultivar (ZP GLORYA) or the Cardinia cultivar (1F CARDINA), reflecting the positive response of these cultivars to reduced weed competition. The findings highlight the importance of effective weed management in improving maize growth and emphasize the combined role of cultivar selection and appropriate weed control strategies in achieving optimum crop performance while minimizing negative environmental impacts.

KEY WORDS: Maize , Dutch cultivar, Yugoslavian cultivar, American cultivar, Cardinia Cultivar,

1.1 Introduction:

Maize (*Zea mays* L.) is considered one of the most important cereal crops worldwide, ranking third after wheat and rice in terms of both economic importance and production. It plays a vital role in human and animal nutrition and is widely utilized in food-processing and feed industries, making it a strategic crop for supporting global food security [1]. Maize is also characterized by its high adaptability to diverse environmental conditions, which has contributed to its widespread cultivation in many countries, including Iraq [2][14][15]..Among cereal crops, maize possesses considerable economic value due to the high nutritional content of its grains, which contain approximately 81% carbohydrates, 10.6% protein, and 4.6% oil. In addition, maize grains are rich in essential vitamins such as vitamins E, B1, and B2. In many developing countries, maize grain is consumed as a staple food and represents an important source of protein for both humans and livestock [3][16].Weeds are regarded as one of the major constraints limiting maize productivity, as they compete with crop plants for essential growth resources , including water, light, nutrients, and space. Such competition negatively affects vegetative growth and ultimately reduces grain yield and its components [4][17][18]. Several studies have demonstrated that inadequate weed control during the early growth stages of maize can result in substantial yield losses, depending on weed species, density, and the duration of weed–crop competition [5][19].Weed management therefore constitutes a fundamental agronomic practice in maize production systems. Weed control methods include mechanical approaches such as tillage, mulching, and hand weeding, as well as chemical control through the use of herbicides. Each method differs in its efficiency and impact on crop growth and productivity [6][20][21]. Previous studies and field experiments have confirmed that integrating different weed management strategies can enhance weed suppression and improve production efficiency compared with reliance on a single control method alone [7][22].The current study seeks to achieve the following objectives:

1. To determine the best methods for weed control in corn crop in terms of their effect on growth traits and yield.

2. To identify the best and most competitive genetic composition of corn against weeds to achieve the highest yield.

1.2 Materials and Methods

1.2.1 Experimental Site:

length})^2Leaf area=0.75×(leaf length)2 [8].

A field experiment was conducted during the autumn growing season on July 1, 2025, in Atwaalat village, Jalawla district, Diyala Governorate, located at latitude 34.273° and longitude 45.165°. Prior to the establishment of the experiment.

1.2.2 Experimental Design:

The experiment was carried out as a factorial experiment in Randomized Complete Block Design (RCBD) with three replicates. Each block consisted of 16 experimental units randomly assigned to ensure compatibility among the studied factors. Each experimental unit measured 3 × 2 m and included five rows spaced 75 cm apart, with 20 cm between plants within rows. A distance of 75 cm was maintained between experimental units and 1.5 m between blocks.

The plots assigned to the mulching treatment were mulched on July 1, 2025, and left undisturbed. After 15 days, these plots were tilled before planting. Four maize cultivars were sown on July 15, 2025: the American cultivar (DKC 6777), the Dutch cultivar (1F-110EB), the Yugoslavian cultivar (ZP GLORYA), and the cultivar Cardinia (1F CARDINA).

1.2.3 Vegetative Growth Characteristics:

1. Plant Height (cm): Plant height was measured using a measuring tape from the soil surface to the last stem node below the tassel at the end of the milk stage. Measurements were recorded for five randomly selected plants from the three central rows of each experimental unit [8].

2. Leaf Area (cm^2 $plant^{-1}$): Leaf area was determined three weeks after female flowering. The length of the leaf located below the upper ear was measured for five randomly selected plants from each experimental unit. Leaf area was calculated according to the following equation:

Leaf area=0.75×(leaf length)2\text{Leaf area} = 0.75 \times (\text{leaf

3. Number of Days to 50% Male Flowering: The number of days from sowing until the appearance of tassels in

50% of the plants within each experimental unit was recorded [9].

4. Number of Days to 50% Female Flowering: The number of days from sowing until the emergence of silks in 50% of the plants within each experimental unit was calculated [9].

5. Ear Height (cm): Ear height was measured from the soil surface to the node bearing the ear using a measuring tape. Measurements were taken from five randomly selected plants within each experimental unit [10].

1.3Results and Discussion

1.3.1 Plant Height (cm): The results presented in Table (1) indicated that there were no significant differences among most cultivars regarding plant height, except for the American cultivar (DKC 6777). The Yugoslavian cultivar (ZP GLORYA) recorded the highest mean plant height (260.26 cm), whereas the American cultivar (DKC 6777) produced the lowest mean value (226.68 cm). These differences may be attributed to genetic variation among cultivars in vegetative growth traits, including growth rate, photosynthetic efficiency, and the ability to utilize available resources effectively.

Weed control methods significantly affected plant height. Hand weeding resulted in the highest average plant height (268.85 cm), reflecting its superior efficiency in reducing weed competition with the crop. This reduction in competition enabled maize plants to make better use of environmental resources such as water, nutrients, and light, thereby enhancing vegetative growth and increasing plant height. In contrast, the untreated control recorded the lowest mean plant height (225.60 cm), which could be attributed to severe weed competition under the absence of weed management, leading to reduced resource uptake efficiency and suppressed vegetative growth. The mulching and chemical weed control treatments produced values of 242.11 and 251.98 cm, respectively, with no significant difference between them. Regarding the interaction between cultivars and weed control treatments, the cultivar Cardinia (1F CARDINA) under hand weeding achieved the highest significant plant height (278.67 cm), indicating the strong positive response of this cultivar to reduced weed competition. Conversely, the untreated control combined with some cultivars, particularly the American cultivar, resulted in the lowest values (210. 80 cm),

Confirming the adverse effects of the absence of weed control on plant growth. These findings highlight the importance of selecting suitable cultivars in combination with effective weed management strategies to achieve optimal vegetative growth. The present results are in agreement with previous studies [11][12][17][18][23], which reported that reducing weed density through efficient weed control practices enhances crop growth and improves vegetative characteristics, including plant height.

Table (1). Effect of Weed Control Treatments, Maize Cultivars, and Their Interaction on Plant Height (cm)

Weed Control Treatments	American Cultivar (DKC6777))	Yugoslavian Cultivar (ZP GLORYA)	Dutch Cultivar (F1-110EB)	Cardinia Cultivar (F1 CARDINA	Mean of Weed Control Treatments
Tillage (One Pass)	210.80 e	263.13 b–c	249.33 b–c	245.20 b–c	242.11 b
Hand Weeding	256.33 b–c	276.40 ab	264.00 b–c	278.67 a	268.85 a
Chemical Control	228.60 d–e	264.27 b–c	263.67 b–c	251.40 b–c	251.98 b
Untreated Control	211.00 e	237.27 c–d	226.47 d–e	227.67 d–e	225.60 c
Mean of Cultivars	226.68 b	260.26 a	250.86 a	250.73 a	—

* Similar letters indicate no significant differences at the 5% level.

1.3.2Leaf area (cm²)

The results presented in Table (2) indicate that there were no significant differences among the mean values of the tested cultivars, as the averages ranged from 622.04 to 663.04 cm². This suggests that the cultivars possessed relatively similar genetic characteristics with respect to leaf area or exhibited comparable responses to the prevailing environmental conditions.

In contrast, weed control treatments had a significant impact on leaf area. Hand weeding produced the highest significant mean value (716.93 cm²), demonstrating its effectiveness in eliminating weeds and reducing competition intensity. Consequently, maize plants were able to utilize light, water, and nutrients more efficiently, leading to greater leaf expansion and increased leaf area.

The untreated control recorded the lowest leaf area value (549.53 cm²), reflecting the adverse effect of increased weed density and severe competition on crop growth. Such competition likely reduced photosynthetic efficiency and limited leaf development. Meanwhile, the tillage and chemical weed control treatments produced intermediate values of 617.70 and 674.70 cm², respectively. These findings indicate that there was little difference between tillage and chemical weed control in reducing weed damage and minimizing their economic and environmental impacts, suggesting that tillage could be considered an environmentally safer alternative to herbicide application, which may pose risks to humans, animals, and the environment.

Regarding the interaction between cultivars and weed control treatments, the cultivar Cardinia (1F CARDINA) under hand weeding achieved the highest significant leaf area (754.72 cm²), followed by the Yugoslavian cultivar (ZP GLORYA) with 746.40 cm². This indicates that these cultivars responded favorably to reduced weed competition. In contrast, the lowest values were recorded under the untreated control, particularly for the Dutch cultivar (530.34 cm²), reflecting the negative impact of high weed density on vegetative growth. These findings agree with those reported by [12][23][24], who indicated that leaf area increases under favorable growth conditions due to enhanced cell division and leaf expansion.

Table (2). Effect of Weed Control Treatments, Maize Cultivars, and Their Interaction on Leaf Area (cm²)

Weed Control Treatments	American Cultivar (DKC6777	Yugoslavian Cultivar (ZP GLORYA))	Dutch Cultivar (F1-110EB	Cardinia Cultivar (F1 CARDINA))	Mean of Weed Control Treatments
Tillage (One Pass)	626.42 c–e	637.02 c–e	618.16 c–e	589.21 c–e	617.70 b
Hand Weeding	677.04 b–c	746.40 a	689.56 b–c	754.72 a	716.93 a
Chemical Control	648.91 c–e	690.63 b–c	650.90 b–c	708.37 ab	674.70 ab
Untreated Control	539.77 d–e	578.11 c–e	530.34 e	549.89 d–e	549.53 c
Mean of Cultivars	623.04 a	663.04 a	622.24 a	650.55 a	—

* Similar letters indicate no significant differences at the 5% level.

1.3.3 Number of Days to 50% Male Flowering: The statistical analysis presented in Table (3) revealed significant differences among cultivar means for the number of days required to reach 50% male flowering. The Yugoslavian cultivar (ZP GLORYA) recorded the highest mean value (56.75 days), whereas the American cultivar (DKC6777) showed the lowest mean value (55.91 days). These differences may be attributed to genetic variation among cultivars in growth rate and physiological development, which ultimately influence flowering time.

Weed control treatments also significantly affected male flowering. Hand weeding recorded the highest mean value (57.75 days), followed by the chemical weed control treatments (57.00 days) and tillage treatment (55.75 days), as compared with the untreated control that recorded the lowest mean value (54.66 days). indicating that complete weed removal reduced competition for resources and provided favorable conditions for plant growth and earlier transition to the reproductive stage. Regarding the interaction between cultivars and weed control treatments, the Yugoslavian cultivar (ZP GLORYA) under hand weeding achieved the highest value (58.66 days), indicating its strong response to reduced weed competition. The lowest values were observed under the untreated control, particularly for the Dutch cultivar (54.33 days), confirming the negative effect of high weed density on delaying flowering. These findings are consistent with those reported by [11][17][24], who stated that reducing weed density improves plant growth and accelerates physiological development, including flowering time.

Table (3). Effect of Weed Control Treatments, Maize Cultivars, and Their Interaction on Number of Days to 50% Male Flowering

Weed Control Treatments	American Cultivar (DKC6777)	Yugoslavian Cultivar (ZP GLORYA)	Dutch Cultivar (F1-110EB)	Cardinia Cultivar (F1 CARDINA)	Mean of Weed Control Treatments
Tillage (One Pass)	55.33 f–g	56.00 f–g	55.66 f–g	56.00 f–g	55.75 c
Hand Weeding	57.00 b–c	58.66 a	58.00 ab	57.33 b–c	57.75 a
Chemical Control	56.33 c–f	57.66 b–c	57.00 b–c	57.00 b–c	57.00 b
Untreated Control	55.00 f–g	54.66 h	54.33 h	54.66 h–g	54.66 d
Mean of Cultivars	55.91 b	56.75 a	56.25 ab	56.25 ab	—

* Similar letters indicate no significant differences at the 5% level.

1.3.4 Number of Days to 50% Female Flowering: The statistical analysis shown in Table (4) revealed significant differences among cultivars in female flowering. The Yugoslavian cultivar (ZP GLORYA) recorded the highest mean value (61.83 days), whereas the American cultivar (DKC6777) showed the lowest mean value (60.16 days). These differences may be attributed to genetic variation among cultivars in growth and physiological development rates.

Weed control treatments also significantly influenced female flowering. Hand weeding achieved the highest mean value (62.66 days), followed by the chemical weed control treatments (61.66 days) and tillage treatment (60.66 days), as compared with the untreated control that recorded the lowest mean value (59.50 days)

indicating that effective weed removal reduced competition for natural resources and promoted favorable conditions for rapid plant development and flowering. This finding further emphasizes the potential efficiency of tillage as an environmentally safer and lower-cost alternative to chemical herbicides.

Regarding the interaction between weed control treatments and cultivars, the Yugoslavian cultivar (ZP GLORYA) under hand weeding recorded the highest significant value (64.00 days), reflecting its strong positive response to reduced weed competition. In contrast, the untreated control produced the lowest value, particularly for the American cultivar (58.66 days), indicating that increased weed density delays female flowering. These results agree with those reported by [11][17][24], who demonstrated that weeds increase the number of days from planting to both male and female flowering.

Table 4. Effect of Weed Control Treatments, Maize Cultivars, and Their Interaction on Number of Days to 50% Female Flowering

Weed Control Treatments	**American Cultivar (DKC6777)**	**Dutch Cultivar (F1-110EB)**	**Yugoslavian Cultivar (ZP GLORYA)**	**Cardinia Cultivar (F1 CARDINA)**	**Mean of Weed Control Treatments**
Tillage (One Pass)	60.00 e–f	61.00 e–f	61.00 e–f	60.66 e–f	60.66 c
Hand Weeding	61.33 c–e	64.00 a	63.33 ab	62.00 b–c	62.66 a
Chemical Control	60.66 e–f	62.66 b–c	61.66 c–d	61.66 c–d	61.66 b
Untreated Control	58.66 g	59.66 f–g	60.00 e–f	59.66 f–g	59.50 d
Mean of Cultivars	60.16 c	61.83 a	61.50 ab	61.00 b	—

* Similar letters indicate no significant differences at the 5% level.

1.3.5 Ear height (cm): The results shown in Table (5) demonstrated significant differences among cultivars in ear height. The Yugoslavian cultivar (ZP GLORYA) recorded the highest mean ear height (86.66 cm), whereas the Cardinia cultivar (1F CARDINA) produced the lowest value (76.91 cm). These differences may be attributed to genetic variation among cultivars in growth characteristics and stem growth distribution, which influence ear position on the plant.

Weed control treatments significantly affected ear height. Hand weeding produced the highest mean value (90.25 cm), followed by the chemical weed control treatments (83.25 cm) and tillage treatment (79.00 cm), as compared with the untreated control that recorded the lowest mean value (73.58 cm)

indicating that complete weed removal during critical growth stages improved the distribution of photosynthetic assimilates within the plant, thereby enhancing stem elongation and increasing ear height.

Regarding the interaction between cultivars and weed control treatments, the Yugoslavian cultivar under hand weeding recorded the highest value (95.00 cm), demonstrating the cultivar's high responsiveness to improved environmental conditions. In contrast, the lowest value was observed for the Cardinia cultivar under the untreated control (71.33 cm), confirming the negative impact of weed competition on crop growth. These findings are consistent with those reported by [13][23][24], who indicated that reducing competition stress improves the distribution of photosynthetic products within the plant, thereby enhancing stem growth and increasing the position of reproductive organs such as ears.

Table 5. Effect of Weed Control Treatments, Maize Cultivars, and Their Interaction on Ear Height (cm)

Weed Control Treatments	American Cultivar (DKC6777)	Yugoslavian Cultivar (ZP GLORYA)	Dutch Cultivar (F1-110EB)	Cardinia Cultivar (F1 CARDINA	Mean of Weed Control Treatments
Tillage (One Pass)	75.33 f–g	87.00 b–c	78.66 f–g	75.00 f–g	79.00 b
Hand Weeding	93.66 ab	95.00 a	89.33 b–c	84.00 b–c	90.25 a
Chemical Control	80.66 c–f	87.00 b–c	88.00 b–c	77.33 f–g	83.25 b
Untreated Control	73.00 f–g	77.66 f–g	72.33 g–f	71.33 g	73.58 c
Mean of Cultivars	76.91 c	86.66 a	82.08 ab	80.41 bc	—

* Similar letters indicate no significant differences at the 5% level.

1.4 Conclusion

The results demonstrated the significant superiority of hand weeding in all growth traits, resulting in increases of approximately 19% in plant height, 30% in leaf area, and 23% in ear height compared with the untreated control, in addition to accelerating flowering by nearly 5%.The tillage and chemical weed control treatments exhibited comparable and moderate efficiency, with improvements ranging from 7% to 20%, supporting the potential use of tillage as an environmentally friendly alternative to chemical herbicides.The Yugoslavian cultivar (ZP GLORYA) showed superior performance in most studied traits, particularly when combined with hand weeding, emphasizing the importance of integrating suitable cultivars with effective weed management practices to achieve optimal vegetative growth and crop performance.

1.5 References

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