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EFFECT ROW SPACING AND HERBICIDES ON GROWTH AND YIELD OF MAIZE (ZEA MAYS L.) AND ASSOCIATED WEEDS

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ABSTRACT
A field experiment was conducted at the research station of the Department of Field Crops, College of Agriculture, University of Diyala, during the spring season of 2025 to evaluate the effect of row spacing and some recently introduced herbicides in Iraq on the growth and yield of yellow corn and its associated weeds. a split-plot arrangement within a Randomized Complete Block Design (RCBD) with three replicates was used. The main treatments included plant densities of 80,000, 66,600, and 57,100 plants ha^{-1}, while the sub-treatments included weed-control treatments: weed-free, weedy check, and herbicide treatments Arrivo, Abel, and Ramses. The results showed the superiority of the plant density 80,000 plants ha^{-1} in most studied traits compared with 66,600 and 57,100 plants ha^{-1}. It produced the lowest weed density at harvest and recorded the highest inhibition percentage and highest leaf area index (8.61 plants m^{-2}, 67.88%, and 3.464 cm^2, respectively), as well as the highest crop growth rate and biological yield. The plant density 57,100 plants ha^{-1} was superior in number of grains per ear and oil percentage, recording 525.66 grains and 4.64%, respectively. Regarding weed-control treatments, the Ramses herbicide excelled in weed inhibition percentage, leaf area index , and crop growth rate, which resulted in the highest grain yield (19.80 t ha^{-1}).The Arrivo herbicide achieved the lowest weed density (6.23 plants ha^{-1}) at the high density of 80,000 plants ha^{-1}.The Abel herbicide with the density 57,100 plants ha^{-1} produced the highest number of grains per ear (549.60 kernels), while Ramses at the same density produced the highest oil percentage (4.76%).The interaction between plant density and weed-control treatments had a significant effect on most studied traits. The results indicate that selecting an appropriate plant density with an effective herbicide plays an important role in achieving optimal crop growth, increasing yield, and improving quality through successful weed suppression and reduced competition, thereby providing greater economic return.

KEYWORDS: Maize (Zea mays L.), row spacing, Herbicide efficacy, chemical control, weed management, maize yield components.

INTRODUCTION
Maize (*Zea mays L.*) is one of the most important strategic and industrial field crops and ranks third globally among major cereal crops after wheat and rice. Its importance lies in its high adaptability to diverse environmental conditions, which has led to its cultivation in most countries of the world, with the possibility of growing it in more than one season per year (Al-Issawi & Abood, 2024).According to the Food and Agriculture Organization (FAO, 2021), global corn production reached approximately 1,148.49 million tons from a cultivated area estimated at **197.2 million hectares**, with an average yield of **5.823 t ha^{-1}**. In Iraq, data from the Ministry of Planning (2023) indicated an increase in agricultural activity for yellow corn, where the cultivated area reached **359,549 dunums** and total production was **538,251 tons**. Maize cultivation in Iraq several challenges, most notably the spread of associated weeds that strongly compete with the crop for essential growth requirements, causing yield losses ranging from **19–51%**. In addition, weeds serve as a source of insects and diseases that infect the crop, thereby reducing production quality (Reuter, 2025). Expansion in yellow corn cultivation is also a major factor contributing to the spread of accompanying weeds (Simic et al., 2025).Many studies confirm that successful **Maize** cultivation depends on limiting the growth and spread of weeds whether annual, biennial, or perennial within yellow corn fields (Shahin et al., 2025). Due to the significant losses caused by weeds, integrated management has become essential in sustainable production systems for this crop (Kaur et al., 2025). Chemical herbicides are considered one of the most effective solutions because of their low cost and ease of application; however, the long-term use of the same herbicide leads to the emergence of herbicide-resistant weeds, a phenomenon that threatens production sustainability. Therefore, agricultural researchers continuously seek to diversify herbicides and introduce new compounds (Pedroso & Mortti, 2025).Plant density is also a determining factor in yellow corn growth and productivity, as plant distribution in the field ensures optimal utilization of growth requirements. This positively affects the balance between vegetative and reproductive growth by increasing photosynthetic efficiency due to larger leaf area, enhancing dry matter accumulation, and ultimately increasing yield (Asad et al., 2021). On the other hand, plant density acts as an indirect weed control method by

increasing competition between crop plants and weeds and reducing light reaching weed plants, thereby suppressing their growth and preventing germination of dormant seeds in the soil, which naturally lowers weed density in the field (Hamza et al., 2022) .Adopting high plant densities in yellow corn cultivation increases competition against weeds, limiting their growth and spread and reducing their number per unit area (Al-Jubouri, 2023). Therefore, increasing plant density is considered a modern scientific approach within integrated and sustainable weed management programs because it enhances the crop's competitive ability (Mansour et al., 2024). Accordingly, the objective of this study was to evaluate the performance of some newly introduced chemical herbicides in Iraq in interaction with different plant density levels and their effect on weed control, growth characteristics, and yield of **Maize** cultivar *Drachma*.

MATERIALS AND METHODS

An experiment was conducted at the research station of the Department of Field Crops, College of Agriculture, University of Diyala, during the spring season of 2025. Yellow corn seeds (cultivar *Drachma*) were sown on 19/3/2025 after proper land preparation in a clay loam soil, aiming to study the effect of plant densities and chemical weed control on the growth and yield of maize and its associated weeds. A Randomized Complete Block Design (RCBD) with a split-plot arrangement and three replicates was used.

Table (1): Physical and Chemical Properties of the Soil for the 2024–2025 Growing Season

Property		Season 2025	unit
Soil particle-size distribution	Sand	26.1	%
	Clay	43.5	
	Silt	30.4	
Soil reaction(pH)		7.9	
Electrical conductivity (ECe)		12.7	ds m^{-1}
Available nitrogen		41.7	Mg. kg^{-1}
Available phosphorus		15.3	
Available potassium		96	
Calcium carbonate		177.4	g. kg^{-1}
Organic matter		6.2	
Soil texture class		Clay loam	

Table (2): Weed Control Treatments, Concentrations Used in the Experiment, and Treatment Codes

N	Treatments	Active ingredient	Application rate
1	(Weed free)	-	Manual weeding by hand hoeing throughout the season
2	(Weedy)	-	Without weed control throughout the season
3	Herbicide (Arrivo 75% SL)	Rimsuper 75%	**1.5 liters per hectare**
4	Herbicide (Abel 30% OD)	Atrazine 20% Nicosulfuron 3% Mesotrione 7%	**1 liter per hectare**
5	Herbicide (Ramses 25% SG)	Rimsulfuron 25%	**50 g/ha**

Studied Traits

Weed species and density at harvest (plants m^{-2}): The weed species growing in the experiment were identified (Table 4), and their density was determined by counting the number of weeds present within **1 m^{-2}** in each experimental unit (Gressel & Kogan, 2020).

Table (3): Weed Species Identified in the Experiment During the Spring Season

Scientific name	**Family**	**Leaf morph type**	**Life cycle**	**Abundance**
Chenopodium murale L.	Amaranthaceae	Slender	Annual	Very dense
Lagonychium farctum L.	Fabaceae	Broad	Perennial	dense
Sonchus oleraceus L.	Compositae	Broad	Annual	Moderate
Corchorus olitorius L.	Malvaceae	Broad	Annual	Low
Sorghum halepense L.	Poaceae	Slender	Perennial	Very dense
Cynodon dactylon L.	Poaceae	Slender	Perennial	Moderate
Cyperus rotundus L.	Cyperaceae	Slender	Perennial	Low
Convolvulus arvensis L.	Convolvulaceae	Broad	Perennial	dense
Setaria viridis L.	Poaceae	Slender	Annual	Low
Alhagi maurorum L.	Fabaceae	Broad	Perennial	Moderate
Malva parviflora L.	Malvaceae	Broad	Annual	Low

Sorghum halepense L.	Poaceae	Slender	Perennial	dense

Inhibition Percentage (%):
The inhibition percentage was calculated according to the following equation (Salman & Hussein, 2018).
Inhibition Percentage (%) = 100 − (A / B × 100)
Where:
A = Dry weight of weeds in the treated (control) plot
B = Dry weight of weeds in the untreated (comparison) plot
Leaf Area Index (LAI)
It was calculated by dividing the leaf area of a single plant by the ground area occupied by that plant (Al-Khafaji & Al-Juhayshi, 2022).
Crop Growth Rate (CGR) (g m^{-2} day^{-1})
One plant was randomly taken from each experimental unit at **60 and 120 days after sowing**, dried, and calculated using the following equation (Abd & Al-Mousawi, 2021):
$CGR = (1 / GA) \times (W_2 - W_1) / (T_2 - T_1)$
Where:
GA = Ground area occupied by the plant
W_1 = Dry weight of the plant sample at the first time (T_1)
W_2 = Dry weight of the plant sample at the second time (T_2)
Number of Kernels per Ear (ear^{-1})
The number of kernels per row was counted manually for three ears randomly selected from the middle rows of each experimental unit, then the average was calculated (Al-Jubouri & Al-Rifai, 2021).
Biological Yield (t ha^{-1})
This trait was calculated by air-drying all plant parts after cutting and placing them in paper bags until constant weight, and then calculated according to the following equation (Al-Tamimi et al., 2022).
Biological Yield (t ha^{-1}) $x = \frac{\text{(Plant density × total dry weight per plant (g)}}{1{,}000{,}000}$
Oil Percentage in Grains:
It was calculated using the following equation.
Oil Percentage (%) $= x = \frac{(\boldsymbol{Weight\ after\ extraction - Weight\ before\ extraction})}{\text{Weight before extraction}}$ X 100 (Ahamed et al., 2022)
The data were statistically analyzed according to a Randomized Complete Block Design (RCBD) with a split-plot arrangement using the **SAS** program. The means were compared using Duncan's Multiple Range Test (DMRT) **at a** 5% probability level (SAS Institute, 2012).

RESULTS AND DISCUSSION

Weed Density Associated with Yellow Corn at Harvest (plants m^{-2})
Table (4) shows the superiority of the high plant density (80,000 plants ha^{-1}) in the trait of weed density at harvest, recording the lowest average density (8.61 plants m^{-2}), which differed significantly from the plant density 66,600 plants ha^{-1} that recorded an average weed density of 11.68 plants m^{-2}. The lowest plant density (57,100 plants ha^{-1}) recorded the highest weed density (13.42 plants m^{-2}).The results indicate that weed numbers gradually decreased as yellow corn plant density increased. This can be explained by interspecific competition for limited resources (water, nutrients, and space), along with the important role of plant density in modifying the light environment. The dense yellow corn canopy acts as a barrier reducing light intensity reaching weeds, weakening their photosynthetic efficiency and reducing germination and vegetative growth due to limited available light energy. These findings agree with many studies indicating the role of plant density in reducing weed growth and spread, including Al-Mohammadi et al. (2022), who concluded that weed density decreased with increasing plant density.Table (4) also shows the superiority of the Arrivo herbicide treatment, which recorded the lowest weed density at harvest (7.47 plants m^{-2}), significantly differing from Abel and Ramses herbicide treatments that recorded 9.34 and 9.733 plants m^{-2}, respectively. In comparison, the weedy treatment recorded the highest weed density at harvest (29.64 plants m^{-2}). This reduction in weed numbers is attributed to herbicide efficiency in inhibiting seed germination and killing weed plants, stopping their growth through direct effects on physiological and biochemical processes. These results agree with Kakade et al. (2020), who found that weed density decreased following herbicide application.The interaction between treatments (Table 4) showed that the highest weed density occurred in the untreated control with plant density 57,100 plants ha^{-1} (34.76 plants m^{-2}), whereas the lowest weed density was achieved with Arrivo herbicide at plant density 80,000 plants ha^{-1} (6.23 plants m^{-2}).

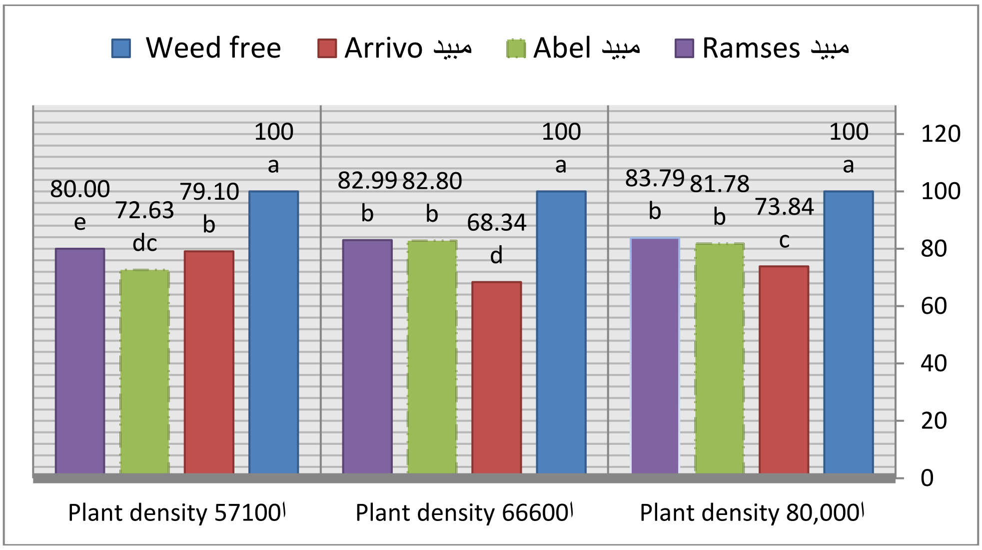
Table (4): Effect of Plant Densities, Treatments Weed Control, and Interaction on Weed Density at Harvest (plants m^{-2})

	Control treatments	

Plant densities (plants ha⁻¹)	Weed free	Weedy	Arrivo Herbicide (75% SL)	Abel Herbicide (30% OD)	Ramses Herbicide (25% SG)	Effect of plant densities
80,000	0.0f	23.66C	6.23e	6.80e	6.36e	8.61 C
66,600	0.0f	30.50b	6.03e	10.40d	11.46 d	11.68 B
57,100	0.0f	34.76a	10.16d	10.83d	11.36 d	13.42 A
Control Treatments	0.0D	29.64A	7.47C	9.34B	9.73B	

Effect of Plant Densities and Weed Control Treatments on Inhibition Percentage

Table (5) shows the superiority of the plant density 80,000 plants ha^{-1} in inhibition percentage, recording the highest value (67.88%), followed by plant densities 66,600 and 57,100 plants ha^{-1}, which recorded average inhibition percentages of 66.82% and 66.34%, respectively .The results indicate that inhibition percentage increased gradually with increasing yellow corn plant density. This is attributed not only to higher productivity but also to suppression of weed spread. High plant densities form a dense canopy that reduces light reaching the soil surface, preventing weeds from performing photosynthesis and consequently reducing their dry weight. Moreover, high yellow corn density produces an extensive root system occupying a larger soil volume, efficiently utilizing water and nutrients, leaving weeds in a constant nutrient deficiency state. These findings agree with Al-Mohammadi et al. (2022), who reported that inhibition percentage increases with increasing plant density.Table (5) also shows the superiority of the Ramses herbicide, which recorded the highest inhibition percentage (82.26%), followed by Abel and Arrivo herbicides with 79.07% and 73.76%, respectively. The increase in inhibition percentage is attributed to the high efficiency of herbicides in suppressing seed germination and killing weed plants, thereby reducing their density and dry weight, which positively reflected in higher inhibition percentage. These results agree with El-Taif & Obaid (2018), who concluded that herbicide use positively reduced weed dry weight and consequently increased weed inhibition percentage.The interaction (Table 5) showed that the Ramses herbicide with plant density 80,000 plants ha^{-1} achieved the highest inhibition percentage (83.79%), whereas Abel herbicide with the lowest plant density recorded the lowest inhibition percentage (72.63%).



Effect of Plant Densities and Weed Control Treatments on Leaf Area Index (cm²):

Table (6) shows a significant effect of plant density, where the density 80,000 plants ha^{-1} was superior in leaf area index, recording the highest value (3.464 cm²). The density 66,600 plants ha^{-1} recorded an average LAI of 3.106 cm², which differed significantly from the low density 57,100 plants ha^{-1}, which recorded the lowest LAI (2.877 cm²).The higher LAI at 80,000 plants ha^{-1} is attributed to the increased number of plants per unit area, which positively reflects on total leaf area compared with lower plant densities. These results agree with Jares (2019), who concluded that high plant densities recorded the highest leaf area index.Table (6) also shows the superiority of the Ramses herbicide, recording the highest LAI (3.279 cm²), followed by Abel (3.112 cm²) and Arrivo (3.102 cm²) compared with the weedy treatment, which recorded the lowest LAI (2.941 cm²). The weed-free treatment recorded the highest LAI (3.312 cm²).The reduction in leaf area index in the weedy treatment is attributed to increased weed density causing strong competition with yellow corn plants for essential growth requirements. In contrast, weed control treatments increased LAI due to reduced weed numbers as a result of the high efficiency of herbicides in suppressing germination and killing weeds through direct effects on physiological and biochemical processes such as inhibition of photosynthesis, suppression of cell division, or restriction of nutrient uptake, depending on the herbicide mode of action. These findings agree with Al-Khazaali et al. (2019).The interaction (Table 6) showed that the weed-free treatment and Ramses herbicide with plant density 80,000 plants ha^{-1} recorded the highest LAI (3.705 and 3.678 cm^2, respectively), whereas the weedy treatment with low plant density 57,100 plants ha^{-1} recorded the lowest LAI (2.970 cm^2).

Table (6): Effect of Plant Densities and Weed Control Treatments on Leaf Area Index (cm^2) of yellow corn (cv. Drachma)

Plant densities (plants ha^{-1})	Control treatments					Effect of plant densities
	Weed free	Weedy	Arrivo 75% SL	Abel 30% OD	Ramses 25% SG	
80,000	3.705a	3.295b	3.316B	3.329b	3.678a	3.464A
66,600	3.261b	2.819ef	3.085Cd	3.179cb	3.187cb	3.106B
57,100	2.970ed	2.709f	2.906e	2.828ef	2.974ed	2.877C
Control Treatments	3.312A	2.941C	3.102B	3.112B	3.279A	

Effect of plant density and weed-control treatments on Crop Growth Rate (g m^{-2} day^{-1}):

Table (7) shows the superiority of the high plant density treatment (80,000 plants ha^{-1}), which recorded the highest crop growth rate of **12.00 g m^{-2} day^{-1}**, compared with the low plant density (57,100 plants ha^{-1}), which recorded the lowest crop growth rate of **10.37 g m^{-2} day^{-1}**. The medium plant density (66,600 plants ha^{-1}) recorded an intermediate value of **11.27 g m^{-2} day^{-1}**.

The reason for the higher value at the high plant density (80,000 plants ha^{-1}) is attributed to the greater number of plants per unit area, which increases plant biomass per unit area. In addition, this treatment showed superiority in weed competition, allowing the crop to grow without competition and perform physiological activities, including photosynthesis, more efficiently. This consequently led to increased dry matter accumulation in the plant. These results agree with those obtained by **Bamaafa and Al-Haider (2021)**, who concluded that crop growth rate increases with increasing plant density.

Table (7) also indicates the superiority of the herbicide **Ramses** treatment in recording the highest average crop growth rate (**11.51 g m^{-2} day^{-1}**), followed by the herbicides **Arrivo** and **Abel**, which recorded averages of **11.06** and **10.48 g m^{-2} day^{-1}**, respectively, compared with the weedy treatment, which recorded the lowest crop growth rate (**10.11 g m^{-2} day^{-1}**). The weed-free treatment recorded the highest crop growth rate (**12.90 g m^{-2} day^{-1}**).

The increase in crop growth rate is attributed to the effectiveness of herbicides in controlling weeds, leading to suppression or inhibition of weed growth. This increased the crop's competitive ability and improved utilization of essential growth requirements compared with the weedy treatment. Consequently, growth indicators such as plant height and leaf area increased, enhancing photosynthesis rates and dry matter accumulation. These findings agree with **Al-Attar (2022)**, who concluded that herbicide spray treatments recorded the highest relative growth rate.

Table (7) further shows the superiority of the **Ramses herbicide combined with high plant density (80,000 plants ha^{-1})**, which recorded the highest crop growth rate (**12.02 g m^{-2} day^{-1}**), compared with the weedy treatment at low plant density (57,100 plants ha^{-1}), which recorded the lowest crop growth rate (**9.47 g m^{-2} day^{-1}**).

Table (7): Effect of plant densities and weed-control treatments on crop growth rate (g m^{-2} day^{-1}) of yellow corn , Drachma cultivar.

Plant densities (plants ha^{-1})	Control treatments					Effect of plant densities
	Weed free	Weedy	Arrivo 75% SL	Abel 30% OD	Ramses 25% SG	
80,000	14.33a	10.37fhg	11.88cbd	11.38ced	12.02cb	12.00A
66,600	12.44b	10.51feg	11.81cbd	10.18fhg	11.44cd	11.27B
57,100	11.92cbd	9.47h	9.49h	9.89gh	11.06 feg	10.37 C
Effect of control treatments	12.90A	10.11C	11.06B	10.48C	11.51	

Effect of plant densities and weed-control treatments on number of kernels per ear:

Table (8) shows the superiority of the low plant density (57,100 plants ha^{-1}) in the trait of number of kernels per ear, recording the highest value of **525.66 kernels**, compared with the high plant density (80,000 plants ha^{-1}), which recorded the lowest average number of kernels per ear (**439.13 kernels**). The plant density of 66,600 plants ha^{-1} recorded an intermediate value (**461.44 kernels**).

This may be due to the fact that the number of kernels per ear is affected by high plant densities, which may lead to failure of pollination and fertilization in one or more rows of the ear, as well as increased competition among plants for growth requirements. These results agree with **Al-Sadi and Al-Aboody (2023)**, who confirmed that low plant densities recorded the highest average number of kernels per ear.

Table (8) also shows the superiority of the herbicide **Ramses** treatment, recording the highest number of kernels per ear (**478.08 kernels**), followed by the herbicide **Arrivo** (**470.88 kernels**), while the herbicide **Abel** recorded **465.99 kernels**, compared with the weedy control treatment, which recorded the lowest average (**385.54 kernels**). The reduction in kernel number in the weedy treatment is attributed to increased weed density, causing competition with maize plants for growth space. In weed-control treatments, an increase in kernel number was observed due to the reduction in weed population resulting from the high efficiency of herbicides in killing and suppressing weeds. These findings agree with **Sabah et al. (2021)**, who confirmed that chemical herbicides produced the highest number of kernels per ear.

Table (8) further indicates the superiority of the herbicide **Abel** combined with the plant density of 57,100 plants ha^{-1}, which recorded the highest number of kernels per ear (**549.60 kernels**), compared with the weedy treatment at a plant density of 66,600 plants ha^{-1}, which recorded the lowest average (**367.93 kernels**).

Table (8): Effect of plant densities and weed-control treatments on the number of kernels per ear of yellow corn, Drachma cultivar.

Plant densities (plants ha^{-1})	Control treatments					Effect of plant densities
	Weed free	*Weedy*	Arrivo 75% SL	Abel 30% OD	Ramses 25% SG	
80,000	548.73b	389.97de	400.27de	421.07dc	435.63dc	439.13C
66,600	575.73ab	367.93e	470.40c	427.30dc	465.83c	461.44B
57,100	605.30a	398.73de	541.97b	549.60b	532.73b	525.66A
Effect of control treatments	576.59A	385.54C	470.88B	465.99B	478.07B	

Effect of plant densities and weed-control treatments on biological yield (t ha^{-1}):

Table (9) shows the superiority of the high plant density treatment (80,000 plants ha^{-1}) in biological yield, which recorded the highest value of **21.97 t ha^{-1}**, compared with the low plant density (57,100 plants ha^{-1}), which recorded the lowest biological yield (**16.46 t ha^{-1}**). This differed significantly from the plant density of 66,600 plants ha^{-1}, which recorded a biological yield of **17.45 t ha^{-1}**.

The higher biological yield at the high density (80,000 plants ha^{-1}) is due to the increased number of plants per unit area, whereas the lower density (57,100 plants ha^{-1}) resulted in reduced biological yield because of fewer plants per unit area. These results agree with **Sabah et al. (2021)**, who concluded that increasing plant population per unit area increases biological yield.

Table (9) also indicates the superiority of the herbicide **Ramses** treatment in biological yield (**19.80 t ha^{-1}**), followed by the herbicides **Arrivo** and **Abel**, which recorded **17.84** and **18.68 t ha^{-1}**, respectively, compared with the weedy control treatment, which recorded the lowest average biological yield (**15.63 t ha^{-1}**). The weed-free treatment recorded a biological yield of **21.17 t ha^{-1}**.

The reduction in biological yield in the weedy treatment is attributed to increased weed density, which competes with maize for essential growth requirements. In weed-control treatments, biological yield increased due to reduced weed numbers as a result of the high efficiency of herbicides in inhibiting weed seed germination and killing weed plants and stopping their growth. These results agree with **Al-Obaidi and Al-Obaidi (2020)**, who confirmed that biological yield increases in weed-control treatments.

Table (9) further shows the superiority of the herbicide **Ramses** combined with the high plant density (80,000 plants ha^{-1}), which recorded **23.43 t ha^{-1}**, compared with the weedy treatment at low plant density (57,100 plants ha^{-1}), which recorded the lowest biological yield (**13.86 t ha^{-1}**).

Table (9): Effect of plant densities and weed-control treatments on biological yield (t ha^{-1}) of yellow corn , Drachma cultivar.

Plant densities (plants ha^{-1})	Control treatments					Effect of plant densities
	Weed free	*Weedy*	Arrivo 75% SL	Abel 30% OD	Ramses 25% SG	
80,000	25.73a	18.36ed	20.90c	21.43c	23.43b	21.97A
66,600	20.23c	14.66g	16.30f	17.53edf	18.53d	17.45B
57,100	17.56edf	13.86g	16.33f	17.10ef	17.43edf	16.46C
Effect of control treatments	21.17A	15.63E	17.84D	18.68C	19.80B	

Effect of plant densities and weed-control treatments on oil percentage (%):

Table (10) shows the superiority of the low plant density treatment (57,100 plants ha^{-1}) in oil percentage, which recorded the highest oil content (**4.64%**), compared with the high plant density (80,000 plants ha^{-1}), which recorded the lowest average oil percentage (**4.28%**). This did not differ significantly from the plant density of 66,600 plants ha^{-1}, which also recorded **4.28%**.

The lower oil percentage at the high density (80,000 plants ha^{-1}) is due to the increased number of plants per unit area and consequently increased competition for growth resources. In contrast, the low density (57,100 plants ha^{-1}) increased oil percentage due to reduced competition for essential growth requirements. These results agree with **Al-Badri (2019)**.

Table (10) also indicates the superiority of herbicide treatments in oil percentage. The chemical herbicides **Ramses**, **Arrivo**, and **Abel** recorded oil percentages of **4.68%**, **4.45%**, and **4.54%**, respectively, compared with the weedy control treatment, which recorded the lowest average (**3.54%**), while the weed-free treatment recorded **5.16%**.

The reduction in oil percentage in the weedy treatment is attributed to competition for growth requirements, as weeds can absorb nutrients from the soil especially nitrogen, phosphorus, potassium, and water leading to weak embryos and disruption of physiological processes responsible for fatty acid synthesis. In addition, competition causes plant stress, pushing the plant toward completing its life cycle rapidly, resulting in incompletely matured grains and consequently lower oil content. These results agree with **Abdul Qader (2024)**, who concluded that oil percentage increases under weed-control treatments.

Table (10) further shows the superiority of the herbicide **Ramses** combined with the plant density of 57,100 plants ha^{-1}, which recorded an oil percentage of **4.76%**, compared with the weedy treatment at a density of 66,600 plants ha^{-1}, which recorded the lowest oil percentage (**3.46%**).

Table (10): Effect of plant densities and weed-control treatments on oil percentage (%) of yellow corn, Drachma cultivar.

Plant densities (plants ha^{-1})	Control treatments					Effect of plant densities
	Weed free	*Weedy*	Arrivo 75% SL	Abel 30% OD	Ramses 25% SG	
80,000	4.80bc	3.53f	4.30ed	4.06e	4.70bcd	4.28B
66,600	5.16ab	3.46f	4.50ecd	4.73bcd	4.60cd	4.49AB
57,100	5.53a	3.63f	4.56cd	4.73bcd	4.76bcd	4.64A
Effect of control treatments	5.16A	3.54C	4.45B	4.54B	4.68B	

REFERENCES

1. Bamaafa, Majid Saeed Salem & Hamed Jaafar Abu Bakr Al-Haider (2021). Effect of plant density on physiological and yield traits of yellow corn plants. *Journal of Modern and Heritage Sciences* 9(1): 5–14.

2. Al-Badri, Ali Khafif Lafta (2019). Effect of plant density and sowing date on seed vigor and viability, yield and its components in yellow corn (*Zea mays L.*). M.Sc. Thesis, Al-Muthanna University, College of Agriculture, 83 pp.

3. Al-Tamimi, Ghassan Thamer & Al-Rifai, Maytham Majeed (2022). Growth and yield response of yellow corn (*Zea mays L.*) to spraying with nano and liquid organic fertilizer. *Karbala Journal of Agricultural Sciences* 9(3): 45–58.

4. Al-Jubouri, Saadoun Hussein (2023). Competitive interference for nutrients between field crops and associated weeds under different plant densities. *Mesopotamia Journal of Agriculture* 51(2): 110–125.

5. Al-Jubouri, Marwan Nouri & Al-Rifai, Maytham Majeed (2021). Growth and yield response of yellow corn (*Zea mays L.*) to different levels of nitrogen and phosphorus fertilization. *Karbala Journal of Agricultural Sciences* 8(4): 104–118.

6. Hamza, Mahmoud Ali; Al-Obaidi, Ahmed Jassim; & Hussein, Alaa Taha (2022). Effect of plant density on competitive interference between yellow corn (*Zea mays L.*) and associated weeds and soil seed bank dynamics. *Iraqi Journal of Agricultural Sciences* 53(4): 812–825.

7. Al-Khazali, Ammar Jassim Ghani; Risan Karim Al-Shatti; Maha Nayef Kadhim; & Khudair Abbas Salman (2019). Effect of herbicides on some growth and yield traits of yellow corn (*Zea mays L.*). *Syrian Journal of Agricultural Research* 6(4): 177–188.

8. Al-Khafaji, Haider Abdul Hassan & Al-Jahishi, Risan Karim (2022). Effect of salicylic acid and kinetin spraying on physiological growth traits and yield of yellow corn (*Zea mays L.*). *Al-Furat Journal of Agricultural Sciences* 14(2): 254–268.

9. Salman, Alaa Muslih & Hussein, Mohammed Ramadan (2018). Effect of interaction between herbicides and seed rates on growth and yield of yellow corn (*Zea mays L.*). *Iraqi Journal of Agricultural Sciences* 49(5): 845–856.

10. Shaheen, Mohammed Samir Abdullah & Al-Obaidi, Mohammed Akram Abdul-Latif (2025). Evaluation of the effectiveness of herbicide Adengo 456 SC in controlling weeds associated with yellow corn (*Zea mays L.*) and its effect on growth and yield traits during spring and autumn seasons. *Mosul University Journal of Agricultural Sciences*, College of Agriculture and Forestry, University of Mosul.
11. Sabah, Qusay Samir; Ali Farhoud Nasser; & Abdul-Salam Ghadhban Makki (2021). Effect of different control methods and plant density on growth and yield of yellow corn (*Zea mays L.*). *Al-Muthanna Agricultural Journal* 8(4): 92–102.
12. Abd, Haider Shaker & Al-Mousawi, Basim Shaker (2021). Effect of shading and plant density on physiological growth traits and yield of yellow corn (*Zea mays L.*). *Iraqi Journal of Agricultural Sciences* 52(4): 910–922.
13. Abdul Qader, Sardar Abdul Jabbar (2024). Evaluation of growth, productivity and weed control of yellow corn (*Zea mays L.*) using some chemical herbicides at different planting distances. M.Sc. Thesis, College of Agriculture, University of Kirkuk.
14. Al-Obaidi, Mohammed Akram Abdul-Latif & Ahmed Mohammed Sultan Al-Obaidi (2020). Performance of different herbicides in controlling weeds associated with yellow corn (*Zea mays L.*). *Kirkuk University Journal of Agricultural Sciences* 11(1): 110–125.
15. Al-Attar, Muhi Al-Din Muwaffaq Muhi Al-Din (2022). Growth and yield response of yellow corn (*Zea mays L.*) to planting distances and herbicides. PhD Dissertation, College of Agriculture and Forestry, University of Mosul, Iraq.
16. Al-Mohammadi, Areej Mohammed Saleh; Shaker Mahdi Saleh; & Mohammed Ramadan Ahmed (2022). Effect of plant density and herbicide Proponit on control of associated weeds and seed yield of sorghum. *Iraqi Journal of Desert Studies* 12(1): 59–68.
17. Mansour, Adel Saleh; Al-Rawi, Khalid Mohammed; & Al-Hadithi, Omar Jassim (2024). Integrated weed management in cereal crops and the role of plant density in enhancing agricultural sustainability. *International Journal Agricultural and Environmental Sciences* 6(1): 215–230.
18. AL-Asadi. D. H. A.. M. A. AL-Abody (2023 a) Evaluation of the performance of three genotypes of yellow corn (Zea mays) cultivated at different planting distances in growth characteristics. Scientific Research Journal of Agriculture and Life Sciences. 3(1):25-30 .
19. Al-Issawi, N. R. & Abood, N. M. 2024. Response Yellow Corn Cultivars (Zea Mays L) To Foliar Application Of Kinetin. Iraqi Journal Of Agricultural Sciences, 55, 494-504.
20. Asad, M.,Hussain , S., & Ahmad, S. (2021). Optimization of phant density for maximizing light interception and grain yield in yellow corn (*Zea mays* L .) . ournal of Crop production and Management, 12(3), 45-58.
21. El-Taif. M. R. A. & A. A. Obaid (2018) Test of the effectiveness of the herbicides Lumax and Camix with the presense of wheat crop Triticum aestivum L. resides in the control of yellow corn (Zea mays L.) 5018. Annals of Agricultural Science Moshtohor. 56(4): 519-530.
22. Jares, D., Krnjic, S.B. Varanicy, M.,and Svenjak,Z. (2019). Effect of plant density on leaf area index, anthesis to Silking interval, yield and yield components of yellow corn inbreds and their sister-lines. Journal of centeral European Agriculture. 20(1): 179-193.
23. Kakade. S. U.. J. P. Deshmukh, S. S. Thakare & M. S. Solanke (2020) Efficacy of pre-and post-emergence herbicides in yellow corn. Indian Journal of Weed Science, 52(2): 143-146
24. Kaur, P., S. S. Rana, R. Kumar, N. Guleria, and B. Singh. 2025. Allelopathy: A green sustainable weed management approach. In Natural Pesticides and Allelochemicals, 1st Edition. pp. 335-351. CRC Press.
25. Pedroso, R. M., and M. L. Moretti. 2025. Weed resistance to herbicides and genetically engineered, herbicide-resistant soybeans as a tool for weed control: Past, present, and future of adoption. In Soybean Production Technology: Crop Pests and Diseases, pp. 327-351. Singapore: Springer Nature Singapore.
26. Reuter, T., K. Nahrstedt, L. Wittstruck, T. Jarmer, G. Broll, and D. Trautz. 2025.Site-specific mechanical weed management in *Zea mays* in North –West Germany. Crop Protection, 190(2):1-6 .107123.
27. Simić, M., V. Dragičević, A. Tataridas, T. Krachunova, J. Srdić, I. Gazoulis, and M Site-specific mechanical weed management in Zea mays in North-West Wolf, T. M., & Whitford, F. (2024). The Science of Spray Drift: Management and Mitigation in Field Trials. Journal of Pesticide Science, 49(1), 45-58.

Sources of variation S.O.V	Degrees of freedom DF	Weed density (plants m^{-2})	Inhibition percentage (%)	Leaf area index (cm^2)	Relative crop growth rate (g m^{-2} day^{-1})	Number of kernels per ear (kernels row^{-1})
Replications	2	0.114	12.54	0.0007	0.114	44.90
Plant densities D	2	10.023^{**}	$9.25^{n.s}$	1.341^{**}	10.023^{**}	30276.67^{**}
Experimental error A	4	0.357	15.80	0.0037	0.357	175.30

Control treatments T	4	10.512^{**}	13505.51^{**}	0.209^{**}	10.512^{**}	41466.01^{**}
Interaction D×T	8	0.986^{*}	45.89^{**}	0.027^{*}	0.986^{*}	2776.62^{**}
Experimental error B	24	0.247	7.91	0.007	0.247	755.23

Sources of variation S.O.V	Degrees of freedom DF	Biological yield (t (ha^{-1}	Oil percentage (%)
Replications	2	0.550	0.044
Plant densities D	2	129.53^{**}	0.508^{**}
Experimental error A	4	0.571	0.046
Control treatments T	4	39.286^{**}	3.134^{*}
Interaction D×T	8	2.122^{**}	$0.109^{n.s}$
Experimental error B	24	0.567	0.063