Impact of Herbicides and Wheat Varieties on Weed Dynamics and Crop Yield

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Abstract

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This study was conducted during the 2023-2024 agricultural growing season in the Nineveh Governorate, Tel Kaif District, Wannah Sub-district, 60 km north of Mosul city. This study aimed to assess the effectiveness of herbicides and wheat varieties on weeds dynamics and crop yield. Varieties used were Jihan and Tammuz and the herbicides used were: Timeline Trion EC, Atlantis OD, Pallas OD, Discipline OD, Axial 050 EC + U46-Combi fluid 6 SL (Mix), and Totic 10 EC + U46-Combi fluid 6 SL (Mix). Planting in the experimental field was conducted on 26/11/2023. The experimental design followed was the randomized complete block design with three replicates. The Tamuz variety excelled in plant height, flag leaf area, and spike density (93.79 cm, 54.98 cm², and 589.76 spikes/m², respectively). Meanwhile, the Jehan variety outperformed in 1000-grain weight and grain yield (36.43 g and 843.50 g/m², respectively). The Discipline herbicide treatment showed superiority in number of weeds, weeds weight, flag leaf area, number of spikes, spike length, and grain yield (12.70 weeds/m², 12.11 g/m², 55.58 cm², 613.71 spikes/m², 10.56 cm, and 901.25 g/m², respectively).

Keywords: Weed control, herbicide, varieties, wheat.

Introduction

Wheat *Triticum aestivum* L., a member of the Poaceae family, stands as one of the most prevalent food crops globally. Wheat yield can potentially be enhanced 11 times when high-yielding varieties are combined with optimal use of fertilizers, irrigation, and herbicides (Wahab & Aljuburi, 2023a). In light of the growing population, the Food and Agriculture Organization (FAO) forecasts that the global population will reach 9 billion by 2050, necessitating a doubling of crop production to satisfy future food demands (FAO, 2020). Global statistics reported that grain production for 2023/2024 will be around 784.91 million metric tons (Statista, 2024). Data for the winter season of 2023 indicated that the total area planted with wheat crops reached 2,105,000 ha, yielding 4,248,000 tons of wheat. The average yield/ ha was approximately 2,018 kg (ASGIS, 2023).

Weeds represent a major environmental factor to agricultural production, leading to significant reduction in crop yield worldwide (Anthimidou *et al.,* 2020). They not only diminish crop quality and quantity but also pose health risks to humans and animals. Weeds compete with crops for essential resources such as light, nutrients, soil moisture, and space. One of the primary factors in decreased wheat yields is the failure to implement scientific methods in planting and managing wheat, particularly weed control. Weeds can lead to yield losses of 30-50%, as they are an important limiting factor in crop growth and productivity (Halawa, 2019).

Herbicides are among the most effective tools for controlling weeds and mitigating losses in agricultural productivity. Chemical control is often more advantageous than traditional methods due to its ease of use, cost-effectiveness, and rapid action in eradicating weeds and reducing their detrimental effects on crop growth and yield (Matzrafi *et al.,* 2017).

The study aims to evaluate six herbicides, five of which are provided to farmers by the Plant Protection Directorate, to determine the most effective for controlling weeds in wheat fields. Additionally, ground and foliar fertilization were compared to assess which is more productive.

Materials and Methods

This study was carried out during 2023 and 2024 agricultural season in the Nineveh Governorate, in Tel Kaif District, Wannah Sub-district, situated 60 km north of Mosul city. The primary objective was to assess the impact of herbicides and ground and foliar fertilization systems on the growth and yield of two bread wheat, *Triticum aestivum* L. varieties and the associated weeds.

Agricultural practices

The experimental plots preparation involved plowing the soil twice in perpendicular directions using a moldboard plow, followed by smoothing the soil with disc harrows. Planting took place on 26/11/2023 using the Jehan and ASmuz wheat varieties. The field was additionally irrigated using fixed sprinklers, and the harvest was completed on 28/5/2023.

Experimental design

The experimental design followed was the randomized complete block design (RCBD) with three replicates. Each experimental unit covered an area of 1.5×3 meters (4.5 m²), with a 2-meter buffer between replicates and a 1-meter buffer between experimental units. The treatments were randomly assigned to the experimental units.

Wheat varieties and herbicides used

The two wheat varieties Jehan and Tamuz were used in this study. In addition, information on herbicides used are summarized in Table 1.

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Table 1. Information on herbicides used in this study.

Commercial Herbicide Name	Active ingredients and concentration	Recommended usage rate	Targeted weeds
Timeline Trion EC	Pinoxaden 0.75%+ Clodinafop-Propargyl 3.0%+ Florasulam 3.0%	1.25 L/ha	Narrow and Broad-leaved weeds
Atlantis OD	Mesosulfuron Methyl 30 g/ kg + Iodosulfuron-Methyl 6 g/ kg + Mefenpyer- Diethyl 90 g/ L	320 g/ha + 0.5 L/ha	
Pallas OD	Pyroxsulam 45g/L	450-500 ml/ha	
Discipline OD	Diflufenican 5% w.v + Mesosulfuron Methyl 0.75% w.v + Iodosulfuron-Methyl 0.25% w.v + Mefenpyer- Diethyl 2.25% w.v	1.25 L/ha	
(Mix) Axial 050 EC + U46-Combi fluid 6 SL	Pinoxaden 50g/ L+ 2.4-D 35% + MCPA 30%	1-1.5 L/ha+ 0.75- 1.0 L/ha	
(Mix) Totic 10 EC + U46-Combi fluid 6 SL	Clodinafop- propargyl 20% + Cloquintocet mexyl 80% +2.4-D 35% + MCPA 30%	600 cm^3/ha + 0.75-1.0 L/ha	

Studied traits

The following traits were investigated: (1) Total weed number (weeds/m^{-2}), (2) Total weed weight (g/m^{-2}), (3) Plant height (cm), (4) Flag leaf area (cm^{-2}), (5) Number of grains per spike, (6) Number of spikes/m^2, (7) 1000 grains weight (g), (8) Grain yield (g/m^2).

Results and Discussion

Total weed number (weeds/m^{-2})

Results obtained (Table 2) showed that there are no significant differences in the total weed number between the Jehan and Tamuz varieties, with averages of 17.12 and 17.38 weeds/m^2, respectively, whereas the herbicides Discipline and Totic+U46 were more effective, with an average of 12.70 and 13.16 weeds/m^2, respectively (Table 3), while the control treatment produced 35.90 weeds/m^2 which is in agreement with has been reported earlier (Al-Jubouri & Anter, 2021). Table 4 summarizes the interaction between varieties and herbicides and indicates that the Jehan variety together with the herbicide Discipline produced 12.44 weeds/m^2, whereas both Jehan and Tamuz varieties in the control treatment produced 35.56 and 36.23 weeds/m^2, respectively.

Total weed weight (g/m^2)

No significant differences in weed weight between the Jehan and Tamuz varieties, (17.63 and 17.78 grams/m^2, respectively) were obtained (Table 2). Table 3 indicates that the herbicides Timeline Trio, Discipline, Axial+U46 and Totic+U46 were more effective (Table 3), compared to the control treatment. Meena *et al.* (2017) observed earlier that mixtures of herbicides targeting narrow leaf and broadleaf weeds were superior in terms of weed density, weight, and overall density. The interaction between varieties and herbicides showed that the Jehan variety with the herbicide Discipline produced 12.44 grams.m^2, whereas both Jehan and Tamuz varieties in the control treatment produced 41.94 and 42.81 grams/m^2 weeds weight respectively (Table 4).

Plant height (cm)

The Tamuz variety was significantly higher (93.79 cm) than the Jehan variety (92.46 cm) (Table 2). The accumulation of biomass early in the season is linked to the early wheat vigor. Previous studies have shown that early crop activity is associated with rapid growth and canopy development (Mwendwa *et al.,* 2020). No significant difference in plant height among all treatments were observed except for when the herbicide Pallas was used (77.80 cm) (Table 3). Various weed control treatments led to a significant increase in plant height and dry matter accumulation at harvest. This increase in plant height is attributed to the improved availability of nutrients, which resulted in vigorous plant growth under different growth conditions (Singh *et al.,* 2017). No significant difference in plant height between the Jehan and Tamuz varieties with all herbicides, except for the herbicide Pallas with the Jehan variety (75.28 cm) (Table 4).

Flag leaf area (cm^2)

The Tamuz variety had a significantly larger flag leaf area (54.98 cm^2), compared to the Jehan variety (53.29 cm^2) (Table 3). The herbicides Timeline Trio and Discipline were more effective compared with the control treatment (Table 2), and this can be attributed to the new herbicide molecules (mixture) that are highly effective at lower doses in killing broadleaf and narrow leaf weeds. These molecules might be more efficient in controlling different weeds and are relatively safer from an environmental pollution perspective (Kumar *et al.,* 2020). The interaction between the wheat variety Tamuz and the herbicide Timeline Trio produced the largest flag leaf area (57.23 cm^2), while both Jehan and Tamuz varieties in the control treatment produced a flag leaf area of 51.49 and 51.64 cm^2, respectively (Table 4).

Table 2. Influence of wheat varieties and associated weeds on wheat growth and yield during the 2022-2023 growing season.

Wheat cultivars	Total weeds number (weeds/m²)	Total weeds weight (g/m²)	Plant height (cm)	Flag leaf area (cm²)	Number of grains per spike	Number of spikes/m²	1000-grain weight (g)	Grain yield (g/m²)
Jehan	17.12 a	17.63 a	92.46 b	53.29 b	552.89 b	10.47 a	36.43 a	843.50 a
Tamuz	17.38 a	17.78 a	93.79 a	54.98 a	589.76 a	10.40 a	32.40 b	801.74 b

Values followed by the same letters in the same column are not significantly different at P=0.05.

Table 3. Impact of herbicides on wheat growth and yield, and associated weeds during the 2022-2023 season.

Herbicides	Total weeds number (weeds/m²)	Total weeds weight (g/m²)	Plant height (cm)	Flag leaf area (cm²)	Number of grains per spike	Number of spikes/m²	1000-grain weight (g)	Grain yield (g/m²)
Control	35.90 a	42.37 a	96.99 a	51.57 e	469.83 d	10.17 b	32.47 d	647.42 d
Timeline Trio	14.63 c	12.90 c	95.43 a	55.59 a	577.78 b	10.38 ab	35.26 ab	876.83 ab
Atlantis	14.63 c	14.95 b	95.28 a	54.21 bc	553.92 c	10.46 ab	35.62 a	852.17 ab
Pallas	16.22 b	15.72 b	77.80 b	53.81 cd	601.78 a	10.41 a b	33.48 c	744.42 c
Discipline	12.70 d	12.11 c	94.88 a	55.58 a	613.71 a	10.56 a	35.04 ab	901.25 a
(Mix) Axial+U46	13.48 cd	13.33 c	95.41 a	53.54 d	579.03 b	10.39 ab	34.42 bc	828.83 b
(Mix)Totic+U46	13.16 d	12.55 c	96.11 a	54.66 b	603.21 a	10.68 a	34.59 ab	907.42 a

Values followed by the same letters in the same column are not significantly different at P=0.05.

Table 4. Effect of the interaction between herbicides treatments and wheat varieties on wheat growth and yield, and on associated weeds during the 2022-2023 season.

Herbicides	Total weed number (weeds/m²)	Total weeds weight (g/m²)	Plant height (cm)	Flag leaf area (cm²)	Number of grains per Spike	Number of spikes/m²	1000-grain weight (g)	Grain yield (g/m²)
Jehan								
Control	35.56 a	41.94 a	96.78 a	51.49 h	436.03 h	10.29 bc	34.50 bc	651.50 e
Timeline Trio	14.35 cde	12.84 def	94.85 a	53.95 def	544.02 f	10.36 bc	37.11 a	900.33 ab
Atlantis	14.71 cde	14.89 cbd	95.12 a	52.57 g	528.03 f	10.48 abc	37.21 a	899.17 ab
Pallas	16.70 b	15.55 b	75.28 c	52.55 g	592.85 bcd	10.33 bc	35.16 b	774.00 cd
Discipline	12.44 f	11.83 f	94.37 a	54.65 cd	613.88 ab	10.48 abc	37.22 a	919.17 a
(Mix) Axial+U46	12.97 ef	14.09 b–e	95.07 a	53.40 f	564.95 e	10.40 bc	36.78 a	841.83 abc
(Mix)Totic+U46	13.08 def	12.29 ef	95.78 a	54.43 cde	590.45 cd	10.97 a	37.01 a	918.50 a
Tamuz								
Control	36.23 a	42.81 a	97.20 a	51.64 h	503.63 g	10.05 c	30.45 g	643.33 e
Timeline Trio	14.90 cd	12.96 c–f	96.00 a	57.23 a	611.55 abc	10.41 bc	33.40 cde	853.33 abc
Atlantis	14.56 cde	15.01 bc	95.45 a	55.84 b	579.80 d e	10.44 bc	34.04 bcd	805.17 bc
Pallas	15.75 bc	15.89 b	80.32 b	55.07 c	610.72 abc	10.49 abc	31.80 f	714.83 de
Discipline	12.96 ef	12.39 ef	95.38 a	56.52 ab	613.53 ab	10.65 ab	32.86 def	883.33 ab
(Mix) Axial+U46	14.00 c–f	12.58 ef	95.75 a	53.68 ef	593.10 bcd	10.38 bc	32.07 ef	815.83 bc
(Mix)Totic+U46	13.24 def	12.80 def	96.43 a	54.89 c	615.97 a	10.40 bc	32.17 ef	896.33 ab

Values followed by the same letters in the same column are not significantly different at P=0.05.

Number of grains per spike

The Tamuz wheat variety produced significantly higher number of grains per spike (589.76 spikes/m^2), whereas the Jehan variety produced 552.89 spikes/m^2 (Table 2). The herbicides Pallas, Discipline, Totic+U46 were more effective, and produced 601.78, 613.71, and 603.21 spikes/m^2, respectively, compared to the control treatment (469.83 spikes/m^2) (Table 3). The reason may be attributed to the efficiency of herbicides in suppressing weeds, thereby reducing competition with weeds and leading to an increase

in the number of spikes, and this is consistent with the findings of Al-Jubouri and Anter (2021). The interaction between Tamuz wheat variety with the herbicide Totic+U46 produced 615.97 spikes/m^2, compared to the Jehan variety with the control treatment which produced 469.83 spikes/m^2 (Table 4).

Spike length

No significant differences in spike length between the Jehan and Tamuz varieties, (10.47 and 10.40 cm, respectively), was observed (Table 3). Results obtained indicated that the herbicide treatments Discipline and Totic+U46 were more effective (10.56 and 10.68 cm, respectively), compared to the control treatment (10.17 cm) (Table 2), which was consistent with a previous report (Shakya & Dixit, 2017). The interaction between Jehan wheat variety and the herbicide (Totic+U46) treatment produced a spike length of 10.97 cm, whereas the Tamuz variety with the control treatment produced a spike length of 10.05 cm (Table 4).

1000-Grain weight (g)

The Jehan wheat variety produced a significantly higher 1000-grain weight (36.43 grams), whereas the Tamuz variety produced 32.40 grams (Table 3). The herbicide Atlantis treatment was more effective, (35.62 grams), compared to the control treatment (32.47 grams) (Table 2), which is in agreement with the findings of Wahab & Aljuburi (2023b), suggesting that the increase in the number of tillers, the weight of 1000 grains, and the number of grains per spike, facilitated by herbicide treatments could be attributed to improved weed control efficiency. Table (4) indicates that the interaction between Jehan wheat variety and herbicide treatments (Timeline Trio, Atlantis, Discipline, Axial+U46, Totic+U46) produced 37.11, 37.21, 37.22, 36.78 and 37.01 g 1000-grain weight, respectively, whereas the Tamuz variety with the control treatment produced 30.45 g 1000-grain weight.

Grain yield (g/m^2)

The Jehan wheat variety produced significantly higher yield (843.50 grams/m^2) compared to Tamuz variety (801.74 grams/m^2 (Table 3). The herbicides Discipline and Totic+U46 were more effective (901.25 and 907.42 grams/m^2, respectively), compared to the control treatment (647.42 grams/m^2 (Table 2). These findings are in agreement with what has been reported by Aljuburi (2026). The interaction between wheat Jehan variety and herbicides (Discipline, Totic+U46) produced 919.17 and 918.50 grams/m^2, respectively. Jehan and Tamuz wheat varieties in the control treatment produced 651.50 and 643.33 grams/m^2, respectively (Table 4).

It can be concluded from this study that no significant differences were found between the wheat varieties on weeds distribution, likely due to the morphological and phenotypical similarities between the two varieties. However, significant differences were observed following weed control treatment with herbicides in the wheat crop. The application of herbicides led to a significant increase in weed control efficiency, reducing the number and dry weight of weeds, and significantly increased wheat yield and its components, compared to the control treatment. The wheat crop showed a clear response to weed control measures, which reduced the damage caused by weed competition and subsequently increased the total yield. The herbicides Discipline and the mixture of Totic+U46 were particularly effective in suppressing weed growth, reducing their dry weight, and enhancing most yield components.

الملخص

النعيمي، محمد أحمد وضياء فتحي الجبوري. 2026. تأثير مبيدات الأعشاب وأصناف القمح في ديناميكية نمو الأعشاب الضارة وإنتاجية المحصول. مجلة وقاية النبات العربية، 44(3):365–369. https://doi.org/10.22268/AJPP-001420

أُجريت هذه الدراسة خلال الموسم الزراعي 2023–2024 في محافظة نينوى، قضاء تلكيف، ناحية وانة، 60 كم شمال مدينة الموصل. هدفت هذه الدراسة إلى تقييم فعالية مبيدات الأعشاب وأصناف القمح على ديناميكية نمو الأعشاب الضارة وإنتاجية المحصول. استخدمت في هذه الدراسة صنفي القمح جيهان وتموز، ومبيدات الأعشاب: الشاهد، Timeline Trion EC، Atlantis OD، Pallas OD، Discipline OD، Axial 050 EC + U46-Combi fluid 6 SL (Mix) و Totic 10 EC + U46-Combi fluid 6 SL (Mix). أُجريت الزراعة في الحقل بتاريخ 2023/11/26، وذلك وفق تصميم القطاعات الكاملة العشوائية بثلاثة مكررات. تفوق الصنف تموز في ارتفاع النبات، ومساحة ورقة العلم، وعدد السنابل (93.79 سم، 54.98 سم²، و 589.76 سنبلة/م²، على التوالي). وفي المقابل، تفوق الصنف جيهان في وزن الألف حبة وإنتاجية الحبوب (36.43 غ و 843.50 غ/م²، على التوالي). أظهرت معاملة مبيد الأعشاب Discipline تفوقاً في عدد الأعشاب، ووزنها، ومساحة ورقة العلم، وعدد السنابل، وطول السنبلة، وإنتاجية الحبوب (12.70 سنبلة/م²، 12.11 غ/م²، 55.58 سم²؛ 613.71 سنبلة/م²، 901.25 غ/م² و 10.56 سم، على التوالي).

كلمات مفتاحية: مكافحة الأعشاب، مبيدات الأعشاب، الأصناف، القمح.

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