Evaluation of the Efficacy of Selected Herbicides on Wild Barley (*Hordeum glaucum* L.) from Different Iraqi Environments

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Abstract

The experiment was conducted in a field plot at Al-Muradiyah Research Station, Babylon Agriculture Directorate, during the winter season of 2024–2025 to evaluate the effects of chemical herbicides on wild barley grass (*Hordeum glaucum* L.) at different growth stages under single infestation conditions. The study was arranged in a split-plot design In randomized complete block design RCBD with three replicates, in which four post-emergence herbicides (Axial, Tarzec, Topic, and Chevalier) were assigned to the main plots, while seed sources of wild barley grass collected from five governorates of Iraq were allocated to the subplots. The treatments were evaluated based on several growth and physiological characteristics of the weed, including plant height, weed density, dry weight, chlorophyll content, control percentage, and inhibition percentage.

The results indicated significant variation in weed response depending on herbicides and seed source. Tarzec exhibited the highest efficacy, achieving a mean control percentage of 75.68% and an inhibition rate of 48.49% at 90 days after treatment. Conversely, Axial was the least effective, with a control percentage of only 39.20%. Furthermore, seed sources showed distinct sensitivity levels; the population from Wasit demonstrated the highest resistance with a control percentage of only 65.43% under Tarzec treatment at 90 days, while the Najaf population was the most sensitive, reaching 82.57%. These findings emphasize that selecting an appropriate herbicide based on seed origin is crucial for the chemical management of bulbous barley.

Keywords: *Hordeum glaucum* L., Herbicides, weed resistance, genetic diversity, assessment periods, weed control.

ISSN 2072-3857

Introduction

One of the major biological limitations to agricultural productivity is weed spread. One of the species that has become particularly problematic is wild barley grass (*Hordeum glaucum* L.), which represents an especially serious challenge in Iraq. It exhibits a high level of adaptability to a wide range of environmental factors and edaphic conditions, enabling its colonization and growth across different agricultural regions. This species is characterized by high genetic variability, high germination capacity, vigorous growth, and pronounced physiological plasticity, which allow it to form dense and persistent stands in subsequent growing seasons [1,2].

The competitive ability of wild barley grass against other species is further enhanced by its rapid phenological development early in the growing season, as well as by its fibrous root system, which enables efficient uptake of nutrients and water from various soil layers. Moreover, its adaptability to different soil types and fluctuating soil moisture conditions makes its control particularly challenging under traditional agronomic practices [3]. Uncontrolled large populations of wild barley grass can exploit available resources extensively, thereby increasing the complexity of field management in subsequent seasons.

The variability in herbicide responses among populations of this weed further complicates its chemical control. Herbicide efficacy depends on the active ingredient, application timing, and the genetic and physiological characteristics of the local population. In addition, soil pH, texture, temperature, and moisture are known to influence herbicide absorption, translocation, and degradation, thereby contributing to variability in control outcomes [4]. The repeated use of herbicides with the same mode of action, particularly those targeting the ALS and ACCase enzymes, has accelerated the development of resistance in weed biotypes, leading to environmental and economic concerns in affected areas [2].

Recent advances in weed science emphasize the importance of evaluating herbicide performance within the context of weed biology and population variability. Accurate assessment requires consideration of multiple growth stages, seed sources, and environmental interactions to explain differential responses and to develop effective, site-specific management strategies [5,1]. Understanding the sensitivity of geographically distinct populations of wild barley grass is essential for optimizing chemical control and minimizing the risk of resistance development.

Accordingly, the objective of the present study was to evaluate the interactive effects of selected post-emergence herbicides and geographically diverse seed sources of wild barley grass (*H. glaucum*) under single infestation conditions on weed suppression assessment intervals. The findings of this study are expected to contribute to the development of more effective weed management strategies and to support sustainable weed management programs in Iraq and other regions with similar environmental conditions.

Materials and Methods

The field experiment was conducted in the winter growing season of 2024–2025 at the Al-Muradiyah Research Station, Babylon Agriculture Directorate, Babylon Province, which is about 20 km south of Al-Hilla city (32.18° N, 44.23° E). The main goals of the research were the evaluation of the effectiveness of the chosen Herbicides in establishing the growth of wild barley grass (*Hordeum glaucum* L.) and to study the effect of the provenance of the weed seeds on the control efficacy indices.

The sampling of soil was conducted before the planting; at depths of 0–30 cm, random samples were taken and analysed on the basis of selected physical and chemical properties by applying routine methods**(**Table1). The 2023–2024 growing season was used to harvest the seeds of the barley grass in the wild, in five governorates located in Iraq, and then kept under proper conditions until they became available to be allocated to the experiment.

Table 1. Physical and chemical properties of the experimental field soil.

Property	**Unit**	**Value**
Soil pH	**-**	**7.8**
Electrical Conductivity (ECe)	**dS m^{-1}**	**3.1**
Organic Matter	**%**	**0.54**
Available Nitrogen (N)	**mg kg^{-1} soil**	**24.3**
Available Phosphorus (P)	**mg kg^{-1} soil**	**7.21**

Property	Unit	Value
Available Potassium (K)	**mg kg⁻ ¹ soil**	**112.6**
Soil Texture	**-**	**Silty Loam**

The experiment was laid out in a split-plot arrangement based on a Randomized Complete Block Design (RCBD) with three replications. The main plots were allocated to the weed seed sources (the five governorates). The sub-plots were assigned to the herbicide treatments, which included four chemical herbicides (Axial, Tarzec, Topic, and Chevalier) plus an untreated (weedy) check for comparison.

Herbicides were Application as a foliar spray per the dosage recommendations of the manufacturers as it is captured in Table 2.

Table 2. Herbicides used in the experiment

Herbicide	Active ingredient	Manufacturer	Rate (ha⁻ ¹)
Axial	Pinoxaden	Syngenta, Switzerland	700–1000 mL
Tarzec	Pyroxsulam + Halauxifen-methyl	Corteva Agriscience, Italy	70 g
Topik	Clodinafop-propargyl	Syngenta, Switzerland	250 ml
Chevalier	Iodosulfuron-methyl-sodium +Mesosulfuron-methyl	Bayer CropScience, Germany	200–300 g

Wild barley grass seeds were sown on 15 November 2024 at a rate of 30 g per experimental unit, ensuring that only the grass weed was present. Each experimental unit consisted of 6 rows, each 200 cm long, with a 20 cm inter-row spacing, resulting in a total area of $2m^2$ (2 m * 1 m) per experimental unit. A 50 cm buffer zone was maintained between adjacent experimental units to prevent cross-contamination.

Measured Traits

ISSN 2072-3857

until a constant weight was obtained, and then converted to g m^{-2}.

6. **Percentage of inhibition (%):** The percentage of inhibition was determined according to the relative reduction in weed dry weight in treated plots in comparison with the untreated control.

Percentage of Inhibition (%) = [(C – T) / C] × 100

Where C is the dry weight of weeds in the untreated control, and T is the dry weight of weeds in the treated plots

Analysis of variance (ANOVA) was performed according to the split-plot design. Means were compared using the Least Significant Difference (LSD) test at a probability level of 0.05.

Results and Discussion

1. Height of wild barley grass after 30, 60, and 90 days after application

Table 3 suggests that the Herbicides had statistically significant effect on the height of *H. glaucum* during all the three study periods (30, 60 and 90 days) after the Application. Tarzec (Florasulam) showed the greatest decrease in the Height of the weeds with the lowest recorded heights of 12.79, 29.95, and 65.45 cm at the time points after

The following weed traits were measured at different times after herbicide application (30, 60, and 90 days):

1. **Weed height (cm):** Ten plants were randomly selected from each experimental unit and measured from the soil surface to the tip of the main stem.

2. **Weed density (plants m^{-2}):** The number of weeds per square meter was recorded.

3. **Chlorophyll content:** Chlorophyll content was determined using a SPAD meter. Measurements were taken from ten plants, and the mean value was calculated.

4. **Percentage of control (%):** The percentage of control was estimated based on the relative reduction in weed density in herbicide-treated plots compared with the untreated control.

   Percentage of Control (%) = [(C – T) / C] × 100

   Where C is the weed density in the untreated control plots, and T is the weed density in the herbicide-treated plots

5. **Weed dry weight (g m^{-2}):** Samples were collected using a metal quadrat with an area of 0.25 m^2. The samples were oven-dried at 70 °C for 48 h

ISSN 2072-3857

time. For example, Tarzec maintained its activity in high-growth populations like Wasit and Babylon, but Axial was much less effective, including in Wasit, where the height of the weeds remained high. Chevalier and Topic showed variable results depending on the seed source, where the highest results were observed in Najaf and Karbala compared to Wasit and Babylon, which supports the idea of mixed genetic and environmental factors influencing weed response to chemical control agents [10].

These results emphasise the importance of considering weed seed provenance and phenological stage in the choice of an herbicide in order to maximise efficacy, as well as the need to consider genetic and environmental variability when developing sustainable chemical control methods.

which the experiment was run. On the other hand, the highest heights of weeds were obtained with the use of Axial (Pinoxaden), which indicates a difference in herbicides, and this can be attributed to the tolerance of the genotype, which in this case is partial [6]. Chevalier and Topic performed moderate efficacy, and there were cases of following regrowth as opposed to the untreated control, which was showing maximum levels of weed height, hence supporting the expected trend.

In terms of provenance of weed seeds, the Wasit population had the highest levels of weed height of 23.29, 41.00, and 73.42 cm at 30, 60 and 90 days, respectively, indicating increased tolerance or resistance to herbicidal pressure. On the contrary, the lowest heights of weeds were exhibited by the Najaf population, which is predictive of high herbicide sensitivity [7,8,9].

The interaction between the herbicide and seed source was found to be significant across all periods of

ISSN 2072-3857

Table 3. Effect of herbicides, weed seed source, and their interaction on *H. glaucum* height (cm) after 30, 60, and 90 days of Application

Treatment	Wasit	Babylon	Al-Qadisiyah	Karbala	Najaf	mean
After 30 days						
Control	25.09	22.64	18.21	15.20	15.04	19.24
Chevalier	23.06	19.21	13.10	12.04	7.15	14.92
Topic	24.08	21.31	15.23	12.24	11.12	16.59
Tarzec	21.15	17.00	11.30	7.29	7.18	12.79
Axial	24.08	21.32	16.07	14.26	11.12	18.97
mean	23.29	20.30	14.78	12.21	11.93	—
LSD 0.05: Herbicides = 3.197, Governorates = 1.792, Interaction = 4.565						
After 60 days						
Control	45.21	41.28	40.02	38.30	38.09	40.58
Chevalier	41.32	36.05	31.33	30.01	26.20	32.98
Topic	42.21	34.15	33.01	31.21	30.23	34.16
Tarzec	37.13	30.20	29.23	26.08	27.09	29.95
Axial	39.11	37.04	35.28	34.08	33.16	35.73
mean	41.00	35.75	33.77	31.94	30.95	—
LSD 0.05: Herbicides = 1.685, Governorates = 1.482, Interaction = 3.296						
After 90 days						
Control	80.30	72.90	71.29	69.14	70.03	72.73
Chevalier	73.12	70.10	68.30	65.17	67.28	68.79
Topic	67.24	72.24	69.20	67.01	66.30	68.40
Tarzec	69.28	67.17	65.30	63.16	62.32	65.45
Axial	77.13	73.08	69.30	68.15	69.03	71.34
mean	73.42	71.10	68.68	66.52	66.99	—
LSD 0.05: Herbicides = 2.577, Governorates = 1.545, Interaction = 3.831						

According to the data provided in Table 4, it can be observed that the effect of Herbicideson chlorophyll content in the leaves of the plant, *H. glaucum*, had a significant impact at all three evaluation times, after 30, 60, and 90 days of the application. The

2. Chlorophyll content in leaves of wild barley grass after 30, 60, and 90 days of Application

ISSN 2072-3857

Najaf and Karbala had the lowest values and were not different among themselves, which demonstrates genetic variation between different genotypes and environmental factors at each of the two locations affecting pigment accumulation [14].

The interaction between Herbicidesand seed origin was not significant at 30 and 90 days but was significant at 60 days following the treatment. Tarzec was most efficient in controlling chlorophyll content in leaves of Najaf and Karbala seed sources, unlike Axial with Wasit seeds, which produced the highest chlorophyll content, meaning that there was a lack of response to the chemical treatment.

Such results highlight the need to take into consideration the source of weed seeds, genetic background, and the local environment when choosing herbicides, because these parameters show variation and significantly affect weed responses, especially in terms of the effects of herbicides on photosynthetic activity.

untreated control condition had the highest chlorophyll content, which showed that photosynthesis was maintained without the addition of the herbicide. Conversely, Tarzec (Florasulam) gave the lowest values, as the mean chlorophyll contents were 11.84, 24.14, and 31.77 SPAD at the respective periods, hence depicting its high efficiency in inhibiting chlorophyll deposition compared to the other herbicides [11,12]. The other herbicides (Axial, Chevalier, and Topic) had moderate reactions, indicating that they were not as effective in reducing chlorophyll accumulation. This disparity can be explained by the fact that the mechanism of action of ACCase- and ALS-inhibiting herbicides is different, and thus affects differently enzymes that are part of photosynthetic pigment pathways [13].

With respect to the origin of weed seeds, the Wasit source indicated the highest values of chlorophyll, with 24.90, 35.75, and 73.42 SPAD after the three evaluation periods, respectively. On the other hand, plants from

ISSN 2072-3857

Table 4. Effect of Herbicides, weed seed source, and their interaction on chlorophyll content of *H. glaucum* leaves after 30, 60, and 90 days of application (SPAD units)

Treatment	Wasit	Babylon	Al-Qadisiyah	Karbala	Najaf	mean
After 30 days						
Control	31.15	30.30	28.17	27.20	28.15	29.00
Chevalier	24.05	21.29	20.14	18.26	18.28	20.40
Topic	27.17	24.18	21.20	20.22	19.29	22.41
Tarzec	15.09	13.27	10.87	9.23	10.75	11.84
Axial	27.05	26.04	24.16	21.14	20.30	23.74
mean	24.90	23.02	20.91	19.21	19.36	—
LSD 0.05: Herbicides = 1.616, Governorates = 0.860, Interaction = N.S						
After 60 days						
Control	40.23	38.20	38.15	37.09	36.27	37.99
Chevalier	36.14	32.02	31.19	29.10	30.11	31.71
Topic	36.01	33.14	32.22	32.06	30.08	32.70
Tarzec	29.27	26.13	24.08	21.02	20.21	24.14
Axial	37.11	35.16	34.13	33.13	32.20	34.35
mean	35.75	32.93	31.96	30.48	29.77	—
LSD 0.05: Herbicides = 1.688, Governorates = 0.909, Interaction = 2.355						
After 90 days						
Control	40.05	38.29	39.01	36.31	37.02	38.14
Chevalier	37.31	36.15	35.05	32.04	33.21	34.75
Topic	38.28	38.02	36.28	34.31	34.06	36.19
Tarzec	35.16	33.30	31.04	29.32	30.04	31.77
Axial	39.23	38.27	37.30	35.04	35.03	36.97
mean	38.01	36.81	35.74	33.40	33.87	
LSD 0.05: Herbicides = 1.685, Governorates = 0.920, Interaction = N.S						

and 90 days of application. Tarzec (Florasulam) resulted in the largest effect on the biomass, as the mean dry weights (data in grams) decreased to 62.77 (30 days), 96.59 g (60 days), and 176.55 g (90 days), showing that the compound has a strong growth-inhibitory effect through

3. Dry weight of wild barley grass after 30, 60, and 90 days of application

Table 5 shows that Herbicides used had statistically significant effect on the dry weight of the plants of *H. glaucum* after 30, 60

ISSN 2072-3857

seeds, and lowest in Najaf seeds, which explains the impacts of genetic and environmental variation in seeds in terms of flexibility and resistance of plants to chemical stress [17].

There was statistically significant interaction between herbicides application and source of seed. Tarzec has always given the fewest dry weights of all seed sources, the minimum being 43.28g (30 days) of the Najaf originated seeds. On the other hand, the best mean dry weight of seeds (117.11g at 30days) was recorded with Axial/Wasit combination, thus showing that there are differences of response that are attributable to inherent genetic and environmental factors.

This observation and the latter exemplify the significance of choosing an effective herbicide, alongside the takes into account of the provenance of weed seeds, the genetic and environmental heterogeneity of which have a significant effect on the weed reaction to chemical control and, by extension, on the increase in biomass.

the disruption of key physiological functions such as photosynthesis and protein and carbohydrate production [15,13].

On the other hand, the mean of the dry weights of the herbicide treatments as of 30, 60, and 90 days showed the highest values in the Axial (Pinoxaden) treatment of 95.13, 141.71 and 237.20 g respectively, with an implication that either the genotypes were less sensitive or partially tolerant to the herbicides. Chevalier and Topic showed intermediate outcomes where the statistical significance of the differences between them and Axial does not significantly differ at most of the time whereas compared to Tarzec, their performance is relatively inconsistent. The highest plant dry weight of the untreated control supported the natural ability of the herbicidal-free accumulation of biomass by the species of *H. glaucum* [16].

In regards to seed provenance, the mean plant dry weight of 124.31 g, 169.18) and 259.8)g at 30, 60, and 90 days were found to be highest in Wasit origin

ISSN 2072-3857

Table 5. Effect of Herbicides, weed seed source, and their interaction on dry weight of *H. glaucum* (g) after 30, 60, and 90 days of application

After 30 days						
Treatment	**Wasit**	**Babylon**	**Al-Qadisiyah**	**Karbala**	**Najaf**	**mean**
Control	213.22	202.30	194.30	183.27	179.23	194.46
Chevalier	98.10	88.00	73.20	60.03	55.22	74.91
Topic	108.05	101.05	93.28	76.08	78.32	91.36
Tarzec	85.08	76.27	64.04	45.18	43.28	62.77
Axial	117.11	105.22	95.21	82.09	76.02	95.13
mean	124.31	114.57	104.01	89.33	86.41	
LSD 0.05: Herbicides = 6.162, Governorates = 1.553, Interaction = 6.618						
After 60 days						
Control	239.03	234.28	230.23	226.26	229.07	231.77
Chevalier	148.24	133.08	114.13	95.30	91.29	116.41
Topic	161.27	151.33	139.14	117.30	115.06	136.82
Tarzec	125.27	114.23	99.11	74.21	70.13	96.59
Axial	172.09	158.10	140.03	122.08	116.26	141.71
mean	169.18	158.20	144.53	127.03	124.36	
LSD 0.05: Herbicides = 6.662, Governorates = 0.959, Interaction = 6.794						
After 90 days						
Control	354.11	345.07	341.05	335.11	336.23	342.31
Chevalier	229.22	208.32	196.32	188.23	183.22	201.06
Topic	245.20	221.05	222.21	210.26	213.13	222.37
Tarzec	202.18	196.27	175.05	158.20	151.07	176.55
Axial	268.29	241.06	233.32	222.32	221.02	237.20
mean	259.80	242.35	233.59	222.82	220.93	
LSD 0.05: Herbicides = 9.186, Governorates = 1.836, Interaction = 9.578						

significant and created an effect on the density of the *H. glaucum* in all the three periods (30, 60 and 90 days) compared. Tarzec (Florasulam) was the most effective at reducing the density of the weeds and gave the lowest values of 115.84, 109.0, and

4. Weed density of wild barley grass after 30, 60, and 90 days of application

Table 6 illustrates that type of herbicide was statistically mutations that can lead to superior tolerance to herbicides [21,22].

The process of seed provenance with herbicide at all times was significant. The lowest density was always found with Tarzec as the highest outcome was noted in Najaf and Karbala 70.2 to 94.32 plants m^{-2}. The effectiveness of the rest of the herbicides depended on seed provenance, and in that case, genetic variation with environment-specific sensitiveness of the chemical [10].

These results suggest that the decline in density of weeds is an effective predictor of the effectiveness of chemical control programs in the short, medium, and long-term periods, which can confirm the need to assess structural features of density along with physiological and developmental traits and fully capture the effectiveness of herbicides [23,13].

103.9 of plants m^{-2} in the 3 periods, respectively, which highlighted its strong ability to reduce initial growth and the appearance of new tillers [18,19,20].

The density of the untreated control was the highest, reaching 426.32, 423.9, and 422.5 plants m^{-2} across the three Periods. This reflects the significant capacity of the weed to grow and proliferate in the absence of chemical intervention. The rest of the herbicides (Axial, Topic, Chevalier) had moderate effects, the effect differed greatly over the periods which represents the difference in their modes of action on growth inhibition and tiller formation.

Regarding seed provenance, Wasit-origin seeds had the highest density (297.36, 281.0, and 299.0 plants m^{-2}) during all the periods, whereas Najaf-origin seeds had the lowest density (226.78, 220.8, and 214.5 plants m^{-2}), thus demonstrating a genetic variation and possible

ISSN 2072-3857

Table 6. Effect of Herbicides, weed seed source, and their interaction on weed density of *H. glaucum* (plants m⁻²) after 30, 60, and 90 days of Application

After 30 days						
Treatment	**Wasit**	**Babylon**	**Al-Qadisiyah**	**Karbala**	**Najaf**	**mean**
Control	440.11	433.08	418.21	423.09	417.14	426.32
Chevalier	271.18	224.25	206.18	192.18	190.21	216.80
Topic	297.28	252.37	228.09	215.01	204.11	239.37
Tarzec	163.14	125.24	107.19	94.32	89.30	115.84
Axial	315.08	286.27	257.26	241.27	233.16	266.61
mean	297.36	264.24	243.39	233.17	226.78	
LSD 0.05: Herbicides = 7.749, Governorates = 5.603, Interaction = 13.061						
After 60 days						
Control	445.0	432.3	415.1	415.3	411.6	423.9
Chevalier	290.0	252.2	229.2	207.2	194.2	234.5
Topic	201.4	233.5	212.1	190.1	185.1	204.4
Tarzec	157.2	118.1	102.3	82.3	85.2	109.0
Axial	311.1	281.3	253.2	233.3	228.2	261.4
mean	281.0	263.5	242.4	225.6	220.8	
LSD 0.05: Herbicides = 11.17, Governorates = 9.20, Interaction = 20.75						
After 90 days						
Control	447.0	435.2	420.2	409.1	401.1	422.5
Chevalier	324.6	249.0	226.3	203.3	191.1	238.9
Topic	266.1	228.1	209.0	188.3	182.3	214.8
Tarzec	154.1	116.7	100.3	78.3	70.2	103.9
Axial	303.1	278.0	249.0	230.2	227.9	257.7
mean	299.0	261.4	241.0	221.8	214.5	
LSD 0.05: Herbicides = 9.84, Governorates = 9.59, Interaction = 20.93						

seed source, and the interaction between the two were both significantly important in the percentage of weed control at all the three Periods (30, 60, and 90 days). Tarzec (Pyroxsulam) showed the greatest efficacy with

5. Percentage of control after 30, 60, and 90 days of treatment

The findings outlined in Table 7 revealed that the Herbicides, sensitivity of populations, which could be related to target-site mutations or other non-target resistance mechanisms [21,22].

There was a high level of interaction between herbicide and Seed sources and Tarzec was very effective on most of the Seed sources, especially Najaf and Karbala (77.74-82.57%), although the performance of Axial was low, specifically with Wasit (28.28-32.06%). The results represent the genetic diversity in absorption, translocation, and metabolism dynamics across the various populations of weeds [24].

These results suggest that the choice of an effective herbicide and the source of the weed seed is important in obtaining the best percentage of control emphasizing that genetic variation should be evaluated during the planning of the chemical control programs.

the highest mean control proportions of 72.93, 74.46, and 75.68% percent for the three periods which are in line with the previously known effects of single-target site inhibitors .Conversely, Axial (Pinoxaden) had the lowest efficacy of 37.53, 38.52 and 39.20% which implies partial tolerance among certain populations. In the case of Chevalier and Topic, the results were moderate, which did not compare efficacy to Tarzec, as the dosage, absorption, and translocation across the plant varied [7].

In terms of weed seed sources, Najaf seeds declared the most response to the herbicides with the highest percentage of control of 45.65, 46.35, and 46.56% during the three periods, compared with Wasit seeds that showed the lowest percent of 32.34, 36.89, and 33.03% as a result of genetic variation and

Table 7. Effect of herbicide type, weed seed source, and their interaction on control percentage of *H. glaucum* after 30, 60, and 90 days of application

After 30 days						
Treatment	**Wasit**	**Babylon**	**Al-Qadisiyah**	**Karbala**	**Najaf**	**mean**
Control	0.00	0.00	0.00	0.00	0.00	0.00
Chevalier	38.26	48.13	50.72	54.59	54.42	49.22
Topic	32.32	41.60	45.48	49.19	51.08	43.94
Tarzec	62.85	71.01	74.40	77.74	78.63	72.93

ISSN 2072-3857

Axial	28.28	33.77	38.51	42.99	44.13	37.53
mean	32.34	38.90	41.82	44.91	45.65	
LSD 0.05: Herbicides = 1.917, Governorates = 1.506, Interaction = 3.559						
After 60 days						
Control	0.000	0.000	0.000	0.000	0.000	0.00
Chevalier	34.86	41.70	44.83	50.16	52.85	44.88
Topic	54.79	46.04	48.95	54.28	55.08	51.83
Tarzec	64.72	72.72	75.41	80.24	79.23	74.46
Axial	30.11	34.98	39.05	43.87	44.58	38.52
mean	36.89	39.09	41.65	45.71	46.35	
LSD 0.05: Herbicides = 2.597, Governorates = 2.073, Interaction = 4.709						
After 90 days						
Control	0. 00	0.00	0.00	0.00	0.00	0.00
Chevalier	27.50	42.82	46.19	50.37	52.41	43.86
Topic	40.36	47.63	50.30	54.03	54.60	49.38
Tarzec	65.43	73.23	76.21	80.93	82.57	75.68
Axial	32.06	36.14	40.77	43.77	43.23	39.20
mean	33.07	39.97	42.69	45.82	46.56	
LSD 0.05: Herbicides = 2.840, Governorates = 1.635, Interaction = 4.118						

inhibitory effect of the compound in curbing vegetative tissue growth through inhibition of the cell division pathway- a phenomenon that is consistent with the already known effects of metabolic pathway inhibitors [25,26].

On the other hand, the lowest activity was recorded with Axial (Pinoxaden) with mean inhibition readings of 51.41, 38.98 and 30.72% at 30, 60 and 90 days respectively, possibly demonstrating the partial tolerance of those populations or a resistance at an early stage.

6. Percentage of inhibition after 30, 60, and 90 days of application

Table 8 shows that the Herbicides had a statistically significant effect on the percentage inhibition in dry weight of the *H. glaucum*, at all the time points (30, 60 and 90 days) compared. Tarzec (Pyroxsulam) showed the highest inhibitory effect with mean inhibitory rates of 68.23, 58.52 and 48.42% at 30, 60 and 90 days respectively showing the strong

ISSN 2072-3857

the Axial and Wasit seed pairing were least inhibited (45.05% at 30 days, 27.95% at 90 days). Such differences are probably characteristic of genetic variation within populations that affects herbicide response, including differences in absorption, translocation, and internal metabolism [2].

These results indicate that treatments which achieved the most inhibition levels, specifically Tarzec used on Najaf and Karbala seed populations, were also associated with large biomass reductions after 90 days, which highlights the essential nature of the timely control of weed growth in suppression of intraspecific competition and enhancement of the success of integrated weed management approaches

Regarding the seed provenance of weeds, the seed population of Najaf and Karbala were the most sensitive, with Najaf having percentages of highest inhibition of 51.90 34.30 45.77 % at 30, 60, and 90 days, respectively, and no statistically significant difference in herbicides between Najaf and Karbala at 30 days. On the contrary, Wasit seeds have shown the least inhibition (26.51 at 90 days), which is also in line with differences in genetic structure and the selection pressure of herbicides used historically in those areas [21,8].

There was a statistically significant herbicide x seed source interaction. The highest percentages of inhibition were obtained with Tarzec and Najaf seed (76.04 % at 30 days and 69.49 % at 90 days). Contrarily,

Table 8. Effect of Herbicides, weed seed source, and their interaction on inhibition percentage of *H. glaucum* after 30, 60, and 90 days of application

After 30 days						
Treatment	**Wasit**	**Babylon**	**Al-Qadisiyah**	**Karbala**	**Najaf**	**mean**
Control	0.00	0.00	0.00	0.00	0.00	0.00
Chevalier	54.02	56.54	62.42	67.39	69.35	61.94
Topic	49.32	50.05	52.00	58.61	56.42	53.28
Tarzec	60.16	62.38	67.16	75.40	76.04	68.23
Axial	45.05	47.98	51.01	55.32	57.71	51.41
mean	41.71	43.39	46.52	51.34	51.90	
LSD 0.05: Herbicides = 1.408, Governorates = 0.923, Interaction = 2.217						

ISSN 2072-3857

After 60 days						
Control	0.00	0.00	0.00	0.00	0.00	0.00
Chevalier	37.93	43.16	50.43	57.95	60.22	49.94
Topic	32.45	35.34	39.51	48.20	49.82	41.06
Tarzec	47.58	51.25	56.99	67.30	69.49	58.52
Axial	27.95	32.43	39.12	46.08	49.29	38.98
mean	29.18	32.44	37.21	43.91	45.77	
LSD 0.05: Herbicides = 1.071, Governorates = 0.813, Interaction = 1.871						
After 90 days						
Control	0.00	0.00	0.00	0.00	0.00	0.00
Chevalier	35.12	39.61	42.42	43.82	45.52	41.30
Topic	30.58	35.91	34.81	37.23	36.61	35.03
Tarzec	42.79	43.10	48.67	52.80	55.10	48.49
Axial	24.06	30.10	31.55	33.62	34.26	30.72
mean	26.51	29.74	31.49	33.49	34.30	
LSD 0.05: Herbicides = 0.990, Governorates = 0.761, Interaction = 1.744						

Conclusions

This experiment shows that there is a significant difference in the level of herbicide efficacy against wild barley (*Hordeum glaucum* L.), with Tarzec being the most effective and consistent treatment across the studied populations, although its efficacy varied between locations. The discriminated responses between populations of weeds imply that there is a local genetic background and historical exposure to herbicides that may increase or decrease tolerance levels. On this basis, the implications of these findings are the dire need to implement site-specific weed control measures and diversification of herbicides modes of action to minimize the chances of resistance development in different farmlands.

ISSN 2072-3857

Acknowledgments

The authors would like to express their sincere gratitude to the Department of Field Crops, College of Agriculture, University of Karbala, for providing the necessary laboratory and field facilities. We also wish to extend our thanks to the technical staff for their invaluable assistance during the field and laboratory research.

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ISSN 2072-3857

ISSN 2072-3857