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The effect of using Herbicides on the growth and yield varieties of wheat (*Triticum aestivum* L.) and accompanying weeds.

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ABSTRACT

A field experiment conducted during the winter agricultural season 2021-2022 in the fields of farmers in Nineveh Governorate Mosul district, in Yaramjah location. The experiment had couple factors, first one was two bread-wheat cultivars (Al-Arabia, Bora, Pisanzo and Tal-Afar3). another factor was three chemical herbicides (Atlantis, Suraj, Limitless) specialized in controlling weeds accompanying wheat crops. In the current experiment, a design (RCBD) with a split-plot, with three replications, and using of the SAS "statistical analysis system" in analyzing data. The results obtained from this research were as follows:
Limitless Herbicide showed the lowest [number, and dry weight] weeds, with a control efficiency of 51.47%, and 51.89% respectively. In trait of spikes number, the cultivar (Pisanzo) was superior, with a record of 428.4 spikes.m^{-2}. In grain yield; the (Pisanzo) cultivar had significantly superior, it was recording 600.5 g.m^{-2}.

1. Introduction

Wheat (*Triticum aestivum* L) is the world's most important staple food cereal and belongs to the Poaceae family. Many countries consider it an integral part of their food security system. More eat it in various forms than a billion people do worldwide. In traits of production, bread wheat ranks as first among food crops around the world (Kumar *et al.* 2020). Experts estimated the wheat crop production at (4,234,000) tons for the season of 2021, showing a decrease ratio as (32.1%) compared with last year's production, which was estimated at (6,238,000) tons. The Directorate of Agricultural Statistics estimated it at (8,576,000) dunams in the last season. Globally, the area of wheat crops is about 222 million hectares (744,000,000 tons) (USDA, 2020). Weeds are the major obstacle to crop production and are responsible for its significant production losses. It competes with crop plants for moisture, nutrients, light and space, thus depriving the crop of vital inputs. Widespread in wheat fields many types of narrow and broad-leaved weeds depend on the conditions between conditions such as humidity, temperature and moisture availability, soil type and agricultural operations. (Singh *et al.* 2022). Given the current situation, checking the bush competitiveness of newly developed wheat cultivars for field evaluation is an important research area, and the competitiveness of crop plants can used as a criterion to check the ability to thrive better under harsh bush conditions (Mahajan and Chauhan 2011). The weeds considered one of the main obstacles in the cultivation of wheat, which alone affects a 33% decrease in the wheat crop. Some new weed herbicide molecules (mixtures) have developed that are highly effective in lower doses to kill broad and narrow-leaved weeds. These particles may be more effective in controlling different weeds. It concluded that herbicides reduced weed growth, leading to an increase in yield (Kumar *et al*. 2020).

2. Materials and Methods

2.1. Location of experiment

A field experiment carried out during the winter agricultural season 2021-2022 in the fields of farmers in Nineveh, Mosul district, in Yaramjah location, where faraway about 12 km southwestern from center of Mosul city.

2.2. Design for experiment and analysis

Using the SAS (Statistical Analysis System) V9, to analyzing the data, and Duncan's' multiple range test (DMRT) used to compare the averages at the probability level (5%), where the means that had the same letters meaning no significant difference (Al-Rawi and Khalafallah, 1980).

2.3. Agriculture and planting time and methods

The experimental land prepared by plowing it perpendicularly with a disc plow and smoothing it with a rake. Planting was done at a seed rate of 30 kg per dunum [1 dunum = 2500 m^2] in the form of lines with a distance of 20 cm between one line and another on 12th – May – 2022. The ground was fertilized according to the recommended proportions. According to the Iraqi Ministry of Agriculture, it requires 50 kg of fertilizer per dunum when planting, and 30 kg of Urea fertilizer per dunum when flowering stage. In addition sprayed herbicides on 20th of March 2022, and weeds samples collected on the date 25th of April 2022.

2.4. The factor applied in experiment: included three factors:

The first factor: four bread wheat cultivars (Al-Arabia, Bora, Pisanzo, and Tal-Afar3).

The second factor: three chemical herbicides (Atlantis, Suraj, and Limitless) specialized in controlling weeds accompanying wheat crops, the table 1 had information of herbicides that using in this experiment.

Table (1): Herbicide information was using in the current experiment (Quoted from: Wahab & Aljuburi, 2023).

Trade Name	Active Substance and Ratio	Chemical Group	Dose Rate	Target Weeds
ATLANTIS	Mesosulfuron Methyl contains 30 g/kg. Iodosulfuron-Methyl sodium 6 g/Kg. Mefenpyer-Diethyl 90 g/Kg.	Sulfonylurea	0.5 Kg/100 L. + 0.5 L/H. Alkyl ether sulfates, sodium salts 26.6%	Control Broad and Narrow Weeds in Wheat Fields
SURAGE	Sulfosulfuron 75% w (a.i)/w	Sulfonylurea	100 – 50 g/a	
LIMITLESS	Mesosulfuron Methyl 3.0%w/w Iodosulfuron-Methy sodium 0.6% w/w Mefenpyer-Diethyl 9.0% w/w	Sulfonylurea	100 g/a + 125 ml. GLYOXAL-LIMIT (Alkyl ether sulfates, sodium salts 27.65%)	

2.5. The following characteristics were studied:

1. Total Number of Weeds (weed.m^{-2}). (T.N.W.).

2. Total Weight of Weeds (g.m^{-2}). (T.W.W.).

3. Plant height (cm)

4. Flag leaf area (cm^2). (F.L.A). Where: F.L.A = maximum length × its maximum width × 0.95. (Simón, 1999).

5. Spikes number per sq. Meter.

6. Number of grains.spikes^{-1} (No. of grains.spikes^{-1})

7. Weight of 1000 grains (g)

8. Biological yield (g. m^{-2})

9. Grain yield (g. m^{-2})

10. Harvest index (%)

3. Results and Discussion

3.1. T.N.W. (weed.m^{-2}):

The results show in Table (2), the effect of cultivars indicating the moral superiority of the cultivar Tal-Afar3 over the studied cultivars, the lowest value of weeds number was (34.63) weed.m^{-2}. The Arabia cultivar, Bora and Pisanzo scored (39.88, 41.63, 42.5) weed. m^{-2}, respectively. This is because of the low density of the weeds in Tal-Afar3 cultivar, which is reflected in weeds' dry weight.

The results of the effect of herbicides on weeds to the significant differences of (Limitless) herbicide over the other treatments and reached the lowest value of weeds number (28.63) weeds .m^{-2} with a control efficiency ratio 51.47% comparing with the comparison treatment which recorded highest number of weeds and reached 59.00 weeds.m^{-2}. The lowest number of weeds (28.63 weeds.m-2) is due to the efficiency of Limitless herbicide in controlling weed growth, as mentioned by Mohammed *et al.* (2016) that the use of mesosulfuron-methyl and iodosulfuron-methyl-sodium is sufficient to inhibit the biosynthesis of amino acids and then prevent the formation of new leaves compared with control treatment.

The table also indicates the interaction between (cultivars) and (herbicide) regarding significant differences of cultivar Tal-Afar3 with SURAGE herbicide and it reached the lowest density of weed 22 weed .m^{-2} at an efficiency ratio 61.06% comparing with control treatment, which reached 56.5 weed. m^{-2}. The reason is that weeds and pre-mixed herbicides with different modes of action are more efficient in controlling weeds, suppressing their growth, and reducing the density of weeds in a crop (Pacanoski and Mehmeti, 2018).

Table 2: Cultivars and Herbicides effect on total weeds number (m^2) during season (2021-2022).

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides
ATLANTIS	36.0 bc	41.5 b	35.5 bc	34.5 bcd	36.88 b
SURAGE	43.0 b	36.5 bc	35.0 bc	22.0 d	34.13 bc
LIMITLESS	25.5 cd	31.0 bcd	32.5 bcd	25.5 cd	28.63 c
CONTROL	55.0 a	57.5a	67.0 a	56.5 a	59.0 a
Cultivars	39.88 a	41.63 a	42.5 a	34.63 b	

3.2. T.W.W. (g. m^{-2}).

The data recorded in table (3) effect of cultivars on the existence of a significant difference for the cultivar Tal-Afar3 over the other cultivars, and the lowest weed density was 134.9 g.m^{-2}.

The table shows the effect of herbicides on this Trait, to the significant superiority of the herbicide treatment of Limitless over the other treatments, which recorded the lowest weight of the weeds reached 113.45 g.m^{-2}, with control efficiency ratio 51.89%

compared with control treatment, which recording the highest weight of the weeds was 235.85 g.m^{-2}. The using chemical herbicides as one of most effective, and lower expensive ways for reducing or grow and inhibit weeds. The high efficiency chemical herbicides are usually using for combat weeds in wheat fields, and it is one of the systemic herbicides for controlling of narrow and broad-leaves weeds in the fields of wheat, which belongs to the sulfonylurea group and contains two active substances [Mesossulfuron-methyl + Iodosulfuron-methylsodium].

The data of the interaction among (cultivars), and (herbicides) indicate significant differences of cultivar Tal-Afar3 with Limitless herbicide, and the lowest weeds' dry weight was recorded 78.44 g.m^{-2}, with a control ratio 65.32% compared with control treatment, which reached 226.2 g.m^{-2}. While the comparison coefficient with the Pisanzo cultivar produced, the largest dry weight of weeds reached 268.0 g.m^{-2}. This result was due to the herbicide's efficiency in growth-inhibiting weed growth, which agrees with (Singh *et al.*, 2018), that the lower dry matter weight of the weeds by weed killers may be attributed to the efficiency of the herbicide mixtures, especially when both broad and narrow-leaved and their greater efficiency in hindering the cell division of the meristem, which causes rapid drying of the weeds.

Table 3: The cultivars and herbicides effects on the total weeds weight (g.m^{-2}) during the season of growth 2021-2022.

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides
ATLANTIS	141.2 def	174.9 cd	114.7 fg	135.5 def	141.55 b
SURAGE	163.7 de	121.4 efg	126.6 ef	99.46 fg	127.77 bc
LIMITLESS	113.1 fg	129.9 ef	132.3 def	78.44 g	113.45 c
CONTROL	241.4 ab	207.8 bc	268.0 a	226.2 ab	235.85 a
Cultivars	164.8 a	158.5 a	160.4 a	134.9 b	

3.3. Plant Height (cm):

The results recorded in Table No. (4) show the effect of cultivars on plant height with a significant superiority of cultivar Tal-Afar3 99.5 cm, an increase of 32.97% over the Bora variety, recording the plant height 66.69 cm.

The effect of herbicides indicated the significant superiority of ATLANTIS and SURAGE herbicides recorded the highest plant height of (81.5, and 81.38) cm, respectively. The control treatment recorded the lowest plant height of 68.25 cm. This is attributed to the role of LIMITLESS in curbing the growth of the weeds and the lack of their densities and dry weights, thus reducing the competition between the weeds and the crop. This reflected in the lack of competition and increased plant height. In contrast, in the comparison treatment, the competition was high and thus caused a decrease in the plant height, which is consistent, with what mentioned by (Al-Jubouri and Antar 2021).

It is clear from the results that effect of interaction among (cultivars) and (herbicides) significant superiority of Tal-Afar3 with the herbicide ATLANTIS, which recorded the highest plant height of 111.5 cm, while the cultivar Pura and Pisanzo, with its comparison treatment recorded the lowest plant height of (57.25, 59.5) cm, respectively. The increase in plant height with this herbicide may be due to less weed growth, which shifted the competition for weeds in favor of the crop. Under less competition for weeds, crop plants use all growth factors and achieve maximum plant height in wheat plant standing and crop (Bari et al. 2020).

Table 4: Cultivars and Herbicides effects on plant height (cm) during the season of growth 2021-2022.

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides
ATLANTIS	73.75 ed	70.75 efg	70.0 efg	111.5 a	81.5 a
SURAGE	74.5ed	72.75 def	78.25 d	100.0 b	81.375 a
LIMITLESS	67.0 fgh	66.0 gh	71.75 efg	93.0 c	74.438 b
CONTROL	62.75 hi	57.25 i	59.5 i	93.5 c	68.25 c
Varieties	69.5 bc	66.69 c	69.88 b	99.5 a	

3.4. F. L. A. (cm^2):

Table (5) shows the effect of cultivars on the trait of the F. L. A. the significant differences of the Pisanzo variety, which recorded the highest average F. L. A. of 31.00 cm^2, which difference of 42.66% from the cultivar Tal-Afar3, that recorded the lowest F. L. A. of 17.96 cm^2.

As for the effect of the herbicide on the trait of the F. L. A. to the significant superiority of the herbicide Limitless, which recorded the largest area of the F. L. A. reaching 30.55 cm^2, with a difference ratio 45.04% at the [control treatment], that reached lowest mean for this trait recorded 16.79 cm^2. This may be attributing to the decrease in the number and weight of the weeds, which was reflected in the reduction of competition and the increase in the F. L. A., as the use of ready-made mixtures of herbicides for weed killers resulting in an effective reduction of the dry weight of the weeds due to the combination of the characteristics of the leafy activity and soil that prevent cell division in the buds, roots and growth by inhibiting the enzyme acetolactase synthase, thus preventing branch chain amino acid biosynthesis. Therefore, the plant suffers from the inability to pass through the phloem

of the plant and the secondary effect is a stunted growth due to halted cell division and slow plant death, in contrast to the single use of any of the herbicides (Meena et al. 2019).

The resulting effect of interaction among (cultivars) and (herbicides) to significant differences of Pisanzo with Limitless herbicide, recorded the largest area of the flag leaf 36.78 cm^2, with difference ratio 45.48% from the control treatment, On the other hand, the cultivar Tal-Afar3 with the control treatment recorded lowest area of the flag leaf reaching 12.92 cm^2.

Table 5. The effect of Cultivars and Herbicides on F. L. A. (cm^2) during the season of growth 2021-2022.

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides
ATLANTIS	31.13 abc	23.69 de	33.6 abc	19.49 efg	26.975 b
SURAGE	29.31 bcd	28.06 cd	33.57 abc	19.22 efg	27.539 ab
LIMITLESS	35.78 ab	29.45 bcd	36.78 a	20.19 ef	30.55 a
CONTROL	20.09 ef	14.11 g	20.05 ef	12.92 g	16.791 c
Varieties	29.08 b	23.83 c	31.0 a	17.96 d	

3.5. Spikes No. per (m^{-2})

The results in table (6) of the trait of the spikes number to significant superiority of the Pisanzo cultivar recorded the highest average spikes number, and 428.4 spikes .m^{-2} with a difference ratio 40.82% comparing with Tal-Afar3 cultivar, that recorded lower mean for this trait, recording to 253.5 spikes.m^{-2}.

The effect of herbicides showed the significant superiority of (Limitless) herbicide, which recorded the largest number of spikes reached 414 spikes.m^{-2}, at an efficiency rate of 41.69%, comparing with control treatment, that recorded with lowest number of spikes and 241.38 spikes.m^{-2}. The increasing in spikes number in the treatment of the (Limitless) herbicide may be attributing to the efficiency of this herbicide in controlling the weeds, which provides sufficient space for the crop due to the low density of the bushes in these treatments. Thus, this reflected in the spikes number. The number of tillers recorded in the control treatment due to the high density of weeds, which compete with the crop plant (Mahbod *et al*, 2014).

The results in table also indicated the effect of interaction among cultivars and chemical herbicides to the significant differences of the Pisanzo cultivar with Limitless herbicide, which recorded the largest number of spikes, 512 spikes.m^{-2}, with an efficiency ratio of 39.16% comparing with control treatment. In contrast, with the control treatment, the cultivar Tal-Afar3 recorded the lowest number of spikes, reaching 160 spikes.m^{-2}. This supports the findings mentioned by (Al-Jubouri and Antar 2021) that using mesosulfuron-methyl + iodosulfuron-methyl leads to an increase in tiller number and the highest spike count due to reduced competition in these treatments.

Table 6: Cultivars and Herbicides effect on the spikes number (spike.m^{-2}) during the growth season 2021-2022.

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides
ATLANTIS	450 abc	284 def	420 abc	274 ef	357 b
SURAGE	388 bcd	420 abc	470 ab	212 fg	372.5 ab
LIMITLESS	416 abc	360 cde	512 a	368 b-e	414 a
CONTROL	266 ef	228 fg	311.5 def	160 a	241.37 c
Varieties	380 ab	323 ab	428.4 a	253.5 b	

3.6. The grains number per spike:

The data shown in table (7) of the effect of cultivars on grains number per spike indicates there are no significantly differences among cultivars in this characteristic. This lack of significant difference between cultivars in this trait could be due to the efficiency of the variety and the increase in the L.F.A., which was then reflected in the traits of the yield components.

The results in the table show the effect of herbicides on the number of grains per spike, indicating that there are significant differences between the herbicides. Limitless herbicide was significantly differences to the other of herbicides, and the higher average number of spikes' grains was 46.65 grains.$spike^{-1}$, with an efficiency rate of 29.47% compared with control treatment, which recorded the lowest average for this trait, and 32.9 grains.$spike^{-1}$. Longer weed competition leads to less effective tillering, and weeds bear fewer spikes and fewer grains per spike than weed-free treatments (Rathod and Vadodaria 2004).

The data of the table for the interactions among cultivars, and herbicides indicate significant differences to the Pisanzu cultivar with limitless herbicide, which recorded the highest mean for this trait, reaching 52.63 grains. $spike^{-1}$ with an efficiency rate of 33.8% for its comparison treatment. In contrast, the Tal-Afar3 cultivar with the control treatment recorded the lowest average for this trait, recording 29.5 grains. $spike^{-1}$ (Chand and Puniya 2017) mentioned that all wheat yield traits have a significant positive correlation with grain yield but a negative correlation with weed density and weed dry weight.

Table 7. The effect of Cultivars and Herbicides on number of grains. Spike^{-1}. during the season of growth 2021-2022.

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides
ATLANTIS	46.13 bcd	42.13 de	42.75 d	46.88 a-d	44.469 ab
SURAGE	43.5 cd	52.13 ab	45.0 cd	31.88 gh	43.125 b
LIMITLESS	40.5 def	44.13 cd	52.63 a	49.35 abc	46.65 a
CONTROL	36.25 efg	31.0 gh	34.84 fgh	29.5 a	32.896 c
Varieties	41.59 a	42.34 a	43.8 a	39.4 a	

3.7. Weight of 1000 grains (g):

The data in Table (8) show the statistical analysis of effect of cultivars on the weight of 1000 grains indicating significantly differences among the cultivars. "Bora" cultivar was superior to the other cultivars, which recorded the highest means for recently trait, and 42.44 g. In contrast, the Arabia, Pisanzo, and Tal-Afar3 cultivars recorded the lowest means for the trait, which reached (36.31, 36.59, 36.87) g, respectively.

The data showed in same table the effect of herbicides to the significant superiority of all herbicides used in the experiment, which shows the highest mean for this trait recorded (39.43, 39.56, 39.59) g for the herbicide ATLANTIS, SURAGE LIMITLESS, respectively. At the same time, the [control treatment] recorded the lowest mean for this characteristic, which was 33.64 g. This is due to the efficiency of these herbicides in controlling the weeds leading to a reduction in competition, which provides the plant with moisture, light and nutrients This is reflected in the process of photosynthesis. Thus, an increase in the accumulation of dry matter in the plant reflected in the components of the crop, including the weight of thousand grains (Al-Jubouri and Antar 2021).

The result in the same table indicates the effect of interaction among cultivars and herbicides , indicating significant superiority of the Bura cultivar with the SURAGE herbicide, and the higher average for this trait were reached to 45.08 g. In contrast, the Arabia cultivar with the [Control treatment] recorded the lowest mean for this trait, which reached 31.20 g. The weed competition for a longer period decreases crop growth and yields components compared to the weed-free treatment (Yadav *et al.*, 2020).

Table 8. The effect of Cultivars and Herbicides on Weight 1000 grain during the season of growth 2021-2022.

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides
ATLANTIS	36.65 d-g	44.13 ab	38.15 cde	38.8 b-e	39.431 a
SURAGE	39.7 bcd	45.08 a	37.13 c-f	36.35 d-g	39.563 a
LIMITLESS	37.7 cde	42.58 ab	39.03 bcd	39.05 bcd	39.588 a
CONTROL	31.2 g	38.0 cde	32.08 fg	33.28 efg	33.638 b
Varieties	36.31 b	42.44 a	36.59 b	36.87 b	

3.8. Biological yield (g .m^{-2}):

The results in Table (9) of the effect of cultivars on its biological yield indicates the significant differences of the Pisanzo cultivar, which recorded the highest mean for this trait, reaching to 1451.7 g. m^{-2} which a difference ratio of 39.04% compared with the Tal-Afar3 cultivar, which recorded lower mean for recently trait, reaching to 884.9 g.m^{-2}.

The table shows effect of herbicides in biological yield, to the significant differences of herbicide "Limitless", where recorded the high mean for this trait, reaching to 1336.46 g. m^{-2}, with an efficiency ratio of 38.22% comparing with the [control treatment], where recorded the lowest mean for this trait, where reaching to 825.57 g. m^{-2}. This result may be attributed to the fact that herbicides, such as Limitless, contain more than one chemical in their composition, which effectively curbs the growth of weeds (Tiwari *et al*., 2015).

The effect of the interaction among cultivars and Herbicide indicates the significant differences of the cultivar Pisanzo with (SURAGE and LIMITLESS) herbicides, which recorded the highest mean for this trait, reaching to 1642.7 and 1620.6 g. m^{-2} with an efficiency ratio of 30.12%, and 31.06% to the [control treatment], respectively. The cultivar Tal-Afar3 with the comparison treatment recorded the lowest average for trait, where reaching to 535.5 g. m^{-2}. These herbicides may attribute to their efficiency in combating widespread weeds, which curbs weed growth and allows plants to form a greater number of tillers, leading to an increase in grain yield. This confirmed by (Evans *et al.* 2016; Lamichhane *et al.* 2017) that mixtures containing chemicals are not like herbicides bush more effective control of weed.

Table 9: Cultivars and Herbicides effect on biological yield weight (g. m^{-2}) during the growth season 2021-2022.

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides

ATLANTIS	1344 abc	836.5def	1411 abc	1108 cd	1175.06 b
SURAGE	1235 bc	1485 ab	1621 a	625.2 ef	1241.55 ab
LIMITLESS	1289 be	1144 cd	1643 a	1271 bc	1336.45 a
CONTROL	894.5 de	739.9 ef	1132 cd	535.5 f	825.56 c
Varieties	1191 b	1051 bc	1452 a	884.9 c	

3.9. Grains yield (g. m^{-2}):

The data in table (10) show there were significant differences among the cultivars in grain yield. The Pisanzo cultivar was superior to the other cultivars and recorded the highest mean grain yield of 600.5 g. m^{-2}, with a difference ratio of 51.19% from the Tal-Afar3 cultivar, where recorded the lowest mean for this trait, recorded to 293.1 $g.m^{-2}$.

The data analysis on the impact of herbicides on grain yield indicated that [LIMITLESS] herbicide outperformed other treatments. A yield of 507.5 g represented the highest mean for this trait. m^{-2}, with an efficiency ratio of 44.61%, while the [Control treatment] only achieved 281.08 g.m2. The reason for this may be that using two or more pesticides in a mixture or succession for both types of broad-leaf and narrow-leafed weeds inhibits the growth of the weeds (Al-Mutrafi *et al.*, 2014).

The results showed the effect of the interaction between the cultivars and herbicides in this trait to the significant superiority of the Pisanzo cultivar with the limitless herbicide, which recorded the highest average for this trait, reaching to 712.7 $g.m^{-2}$, with an efficiency rate of 38.36% for the comparison treatment. In contrast, the cultivar Tal-Afar3 with the [control treatment] recorded the lowest mean for this trait, reaching to 16.58 g. m^{-2}. The reason for this is that these herbicides are superior in weed control, which resulted in an increase in the number of weeds and spikes. This confirmed by (Evans *et al.* 2016; Lamichhane *et al.* 2016) that mixtures containing chemicals that are not similar to weed killers are more effective in controlling weeds.

Table 10. The effect of Cultivars and Herbicides on grain yield weight ($g.m^{-2}$) during the season of growth 2021-2022.

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides
ATLANTIS	486.2 cd	299.0 fg	578.5 bc	372.1 def	433.92 b
SURAGE	408.2 def	662.7 ab	671.6 ab	188.6 gh	482.78 ab
LIMITLESS	402.3 def	460.2 cd	712.7 a	454.8 cde	507.50 a
CONTROL	326.7 ef	201.5 gh	439.3 ed	156.8 h	281.07 c
Varieties	405.8 b	405.9 b	600.5 a	293.1 c	

3.10. Harvest Index (%):

The data in table (11) shows through the statistical analysis presented significant differences among the cultivars in the harvest index. Pisanzo cultivar was significantly superior in this trait to the other cultivars, and the highest mean for this trait was 41.2%. In contrast, the Tal-Afar3 cultivar recorded the lowest average for this trait, 32.21%.

All herbicides used in the experiment exhibited significant superiority over the comparison treatment, as indicated by the harvest index characteristic, with recorded averages of (36.83, 37.37, 37.60)% for the herbicides Atlantis, SURAGE, and Limitless, respectively. The comparison treatment recorded the lowest mean for this treatment, reaching 32.97%.

The table showed the effect of the interaction above cultivars and herbicides in the harvest index to significant differences of the Bura cultivar with the SURAGE herbicide, and the higher average for this trait was 44.53%, with an efficiency rate of 38.89% for the [control treatment], where recorded the lowest where mean for this trait among the coefficients used in the experiment, which recorded to 27.21%.

Table 11. The effect of Cultivars and Herbicides on Harvest yield % during the season of growth 2021-2022.

Treatment	Al-Arabia	Bora	Pisanzo	Tal-Afar3	Herbicides
ATLANTIS	36.87 a-e	35.7 b-f	41.14 abc	33.61 c-g	36.83 a
SURAGE	33.21 d-g	44.52 a	41.44 abc	30.19 fg	37.34 a
LIMITLESS	31.36 efg	39.91 a-b	43.36 ab	35.76 b-f	37.59 a
CONTROL	36.53 b-f	27.21 g	38.84 a-e	29.29 fg	32.96 b
Varieties	34.49 bc	36.84 b	41.2 a	32.21 c	

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References

[1] **Aljuburi D F, Anter, S H (2021)**. Effect of Tillage System and Chemical Herbicides on Growth and Yield of Wheat *Triticum astivium* L. for Associated Weed in Dry Land. *Plant Cell Biotechnol Mol Biol*, 65-73.

[2] **Al-Mutrifi HIT, Helmoud NR, Al-Fartousi HAK. (2014)**. Individual and combined effect of different herbicides in weed control, growth and yield of wheat. *Karbala University Journal,* 12(First Issue) Scientific.

[3] **Al-Rawi, K M, Khalaf Allah A M. (1980)**. Design and analysis of agricultural experiments. *El Mousel Univ., Iraq*, *19*, 487.

[4] **Bari A, Baloch M S, Shah A N, Khakwani A A, Hussain I, Iqbal J, Ali A, Bukhari M A. (2020).** Application of various herbicides on controlling large and narrow leaf weeds and their effects on physiological and agronomic traits of wheat. *Planta daninha*, *38*.

[5] **Chand L, Puniya R. (2017).** Bio-efficacy of alone and mixture of herbicides against complex weed flora in wheat (*Triticum aestivum*) under sub-tropical conditions. *Indian J. Agric. Sci.*, *87*, 1149-1154.

[6] **Directorate of Agricultural Statistics - central statistical organization Iraq. (2019).** Statistical report on wheat and barley production, https://cosit.gov.iq/documents/population/demographic/reports/UNESCO-EU%20LMS%20Report_Agriculture_20022019.pdf

[7] **Evans J A, Tranel P J, Hager A G, Schutte B, Wu C, Chatham L A, Davis A S. (2016).** Managing the evolution of herbicide resistance. *Pest Manag. Sci.*, *72*(1), 74-80.

[8] **Kumar A, Singh R S, Singh M P, Kumar P. (2020).** Effect of various herbicides to control of weeds in wheat and associated weeds. *J. Pharm. Innov.* 9(9): 275-280.

[9] **Lamichhane J R, Devos Y, Beckie H J, Owen M D, Tillie P, Messéan A, Kudsk P. (2017).** Integrated weed management systems with herbicide-tolerant crops in the European Union: lessons learnt from home and abroad. *Crit. Rev.*, *37*(4), 459-475.

[10] **Mahajan G, B S Chauhan. (2011).** Effects of planting pattern and cultivar on weed and crop growth in aerobic rice system. *Weed Technol*. 25: 521-525.

[11] **Mahbod M, Zand-Parsa S, Sepaskhah A R. (2014).** Adjustment of radiation use efficiency of winter wheat by air temperature at different irrigation regimes and nitrogen rates. *Arch. Agron. Soil Sci. 60*(1), 49-66.

[12] **Meena V, Kaushik M K, Dotaniya M L, Meena B P, Das H. (2019).** Bio-efficacy of readi-mix herbicides on weeds and productivity in late-sown wheat. *Indian j. weed sci.* 51(4): 344–351, 2019.

[13] **Mohammed A T, R K Shati, A J Ali. (2016).** Evaluate the effectiveness of the weed herbicide atlantis WG for some varieties of wheat which be approved in Iraq and associated weed and its impact on the economic quotient. *AJAS*, 14 (1): 183-194.

[14] **Pacanoski Z, Mehmeti A. (2018).** POST herbicide programme for effective weed control in winter wheat (*Triticum aestivum* L.).*–Agron. Res.* 16: 1796–1808.

[15] **RathodI R, Vadodaria RP. (2004).** Response of irrigation and weed management on productivity of wheat under Middle Gujarat condition. *Pak. J. Biol. Sci* 7(3): 346–349.

[16] **Simón, M. R. (1999).** Inheritance of flag-leaf angle, flag-leaf area and flag-leaf area duration in four wheat crosses. *Theoretical and applied genetics*, *98*, 310-314.

[17] **Singh S P, Yadav R S, Kumawat A, Bairwa R C. (2018).** Weed control in greengram (*Vigna radiata*) and its residual effect on Indian mustard (*Brassica juncea*). *Indian J. Agron.* 63(1): 21–25.

[18] **Singh V V, Singh S K, Srivastava S K, Pratap T. (2022).** Two novel herbicide molecules are being evaluated in a tank mix with conventional herbicides for use against complex weed flora and nutrient uptake in irrigated wheat (Triticum aestivum L.). *J. Pharm. Innov.* 11(5): 546-551

[19] **Tiwari A, Verma, B K, Dev J, Kumar R. (2015).** Bioefficacy of clodinafop-propargyl+ metsulfuron-methyl against complex weed flora in wheat. *Indian j. weed sci. 47*(4), 422-424.

[20] **USDA.** World agricultural supply and demand estimates, 2020 .

[21] **Wahab, S. E. A., & Aljuburi, D. F. (2023, December).** Effect Concentrations of LIMITLESS WG Herbicides and Varieties on the Growth and Yield of Wheat (Triticum aestivum L.) and Associated Weeds. In IOP Conference Series: *Earth and Environmental Science* (Vol. 1262, No. 5, p. 052045). *IOP* Publishing.

[22] **Yadav DK, Verma SK, Pratap V, Yadav SP, Jaysawal PK. (2020).** Available nutrients in soil are influenced by planting techniques and weed management options in wheat. Int. J. Chem. Stud. 8(4):2718-2721.