



# Effectiveness of some herbicides and their application periods on corn(Zea mays L.) productivity.

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# ABSTRACT

A field experiment was carried out in the fall agricultural season 2023 in the village of Tal Hussein, affiliated to the Hawija District in Kirkuk Governorate, and after preparing the soil by plowing and fertilizing and according to recommendations, planting was carried out on 7/14/2023 with the RAYAL (NEVADA) variety that was obtained from the markets. Local. A two-factor experiment was implemented according to a randomized complete block design (R.C.B.D.), with three sectors, each sector containing (20) experimental units. The matches between the parameters were randomly distributed, and the area of the experimental unit was (4x4) m. Each experimental unit contains (5) lines, and the space between one line and another is 75 cm, between one plant and another is 15 cm, one experimental unit and another is 50 cm, and between one repeat and another is 1.5 m. The experiment was under a sprinkler irrigation system, and the following results were obtained: The herbicides had a clear significant effect on the total number of bushes for all periods, where the Rimisulfuron + Atrazine mixture gave the lowest average on the bush number characteristic and amounted to 7.58, which did not differ from the Rimisulfuron pesticide alone, as well as a decrease in the dry weight of the bush, whether due to individual factors or interaction between the two factors, as it was recorded Rimisulfuron herbicide had the lowest average dry weight after the weedless treatment, reaching 13.50 and 0.00, respectively. As for the yield characteristics and their components, herbicides had a significant effect on most traits, especially the number of grains. A head and a weight of 300 grains and grain yield gave the highest averages for the Rimisulfuron herbicide treatments, reaching 17.46, 644.75, and 185.00, respectively, except for grain yield, where the Atrazine pesticide treatment was superior, giving 2652.67, and these treatments were close to the weed-free treatment. As for the period factor, there were no significant differences for most of these traits except grain yield, as the period 30 days after germination gave the highest average, amounting to 2478.93, which did not differ significantly from the periods 15 days and 60 days after germination.

Keywords: Herbicides, Periods spray, Weeds, Maize, Yield ...

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# INTRODUCTION

Zea mays L. occupies the third position after the most important crops, wheat and rice, and is one of the most important cereal crops in the world in terms of its multiple uses [1]. Maize is used in human nutrition [2]. Maize belongs to C4 carbon fixation plants [3]. It is considered one of the most important cereal crops when compared to other crops, as its economic importance lies in the fact that its seeds contain carbohydrates (81%), protein (10.6%), and oil (4.6%), in addition to containing vitamins E, B1, and B2 [4]. Also, many people use maize grains, especially in developing countries, as a staple food and source of protein for humans and animals [5]. The presence of weeds in maize fields is one of the major problems facing farmers, and causes a reduction in grain yield and quality. Weed competes the crop for water, food and light, as well as the increase in the economic cost resulting from control operations [6]. It is necessary to pay attention to the weed control process, which cause large crop losses, as the percentage of loss in Iraq due to weeds (25-40%). The weed pressure reduces production and leads to a quality deterioration, and causes problems in irrigation channels and harvest [7]. This requires weed control after emergence, which appears after 15-25 days of planting, because the weeds have intense competition for growing resources, reducing corn productivity [8]. The chemical method is one of the methods that has been used as an effective way in weed control, as it works to kill or prevent the growth of weed infestations in maize fields. Therefore, the study aims to find out:

- 1. The effect of the weed-removal period associated with the maize.
- 2. The best pesticides, their mixtures, and their effectiveness on weeds.
- 3. Interactions between these factors and their impact on growth and yield.

#### Material and methods

A field experiment was carried out during the autumn season, where the crop was cultivated on 14/7/2023 in Tal Hussein village (Hawija district)/Kirkuk governorate. The site is located at latitude (35.401) and a longitude of (43.88), and soil samples were collected from the field with a depth of (0-30 cm). Samples were taken randomly from (3) different sites before maize planting, for soil physical and chemical properties. The samples were mixed and analyzed in the laboratories of the Faculty of Agriculture Hawija. The American hybrid maize called RAYAL (NEVADA), which was obtained from the local market, the land was prepared by plowing twice by using a disc plow and smoothing with a harrow to create a good place for seeds. The experiment was applied according to the randomized complete block design R.C.B.D with three blocks, each contains (20) experimental units, which distributed randomly. Experimental unit area was 4 x 4 contains five lines and the distance between them 75 cm while the experimental units separated by 50 cm and between the plants was 15 cm. Distance between the blocks was 1.5 m, the seeds were planted on 14 /7/2023. Under the sprinkler irrigation system, the field was fertilized with Diamonium phosphate (DAP) at rate 320 kg/ha [9]. The harvesting process was done manually on 18/11/2023 by choosing 5 plants randomly from the middle three lines of each experimental unit at physiological maturity. The experiment included two factors, the first factor includes combinations of different pesticides, where the following treatments were used (comparison treatment (non-control) and weed-free treatment) and 2.5 kg / ha Atrazine herbicide. And 50 gm / h Rimsulfuron herbicide with 250 ml of diffuser material. And a mixture of 2.5 kg / ha herbicide Atrazine with 50 gm / ha herbicide Rimsulfuron with 250 ml diffuser). These quantities were used as recommended. A 16-litre portable backpack sprayer was used. The second factor: was the periods of weed control, which included four periods after germination:

- 1- First period: 15 days after germination.
- 2- Second period: 30 days after germination.
- 3- Third period: 45 days after germination.
- 4- Fourth period: 60 days after germination.

# Studied traits:

- 1. Weed traits: existing weeds in the experimental area were diagnosed after 30 days of cultivation.
- 2. Weed total number.m<sup>2</sup>: total weed been measured in square meter by using a measure tape in each experimental unit after 30 days of weed control.
- 3. Weed dry weight (g.m<sup>2</sup>): weed dry weight was calculated after 30 days of control. The unaffected weeds by herbicides were cut at soil surface for one square meter of each experimental unit defined by a measure tape weed collected and placed in a paper bag. Samples were dried in an electric oven at 70 C° until the weight was stabilised [10].
- 4. Grains per ear: grains in a line calculated as a mean for five plants selected randomly from the three middle rows of each experimental unit.
- 5. 300 grain weight: 300 grains were calculated after threshing and counting them manually from each sample taken for five plants harvested from each experimental unit. Weight been taken by a sensitive scale after adjusting the grain humidity at 15.5% [11].
- 6. Total grain yield (t.ha<sup>-1</sup>): The total grain yield was calculated after adjusting the humidity, by weighing the grain yield of 5 grains, multiplied by the plant density [11].

# **Results and discussion**

1. Weed total number.m<sup>2</sup>:

Table (1) showed that there are significant differences between the means, where weed-free outperformed compared to the other treatment for all spraying periods. This is because all control methods were used in this treatment and the weed number was 0.00 followed by the treatments of the herbicide Rimsulfuron which gave 6.50 plants.  $m^2$  which did not differ from the treatment of the Atrazine + Rimsulfuron mixture which gave an average of 7.58 plants.  $m^2$  Atrazine alone recorded 13.83 plants.  $m^2$  treatment with herbicides affected the density of the weed and these results are consistent with [12]. The bilateral interference between the two factors of the study (herbicides and spraying periods) showed significant differences. Interaction between (Rimsulfuron + spraying after 60 days of germination) gave the lowest average number of weeds amounted to (4.33) plants.  $m^2$ . While the interaction treatment between Atrazine and 15 days after germination recorded the highest density of associated weeds with maize with an average (20.33) plants.  $m^2$ .

| Spraying periods | 15 days after germination | 30 days after germination | 45 days after germination | 60 days after germination | Treatments means |
|------------------|---------------------------|---------------------------|---------------------------|---------------------------|------------------|
| Treatments       |                           |                           |                           |                           |                  |
| Control          | 68.33 b                   | 83.33 c                   | 33 .96 a                  | 100.00 a                  | 0.87 a           |
| Weeds free       | 0.00 f                    | 0.00 f                    | 0.00 f                    | 0.00 f                    | 0.00f            |

| Atrazine                     | 33.20 d  | 33 .15 de | 9.00 def | 10.67 def | 13.83 b |
|------------------------------|----------|-----------|----------|-----------|---------|
| Rimsulfuron                  | 7.33 ef  | 6.33 ef   | 8.00 def | 4.33 ef   | 6.50 c  |
| Atrazine<br>+<br>Rimsulfuron | 8.67 def | 8.33 def  | 8.33 def | 5.00 ef   | 7.58 c  |
| Spraying periods means       | 23.93 a  | 19.67 d   | 24.33 a  | 24.00 a   |         |

Means with similar letters have no significant difference according to the Dunkin test at 0.05

# 2. Weed dry weight (g.m<sup>2</sup>):

Appears results from table (2) that, the weeds dry weight affected by both studied factors, where weed dry weight decreased by spraying herbicides, as the spraying treatment with Rimsulfuron gave the lowest average 13.50 g m<sup>-2</sup>. While treatments of Rimsulfuron + Atrazine record higher average (18.66 and 30.91) g m<sup>-2</sup> respectively. Control record highest weed dry weight 247.16 g m<sup>-2</sup>. This happened due to the effect of herbicides in inhibiting weed growth, which is reflected in their numbers and low ability to metabolize carbon, and this is negatively reflected on their absorption of nutrients and thus low growth, these results are in line with [13, 14 and 15]. Herbicides spraying periods showed significant results for weed dry weight Table (4), and it noted that the best date for spraying was after 45 days, as it gave the lowest average weed dry weight of (50.86) g m<sup>-2</sup>. This is because after 45 days the weed was in the stage of active vegetative growth and herbicides addition worked to destroy the chloroplasts and thus reduce the process of carbon metabolism, which is reflected on weeds and leads to reducing their dry weight, as well as weeds after 45 days has completed its growth while after 15 days of germination most weeds had germinating seeds, allowing them to grow. From interaction between studied factors, the results of Table (2) showed that there are significant differences in the weed dry weight associated with maize. Where the Rimsulfuron treatment alone record the lowest average after 60 days 8.33 g m<sup>-2</sup>. Which did not differ significantly from the treatment of Rimsulfuron after 45 days, while the Atrazine treatment gave the highest average of weed dry weight after 15 days of germination, which amounted to 36.67 g m<sup>-2</sup>.

| Spraying periods             | 15 days after germination | 30 days after germination | 45 days after germination | 60 days after germination | Treatments means |
|------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|------------------|
| Treatments                   |                           |                           |                           |                           |                  |
| Control                      | 254.33 a                  | 262.67 a                  | 204.67 b                  | 267.00 a                  | 247.16 a         |
| Weeds free                   | 0.00 d                    | 0.00 d                    | 0.00 d                    | 0.00 d                    | 0.00 d           |
| Atrazine                     | 36.67 c                   | 22.33 cd                  | 26.67 cd                  | 38.00 c                   | 30.91 b          |
| Rimsulfuron                  | 33.00 cd                  | 4.00 cd                   | 8.67 cd                   | 8.33 cd                   | 13.50 cd         |
| Atrazine<br>+<br>Rimsulfuron | 26.33 cd                  | 22.67 cd                  | 14.33 cd                  | 11.33 cd                  | 18.66 cd         |
| Spraying periods means       | 70.06 a                   | 62.33 a b                 | 50.86 b                   | 64.93 a                   |                  |

Table (2) Effect of herbicides and spraying periods and their interaction on Weed dry weight (g.m<sup>2</sup>)

Means with similar letters have no significant difference according to the Dunkin test at 0.05

# 3. Grains per ear:

Table (3) shows significant differences between the means of control treatments on grains per ear, where the spraying treatment with Rimsulfurona gave the highest average number (644.45) grains per ear. While the comparative treatment recorded an average of (468.17) grains per ear, which did not differ from weed-free treatment. The reason for high performance of weed-free treatment in grains per ear may be attributed to the suitability of the environmental conditions at that time, which helped increase the incidence of pollination of the maize plant. This, reflected in the increase in number of grains per ear, and this is consistent with [16 and 17]. Who found that increasing grains per ear happens during the control process, which leads to a reduction in weed numbers and prevents or reduces their competition with maize. This reflected positively on increasing plant growth and grains per ear. As for the effect of spraying periods, the results of Table (3) showed

that there were no significant differences between the means for all periods 15, 30, 45 and 60 days after germination, where they were (590.80, 588.73, 564.53 and 589.47) grains per ear respectively. Interactions between the studied factors showed that, there are significant differences between the means. Where Rimsulfurona record the highest average of (704.00) grains per ear Table (3) when used after 60 days of germination. While the control was with 60 days after germination, which gave the lowest (440.00) grains per ear.

| Table | (3) Effect | of herbicides | spraving | periods a | nd their | interaction o | n Grains | per ear |
|-------|------------|---------------|----------|-----------|----------|---------------|----------|---------|
|       | (-)        |               | J - O    |           |          |               |          |         |

| Spraying periods             | 15 days after germination | 30 days after germination | 45 days after germination | 60 days after germination | Treatments means |
|------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|------------------|
| Treatments                   |                           |                           |                           |                           |                  |
| Control                      | 527.33 bcd                | 436.33 d                  | 469.00 cd                 | 440.00 d                  | 468.17 c         |
| Weeds free                   | 626.33 abc                | 630.00 abc                | 651.67 ab                 | 640.33 ab                 | 637.08 a         |
| Atrazine                     | 561.33 abcd               | 630.67 abc                | 623.00 abc                | 620.67 abc                | 608.92 ab        |
| Rimsulfuron                  | 641.67 ab                 | 660.00 ab                 | 573.33 abcd               | 704.00 a                  | 644.75 a         |
| Atrazine<br>+<br>Rimsulfuron | 597.33 abcd               | 586.67 abcd               | 505.67 bcd                | 542.33 abcd               | 558.00 b         |
| Spraying periods means       | 590.80 a                  | 588.73 a                  | 564.53 a                  | 589.47 a                  |                  |

Means with similar letters have no significant difference according to the Dunkin test at 0.05

# 4. 300 grain weight (g):

Table (4) indicates that there are significant differences between the means for herbicide treatments, where Rimsulfuron record the highest value (84.00) gm for 300 grain weight compared to the other treatments and control (80.00) g. The reason for low grain weight for Rimsulfuron compared to control treatment is due to the weed competition with the crop throughout the growing season on growth requirements such as water and elements as well as competition for light, which contributed to restricting plant growth, and the low efficiency of the physiological processes that take place within its tissues, especially the process of photosynthesis and then the decrease in metabolic products and the low plant efficiency to transfer of products to the reproductive parts of the plant, and then decrease the number of grains per ear and the weight of the grain. These results are consistent with (18 and 13). The increase in weed density significantly reduced the number of grains per ear and grain weight, as for the effect of spraying periods, the results of Table (5) showed that there were no significant differences between the means for all spraying periods in 300 grains weight (83.26, 83.00, 80.26 and 82.40) grams for the periods 15, 30, 45 and 60 days after germination respectively. For the interaction, the results of Table (4) showed that there are significant differences between the means, as the weed-free treatment had significant effect when it used after 15 days of germination (86.33), which did not differ from the treatments of Rimsulfuron and Atrazine herbicides and the mixture when used after 15, 45 and 60 days (85.00) respectively. This is due to the use of herbicides in the appropriate periods of interaction and not allowing the weed to continue to compete with the crop for growth requirements, which led to an increase in growth, which reflected positively on 300 grains weight.

Table (4) Effect of herbicides and spraying periods and their interaction on 300 grain weight (gm)

| Spraying periods | 15 days after germination | 30 days after germination | 45 days after germination | 60 days after germination | Treatments means |
|------------------|---------------------------|---------------------------|---------------------------|---------------------------|------------------|
| Treatments       |                           |                           |                           |                           |                  |
| Control          | 81.33 ab                  | 83.33 a                   | 75.00 b                   | 80.33 ab                  | 80.00 b          |
| Weeds free       | 86.33 a                   | 80.00 ab                  | 81.66 ab                  | 81.66 ab                  | 82.41 ab         |
| Atrazine         | 82.66 ab                  | 85.00 a                   | 81.33 ab                  | 82.66 ab                  | 82.91 ab         |

| Rimsulfuron                  | 84.33 a  | 85.00 a  | 81.66 ab | 85.00 a  | 84.00 a  |
|------------------------------|----------|----------|----------|----------|----------|
| Atrazine<br>+<br>Rimsulfuron | 81.66 ab | 81.66 ab | 81.66 ab | 82.33 ab | 81.83 ab |
| Spraying periods means       | 83.26 a  | 83.00 a  | 80.26 a  | 82.40 a  |          |

Means with similar letters have no significant difference according to the Dunkin test at 0.05

# 5. Total grain yield (t.ha<sup>-1</sup>):

The results of statistical analysis, proved significant effect of herbicides, It noted from Table (5) that, Atrazine gave the highest average grain yield, followed by Rimsulfuron and finally the mixing treatment of Rimsulfuron + Atrazine 2652.67, 2449.42 and 2273.17 t.ha<sup>-1</sup> compared to the control treatment that gave (2105.42) t.ha<sup>-1</sup>. The weed-free treatment also gave (2605.17) t.ha<sup>-1</sup>. Which did not differ significantly from herbicide treatments. This is the reason for the significant effect of weed-control treatments over the control. This attributed to the role of herbicide in reducing weed competition through the elimination or reducing their growth and density Table (3), and reduces their dry weight Table (5). This improved crop vegetative growth, which resulted in an increase in the accumulation of dry matter, which was positively reflected in the increase in the grains number and 300 grains weight, thus increasing grain yield [18 and 13]. The herbicide spraying periods significantly affected the grain yield, as the periods 15, 30 and 60 gave a significant means (2465.60, 2478.93 and 2536.73) t. ha<sup>-1</sup> respectively. And a significant difference compared to the period of 45 days, which amounted (2187.40) t. ha<sup>-1</sup>. The reason may be due to the use of these herbicides in the appropriate periods which caused a damage in growth and the components of the yield, either the effect of the interaction between the studied factors has shown Table (5) that there are significant differences between where the use of Rimsulfuron after 30 days of germination (3011.3) t. ha<sup>-1</sup>, compared to the control after 30 days (1588.3) t.ha<sup>-1</sup>.

| Spraying p<br>Treatments     | periods | 15 days after germination | 30 days after germination | 45 days after germination | 60 days after germination | Treatments<br>means |
|------------------------------|---------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------|
| Control                      |         | 2249.7 def                | 1588.3 g                  | 2153.0 ef                 | 2430.7 cde                | 2105.42 c           |
| Weeds free                   |         | 2640.7 abcd               | 2745.7 abc                | 2528.7 bcde               | 2505.7 bcde               | 2605.17 ab          |
| Atrazine                     |         | 2451.3 cde                | 2656.7 abc                | 2644.0 abcd               | 2858.7 ab                 | 2652.67 a           |
| Rimsulfuron                  |         | 2475.0 bcde               | 3011.3 a                  | 1585.3 g                  | 2726.0 abc                | 2449.42 b           |
| Atrazine<br>+<br>Rimsulfuron |         | 2511.3 bcde               | 2392.7 cdef               | 2026.0 f                  | 2162.7 ef                 | 2273.17 c           |
| Spraying periods             | means   | 2465.60 a                 | 2478.93 a                 | 2187.40 b                 | 2536.73 a                 |                     |

Table (5) Effect of herbicides and spraying periods and their interaction on Total grain yield (t.ha<sup>-1</sup>)

Means with similar letters have no significant difference according to the Dunkin test at 0.05

| Appendix (1) ana | lysis variance | e of the studied | field traits re- | presented by so | quare mean de | viations M.S. |
|------------------|----------------|------------------|------------------|-----------------|---------------|---------------|
|                  | 2              |                  |                  |                 | 1             |               |

| Source<br>difference | of | Degree of freedom | Weed<br>number | total | weed dry weight<br>(g.m-2 | Grains per ear | 300 grain<br>weight (g) | Total grain yield<br>(t.ha <sup>-1</sup> ) |
|----------------------|----|-------------------|----------------|-------|---------------------------|----------------|-------------------------|--|
| Blocks               |    | 2                 | 166.86         |       | 74.45                     | 5654.066       | 8.066                   | 364556.117                                 |

| Herbicides (A)                   | 4  | 15656.85<br>** | 129980.65<br>** | 63662.10<br>**  | 26.308<br>n.s | 629305.125<br>** |
|----------------------------------|----|----------------|-----------------|-----------------|---------------|------------------|
| Spraying periods (B)             | 3  | 73.79<br>n.s   | 988.63<br>n.s   | 2379.79<br>n.s  | 27.755<br>n.s | 366249.089<br>** |
| Herbicides ×<br>Spraying periods | 12 | 159.68<br>**   | 586.36<br>n.s   | 5149.252<br>n.s | 11.852<br>n.s | 358412.381<br>** |
| Experimental<br>Error            | 38 | 43.37          | 319.39          | 7121.926        | 15.785        | 42284.362        |

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- n.s= non-significant \*\*=0.01 \*=0.05
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# تأثير مكافحة الادغال على حاصل الذرة الصفراء (Zea mays L).

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الخلاصة

نفذت تجربة حقلية في الموسم الزراعي الخريفي 2023-2024 في قرية تل حسين التابعة الى قضاء الحويجة في محافظة كركوك وبعد تهيئة التربة من حراثة وتسميد وحسب التوصيات ، اذ تمت الزراعة يوم 2023/7/14 بصنف (RAYAL(NEVADA الذي تم الحصول علية من الاسواق المحلية. وطبقت تجربة عامليه وفق تصميم القطاعات العشوائية الكاملة R.C.B.D وبثلاثة قطاعات يحتوي كل قطاع على (20) وحدة تجريبية. ووز عت عليها التوافيق بين المعاملات عشوائيا وبلغت مساحة الوحدة التجريبية (4x4) م. وتحتوي كل وحدة تجريبية على (2) وحدة تجريبية. ووز عت عليها التوافيق بين المعاملات عشوائيا وبلغت مساحة مكرر واخر 1.5 م، وقد كانت التجريبة تحت نظام الري بالرش، فقد تم المصاحة بين خط واخر 75سم وبين نبات واخر 150 من و

كانت لمبيدات الادغال تأثيرا معنويا واضحا في صفة العدد الكلي للأدغال ولجميع الفترات حيث اعطى خليط مبيد Rimisulfuron + Atrazine اقل متوسط في صفة عدد الادغال وبلغ 7.58 والذي لم يختلف عن مبيد ال Rimisulfuron لوحدة وكذلك انخفاض الوزن الجاف للأدغال سواء بالعوامل الفردية او التداخل بين العاملين حيث سجل مبيد Rimisulfuron اقل متوسط للوزن الجاف بعد المعاملة الخالية من الادغال وبلغ 13.50 و 0.00 على التوالي. اما في صفات الحاصل ومكوناته فقد كانت للمبيدات تأثير معنوي لأغلب الصفات وخاصة عدد الحبوب. عرنوص ووزن 300 حبة وحاصل الحبوب اذ اعطت اعلى متوسطات عند معاملات مبيد Rimisulfuron وبلغ 17.50 و 185.00 على متوسط للوزن الجاف بعد المعاملة الخالية من الادغال وبلغ 13.50 و 0.00 على التوالي. اما في صفات الحاصل مديد Rimisulfuron وبلغ 17.40 و 17.50 و 185.00 على التوالي عدا حاصل الحبوب فكانت معاملة مبيد Atrazine هي الحبوب اذ مديد Rimisulfuron وبلغ 17.40 و 17.50 و 205.050 على التوالي عدا حاصل الحبوب فكانت معاملة مبيد Atrazine هي المتوقة واعطت 2652.67 وكانت تلك المعاملات قريبة من المعاملة الخالية من الادغال. اما عامل الفترات فلم تكن هذاك فروقات معنوية لأغلب تلك الصفات عدا المعاملات قريبة من المعاملة الخالية من الادغال. اما عامل الفترات قلم تكن هذاك فروقات معنوية لأغلب تلك الصفات عدا حاصل الخبوب الانبات. الانبات اعلى متوسط وبلغ 24.79 و الذي لم يختلف معنويا عن الفترات 15 يوم و 60 يوم بعد الانبات.

الكلمات المفتاحية: المبيدات، فترات الرش، الادغال، الذرة الصفراء، الحاصل.