Evaluation of the Effectiveness of 2.4-D 72% Herbicide in Combating Weedy Leaves Associated with Different Varieties of Forage Sorghum (*Sorghum bicolor* L.) and Its Effect on Growth Characteristics

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Abstract. A field experiment was conducted in the fields of a farmer in the (Koldara) area, which belongs to the district of Alton Kubri (Dibs District) in Kirkuk Governorate. Planting took place in the spring season on 28/3/2023 after preparing the soil. Phosphate P_2O_5 fertilizer was added before planting, 100 kg.ha $^{-1}$, while nitrogen fertilizer was added after planting (320) kg. ha $^{-1}$ per batch in the form of urea fertilizer (46% N) and in two batches, one batch after planting and the second batch before the flowering of the Sorghum crop. A factorial experiment was designed according to a randomized complete block design (R.C.B.D.). With three replicates and two factors: spraying 2.4-D 72% herbicide in an amount of 1500 cm^3.ha^{-1} spray on the soil before planting, six varieties of forage Sorghum : Bohouth, Giza, J, Rabeh, Warka ,Inqaz,. The results of the study showed that the 2.4-D herbicide, when used before planting, was effective in reducing the number of weeds with susceptible leaves, as well as the dry weight of the weeds that escaped or were not affected by the herbicide, as well as the high control rate that was achieved as a result of the use of that herbicide and that method of control. This had a positive effect on the characteristics of vegetative growth, as the height of the plant and the number of branches increased, and demonstrated the superiority of the variety Anqaz and Warka in those two important characteristics for fodder purposes.

Keywords. Sorghum varieties, Weeds, 2.4-D herbicide.

1. Introduction

Sorghum (*Sorghum bicolor* L.) is a widely adapted crop with high potential for bioenergy production , Cellulose, hemicellulose and lignin are the main components of sorghum biomass, which are the most abundant renewable resources on Earth and can be used as alternatives to petroleum and other materials [1]. Sorghum bioenergy is also of interest due to its relatively low input requirements, drought tolerance, and ability to maintain high biomass yields in a wide range of soils and environmental condition p[2]. For these reasons, this crop is well adapted to semi-arid regions and can

be grown instead of maize in non-irrigated cropping systems [3] [4]. Sorghum is also one of the important grain crops after wheat, rice, corn and barley in terms of cultivated area and production [5]. It is food for more than 500 million people in more than 30 countries. This crop has received great attention recently, not only because it is the fifth cereal crop, but also because it is an unsubsidized crop and its production capacity is unexploited. It is possible that Sorghum will contribute to solving the food crisis. Especially for peoples and regions that are in increasing need of it[6]. The Weeds constitutes one of the main agricultural problems for profitable agricultural production, as it acts as a host for diseases and insects, in addition to its negative impact in reducing the quantity of yield and the quality of strategic crops, especially sorghum[7]. However, sorghum is a poor competitor against weeds due to slow growth and poor vigor during the first three or four weeks after emergence, although it eventually establishes a dense canopy [8]. After this crop stage (after canopy formation), the competitive ability of sorghum increases thanks to the high plant density and height, which reduces the appearance and growth of weeds. In sorghum, the critical period for weed control was from 14 to 58 days after emergence [9]. Because of these growth habits weedy and uncontrolled infestation in the early stages of sorghum can lead to poor crop establishment or complete crop failure. The use of pre-emergence herbicides is of greater importance in due to their effectiveness from the initial stages, while post emergence herbicides may help avoid weed problem in later stages [10] [11] .

The study aims to: Know the effectiveness of the pesticide2, 4-D when used before planting mixed with the soil, as well as the effect of this control on the characteristics of harmful weeds and its effect on the growth of six varieties of forage sorghum and to show the characteristics of these distinct varieties.

2. Materials and Methods

A field experiment was conducted in the fields of a farmer in the (Koldara) area, which belongs to the district - Alton Kubri - (Dibs District) in the Kirkuk Governorate, located at latitude 35.65 north and longitude 44.37 east according to the program (Maps.me), and it is about 23 km away. North of Kirkuk city. Planting took place in the spring session on April 28, 2023. A composite sample was taken from the experimental land to study its physical and chemical traits.

Table 1. Chemical and physical traits of soil at experiment site and at a depth of (30) m.

Traits	pH	E.C	Total Nitrogen	Total phosphorus	Ready potassium	O.M	Soil texture
Measuring unit	-	Ds m $^{-1}$	(%)	(ppm)	(ppm)	(%)	-
Unit	7.83	2.17	28	5	129	0.72	Sandy loam

After preparing the soil in terms of perpendicular plowing and leveling and smoothing. Phosphate P_2O_5 fertilizer was added before planting, 100 kg.ha^{-1}, while nitrogen fertilizer was added after planting (320 kg.ha^{-1}). One batch in the form of urea fe rtilizer (46% N) and in two batches, one batch after planting and the second batch before the flowering of the Sorghum crop **[12]**. A factorial experiment was designed according to a randomized complete block design (R.C.B.D.). With three replicates and two factors:

- The first factor

The herbicide 2.4-D 72% was sprayed in an amount of 1500 cm^{-1}.ha^{-1} on the soil before planting. It was mixed with the soil using a backpack pump with a capacity of 16 liters of water with constant pressure, then the seeds were planted in an amount of(160) kg.ha^{-1} . And on lines, the distance between one line and another was 50 cm and between one plant and another was 10 cm because it was agriculture for fodder production, with the comparison treatment (without the use of herbicide).

- Second factor

Six varieties of sorghum were grown: Bohouth, Giza, J, Rabeh, Warka , Inqaz.

The number of experimental units was 2 x 6 x 3 = 36 experimental units, and the area of the experimental unit was 4 x 4 m.

2.1. The Following Characteristics were Studied

2.1.1. Characteristics of Weeds Include
- Total number of weeds
- Dry weight of weeds (g)
- Control percentage %

2.1.2. Characteristics of Vegetative Growth Include
- Plant height (cm)
- The number of branches per plant

2.2. Statistical Analysis
The data were analyzed according to the program [13] and the means were compared according to the Duncan multinomial test at the 5% probability level [14].

3. Results and Discussion

3.1. The Effect of 2.4-D Pesticide on Weed Characteristics

3.1.1. Total Number of Broad Weeds
The results of Table (2) indicate that there are significant differences among the averages of the treatments as a result of the effect of the pesticide 2.4-D when used to combat the broadleaf weeds accompanying the sorghum crop before planting, as the number of weeds decreased by a large percentage compared to the comparison treatment that did not combat, as it gave the lowest average. The number of weeds reached 3.38 plants.m^2, and this indicates the high degree of the herbicide used and the method of spraying. As for the variety factor, the results of Table (2) showed that there were significant differences between the averages of the treatments, as the Warka variety outperformed the rest of the varieties, as it gave the lowest number of bushes in this variety, which amounted to 7.33. Plants.m^2. Perhaps the reason is due to the rapid growth of this variety, which shades the weed and reduces its number. As for the effect of the interaction between the two factors of the study, the results of Table (2) showed that there are significant differences between the averages. The Warka variety outperformed when using 2.4-D herbicide, and as we mentioned. Previously.

Table 2. Effect of 2.4-D herbicide on the number of total broad weeds associated with forage sorghum varieties and their interactions.

Varieties / Treatments	Bohouth	Giza	J	Rabeh	Warka	Inqaz	Herbicide effect
2.4-D	3.00 cd	6.00 c	4.33 cd	2.00 d	1.33 d	3.66 cd	3.38 b
Control	20.33 a	13.66 b	12.00 b	13.33 b	13.33 b	11.66 b	14.05 a
Varieties effect	11.66 a	9.83 ab	8.16 bc	7.66 bc	7.33 c	7.66 c	

3.1.2. Dry Weight of Weeds (g)
The results of Table (3) showed that there are significant differences between the means of the treatments in the effect of 2.4-D herbicide on the dry weight of the weeds accompanying the fodder sorghum crop, through reducing the dry weight of these weeds (broad-leaved) when using this herbicide by spraying on the soil before Pre-Planting and mixing it with the soil by inhibiting the germination process and the formation of shoots for this weed, as the lowest dry weight was recorded compared to the comparison treatment and amounted to 73.39 g.m^2. As for the effect of the varieties on this trait, the results of Table (3) showed that there were significant differences between the averages of the treatments, as the variety achieved (G) Minimum average dry weight, It reached 176.0 g.m^2 compared to the comparison treatment in which the dry weight reached 806.6 g.m^2. The reason for this may be attributed to the rapid germination of the seeds of this superior variety, and thus this leads to an increase in the competitive ability of the (J) variety, which makes it more shading of the weed and reduces growth, which is reflected in the reduction of dry weight. As for the effect of the

interaction of the study factors, the results of Table (3) showed that there were no significant differences among the averages of the coefficients.

Table 3. The effect of 2.4-D herbicide on the dry weight of broad weeds associated with forage sorghum varieties and their interactions.

Varieties/ Treatments	Bohouth	Giza	J	Rabeh	Warka	Inqaz	Herbicide effect
2.4-D	7o.3 d	89.6 d	72.6 d	55.0 d	85.0 d	67.6 d	73.39 b
Control	806.6 a	370.6 bc	279. 3 c	439.6 b	431.3 b	393.6 b	453.56 a
Varieties effect	438.5 a	230.1 b	176. 0 b	247.3 b	258.1b	230.6 b	

3.1.3. The Percentage of Weed Control (%)

The results of Table (4) showed that there are significant differences between the averages of the effect factors of the herbicide 2.4-D on the weed control rate, as the use of the mentioned herbicide gave the highest average in the broad-leaved weed control rate, which amounted to 73.55% compared to the comparison treatment, where this herbicide was used before planting, and perhaps The reason is due to the high effectiveness of 2.4-D herbicide, whether it is used after emergence and at the stage of 2-4 leaves or before planting by spraying on the soil .As for the effect of the varieties on the percentage of control, the results of Table (4) showed that there are significant differences between the averages of the varieties in the percentage of control, as the variety Rabeh outperformed the rest of the varieties in that trait and recorded the highest average in the percentage of control, reaching 41.66% compared to the rest of the varieties. The reason for this may be due to the speed of germination. This variety predates the bush, which provides a great competitive opportunity. The plants spread throughout the experimental field, which reduced the number of broad-leaved weeds, and this was reflected in the control rate well. As for the interaction between the study factors, the results of Table (4) show that there are significant differences between the averages of the treatments in this trait, as the Rabeh variety excelled when using 2.4-D herbicide before planting and gave the highest average in the control rate, reaching 83.33% compared to the comparison treatment that did not control, and this may be attributed to The reason for this is the response of this variety when controlling the soil with the herbicide and before planting, as well as demonstrating the ability of the plants of this variety to germinate faster than the weed seeds spread in the experimental field.

Table 4. Effect of 2.4-D herbicide on the weed control rate (%) of broad grains associated with forage sorghum varieties and their interactions.

Varieties / Treatments	Bohouth	Giza	J	Rabeh	Warka	Inqaz	Herbicide effect
2.4-D	79.66 a	67.00 bc	66.00 c	83.33 a	67.33 bc	78.00 ab	73.55 a
Control	0.00 d	0.00 d	0.00 d	0.00 d	0.00 d	0.00 d	0.00 b
Varieties effect	39.83 ab	33.50 ab	33.00 b	41.66 a	33.66 ab	39.00 ab	

3.2. The Effect of Using 2.4-D Herbicide on Vegetative Growth Characteristics

3.2.1. Plant Height (cm)

The results of Table (5) showed that there are significant differences between the averages of the 2.4-D herbicide effect treatments, as it achieved the highest average plant height of 145.33 cm compared to the weedy treatment (control), in which the average plant height reached 110.16 cm. This may be due to competitive ability. The high growth of broad-leaved bushes accompanying forage sorghum plants, as well as the speed of their germination before the crop, which enhances this ability and competes with the crop for growth requirements. As for the effect of varieties on plant height, the results of Table (5) show that there are significant differences Among the average coefficients of sorghum varieties, as this trait is considered a genetic trait, so the effect of combating weeds is to clearly show this characteristic of the variety, as the Inqaz variety achieved the highest average plant height, reaching 143.5 cm, compared to the rest of the varieties, especially the Giza variety, which

achieved the lowest average plant height. It reached 111.5 cm. As for the interaction between the study factors, the results of Table (5) showed that there are significant differences between the average coefficients for the study factors, as the Warka variety, when controlled in the field with 2.4-D herbicide before germination, achieved the highest average plant height, reaching 151.3 cm, which did not differ significantly from the Inqaz variety, as It achieved an average height of 149.6 cm. This is due, as we mentioned, to the manifestation of the genetic characteristic when controlling with this pesticide for those weeds that are characterized by large growth requirements compared to sorghum, which is different in its morphological shape and leaf area, which reduces this effect on growth, which is required for the purpose of agriculture.

Table 5. Effect of 2.4-D herbicide on plant height characteristics of forage sorghum varieties and their interactions.

Varieties / Treatments	Bohouth	Giza	J	Rabeh	Warka	Inqaz	Herbicide effect
2.4-D	145.0 ab	143.0 abc	136.3 abc	146.6 ab	151.3 a	149.6 a	145.33 a
Control	108.6 cd	80.0 d	114.0 bcd	108.3 cd	112.6 bcd	137.3 abc	110.16 b
Varieties effect	126.8 ab	111.5 b	125.1 ab	127.5 ab	132.0 ab	143.5 a	

3.2.2. Number of Branches. Plant^{-1}

The results of Table (6) showed the effect of controlling broad-leaved weeds with the herbicide 2.4-D before germination on the number of branches. Plant^{-1}, as the herbicide treatment above achieved the highest average number of branches per plant, reaching 2.84 branches, compared to the comparison treatment, which achieved the lowest average in This characteristic reached 1.38 branches. This is due to the intense competition of the weed for growth requirements, which hinders the branching of the plant, in which branching is important in increasing the quantity and quality of fodder for this crop. As for the effect of varieties, the results of Table (6) showed that there are significant differences between the average coefficients for this trait, as it was found that the varieties differ among themselves in the number of branches, and this makes this variety desirable for cultivation for fodder purposes. The Inqaz variety achieved the highest average number of branches per plant, which amounted to 2.31 branches. Compared to the rest of the varieties, especially the Giza variety, which was distinguished by the lowest average number of branches, which was 1.93 branches. As for the interaction between the study factors, the results of Table (6) showed that controlling the broad-leaved bush with 2.4-D herbicide before germination gives the corn plant a greater ability to show the variety's character in a significant way, as the variety achieved the Inqaz of plants with that herbicide and before germination had the highest average in the number of branches character. For each plant, it reached 3.13 branches. Plant^{-1}. This is because the control before germination of those weeds has intense competition, thus giving the plant an opportunity to fully benefit from the growth requirements and show the variety characteristic that distinguishes the Inqaz variety.

Table 6. Effect of 2.4-D herbicide on the number of branches.plant^{-1} for forage sorghum varieties and their interactions.

Varieties / Treatments	Bohouth	Giza	J	Rabeh	Warka	Inqaz	Herbicide effect
2.4-D	2.73 ab	2.60 b	2.90 ab	2.93 ab	2.76 ab	3.13 a	2.84 a
Control	1.20 c	1.26 c	1.43 c	1.36 c	1.53 c	1.50 c	1.38 b
Varieties effect	1.96 ab	1.93 b	2.16 ab	2.15 ab	2.15 ab	2.31 a	

Conclusions

Based on these results, we can conclude the following:

The use of 2.4-D herbicide before planting has led to a significant and early reduction in the number of weeds, that is, before germination, which gives the forage sorghum plant sufficient opportunity to benefit from growth requirements such as water, nutrients, and light necessary for photosynthesis

processes, and thus this has had a positive impact on the characteristics of weeds come first in reducing competition and vegetative growth characteristics such as plant height and the number of branches per plant, with the recommended concentrations of 2.4-D herbicide72% for broad-leaved weeds.

Recommendations

The following may be recommended:

Use 2.4-D herbicide before planting in the sorghum crop at the recommended concentrations. The herbicide must also be covered after spraying in order to avoid exposure to photodegradation and to take into account environmental conditions such as temperatures and winds.

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