Effect of some herbicides and white goosefoot extract on weeds accompanying three varieties of soybean

Farouq Salim Jasem 1 Watheq Falhi Hammood ²

1Department of Field Crops, College of Agricultural Engineering Sciences, University of Baghdad, Iraq.

2Department of Field Crops, College of Agricultural Engineering Sciences, University of Baghdad, Iraq

farouq.jabr2306m@coagri.uobaghdad.edu.iq wathiq.filhye@coagri.uobaghdad.edu.iq

Abstract

A field experiment was conducted during the summer of 2024 at Experimental Station A, located in the College of Agricultural Engineering Sciences at the University of Baghdad / Al-Jadriya. The station is situated at a longitude of 44 east and a latitude of 33 north. The objective of the experiment was to assess the competitiveness of different soybean varieties against accompanying weeds. Additionally, the study aimed to assess the effectiveness of the pre-emergence herbicide Trifluralin in combination with post-emergence herbicides and aqueous white goosefoot leaf extract to reduce weed damage. The experiment was conducted using a randomized complete block design (RCBD) with a split-plot arrangement, consisting of three replicates. The main plots involved the three soybean varieties (Shaimaa, Lee74, Giza22), while the sub-plots included five weed control treatments as follows: 1- Trifluralin 48% EC treatment at a rate of 2.4 L ha-1. 2- Trifluralin 48% EC treatment at a rate of 2.4 L ha-1 + a combination of Bentazon 480 S/L at a rate of 4 L ha-1 + Clethodim 24% EC at a rate of 0.5 L ha-1. 3- Trifluralin 48% EC treatment at a rate of 2.4 L ha-1 + aqueous extract of the white goosefoot plant at a rate of 18 L ha-1. 4- Treatment of Trifluralin 48% EC at a rate of 2.4 L ha-1 + weeding 30-45 days after planting. 5- Weedy treatment. The results indicated that the variety Shaimaa was superior compared to other varieties, achieving the lowest average weed dry weight of 99.68 g m-2. Additionally, the variety Shaimaa demonstrated the largest average leaf area, with values of 52.59 dm² . Furthermore, it produced the greatest average number of pods per plant and seeds per pod, reaching 196.80 pods plant-1 and 2.456 seeds pod-1, respectively. Finally, the variety Shaimaa achieved the highest seed yield, totaling 3.151 t ha-1. The Treatment T4, applying Trifluralin 48% Ec at a rate of 2.4 liters ha-1, plus weeding after 30 and 45 days after planting was superior, achieving the lowest weed dry weight, reaching 30.08 g m-2; the highest average leaf area reaching 63.56 dm² ; the highest main number of pods per plant and number of seeds per pod, reaching 226.00 pods plant-1 and 2.66 seeds pod-1 respectively; and the highest seed yield reaching 3.901 t ha-1. The interaction effect was significant for most of the traits studied. Specifically, the combination of the variety Shaimaa with the treatment T4 resulted in the greatest number of pods per plant, reaching 191.33 g plant-1 and 233.00 pods plant-1, respectively. These results confirm that the integration of different varieties, the application of herbicides, and the use of the extract all contributed to enhancing various growth traits, increasing yield, and effectively controlling accompanying weeds.

Keywords: Soybean, Trifluralin, Manual weeding, Clethodim, Bentazon, White goosefoot

*** Part of the master's thesis for 1st author.**

ISSN 2072-3857

Introduction

Soybean cultivation in Iraq faces numerous challenges that impact its productivity. These challenges include environmental factors such as humidity, temperature, and light, along with agricultural practices, seed vitality, seedbed preparation, moisture content, and planting depth. The observed differences in productivity and yield loss percentages among some soybean varieties may be attributed to morphological variations between them, as influenced by the presence or absence of weeds. One approach to achieving desired outcomes could be to leverage the genetic characteristics of soybean varieties in relation to weed competition. By understanding how different varieties perform under weed competition and control, we can gain insights into their behaviors and responses. This knowledge may help us uncover the genetic potential of the varieties by synchronizing the growth of their various organs with the weed development and the impact of weed competition. Ultimately, this can influence traits related to vegetative growth, yield, and yield components. Weeds dramatically limit soybean plant growth, causing losses as high as 82%. They compete with crops for essential resources such as nutrients, water, light, and space. Additionally, certain weeds release chemicals that inhibit crop growth, leading to a decline in crop yield and quality [29]. The decline in crop productivity is primarily due to the failure to implement scientific methods and modern agricultural practices that enhance crop growth and development while also controlling the negative impact of accompanying weeds. As a result, various treatments have been adopted to manage the weed population, including the application of pre-emergence and post-emergence herbicides. Many researchers have found that using pre- and post-emergence herbicides significantly impacts weeds by reducing their numbers and dry weight, which in turn, improves crop traits, including yield and its components. The application of selective herbicides in soybean fields has been effective against annual weeds and has resulted in higher soybean yields. Examples of effective herbicides include Bentazon [12, 23, 31]. Manual weeding is highly effective for eliminating weeds and increasing soybean yields [1, 18, 20, 21, 24]. Additionally, herbicides are often used in line with manual weeding to expand the range of weed control and reduce the required herbicide dose [16, 27, 32]. Numerous studies have been conducted worldwide on incorporating allelopathy into weed control programs, yielding significant reductions in weed density and dry weights [3, 6 , 26] . These findings have been positively reflected in increased crop yields. However, the use of allelopathy in weed control cannot achieve the high efficiency of herbicides, especially in selectively controlling weed plants. Additional efforts are necessary to enhance the effectiveness of controlling weeds and improving crop production. To attain this, several elements of integrated weed management were implemented, including selecting crop varieties with a greater ability to compete with weeds, applying herbicides both pre- and post-emergence, utilizing plant extracts, and performing manual weeding. These combined strategies aim to reduce or eliminate weed growth, ultimately enhancing crop yields. Consequently, this study aimed to investigate the following:

-1Determine the competitiveness of three soybean varieties to accompanying weeds.

-2Evaluating the effectiveness of Trifluralin herbicide used pre-emergence, along with post-emergence herbicides, aqueous extracts of white goosefoot, and manual weeding to mitigate damage caused by weeds, thereby contributing to sustainable development goals.

-3The potential for utilizing the cultivar's competitiveness with white goosefoot leaf extract, some chemical herbicides, and manual weeding to control weeds accompanying this crop, thus achieving the highest yield and best quality.

-4The role of varieties, herbicides, plant extracts, and manual weeding in the integrated control accompanying the crop, soybean.

Materials and methods

A field experiment was conducted during the summer season of 2024 in the College of Agricultural Engineering Sciences, University of Baghdad/Al-Jadriya, specifically at Station A, located at a longitude of 44° east and a latitude of 33° north. The study aimed to evaluate the competitiveness of various soybean varieties against accompanying weeds, as well as to assess the effectiveness of the pre-emergence herbicide Trifluralin in combination with post-emergence herbicides and the aqueous extract of white goosefoot in order to minimize the damage caused by weeds. The experiment was applied according to the Randomized Complete Block Design (RCBD) with a split-plot arrangement, involving three replicates to constitute 45 experimental units in total. The three soybean varieties (Shaima, Lee74, and Giza 22) occupied, while the subplots included five weed control treatments as follows:

T1- Treatment with Trifluralin 48% Ec at a rate of 2.4 L.ha-1 (recommendation.(

T2- Treatment with Trifluralin 48% Ec at a rate of 2.4 L.ha-1 + a combination of Bentazon 480 S/L at a rate of 4 L.ha-1 + Clethodim 24% Ec at a rate of 0.5 L.ha-1.

T3- Treatment with Trifluralin 48% Ec at a rate of 2.4 L.ha-1 + aqueous extract of the white goosefoot plant at a rate of 18 Lha-1.

T4- Treatment with Trifluralin 48% Ec at a rate of 2.4 lL.ha-1 + weeding 30 and 45 days after planting.

T5- Weedy Treatment: Weeds are allowed to grow and compete with different soybean varieties throughout the growing season.

Soil service practices were conducted before planting, which included plowing, pulverizing the soil, and leveling the ground. The experimental area was divided into plots, each with an experimental unit of 7.5 m² (2.5 m in length and 3 m in width). Each plot contained four furrows, spaced 75 cm apart. Seeds were planted in pits that were 20 cm apart, resulting in a planting density of 66,666 plants ha-1 [8] . Pre-plant irrigation was conducted, and the experimental land was allowed to dry for three days. The seeds of the soybean varieties were then planted on June 27, 2024, at a depth of 2-3 cm, placing 2-3 seeds per pit. Two weeks after planting, the seedlings were thinned manually to one plant per pit. Soil was fertilized with nitrogen fertilizer in the form of urea (46% nitrogen) at a rate of 160 kg N ha^{-1} in two equal batches, the first at planting and the second at the inflorescence stage. Triple superphosphate fertilizer (46% P_2O_5) was added at a rate of 80 kg P_2O_5 ha^{-1} in one batch before planting [4]. The field was irrigated whenever necessary. Soybean plants were harvested once the leaves had yellowed and fallen, the pods had turned brown, and the seed moisture content had reached 14% for each variety [5]. Herbicides and extracts were applied using a 16-liter backpack sprayer, which was pre-calibrated to ensure complete coverage of the field based on the treatments used.

Samples of white goosefoot plant leaves were collected from the fields of the College of Agricultural Engineering Sciences at the University of Baghdad in Al-Jadriya. Next, the leaves were air-dried. After drying, the samples were ground into a fine powder. Then, the powder was collected in plastic bags and sent to the laboratories of the Ministry of Science and Technology for the extraction of active ingredients, which will be processed into a liquid form suitable for spraying.

Water extraction of the white goosefoot plant leaves

The extraction process involved mixing 20 grams of plant powder with 40 milliliters of chloroform, continuously stirring for 24 hours at room temperature. After this period, the mixture was subjected to ultrasonic treatment for 15 minutes. Following this, 100 milliliters of butanol were added, and the mixture was transferred to a separating funnel. The polar organic layer containing butanol was collected and placed in a rotary evaporator to obtain a dry extract. This extraction procedure was repeated three times to acquire an amount sufficient for analysis.

Analysis Conditions

The assay was conducted at the laboratories of the Ministry of Science and Technology, Department of Environment and Water. The procedure involved determining the total amount of phenolic compounds in the ethanolic extract using the standard Folin–Ciocalteu reagent. The reaction mixture consisted of 100 µL of the extract, 500 µL of Folin–Ciocalteu reagent (Merck, Germany), and 1.5 mL of 20% sodium carbonate. The sample was then vortexed and diluted with distilled water to a final volume of 100 mL. After allowing the mixture to react for 2 hours, the absorbance was measured at 765 nm and used to estimate the phenolic content based on a calibration curve prepared with gallic acid (Sigma-100 .(

Table1.Analysis of phenolic substances from goosefoot extract.

No	Name	Con (mg / g)
1	Caffeic acid	24.76
2	Syringic acid	17.28
3	P- Coumaric acid	19.56
4	Ferulic acid	17.64
5	Gallic acid	10.39
6	Protocatechuic acid	23.30
7	Vanillic acid	18.54

Studied traits

-1Weed dry weight (g m-2): The weeds were cut at harvest time at soil level, placed in perforated paper bags, and left to dry naturally until their weights stabilized. Then, the dry weight of the weeds was calculated.

-2Inhibition percentage (%): Calculated according to the following equation [3] Inhibition percentage (%) = 100 - A\B × 100 Where:

A = dry weight of weeds in control treatments

B = dry weight of weeds in the weedy treatment

-3Plant leaf area cm²: The leaf area was measured at the pod formation stage according to the equation of [33] and then converted to dm².

)W.L) (723.0) + 624.LA = 0

LA= 0.624 + (723. 0) (W.L(

Where LA = leaf area (cm² (

L = leaf length (cm(

W = maximum width of the leaf (cm.(

-4Number of pods per plant (pod plant-1 :(

The average number of pods was calculated in the five plants randomly chosen from each experimental unit.

ISSN 2072-3857

-5Number of seeds per pod (seeds pod-1): The average number of seeds per pod was calculated for 20 pods chosen randomly from each experimental unit.

-100-6seed weight (g): 100 seeds representing the harvested sample were taken from the experimental unit, and their weight was measured using a sensitive electronic scale.

-7Total seed yield (t ha¹): The seed yield was estimated from the plants harvested from the two middle lines, plus the yield of the five plants. The average yield was calculated and converted into tons per hectare.

Statistical analysis

Data for the traits under study were collected and tabulated, and then statistically analyzed following the randomized complete block design (RCBD) using the software GENSTAT. The arithmetic means of the treatments were compared based on the least significant difference (LSD) at the probability level 0.05 [30. [

Results and discussion:

During the growing season, a total of nine weed species were identified, seven of which were broad-leaved. The most prevalent among these weeds were nut grass, purslane, and purple pain-grass, while only small numbers of black nightshade and datura were observed. In terms of narrow-leaved weeds, only two species were present, as indicated in the table below.

Table 2. Weed species grown in the experimental land during the summer season of 2024

English name	Scientific name	Family name	Type	Life cycle
Purplepain- Grass	*Echinochloa colonum* L.	poeceae	Narrow- leaf	Annual
Purslane	*Portulaca oleracea* L.	Portulaca ceae	Broad- leaf	Annual
Rough pigweed	*Amaranthus retroflexus* L.	Amaranthaceae	Broad - leaf	Annual
Black nightshade	*Salanum nigrum* L.	solanaceeae	Broad – leaf	Annual
Nut grass	*Cyperus rotundus* L.	cyperaceae	Narrow – leaf	perennial
European heliotrope	*Heliotrpium europaeum* L.	Boragin aceae	Broad – leaf	Annual
Jimson Weed	*Datura stvamonium* L.	Solanaceae	Broad – leaf	Annual
Jute mallow	*Corchorus olitorus* L.	Malvaceae	Broad –leaf	Annual
Cheese weed	*Malva parviflora* L.	Malvaceae	Broad – leaf	Annual

Effect of varieties and control treatments on some weed traits:

Dry weed weight (g m-2(

The results presented in Table 3 show significant differences between the varieties, control treatments, and their interactions regarding the dry weight of weeds. The variety Shaimaa had the lowest average dry weight at 99.68 g m², while the varieties Lee74 and Giza 22 recorded average dry weights of 104.45 g m-2 and 107.63 g m-2, respectively. These variations may be attributed to differences in the density and species of weeds observed in the field, as well as to the different capabilities of the varieties to compete with the accompanying weeds, which ultimately affects weed dry weights. The results demonstrated that there was a significant effect of the weed control treatments on the dry weed weight. Treatment T4, which involved pre-emergence

ISSN 2072-3857

spraying of the herbicide Trifluralin at a rate of 2.4 L ha-1, combined with weeding 30 and 45 days after planting, resulted in the lowest dry weight of weeds, at 30.08 g m-2. This superior treatment was followed by treatment T2, which was spraying Trifluralin at a rate of 2.4 L ha-1 + a combination of the herbicides Bentazon at a rate of 4 liters ha-1 + Clethodim at a rate of 0.5 liters ha-1, where the dry weight of weeds reached 52.07 g m-2, compared to the weedy treatment, at which the dry weed weight was 292.23 g m-2. The decrease in weed dry observed in the manual weeding treatments, in combination with herbicide application or the use of three types of herbicides together, can be attributed to their effects on photosynthesis and energy production. Additionally, the extract containing phenolic acids contributes to inhibiting weed growth by damaging leaves and roots. This combination of various control methods demonstrates their integrated impact in the reduction of weed dry weight in the experimental area [13. [

The interaction effect between control treatments and varieties was significant, as the varieties Lee74 and Shaimaa with the treatment T4 recorded the lowest weed dry weight, reaching 28.76 and 29.00 g m-2, respectively. In contrast, the variety Lee74 with the weedy treatment recorded the highest dry weight of weeds, reaching 316.99 g m-2. This result explains the role of integration between varieties and control treatments in reducing the dry weight of weeds accompanying the crop, thus showing the varieties have a different response to the control treatments used compared to the weedy treatment.

Inhibition percentage of weed dry weight(%)

Results in Table 3 reveal a significant effect of varieties, control treatments, and their interaction on the inhibition percentage of the dry weight of weeds. The variety Lee74 achieved the highest inhibition percentage of 67.03%, followed by the two varieties Shaimaa and Giza 22 with inhibition percentages of 64.72% and 61.15%, respectively. This result is consistent with those obtained by [11] , suggesting that the mechanism of competition for weeds may be due to the variety's ability to obtain nutrients and water.

Table 3. Effect of varieties, weed control treatments, and their interactions on weed dry weight (g m-2), inhibition percentage, leaf area.

Traits / Treatments		Weed dry weight g m^{-2}	Inhibition %	Leaf area(dm^2)
Shaima		99.68	64.72	52.59
Lee74		104.45	67.03	47.62
Giza 22		107.63	61.15	47.56
L.S.D 0.05		7.582	2.433	1.042
T1		72.75	74.88	45.32
T2		52.07	82.06	57.31
T3		72.49	74.93	49.21
T4		30.08	89.63	63.56
T5		292.23	0.00	30.89
L.S.D 0.05		4.484	1.186	1.839
Shaima	T1	65.29	76.89	48.84
	T2	48.86	82.70	59.34

ISSN 2072-3857

	T3	72.66	74.28	53.92
	T4	29.00	89.74	66.03
	T5	282.61	0.00	34.84
Lee74	T1	65.84	79.20	47.58
	T2	49.52	84.35	57.81
	T3	61.16	80.69	44.72
	T4	28.76	90.90	57.61
	T5	316.99	0.00	30.39
Giza 22	T1	87.11	68.55	39.55
	T2	57.84	79.14	54.78
	T3	83.66	69.83	49.00
	T4	32.47	88.25	67.04
	T5	277.08	0.00	27.43
L.S.D 0.05		9.094	2.679	2.936

T1: Herbicide Trifluralin 480 g at a rate of 2.4 L ha-1.
T2: Herbicide Trifluralin 480 g at a rate of 2.4 L ha-1+ Herbicide Bentazon 480 SL at a rate of 4L ha-1 + Herbicide Clethodim 24% EC at a rate of 0.5 L ha-1.
T3: Herbicide Trifluralin 480 g at a rate of 2.4L ha-1+ white goosefoot leaf extract at rate 18 L ha-1.
T4: Herbicide Trifluralin 480 g at a rate of 2.4L ha-1+ Manual weeding 30 and 45 days after planting.
T5: Weedy Treatment, allowing weeds to grow and compete with different soybean varieties throughout the growing season.

Regarding the effect of control treatments on the inhibition percentage, treatment T4 showed the highest inhibition percentage of the dry weight of the weeds, reaching 89.63%. In contrast, treatment T2 recorded a lower inhibition percentage, of 82.06%. This result is consistent with [2], who reported that the use of herbicides led to a reduction in the dry weight of the weeds by high percentages. The effectiveness of herbicides in controlling weeds is largely due to their ability to reduce weed populations. For instance, the herbicide Trifluralin affects the germination of weed seeds and disrupts the physiological processes of growth. When absorbed by the plumule of weed seedlings, it is transported to the active meristematic areas, causing swelling and tearing of plant tissues. On the other hand, Bentazon inhibits weed growth by disrupting photosynthesis. It acts by disabling the photosystem II in chloroplasts, which prevents the formation of ATP and NADPH—two essential molecules for energy production. This disruption results in a deficiency of food and energy necessary for plant growth, ultimately causing the cessation of weed growth and their demise [15]. The herbicide Clethodim inhibits weed growth by blocking the enzyme ACCase, which is responsible for producing the energy required for weed development. This action leads to the inhibition of growth and ultimately results in the death of weed plants. Additionally, white goosefoot leaf extract, which contains phenolic acids, contributes to weed control by damaging the leaves and roots of the plants, further inhibiting their growth [13]. Furthermore, the practice of manual weeding after applying herbicides plays a significant role in decreasing the number of weeds.

The interaction between control treatments and varieties significantly affected the percentage of weed dry weight inhibition. All varieties, when interacted with treatment T4, recorded the highest inhibition percentage of

ISSN 2072-3857

the weed dry weight, reaching 90.90%, 89.74%, and 88.25%, respectively. These highly affected interactions were followed by treatment T2, interacting with the varieties Lee74 and Shaimaa, resulting in inhibition percentages of 84.35% and 82.70%, respectively. In comparison, treatment T1 with the variety Giza 22 had the lowest inhibition percentage of the weed's dry weight, recording 68.55%.

Effect of varieties, control treatments and their interaction on Leaf area (dm²:(

Data in Table 3 illustrate that the varieties, weed control treatments, and their interaction significantly affected the leaf area. The variety Shaimaa produced the highest leaf area, averaging 52.59 dm², while the varieties Lee74 and Giza 22 achieved leaf areas of 47.62 and 47.56 dm² on average, respectively. The reason for the difference in leaf area among varieties is due to genetic variation in their genetic and physiological traits, as well as in their ability to compete with weeds, which is represented by the height of their plants and their dry weights .

Concerning the impact of weed control treatments on crop leaf area, treatment T4 achieved the highest average leaf area of 63.56 dm², followed by the treatment T2, which had an average leaf area of 57.31 dm². In comparison, the weedy treatment recorded the lowest average leaf area of 30.89 dm². The superiority of the T4 and T2 treatments for this trait can be attributed to the lack of competition from weeds for the essential growth resources needed by the economic crop plant. This competition has a significant impact on the increase in leaf area, particularly during the early stages of growth. As a result, the overall growth of the plant is enhanced, resulting in larger leaves and increased photosynthesis volume. Furthermore, the role of herbicides in reducing weed density is noteworthy. The herbicide Trifluralin affects the germination of weed seeds and disrupts the physiological growth processes after being absorbed by the plumule of weed seedlings. It is then translocated to the active meristematic zones, causing swelling and tearing of plant tissues. Bentazon, on the other hand, inhibits weed growth by disrupting photosynthesis in the chloroplasts, specifically targeting Photosystem II. This disruption prevents the formation of NADPH and ATP, two crucial molecules needed for energy production. As a result, the production of food and energy essential for plant growth is compromised, leading to stunted weed growth and eventually their death [15]. The herbicide Clethodim inhibits weed growth by blocking the enzyme ACCase, which is responsible for producing the energy required for weed growth, resulting in growth inhibition and the death of weed plants. There is also the role of white goosefoot leaf extract, which contains phenolic acids, in inhibiting weed growth by damaging the leaves and roots of the weed and thereby inhibiting its growth [13]. There is also the role of manual weeding after applying herbicides in reducing the number of weeds.

The effect of the interaction between control treatments and varieties on leaf area was significant, as the two varieties, Giza 22 and Shaimaa, which interacted with treatment T4, produced the highest average leaf areas of 67.04 and 66.03 dm², respectively. In contrast, the variety Giza 22, which interacted with the weedy treatment, recorded the lowest average of 27.43 dm². It is evident that the varieties responded to the different weed control treatments, which was reflected in an increase in their leaf area compared to the weedy treatment, in which the varieties recorded the lowest leaf area.

Effect of varieties, weed control treatments, and their interactions on yield and its components:

Number of pods per plant (pod plant-1:(

Table 4 shows that there is a significant effect of the varieties, weed control treatments, and their interaction on the number of pods per plant. The variety Shaimaa yielded the highest number of pods per plant, averaging 196.80 pods plant-¹, followed by the variety Giza 22, which produced 189.67 pods plant-¹. In contrast, the variety Lee74 produced the lowest average of 180.93 pods plant-1. This result is consistent with that of [9, 10, 28] regarding the variation in the number of pods per plant among soybean varieties.

The weed control treatments had a significant effect on the number of pods per plant. The treatment T4 yielded the highest number of pods per plant, averaging 226.00 pods plant-1, followed by treatment T2, which had 206.22 pods plant-1. In comparison, the weedy treatment T5 recorded the lowest average number of pods per plant, producing 162.56 pods plant-1. The reason for the superiority of treatments T4 and T2 is due to the absence of competition from weeds to the crop plants for the various growth requirements such as light and nutrients, which leads to an increase in the photosynthesis process and consequently provides the emerging flowers and developing pods with their requirements of manufactured food to increase the percentage of fertility and fruit set in them. These results are consistent with those reported by [17], which indicate that the highest rate of pod number in soybean plants occurs when weeds are controlled and their competitiveness for crop growth is reduced. It may also be attributed to the effective role of the herbicides. The herbicide Trifluralin impacts the germination of weed seeds and the physiological growth processes after the plumule of weed seedlings absorbs it and transports it to the active meristematic zones, resulting in swelling and tearing of plant tissues. The herbicide Bentazon inhibits weed growth by disrupting the photosynthesis process through its effect on the Photosystem II system in chloroplasts, thereby preventing the formation of ATP and NADPH, the two molecules necessary for energy production. This effect results in a deficiency in the production of food and energy necessary for plant growth, leading to the cessation of weed growth and its eventual death [15]. The herbicide Clethodim inhibits weed growth by targeting the enzyme ACCase, which is essential for producing the energy needed for that growth. This ultimately leads to the inhibition of growth and the death of weed plants. Additionally, the extract from white goosefoot leaves, which contains phenolic acids, also plays a role in suppressing weed growth by damaging their leaves and roots, thereby hindering their overall development [13]. Furthermore, manual weeding after applying herbicides can effectively reduce weed density and their dry weights.

The interaction between weed control treatments and plant varieties had a significant influence on the number of pods produced per plant. The combination of the two varieties, Shaimaa and Giza 22, with treatment T4 resulted in the highest average number of pods, with Shaimaa averaging 233.00 pods plant-1 and Giza 22 averaging 229.00 pods plant-1. Following this, Giza 22 combined with treatment T2 yielded an average of 212.00 pods plant-1. In contrast, the Giza 22 variety subjected to the weedy treatment T5 recorded the lowest average, with only 155.00 pods per plant. Overall, the varieties demonstrated a positive response to the different weed control treatments, leading to an increase in the number of pods per plant compared to those grown under weedy conditions.

Number of seeds per pod :

The results in Table 4 demonstrate a significant effect of the weed control treatments and the interaction between the varieties and the control treatments on the number of seeds per pod. The variety Shaimaa was superior in this trait, producing the highest number of seeds per pod, averaging 2.4560 seeds pod-1, followed by the variety Giza 22, which produced an average of 2.4220 seeds pod-1, while the variety Lee 74 had the

ISSN 2072-3857

lowest average of 2.3913 seeds pod-1. The differences observed among varieties in this trait can be attributed to variations in their growth patterns, branching characteristics, and the number of pods produced per plant. This finding aligns with the results obtained by [7,28] , who indicated that the differences in this trait come from the genetic variation between them.

The weed control treatments affected the number of seeds per pod; treatment T4 yielded the highest average number of seeds (2.66 seeds pod-1), followed by treatment T2, which had an average of 2.58 seeds pod -1, compared to the weedy treatment T5, which had an average of 2.19 seeds pod-1. The superiority of treatment T4 can be attributed to the favorable growing conditions experienced by the soybean plants, as they were free from weed competition for essential resources, allowing the plants to develop a larger leaf area with greater efficiency, resulting in the production of sufficient dry matter for larger fruit units [9] . Additionally, this treatment reduced weed density and their dry weights, which led to an increased percentage of weed control and a higher inhibition rate of weed dry weight, due to the efficient action of the used herbicides. The herbicide Trifluralin impacts the germination of weed seeds and disrupts the physiological growth processes after being absorbed by the plumule of weed seedlings. It then moves to the active meristematic zones, causing swelling and damage to plant tissues .

On the other hand, the herbicide Bentazon inhibits weed growth by disrupting the photosynthesis process. It targets the Photosystem II system in chloroplasts, preventing the formation of ATP and NADPH, which are essential molecules for energy production. This disruption results in a lack of food and energy necessary for plant growth, ultimately leading to the cessation of weed growth and death [15] . The herbicide Clethodim inhibits weed growth by blocking the enzyme ACCase, which is essential for producing the energy necessary for plant growth. This results in the inhibition and eventual death of weed plants. The extract of white goosefoot leaves, which contains phenolic acids, also suppresses weed growth by damaging the leaves and roots, thereby stunting their development [13]. Additionally, the manual weeding process implemented after herbicide application helps reduce weed density and dry weights, which in turn improves the number of seeds per pod. This finding aligns with [25], who reported that effective weed control in soybean crops results in an increased number of seeds per pod.

The effect of the interaction between weed control treatments and varieties on the number of seeds per pod was not significant.

-100seed weight (g: (

The results in Table 4 indicate a significant effect of the varieties, weed control treatments, and the interaction between varieties and control treatments on the weight of 100 seeds. The variety Shaimaa exhibited the highest weight of 100 seeds, averaging 14.493 g, followed by the variety Giza 22, which yielded an average of 100 seeds weighing 14.370 g. In contrast, the variety Lee 74 yielded the lowest 100-seed weight, averaging 13.798 g. The reason for this is that the variety Shaimaa differs genetically and physiologically from the variety Lee 74. [7] also explained that soybean varieties vary in yield components, including 100-seed weight (g), as well as in their ability to compete with weeds and reduce their dry weights (Table 3.(

The weed control treatments had a significant influence on the weight of 100 seeds. The treatment T4 resulted in the highest 100-seed weight average of 16.100 g, followed by treatment T2, with a 100-seed weight of 14.974 g. In contrast, the weedy treatment (T5) yielded the lowest 100-seed weight average (12.272 g). The increase in seed weight observed across various weed control treatments is attributed to the reduced competition between weed plants and crop plants for essential resources such as nutrients, water, and light. This lack of competition positively affects the leaf area of the crop plants, enhancing their photosynthesis efficiency. As a result, there is a greater production of dry matter, which is transported from the source (the leaves) to the sink (the seeds). Consequently, this leads to the accumulation of materials in the seeds, ultimately increasing seed weight. The herbicide Trifluralin affects weed plants by interfering with their seed germination and disrupting their growth processes. After being absorbed by the plumules of weed seedlings, it is translocated to the active meristematic zones, causing swelling and damage to the plant tissues. The herbicide Bentazon inhibits weed growth by disrupting the photosynthesis process. Specifically, it targets photosystem II in chloroplasts, preventing the formation of ATP and NADPH- the two molecules essential for energy production. This disruption leads to a deficiency in the production of food and energy vital for plant growth, ultimately resulting in the cessation of weed growth and the death of the plant [15]. The herbicide Clethodim prevents weed growth by inhibiting the enzyme ACCase, which is responsible for producing the energy needed for weed growth, leading to inhibition of growth and death of weed plants. There is also the white goosefoot leaf extract, containing phenolic acids, which plays a role in inhibiting weed growth by damaging the leaves and roots and inhibiting their growth [13] , in addition to the manual weeding after applying the herbicides, and the role it plays in reducing the density of weeds and their dry weights. The interaction between weed control treatments and varieties significantly affected the 100-seed weight. The interaction between the varieties Shaimaa and Giza 22 with the treatment T4 yielded the highest 100-seed weight, averaging 16.637 and 16.427 g, respectively. In contrast, the variety Lee74 with the treatment T5 had the lowest average of 12.073 g. The reason for the superiority of the two varieties, Shaimaa and Giza 22, with the treatment T4, may be due to the absence or lack of competition between weeds and crop plants, which positively affects the seeds, increasing the 100-seed weight. The performance of the varieties showed a response to the weed control treatments used, which explains the integration between the varieties and the treatments in improving seed weight compared to the behavior of these varieties in the presence of weeds.

Seed yield (t ha-1 : (

The results in Table 4 illustrate that the varieties, control treatments, and their interaction significantly affected the seed yield (t ha-1). The variety Shaimaa produced the highest average seed yield of 3.151 t ha-1, followed by the variety Giza 22, which produced an average seed yield of 3.062 t ha-1. In comparison, the variety Lee 74 recorded the lowest seed yield, averaging 3.062 t.ha-1. The superiority of the varieties Shaimaa and Giza 22 in this trait is attributed to their superiority in traits of the number of pods, the number of seeds per pod, and the 100-seed weight. These results are consistent with [14] findings, which suggest that the yield difference is attributed to variations in yield components between varieties.

Regarding the weed control treatments and their impact on seed yield, treatment T4 achieved the highest average yield of 3.901 tons per hectare (t ha-1). This effect was followed by treatment T2, which yielded an average of 3.198 t ha-1. In contrast, the weedy treatment, T5, recorded the lowest average yield of 2.566 t ha-1. The superior performance of treatments T4 and T2 can be attributed to the lower weed dry weight (Table 3), which reduced competition between weeds and crop plants. This lack of competition led to an increase in yield components, including seed yield. Conversely, the lower yield observed in the weedy treatment (T5) was due to the negative effect of this treatment on all yield components, which was reflected negatively in the seed yield. The herbicide Trifluralin affects the germination of weed seeds and disrupts the physiological growth processes once the plumules of weed seedlings absorb it. It moves to the active meristematic zones, causing swelling and tearing of plant tissues. Bentazon herbicide inhibits weed growth by disrupting photosystem II, which is essential for energy production. This disruption leads to a deficiency in the food and energy required for plant growth, ultimately resulting in the cessation of weed growth and the death of the plants [15]. The herbicide Clethodim targets the enzyme ACCase, which is crucial for energy production in weeds. By interfering with this enzyme, Clethodim inhibits weed growth and leads to the plants' death. Additionally, white goosefoot leaf extract, which contains phenolic acids, helps inhibit weed growth by damaging the leaves and roots, thereby hindering their growth [13]. Manual weeding following the application of herbicides helps to reduce both weed density and dry weed weight. The interaction effect between weed control treatments and the varieties on seed yield was insignificant.

Table 4. Effect of varieties, weed control treatments, and their interaction on the

No. of pods plant-1, No. of seeds pod-1, 100 seed weight (g), and seed yield (t ha-1.(

Traits / Treatments		Number of (pod plant $^{-1}$)	number of seeds pod $^{-1}$	weight of 100 seeds (g)	seed yield (t ha $^{-1}$)
Shaima		196.80	2.45	14.493	3.151
Lee74		180.93	2.39	13.798	3.062
Giza 22		189.67	2.42	14.370	3.119
L.S.D 0.05		8.974	0.032	0.5970	0.0473
T1		174.22	2.37	13.650	2.943
T2		206.22	2.58	14.974	3.198
T3		176.67	2.29	14.104	2.946
T4		226.00	2.66	16.100	3.901
T5		162.56	2.19	12.272	2.566
L.S.D 0.05		4.532	0.039	0.2846	0.0803
Shaima	T1	182.00	2.44	14.073	3.003
	T2	208.33	2.62	15.073	3.205
	T3	186.67	2.33	14.333	3.046
	T4	233.00	2.70	16.637	3.907
	T5	174.00	2.17	12.347	2.592
Lee74	T1	166.33	2.33	13.337	2.852
	T2	198.33	2.52	14.630	3.183
	T3	165.33	2.25	13.713	2.851
	T4	216.00	2.63	15.237	3.880
	T5	158.67	2.21	12.073	2.544
Giza 22	T1	174.33	2.36	13.540	2.973
	T2	212.00	2.60	15.220	3.205
	T3	178.00	2.29	14.267	2.942
	T4	229.00	2.66	16.427	3.916
	T5	155.00	2.19	12.397	2.561
L.S.D 0.05		10.017	N.S	0.6519	N.S

ISSN 2072-3857

T1: Herbicide Trifluralin 480 g at a rate of 2.4 L ha-1.
T2: Herbicide Trifluralin 480 g at a rate of 2.4 L ha-1+ Herbicide Bentazon 480 SL at rate 4L ha-1 + Herbicide Clethodim 24% EC at a rate of 0.5 L ha-1.
T3: Herbicide Trifluralin 480 g at a rate of 2.4L ha-1+ white goosefoot leaf extract at rate 18 L ha-1.
T4: Herbicide Trifluralin 480 g at a rate of 2.4L ha-1+ Manual weeding 30 and 45 days after Planting.

T5: Weedy Treatment, allowing weeds to grow and compete with different soybean varieties throughout the growing season.

Conclusion

Based on the research results, we conclude that integrating various herbicides—both pre-emergence and post-emergence—along with white goosefoot extract and hand-weeding effectively reduced the dry weight of weeds. This reduction enabled the crop plants to Utilize their growth requirements, resulting in improved growth characteristics, including increased dry weight, larger leaf area, and a higher leaf index. Consequently, this resulted in enhanced yield and yield components compared to the weed-free treatment.

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