Efficiency of Salicylic Acid Application on growth and yield of chickpea (*Cicer arietinum L.*)

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Abstract

The research was conducted in the 2019-2020 season in Al-Kasak sub-district of Tal Afar district, 50 km west of the city of Mosul, to study the effect of salicylic acid on the growth characteristics, yield and protein content of chickpea plant (Cicer arietinum L). Salicylic acid (SA) was used at concentrations of 0.0, 50, 100, 150, and 200 mg/L in three dates: the first date: soaking the seeds with SA for 8 hours and the second date: spraying with SA 30 days after planting and the third date: spraying with SA 50 days after planting.

The results of the study showed:

in vegetative growth characteristics; All concentrations of salicylic acid (50, 100, 150 and 200 mg/L) caused a significant increase in the vegetative growth characteristics. The maximum was 39.88 cm in plant height at 150 mg/L and the lowest was 27.7 for the control treatment, while the concentration was 200 mg/L. Significant increase in leaf area, the top of which was 549.52 $cm^2.plant^{-1}$ compared to 172.76 $cm^2.plant^{-1}$, and the number of leaves and number of branches increased significantly in all concentrations of salicylic acid used, which reached a maximum of 82.38 $leaves.plant^{-1}$ and 2.74 $branches.plant^{-1}$ respectively at concentration 200 mg/L compared to 49.78 $leaves.plant^{-1}$ and 1.37 $branches.plant^{-1}$. The dry weight increased significantly with the increase of concentrations, especially the concentration 150 mg /L, it reached 7.93 g. $plant^{-1}$ compared to 4.90 g. $plant^{-1}$.

As for the dates, their effect differed according to the studied characteristics. The best date for using salicylic acid was the third date (spraying after 50 days of planting) in terms of plant height, number of leaves, leaf area and number of branches, while the first date was the best in dry weight.

In the yield characteristics; The results showed that all the used concentrations of salicylic acid had the ability to improve the yield characteristics in varying proportions according to the concentration. The concentration of 100 mg / L was distinguished in reducing the time required for the appearance of the first pod, as it reduced the period from 73.78 days in the comparison treatment to 70.67 days from the date of cultivation. As for the concentration of 150 mg/L, it was characterized by a significant increase in each of the traits; The number of pods (9.58 $pods.plant^{-1}$) compared to (5.95 $pods.plant^{-1}$) in the control treatment, and the plant yield from seeds (50.94 g/m^2) compared to (34.40 g/m^2) in the comparison treatment, and the biological yield (151.2 g/m^2) compared to (93.9 g/m^2) in the comparison treatment And seed protein (27.36) compared with (20.66) in the comparison treatment, and in the weight of 100 seeds also (27.87 g) compared to (25.81 g) when the comparison.

The dates of treatment with SA showed the superiority of the first date (soaking before planting) in most of the yield traits represented in the number of total pods, weight of 100 seeds, plant yield of seeds and biological yield, while the second date showed superiority in the characteristic of the time required for the emergence of the first pod and The seed protein.

Introduction

Chickpea (Cicer arietinum L.) is one of the important leguminous crops and is characterized by its ability to absorb water from the soil with high efficiency from the depths of the soil (22), and it is currently one of the most widely consumed and widespread legumes in the tropics and subtropics and temperate regions, but drought conditions are one of the most influential and determinant factors for the growth, survival and production of chickpea (34).

Chickpea is the third most important legume crop in production next to dry beans and peas. The area of chickpea production is about 11.3 million hectares in the world and

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the average yield or yield is 849 kg/ha (18), and in Nineveh, the average yield is estimated at 200 kg/D (16).

From the nutritional point of view, chickpeas are an important source of protein and carbohydrates, which together constitute 80% of the total dry matter weight of the seeds (15), B vitamins and various elements (27) and the percentage of protein is estimated at (17-22%). However, a lot of research indicates higher levels, up to (25.3-28.9%) (10).

Chickpeas can be considered a healthy "functional food" for its acceptable role in the processing of proteins and fibers. Vitamins and various elements such as Ca, Mg, P and K as well as biologically active compounds such as phenols and polysaccharides, and important unsaturated fatty acids such as linoleic and oleic and sterols, which can potentially help reduce the risk of chronic diseases.

Chickpea production is greatly affected by environmental conditions such as drought and low temperature due to the sensitivity of the crop to frost and the possibility of infection with leaf spot disease (Ascochyta), which is active during frost periods. Salicylic acid (SA), which improves the plant's ability to withstand harsh environmental conditions and pathogens (14), provides protection against stress types such as environmental stress, salt, drought, thermal stress and heavy metals (21) and (7) And its contribution to regulating plant growth and development and its metabolic processes. The effectiveness of salicylic acid often depends on the plant type, the time of addition and the concentration used (21).

The current study aims to determine the best concentration of the growth regulator of salicylic acid and to determine the best date for adding the regulator in chickpea plant under dehydrating conditions, while studying the response of the plant to different concentrations and dates of addition to this regulator.

Materials and methods:

A field experiment was carried out on February 28, 2019 in Al-Kasak sub-district of Tal Afar district, 50 km west of the city of Mosul, to study the effect of salicylic acid on growth characteristics, yield and protein content. Chickpea plant (Cicer arietinum L) variety flip97-706c obtained from the Dohuk Agriculture Department was cultivated. The agricultural operations included: conducting two orthogonal plowing of the land by the plow and then smoothing it by means of the knuckle, and the transactions were distributed to the experimental units for each repeater randomly, and the number of transactions in each sector was 15 factorial treatments resulting from the combination between: The first factor (5 concentrations) x factor The second (3 dates) x three repetitions = 45 experimental units, and each experimental unit contains three lines, each line 5 meters long. The distance between one line and another is 35 cm, and the distance between the grooves is 15 cm (Ali, 1990). The seeds were sown at a depth of approximately 5 cm. Fertilization was done with NPK compound fertilizer (neutral: 20.20.20) at a rate of 40 $kg.h^{-1}$ when planting (8). A randomized complete block design (R.C.B.D) was used to analyze the results and the Duncan test was adopted to determine the differences between the treatments (4).

2.1-Vegetative growth characteristics:

they were measured over several periods, and the period after 80 days of planting (at harvest) was chosen to represent the results of the current research. It included all of the following attributes:

2.1.1- Plant height (cm): The average plant height was adopted from five plants randomly selected from the median lines of each experimental unit, and their height was measured from the soil surface to the top of the plant after the plant's growth was completed and the pods were formed.

2.1.2- Number of Leaves: The number of leaves was calculated for five randomly selected plants and marked from the median lines of each experimental unit and their average was taken to calculate the average number of leaves per plant.

2.1.3- Leaf area ($cm^2.plant^{-1}$): The leaf area was measured by taking a picture of the plant leaves (upper, middle and lower) and transferring the image to the program, then multiplying the calculated leaf area rate by the

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number of plant leaves in each treatment. Using ImageJ software (9).

2.1.4- Number of branches. Plant-1: according to the number of branches of five marked plants from the middle lines of each experimental unit and their average was taken to calculate the average number of branches per plant.

2.1.5- Dry weight: the plant was dried at 70 °C for 72 hours. After the weight was stable, the dry weight of the plant was calculated using a sensitive electronic scale for five plants from each replicate, and then the average dry weight of the plant was extracted (g. plant^{-1}).

2.2 - Yield characteristics:

2.2.1- The number of days required for the appearance of the first pod: The number of days from sowing until the appearance of the first pod was calculated for each treatment of the experimental units.

2.2.2- Total number of pods (pod. plant^{-1}): It was calculated from twenty plants from each experimental unit, then calculated the average number of pods per plant in each plant.

2.2.3- Weight of 100 seeds (g): It was calculated by taking 100 seeds at random from the yield of each experimental unit and weighing them with a sensitive scale.

2.2.4 - Seed yield (gm/m^2): according to the seed yield by multiplying the average grain weight of one plant by the number of plants per square meter.

2.2.5 - Biological yield g/m^2: The midline plants (3 meters long) were harvested from each experimental unit at a rate of (20 plants) for each replicate, dried aerobically, and then all the harvested plants (vegetative and pods) were weighed from this line and a rate was extracted from them. Biological yield.

2.2.6-content of protein in seeds and leaves (%): The protein in seeds and leaves was estimated by estimating the percentage of nitrogen using the Kjeldahl method. The percentage of protein was calculated by multiplying the percentage of nitrogen by 6.25 (1).

Results and discussion

3.1.1- Plant height (cm): Table (1) shows that there are significant differences in the concentrations of salicylic acid in the character of plant height, as it was noted that all concentrations of salicylic acid led to a significant increase in plant height that reached 39.88 and 39.44 cm at the concentrations 150 and 200 mg/L respectively, while it was found that the lowest rate of the trait when the comparison treatment was 27.70 cm, no significant differences were observed between the dates of SA addition. The effect of the interaction showed that the interaction between the concentration 150 mg/L with soaking was 41.56, and the lowest rate of the trait when the interaction between the comparison treatment with the second spraying time was 27.11 cm. These results agree with what (16) found in the presence of a significant increase in plant height when they used pre-soaking with salicylic acid SA at a concentration of 50 ppm for chickpea seeds before planting and foliar spraying at a concentration of 100 ppm) in the vegetative growth stage.

3.1.2- Number of branches/plant: The results in Table (1) indicated that there was a significant increase in the number of branches characteristic of concentrations 150 and 200 mg/L, reaching (2.70,2.74 branches.plant^{-1}) compared to (1.37 branches.plant^{-1})for the comparison treatment. The third date showed a significant superiority of (2.93 branches.plant^{-1}). This may be due to the increase in plant growth and the beginning of the emergence of branches, where the effect of SA is effective in these stages because it encourages the formation of side branches. As for the interaction, it was significant between the concentrations of 100, 150 and 200 mg/L significantly with the date of the third spray, and it was 3.22, 3.67 and 3.89 branches.Plant^{-1}, respectively, for the above concentrations compared to the interaction with the control treatment, which showed the lowest rate of the trait reached 1.02 branches.Plant^{-1} when overlapping with soaking time. These results are in agreement with (16), who observed an increase in the number of branches when soaking (at a concentration of 50 ppm) and spraying (at a concentration of 100 ppm) with salicylic acid, and spraying was better than soaking in increasing the number of branches.

While (31) reported the highest number of branches at a concentration of 5-10 M of SA, while (12) obtained the highest number of branches using a concentration of 1.5 (mM) of SA (equivalent to 207 mg/L). It also agrees with (3).

Table (1) Effect of salicylic acid and treatment dates on plant height and number of branches of *Cicer arietinum*.L`

Number of branches				plant height (cm)				salicylic acid mg/L
average conc.	**Third date**	**second date**	**first date**	**average conc.**	**Third date**	**second date**	**first date**	
1.37 d	1.67 f- c	1.44 e f	10.2 f	**27.70 d**	28.55 f g	27.11 g	27.44 g	**control**
1.89 c	2.22 b c d	1.67 f- c	1.78 e- b	**32.52 c**	34.00 c d e	32.56 d e	31.00 e f	**SA50**
2.33 ب	3.22 a	2.22 b c d	1.55 d e f	**34.78 b**	34.44 c d	34.89 c d	35.00 c d	**SA100**
2.70 a b	3.67 a	2.33 b c	2.11 e- b	**39.88 a**	40.67 a b	37.44b c	41.56 a	**SA150**
2.74 a	3.89 a	2.45 b	1.89 e- b	**39.40 a**	37.33 b c	41.44 a	39.44 a b	**SA200**
	2.93 a	**2.02 b**	**1.67 c**		**35.00 a**	**34.68 a**	**34.89 a**	**average of date**

Common averages with the same letters for each adjective do not differ significantly according to Duncan test at 5% probability level.

3.1.3- Number of leaves.plant^{-1}: Table (2) shows that all the concentrations of salicylic acid led to a significant increase that was proportional to the increase in concentration, and the highest were 76.33 and 82.38 leaves.Plant^{-1} at concentrations 150 and 200 mg/L, respectively, while the lowest average number of leaves was when the control treatment (49.78 leaves.plant^{-1}), the effect of the

treatment date showed that the third date (74.31 leaves.plant^{-1}) compared to the first and second dates reached 61.11 and 65.73 leaves.plant^{-1}, respectively. The best interaction was found from the concentration of 200 mg/L with the second spraying date (93.67 leaves.plant^{-1}), while the lowest rate when the interaction between the comparison treatment with the second spraying date was (45.22 leaves.plant^{-1}). The results agree with (20) that SA is related to photosynthesis reactions in leaves and evidence of leaf number improvement. These results are also consistent with (32).

3.1.4- Leaf area (cm^2.plant^{-1}): The results in Table (2) indicate the superiority of all concentrations of salicylic acid in the leaf area and it was with a significant increase in proportion to the increase in concentration. The highest area was (478.3 and 549.5 cm^2.plant^{-1}) for the two concentrations. 150 and 200 mg/L, respectively, while the lowest rate was in the control treatment (172.76 cm^{2}plant^{-1}). The percentage increase in leaf area was 68.56% for the highest concentration of 200 mg/L. The effect of the appointments showed that the third appointment was 429.17 cm^2.plant^{-1} compared to the first and second dates. The interaction between the concentration of 200 mg/L when overlapping with the second and third dates was 590.7 and 591.3 cm^2.plant^{-1}, respectively. Perhaps the ability of salicylic acid to increase the expansion of leaves is due to the increase in cell expansion and expansion through its

effect on increasing the level of auxins and cytokinins, which affect the increase in cell division and its role in increasing the efficiency and effectiveness of carbon building in the plant and increasing the leaf area of the plant (29).

Table (2) Effect of salicylic acid and treatment dates on number of leaves and leaf area of chickpea plant

leaf area				number of leaves				salicylic acid mg/L
average conc.	**Third date**	**second date**	**first date**	**average conc.**	**Third date**	**second date**	**first date**	
172.8 d	197.0 f g	164.8 g	156.5 g	**49.78 c**	56.89 e f g	45.22 f g	47.22 f g	**control**
266.1 c	365.7 c d e	200.2 f g	232.2 e f g	**60.74 b**	73.99 e - b	49.89 g	58.33 e f g	**SA50**
407.3 b	506.7 a b c	384.2 c d	331.0 d e f	**66.04 b**	78.00 d- a	60.56 g- c	59.55 g- d	**SA100**
478.3 a b	485.1 a b c	537.0 a b	412.9 b c d	**76.33 a**	75.11 e - b	79.33 a b c	74.56 e - b	**SA150**
549.5 a	591.3 **a**	590.7 **a**	466.6 d- a	**82.38 a**	87.57 a b	93.67 **a**	65.89 e- c	**SA200**
	429.2 a	**375.4** a b	**319.8 b**		**74.31 a**	**65.73 b**	**61.11 b**	**average of date**

3.1.5- Plant dry weight (g.plant^{-1}): Table (3) indicates the effect of salicylic acid concentrations on the dry weight characteristic of chickpea plant, which shows that there were significant differences for all concentrations of salicylic acid in the dry weight characteristic of the plant and were 6.09, 7.03, 7.93 and 6.83 g. Plant^{-1} for concentrations of 50, 100, 150 and 200 mg/L and the best of which was 150 mg/L compared to the control plants that showed the lowest dry weight of 4.93 g.Plant^{-1}, and it was noted that the first date (soaking with SA) showed a significant superiority in the dry weight of the plant amounted to 7.29 g.plant^{-1}, while the lowest date was in the third (spraying after 50 days) was 5.87 g.plant^{-1} The interaction of concentration 150 mg/L with the first and second appointment showed a significant superiority of 9.11 and 8.36 g.plant^{-1}, respectively, while the concentration of 100 mg/L SA with the first appointment showed a superiority of 8.53 g.plant^{-1}, while the lowest rate was The dry weight when overlapped with the comparison treatment with the third date was 4.54 g.plant^{-1}. These results agree with Muhammad et al. (2017) that the use of salicylic acid caused an increase in the dry weight percentage after treatment with salicylic acid, which reached 75% at a concentration of 2.0 mM, and also agree with (30) who used soaking chickpea seeds at a concentration of 1.5, which caused a significant increase. in dry weight.

The researchers explained the effect of salicylic acid in increasing vegetative growth to its effect on cell division and increasing meristematic activity. It facilitates the transfer of nutrients to the branches and their development and regulation of the pathways of other hormones and their balance, especially the increase in the level of auxins and cytokinins, which affects the increase in cell division (21) (24). In addition to the physiological role of SA in regulating signal transduction during leaf gene expression processes (28) (21).

Table (3) Effect of salicylic acid and treatment dates on the dry weight of chickpea plants (gm.plant^{-1})

average conc.	Third date	second date	first date	salicylic acid mg/L
4.93 d	4.54 f	5.04 e f	5.21 d e f	**control**
6.09 c	6.02 f- c	5.59 f- c	6.67 c d e	**SA50**
7.03 b	6.16 f- c	6.40 c d e	8.53 a b	**SA100**
7.93 a	6.33 c d e	8.36 a b	9.11 **a**	**SA150**
6.83 b c	6.30 c d e	7.27 b c	6.91 b c d	**SA200**
	5.87 b	**6.53 b**	**7.29 a**	**average of date**

and the relationship of SA with photosynthetic reactions in leaves and evidence of improving the number of leaves and increasing their leaf area, which is associated with an increase in the secondary metabolic rate, an increase in cell division, prevention of defoliation and prevention of yellowing for its positive effect on increasing protein and retaining chlorophyll, and these results also agree with (32). It also agrees with (11) when soaking chickpea seeds and treating plants by foliar spraying with salicylic acid.

yield characteristics:

3.2.1- The period required for the appearance of the first pod (day): Table (4) shows the effect of salicylic acid concentrations on the time required for the emergence of the first pod of chickpea plant, which showed a significant effect in reducing the time required for the first pod to be at concentration 100 and 150 mg/L, reaching 70.67 and 71.22 days, respectively, while the longest period of pod emergence was observed. In the absence of SA (the comparison) it was 73.78 days. The best date to reduce the period was the second date, which reduced the period to 71.20 days compared to the other dates. The best interaction resulted from the concentration of 100 mg/L with the second date 69.0days, while the emergence of pods was significantly delayed in the control plants on the first date to 74.67 days. This result is in agreement with what (33) stated, who obtained the least time in the appearance of the first pod, significantly, by using salicylic at a concentration of 100 mg / liter in marrow plant. This result is in agreement with (2) and (33), who obtained the lowest time in the appearance of its first horn significantly by using salicylic at a concentration of 100 mg/L in marrow plant. These results indicate that the appropriate concentration to stimulate the formation of pods is 100 and 150 mg / liter and speeding up their appearance, perhaps due to the appropriate internal concentration of the plant in stimulating the metabolic processes encouraging the transformation of vegetative buds to flower. Encouraging flowering by compatibility with endogenous growth hormones such as IAA, KIN and GAs, and increasing the activity of some important enzymes in flowering and early flowering (5).

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Table (4) Effect of salicylic acid and treatment dates on the time required for the emergence of the first pod of the chickpea plant

average conc.	Third date	second date	first date	salicylic acid mg/L
73.78 c	74.33 e	72.33 c d	74.67 e	**control**
72.00 b	72.00 b c d	72.00 b c d	72.00 b c d	**SA50**
70.67 a	70.67 b	69.00 a	72.33 c d	**SA100**
71.22 a	71.67 b c	70.67 b	71.33 b c	**SA150**
72.55 b	72.33 c d	72.00 b c d	73.33 d e	**SA200**
	72.20 b	**71.20 a**	**72.73 b**	**average of date**

3.2.2- Total number of pods (pod. plant^{-1}): Table (5) shows that there are significant differences in the concentrations of salicylic acid in the characteristic of the average number of pods.plant^{-1} compared to the untreated plants. Where The highest rate using concentrations 150 and 200 mg/L was 9.58 and 9.22 pods/plant, while it was noted that the lowest rate for the trait was 5.95 pods/plant in the comparison treatment. As for the dates of addition, there were significant differences, as the first date (soaking) gave the highest rate of the trait amounting to 10.15 pods.plant^{-1}, while the results showed that the lowest rate of the trait was at the third date (spraying after 50 days), which amounted to 6.79 pods.plant^{-1}. The effect of the interaction showed that there were significant differences between the concentrations and the dates of addition in the characteristic of the average number of pods.plant^{-1}, as the interaction between the two concentrations 100 and 150 mg/L with the first date (soaking) was superior to the highest number of pods that amounted to 11.51 and 12.42, respectively, and the lowest rate of the trait was when the interaction between the two treatments The comparison with the third date was 5.29 pods.plant^{-1}, and the increase in the number of pods may be due to the increase in the number of branches and thus the increase in the number of pods resulting from the use of salicylic acid (SA) with appropriate concentrations, especially the 150 mg/l concentration used in the current study.

These results are in agreement with (6) using the 5–10 Müller concentration and with (31). And with (23) at concentration (1 mM = 138 mg/L) which caused a significant increase in the number of pods.

3.2.3 - 100-seed weight (g): Table (5) shows the efficiency of the concentrations used of salicylic acid in increasing the weight of 100 seeds of chickpea plant, where all the concentrations used caused a significant increase in this trait, and the highest rate was when using the concentration of 200 mg/L, which amounted to 27.87 g, while the lowest rate for the trait was 25.81 g when the comparison treatment. And the effect of the appointments showed that the first appointment (27.6 g) exceeded the other appointments. While the interaction between the concentrations and the dates of addition showed significant differences for the concentration 100, 150 and 200 mg/L, the best of which was the concentration 200 in the first date (soaking) amounted to 28.48 g, while the lowest when the interaction between the comparison treatment with the third date was 24.95 g. These results are in agreement with (12) using a concentration of 1.5 mM of SA and with researchers (25) at a concentration of 0.7 mM using the method of SA spray, which may be due to the contribution of salicylic acid in the processes

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of transporting nutrients and increasing cell division and fruit development.

Table (5) Effect of salicylic acid and treatment dates on the average number of pods and weight of 100 seeds of Chickpea plant

weight of 100 seeds				number of pods				salicylic acid mg/L
average conc.	**Third date**	**second date**	**first date**	**average conc.**	**Third date**	**second date**	**first date**	
25.81 c	24.95 e	26.14 c d e	26.35 c d e	**5.95 b**	5.29 e	6.35 d e	6.22 d e	**control**
26.99 b	25.58 d e	28.18 a b c	27.21 a b c	**8.71 a**	8.11 b-e	7.72 b-e	10.30 a b	**SA50**
27.62 a	28.14 a	26.25 b -e	28.47 a	**8.62 a**	6.63 c d e	7.72 b-e	11.51 a	**SA100**
27.65 a	27.16 a b c	28.05 a	27.74 a b	**9.58 a**	6.48 c d e	9.83 a b c	12.42 a	**SA150**
27.87 a	27.03 a -d	28.11 a	28.48 a	**9.22 a**	7.87 b-e	9.48 a -d	10.31 a b	**SA200**
	26.57 b	**27.35** a b	**27.65** a		**6.79 c**	**8.22 b**	**10.15 a**	**average of date**

3.2.4- seed yield (g/m^2): Table (6) shows that all the concentrations of salicylic acid were significantly superior to the seed yield of chickpea plant, reaching a maximum of 50.94 g.m^2 at a concentration of 150 mg/L compared to the seed yield in the control treatment of 34.40 g.m^2. The best date for using salicylic acid was on the first date (soaking the seeds before planting), where the rate of chickpea yield was 55.85 g/m^2 and the lowest was on the third date (spraying after 50 days), which amounted to 32.56 g/m^2. The interaction rates between the concentrations and the treatment dates indicated that the concentration of 150 mg/L of SA in the first date (soaking) exceeded 70.11 g/m^2, and the lowest was when the comparison was overlapped on the third date, which amounted to 29.85 g/m^2.

These results indicate the efficiency of salicylic acid with the concentrations used, especially the concentration of 150 mg / liter, in increasing the productivity of the chickpea crop with an increase of 48.1% compared to the comparison, although the production rates are less than the standard production rates due to the lack of the amount of rain falling in the Al-Kasak region (Department of Meteorology And seismic monitoring in Nineveh Governorate, 2019), which is considered outside the rain line, but the growth regulator (SA) showed a significant superiority by increasing the yield in unit area (gm/m^2) and the appropriate concentration (150 mg/L) and the first date gave the best opportunity for plant growth and development. These results agree with (19) who obtained a yield of 504 kg/ha by using salicylic acid at a concentration of 200 mg/L spray on the leaves and the comparison gave 303 kg/ha, and agree with (29) at a concentration of 1.5 mM Muller, with (16)

3.2.5- Biological yield, g/m^2: It is noted from Table (6) that salicylic acid significantly increased the biological yield in all concentrations. The maximum yield reached 151.2 g/m^2 at concentration 150 mg/L, followed by concentration 100 and 200, which reached 134.0 and 130.1 g/m^2 respectively compared to 93.9 g/m^2 in a comparison treatment. The results showed that the first (soaking) date was significantly superior with a yield of 138.9 g/m^2 compared to the second and third spraying dates, which amounted to 124.5 and 111.9 g/m^2 respectively. The

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interaction of salicylic acid with a concentration of 150 mg/L was superior in the first and second dates, which amounted to 173.7 and 159.4 g/m^2 respectively, while the lowest biological yield when the comparison with the third date was overlapped was 86.5 g/m^2. The increase in biological yield when treated with salicylic acid is due to its effective role in stimulating the characteristics of vegetative growth and yield characteristics. The results agree with (19), who showed that the growth regulator salicylic acid caused a significant increase in biological yield of 1239.2 kg/ha (123.9 g/m^2) compared to 1027.3 kg/ha (102.7 g/m^2) in the control plants, indicating the efficiency of The SA in water use.

Table (6) Effect of salicylic acid and treatment dates on seed yield rate and biological yield of Chickpea plant

biological yield				seed yield rate				salicylic acid mg/L
average conc.	**Third date**	**second date**	**first date**	**average conc.**	**Third date**	**second date**	**first date**	
93.9 d	86.5 f	96.1 e f	99.2 d e f	**34.40 b**	29.85 e f	33.78 d e f	39.57 c d e	**control**
116.1 c	114.8 c-f	106.6 c-f	127.1 c d e	**43.87 a**	34.41 d e f	42.18 c d e	55.01 a b c	**SA50**
134.0 b	117.4 c-f	122.1 c d e	162.6 a b	**45.95 a**	34.44 d e f	41.20 c d e	62.21 a b	**SA100**
151.2 a	120.6 c d e	159.4 a b	173.7 a	**50.94 a**	30.69 e f	52.01 a-d	70.11 a	**SA150**
130.1 b c	120.1 c d e	138.5 b c	131.7 b c d	**43.42 a**	33.42 d e f	44.49 b-e	52.36 a-d	**SA200**
	111.9 b	**124.5 b**	**138.9 a**		**32.56 c**	**42.73 b**	**55.85 a**	**average of date**

3.2.6- Protein content of chickpea seeds and leaves (%): Table (7) shows a significant increase in protein content in chickpea seeds for all concentrations used, especially high ones, which led to a significant increase in protein content of 27.36% at 150 mg/L concentration, while the lowest rate of protein (20.66%) was observed in the comparison treatment. These results indicate an increase in protein content by 24.48% using the above concentration. In the leaves, a significant increase was observed for all concentrations, and the best concentration was 150 mg/L, which gave a content of 10.18%, while the other concentrations showed a significant increase, but with a lower percentage compared to the protein content in the leaves of the control plants (4.10%). These results are in agreement with many researchers, including (6) who obtained a 14.0% increase in protein content in chickpeas, and with (19) who obtained a percentage of (46.1%) at a concentration of 200 mg/L and agree with (13). With (26) and (24) who note that SA affects processes related to seed primary metabolism and seed quality, including protein synthesis and transport of the stored protein in the seed that increases seed vigor (31) and that it increases the efficiency of nitrogen recirculation through a higher upregulation of protein degradation and amino acid transport in leaves.

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Table (7) Effect of salicylic acid and treatment dates Protein content in chickpea seeds and leaves %

Protein content in chickpea leaves				Protein content of chickpea seeds				salicylic acid mg/L
average conc.	**Third date**	**second date**	**first date**	**average conc.**	**Third date**	**second date**	**first date**	
4.10 e	3.90 j	4.30 h	4.10 i	**20.66 e**	20.62 j	20.79 j	20.58 j	**control**
5.76 d	6.18 e	5.90 f	5.20 g	**21.61 d**	21.24 h	21.89 g	21.72 g	**SA50**
7.41 c	8.89 b	7.19 d	6.16 e	**24.28 c**	22.58 f	25.43 d	24.85 e	**SA100**
10.18 a	11.23 a	11.13 a	8.20 c	**27.36 a**	24.63 e	30.87 a	26.60 c	**SA150**
7.89 b	8.32 c	8.23 c	7.14 d	**24.65 b**	21.52 g h	27.87 b	24.58 e	**SA200**
	7.70 a	**7.35 b**	**6.16 c**		**22.11 c**	**25.37 a**	**23.66 b**	**average of date**

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