International Journal of
Biological Engineering and Agriculture

ISSN: 2833-5376
Volume 2 | No 12 | Dec -2023

Effect of Spraying with Salicylic Acid and Boron and Their Interference on The Growth and Evolution of the *Vicia faba.L.* plant

Sara Ali Hussein[1], Mahmoud Shakr Al-jubory[2]
Department of Biology, College of Science, University of Kirkuk, Iraq.
Email: sly647539@gmail.com

Abstract: The study was conducted in 2022–2023. to To evaluate the response of two genetic varieties of Spanish Lupinus albus (LueDeotono) and the local variety when exposed to different levels of boron (50, 25, 0) mg.L-1 and salicylic acid (200, 100, 0) mg.L-1, an experiment was conducted using a randomised complete block design (RCBD) with three replicates for each treatment. The results indicated that the local variety exhibited a significant superiority over the Spanish variety in terms of the number of branches, leaf area, and chlorophyll content. On the other hand, the Spanish variety outperformed the local variety in terms of the number of pods and yield. In summary, the local variety of Lupinus albus showed better performance in terms of vegetative characteristics such as branches, leaf area, and chlorophyll content, while the Spanish variety excelled in reproductive characteristics, including the number of pods and yield. The spraying with boron showed an increase in the number of pods and chlorophyll content. On the other hand, salicylic acid spraying led to a significant increase in the number of branches, leaf area, and yield. However, the interference between varieties and boron levels resulted in a significant decrease in all parameters except for chlorophyll content. While interferences between varieties and salicylic acid spraying showed a significant increase in all parameters except chlorophyll content, interferences between boron concentrations and salicylic acid spraying resulted in a significant increase in leaf area, number of pods, yield, and chlorophyll content. The number of branches, however, did not show a significant increase. Furthermore, the three-way interference between varieties, boron concentrations, and salicylic acid application led to a significant increase in all parameters studied.

Keywords: spraying, boron, salicylic acid, levels, Vicia Faba.L

INTRODUCTION

The broad bean plant (*Vicia faba L.*) is considered a crucial winter crop, known for its high protein content, ranging from 25% to 40% (Natalia et al., 2008). This makes it a significant source of green protein, playing a vital role in the diet of populations, especially those with limited income. Additionally, it contributes to soil fertility improvement due to the presence of root nodules that fix nitrogen (Carmen et al., 2005). The cultivation of broad beans is widespread in many countries worldwide, particularly in the Middle East. They are used in the production of animal fodder and serve as organic green fertiliser in nutrient-poor soils. Moreover, they have a beneficial impact on soil biology through the activity of Rhizobium bacteria (Ali, 2007). Despite the importance of this crop, its yield per unit area remains relatively low compared to global production. Addressing this production gap and achieving higher yields necessitates substantial efforts and in-depth studies to enhance global production.

One of the most important scientific uses to increase production is the judicious application of fertilisers in appropriate quantities to enhance productivity when growth conditions are favourable Megnel and Arneke, (1982). Boron is used as one of these essential nutrients in this context.

Boron plays a vital role in the fruiting process by stimulating plants during the flowering stage. It also facilitates the movement of photosynthetic products from the leaves to various parts of the plant, aiding in the transport of certain hormones. Moreover, it plays a role in the fertilisation process. The lack of response of some plants to soil fertilisation with certain nutrients can be attributed to their fixation in the soil and the plant's inability to absorb and utilise them. Saadallah and Al-Khafaji,(2003). Therefore, foliar fertilisation, where nutrients are applied to the leaves, is considered an important technique. Hussein (2021) indicated that using concentration 20 $mg.L^{-1}$ of boron led to an increase in the yield characteristics of strawberry plants including number of fruits it reached 11.86 $fruit.plant^{-1}$ and yield reached 197.90 g comparative with the control treatment . Salicylic acid, a natural hormone extracted from willow plants, chemically represented as ortho-hydroxybenzoic (C6H4(OH)COOH) and denoted as SA, plays a role in regulating physiological processes in plants, including biotic and abiotic stress responses. Hence, this study aims to evaluate the role of boron and salicylic acid in the growth and development of broad bean plants.Abdulaziz(2023) indicated that using concentration 300 $mg.L^{-1}$ of salicylic acid led to an increase in the number of frond of date plam reached 6.67 $frond.seedling^{-1}$ and carbohydrate content reached 3.52% comparative with the control treatment.Lateef et al (2021) indicated that using concentration 1 $ml.L^{-1}$ of boron led to an increase in the leaf area of apricot plant reached 24.79 cm^2 comparative with the control treatment .

MATERIALS & METHODS

The experiment was conducted during the 2023–2022 growing season following a randomised complete block design (RCBD) with three replicates for each treatment to study the effect of foliar nutrition using concentrations of(50,25,0)mg/L^{-1} of boric acid as well as 200, 100, and 0 mg/L-1 of salicylic acid. Seeds of the local and Spanish varieties of broad beans were obtained from agricultural offices in Kirkuk province. The broad bean seeds for both varieties were sown on October 29, 2022, with five seeds per pot. After ten days of germination, the seedlings were thinned to three plants per pot. The planting was done in plastic pots with a height of 25 cm and a diameter of 30 cm, filled with 7 kg of soil obtained from a nursery. Laboratory testing of the soil was conducted to determine its physical and chemical properties in the laboratories of the Kirkuk Agriculture Directorate, as illustrated in Table 1. Thirty days after planting, the first foliar spray was applied to the plants using concentrations of boric acid (50, 25, 0 $mg.L^{-1}$) and salicylic acid (200, 100, 0 $mg.L^{-1}$) plus 1 mL/L^{-1} of a stabilising agent (Zahi[1]) using a manual 1-litre sprayer until complete wetting. After another 30 days from the first spray, the second foliar spray was applied using the same concentrations as mentioned above.

The Studied Traits

Leaf Area (cm^2 per $plant^{-1}$):

Leaf area was measured using a scanning device with Dighmizer software, following the method described by Sadik et al. (2011)

Number of Branches (branches per $plant^{-1}$):

[1] Zahi = dishwashing liquid

The number of branches was calculated after the elongation and flowering stages for each replicate, and the average was determined.

Number of pods (pods per plant^{-1}):

The number of pods was counted after the maturity stage for each replicate, and the average was calculated.

Yield (grammes per plant^{-1}):

The weight of seeds in each pot was measured, and the average yield was calculated.

Chlorophyll Content Estimation (mg/g^{-1} fresh weight):

The total chlorophyll content in the leaves was determined using the method described by Krudson et al. (1977).

RESULT & DISCUSSION

Leaf Area

Table 1 illustrates the impact of varieties, boron spraying, salicylic acid, and their interaction on the leaf area of broad bean plants. The results indicate a significant increase in leaf area, where the concentration of 200 mg.L^{-1} of salicylic acid produced the highest leaf area, reaching 16.15 cm² per plant^{-1} compared to the control treatment, which measured 14.07 cm² per plant^{-1}. These findings are consistent with those obtained by Al-Wattar & Al-Hamdani (2021). This increase in leaf area can be attributed to the role of salicylic acid in cell elongation and division by elevating auxin levels in the leaves. Additionally, salicylic acid enhances enzymatic activity in the photosynthesis process, which contributes to the expansion of the leaf area.

As indicated by the results in the table above, there is a significant increase in leaf area due to the effect of varieties. The local variety exhibited the highest leaf area, measuring 16.30 cm² per plant^{-1}, in comparison to the Spanish variety, which had a leaf area of 13.07 cm² per plant^{-1}. This difference can be attributed to the genetic variation between the two varieties or possibly the local variety's adaptation to prevailing environmental conditions.

The results also showed that the impact of boric acid concentrations led to a significant decrease in leaf area. The concentration of 0 mg.L^{-1} of boric acid resulted in the highest leaf area, measuring 17.36 cm² per plant^{-1}, compared to the treatment with the smallest leaf area, which measured 12.46 cm² per plant^{-1} at a concentration of 25 mg.L^{-1} of boric acid.

Regarding the two-way interaction between boric acid concentrations and varieties, there was a significant decrease in leaf area. The concentration of 0 mg.L^{-1} of boric acid resulted in the highest leaf area, measuring 21.34 cm² per plant^{-1} for the local variety, compared to the treatment with the smallest leaf area, which measured 11.59 cm² per plant^{-1} for the Spanish variety at a concentration of 25 mg.L^{-1} of boric acid.

As for the two-way interaction between varieties and salicylic acid, the results showed a significant increase in leaf area. The concentration of 200 mg.L $^{-1}$ of salicylic acid resulted in the highest leaf area, measuring 18.06 cm² per plant^{-1} for the local variety, compared to the treatment with the smallest leaf area, which measured 10.67 cm² per plant^{-1} for the Spanish variety at a concentration of 0 mg.L^{-1} of salicylic acid.

Furthermore, the results from Table 1 demonstrate that the two-way interaction between boric acid concentrations and salicylic acid achieved a significant increase. The combination of 0 mg.L^{-1} of boric acid and 200 mg.L^{-1} of salicylic acid resulted in the highest leaf area, measuring 20.35 cm² per plant^{-1}, compared to the treatment with the smallest leaf area, which measured 10.91 cm² per plant^{-1}, obtained at a concentration of 25 mg.L^{-1} of boric acid and 0 mg.L^{-1} of salicylic acid.

Moreover, the three-way interaction between varieties, boric acid, and salicylic acid demonstrated a significant increase. The combination of 0 mg.L^{-1} of boric acid and 200 mg.L^{-1} of salicylic acid resulted in the highest leaf area, measuring 25.98 cm² per plant^{-1} for the local variety, in contrast to the treatment with the smallest leaf area, which measured 9.41 cm² per plant^{-1} for the Spanish variety at a concentration of 25 mg.L^{-1} of boric acid and 0 mg.L^{-1} of salicylic acid.

Table(1) impact of Varieties, boron spraying, salicylic acid, and their interaction Leaf area(Cm^2.Plant^{-1})

Average Interaction between Boron and varieties	**Concentrations of Salicylic (mg.L^{-1})**			**Concentrations of Boron (mg.L^{-1})**	**Varieties**
	200	100	0		
21.33^{a}	25.98^{a}	15.05^{cd}	22.96^{b}	0	**Local**
13.32^{b}	14.79^{cde}	12.79^{def}	12.41^{e-g}	25	
14.23^{b}	13.42^{de}	12.22^{d-g}	17.06^{c}	50	
13.38^{b}	14.72^{cde}	12.85^{def}	12.57^{e-g}	0	**Lue Deotono**
11.59^{c}	13.07^{de}	11.65^{efg}	9.41^{g}	25	
13.12^{bc}	14.28^{cde}	15.07^{cd}	10.02^{fg}	50	
	16.15^{a}	13.27^{b}	14.07^{b}	**Average effect of Salicylic concentrations**	
Average Interaction between Salicylic and varieties					
Average effect of varieties	**Concentrations of Salicylic (mg.L^{-1})**			**Varieties**	
	200	100	0		
16.30^{a}	18.06^{a}	13.35^{b}	17.48^{a}	**Local**	
12.70^{b}	14.24^{b}	13.19^{b}	10.67^{c}	**Lue Deotono**	
Average Interaction between Salicylic and Boron					
Average effect of Boron concertration	**Concentrations of Salicylic (mg.L^{-1})**			**Concertration of Boron(mg.L^{-1})**	
	200	100	0		
17.36^{a}	20.35^{a}	13.95^{c}	17.77^{b}	0	
12.46^{c}	14.25^{c}	12.22^{cd}	10.91^{d}	25	
13.68^{b}	13.85^{c}	13.65^{c}	13.54^{c}	50	

Branchs Number

Table 2 illustrates the impact of varieties, boron spraying, salicylic acid, and their interaction on the number of branches in broad bean plants. The results show that salicylic acid had a non-significant effect on the number of branches. The concentration of 100 mg.L^{-1} of salicylic acid produced the highest number of branches, reaching 4.94 branches per plant^{-1}, compared to the control treatment, which had a value of 4.72 branches per plant^{-1}. These findings align with those reported by Rasheed (2018), where the increase in the number of branches can be attributed to the role of salicylic acid in stimulating physiological processes, promoting cell division, and maintaining hormonal balance, thus encouraging the concentration of gibberellins and auxins that enhance the growth of vegetative parts.

Similarly, the results in the table above indicate no significant difference between the varieties in the number of branches. The local variety achieved the highest value in the number of branches for broad bean plants, approximately 4.81 branches per plant^{-1}, compared to the Spanish variety, which measured 4.37 branches per plant^{-1}. This can be attributed to the genetic variations between the two varieties.

As for the impact of boric acid concentrations, the results indicate no significant effect on the number of branches in broad bean plants. The concentration of 0 mg.L^{-1} of boric acid resulted in the highest value, measuring 4.78 branches per plant^{-1}, compared to the concentration of 25 mg.L^{-1} of boric acid, which yielded the lowest value at 4.44 branches per plant^{-1}.

Regarding the two-way interaction between boric acid and varieties, there is no significant difference observed. The concentration of 0 mg.L^{-1} of boric acid yielded the highest value in the number of branches for broad bean plants, measuring 5.22 branches per plant^{-1} for the local variety, compared to the lowest value of 4.11 branches per plant^{-1} for the Spanish variety at a concentration of 25 mg.L^{-1} of boric acid.

As for the two-way interaction between salicylic acid concentrations and varieties, no significant increase was observed. The two concentrations, 100 mg.L^{-1} of salicylic acid, resulted in the highest number of branches for the local variety, reaching 5.45 branches per plant^{-1}, compared to the lowest number of branches at 3.56 branches per plant^{-1} for the same variety at a concentration of 200 mg.L^{-1} of salicylic acid.

The results in the table above indicate that the two-way interaction between boric acid and salicylic acid concentrations led to a non-significant increase. The highest value was recorded at concentrations of 0 and 100 mg.L^{-1} of both boric and salicylic acid, reaching 5.83 branches per plant^{-1}, compared to the lowest number of branches at concentrations of 0 and 200 mg.L^{-1} of both boric acid and salicylic acid, which was 3.3 branches per plant^{-1}, respectively.

The results of the three-way interaction between varieties and concentrations of boric acid and salicylic acid led to a significant increase in the number of branches. The highest value was obtained at a concentration of 50 mg.L^{-1} of boric acid and 0 mg.L^{-1} of salicylic acid, reaching 7.67 branches per plant^{-1} for the local variety, compared to the lowest number of branches, which was 2.00 branches per plant^{-1} for the same variety at a concentration of 50 mg.L^{-1} of boric acid and 200 mg.L^{-1} of salicylic acid. This increase in the number of branches can be attributed to the role of boric acid in the transport of carbohydrate materials from source to sink, leading to cell expansion and growth, which is consistent with findings by Fadhil et al, (2020).

Table(2) impact of Varieties, boron spraying, salicylic acid, and their interaction Branch number(Branch.Plant^{-1})

Average Interaction between Boron and varieties	**Concentrations of Salicylic (mg.L^{-1})**			**Concentrations of Boron (mg.L^{-1})**	**Varieties**
	200	100	0		
5.22^{a}	5.67^{a-d}	6.00^{abc}	4.00^{a-d}	0	**Local**
4.78^{a}	3.00^{bcd}	6.67^{ab}	4.67^{a-d}	25	
4.44^{a}	2.00^{d}	3.67^{bcd}	7.67^{a}	50	

4.33^{a}	4.67^{a-d}	5.67^{a-d}	2.67^{cd}	0	**Lue Deotono**
4.11^{a}	3.67^{bcd}	3.33^{bcd}	5.33^{a-d}	25	
4.67^{a}	5.67^{a-d}	4.33^{a-d}	4.00^{a-d}	50	
	4.11^{a}	4.94^{a}	4.72^{a}	**Average effect of Salicylic concentrations**	
Average Interaction between Salicylic and varieties					
Average effect of varieties	**Concentrations of Salicylic (mg.L^{-1})**				**Varieties**
	200	100	0		
4.81^{a}	3.56^{a}	5.45^{a}	5.44^{a}		**Local**
4.37^{a}	4.67^{a}	4.44^{a}	4.00^{a}		**Lue Deotono**
Average Interaction between Salicylic and Boron					
Average effect of Boron concertration	**Concentrations of Salicylic (mg.L^{-1})**				
	200	100	0		
4.78^{a}	5.17^{a}	5.84^{a}	3.33^{a}		0
4.44^{a}	3.32^{a}	5.00^{a}	5.00^{a}		25
4.56^{a}	3.83^{a}	4.00^{a}	5.83^{a}		50

Pods Number

Table 3 illustrates the impact of varieties, boron element spraying, salicylic acid, and their interaction on the number of pods in the broad bean plant. The results indicated a non-significant decrease, as the concentration of 0 mg.L^{-1} of salicylic acid gave the highest value for the number of pods, which reached 6.89 pods per plant^{-1}, compared to the lowest number of pods, which was 6.72 pods per plant^{-1} at a concentration of 100 mg.L^{-1} of salicylic acid.

As the results in the above table demonstrate, the role of varieties was significant, as the Spanish variety achieved a significant increase in the number of pods, reaching 7.41 pods per plant^{-1} compared to the local variety, which had 6.19 pods per plant^{-1}. This can be attributed to the genetic differences between the varieties and their responsiveness to environmental conditions.

The results also highlighted the role of boric acid, as a significant difference was observed. The concentration of 50 mg.L^{-1} of boric acid yielded the highest number of pods, reaching 7.22 pods per plant^{-1}, compared to the concentration of 0 mg.L^{-1}, which resulted in 6.83 pods per plant^{-1}. This increase in the number of pods can be attributed to the role of boric acid in stimulating the process of photosynthesis, thereby promoting flower formation, ultimately leading to an increase in the number of pods. This finding is consistent with what was reported by Fadhil et al. (2020).

However, the interaction between varieties and concentrations of boric acid showed a significant decrease. The concentration of 0 mg.L^{-1} of boric acid resulted in the highest number of pods, reaching 8.22 pods per plant^{-1} for the Spanish variety, compared to the lowest number of pods, which was 5.44 pods per plant^{-1} for the local variety at the same concentration of 0 mg.L^{-1}.

As for the two-way interaction between varieties and salicylic acid, it showed a significant difference. The concentrations of 100 and 0 mg.L^{-1} of salicylic acid gave the highest number of pods for the Spanish variety, reaching 7.44 pods per plant^{-1} compared to the lowest number of pods, which was 6.00 pods per plant^{-1} for the local variety at a concentration of 100 mg.L^{-1} of salicylic acid. This increase in the number of pods can be attributed to the role of salicylic acid in stimulating physiological processes, promoting flowering, and enhancing the photosynthesis process. This finding aligns with the results obtained by Prakash et al. (2019).

The results indicated that the two-way interaction between the concentrations of boric acid and salicylic acid achieved a significant difference. The concentration of 50 $mg.L^{-1}$ of boric acid and 0 $mg.L^{-1}$ of salicylic acid gave the highest number of pods, reaching 9.17 pods per $plant^{-1}$ compared to the lowest number of pods, which was 5.00 pods per $plant^{-1}$ at a concentration of 25 $mg.L^{-1}$ of boric acid and 0 $mg.L^{-1}$ of salicylic acid. This increase in the number of pods can be attributed to the synergistic effect of boric and salicylic acids in promoting pod formation and development.

The three-way interaction between the varieties, boric acid, and salicylic acid achieved a significant increase. The concentration of 50 $mg.L^{-1}$ of boric acid and 0 $mg.L^{-1}$ of salicylic acid gave the highest number of pods, reaching 10.00 pods per $plant^{-1}$ for the local variety, compared to the lowest number of pods, which was 4.00 pods per $plant^{-1}$ for the same variety. This substantial increase in pod production can be attributed to the combined effect of boric acid and salicylic acid in enhancing pod formation and development, particularly for the local variety.

Table (3) impact of Varieties, boron spraying, salicylic acid, and their interaction pod number (pod $.Plant^{-1}$)

Average Interaction between Boron and varieties	**Concentrations of Salicylic ($mg.L^{-1}$)**			**Concentrations of Boron ($mg.L^{-1}$)**	**Varieties**
	200	100	0		
5.44^{d}	6.33^{c-f}	5.00^{fg}	5.00^{fg}	0	**Local**
6.00^{cd}	7.67^{b-e}	6.33^{c-f}	4.00^{g}	25	
7.11^{abc}	4.67^{fg}	6.67^{c-f}	10.00^{a}	50	
8.22^{a}	7.67^{b-e}	9.00^{ab}	8.00^{a-d}	0	**Lue Deotono**
6.67^{bc}	6.33^{c-f}	7.67^{b-e}	6.00^{d-g}	25	
7.33^{ab}	8.00^{a-d}	5.67^{efg}	8.33^{abc}	50	
	6.78^{a}	6.72^{a}	6.89^{a}	**Average effect of Salicylic concentrations**	
Average Interaction between Salicylic and varieties					
Average effect of varieties	**Concentrations of Salicylic ($mg.L^{-1}$)**				
	200	100	0	**Varieties**	
6.19^{b}	6.22^{bc}	6.00^{c}	6.33^{abc}	**Local**	
7.41^{a}	7.33^{ab}	7.44^{a}	7.44^{a}	**Lue Deotono**	
Average Interaction between Salicylic and Boron					
Average effect of Boron concertration	**Concentrations of Salicylic ($mg.L^{-1}$)**			**Concentrations of Boron ($mg.L^{-1}$)**	
	200	100	0		
6.83^{ab}	7.00^{b}	7.00^{b}	6.50^{b}	0	
6.33^{b}	7.00^{b}	7.00^{b}	5.00^{c}	25	
7.22^{a}	6.33^{bc}	6.17^{bc}	9.17^{a}	50	

Yields

Table 4 illustrates the impact of varieties, boron application, salicylic acid, and their interactions on the seed yield of bean plants. The results indicated a significant difference, as the concentration of 100 $mg.L^{-1}$ of salicylic acid resulted in the highest seed yield, reaching 51.52 grammes per $plant^{-1}$ compared to the control coefficient, which yielded 49.20 grammes per $plant^{-1}$. This increase in seed weight can be attributed to the role of salicylic acid in enhancing root system development by reducing ion leakage, increasing water content, and reducing transpiration rate. These effects lead to the formation of new plant tissues and membranes, as described by Al-Dabagh (1992).

The results presented in the above table highlight the role of varieties in seed weight, as there was a significant increase when the Spanish variety was used, yielding the highest seed weight at 68.48 grammes per $plant^{-1}$ compared to the local variety, which produced the lowest seed weight at 29.80 grammes per $plant^{-1}$. This difference can be attributed to the genetic variations between the two varieties, as each variety possesses distinct genetic traits.

However, the results in Table 4 indicated that the application of boric acid did not lead to a significant change in seed weight. The highest seed weight was recorded at 53.90 grammes per $plant^{-1}$ when 100 $mg.L^{-1}$ of salicylic acid was applied, compared to the lowest seed weight of 44.09 grammes per $plant^{-1}$ when 25 $mg.L^{-1}$ of boric acid was used.

On the other hand, the interaction between boric acid and varieties had a significant effect. The highest seed yield of 82.60 grammes per $plant^{-1}$ was achieved with the Spanish variety when 100 $mg.L^{-1}$ of boric acid was applied, compared to the lowest seed yield of 25.19 grammes per $plant^{-1}$ for the local variety when 0 $mg.L^{-1}$ of boric acid was used.

As for the two-way interaction between varieties and salicylic acid, a significant difference was observed. The highest seed yield of 70.58 grammes per $plant^{-1}$ was achieved with the Spanish variety when 200 $mg.L^{-1}$ of salicylic acid was applied, compared to the lowest seed yield of 22.81 grammes per $plant^{-1}$ for the local variety when 200 $mg.L^{-1}$ of salicylic acid was used. This increase in seed yield can be attributed to the role of salicylic acid in promoting cell division, enhancing meristematic activity, facilitating nutrient transport to the branches, regulating hormonal balance in plants, including auxins and cytokinins, and its involvement in signal transduction during gene expression, which is consistent with the findings of Al-Rawi (2017).

The results in the above table indicate that the interaction between concentrations of boric acid and salicylic acid achieved a significant increase. The highest seed yield of 63.57 grammes per $plant^{-1}$ was obtained when 100 $mg.L^{-1}$ of salicylic acid was combined with 0 mg.L of boric acid, compared to the lowest seed yield of 43.28 grammes per $plant^{-1}$ when 200 $mg.L^{-1}$ of salicylic acid was combined with 25 $mg.L^{-1}$ of boric acid. This increase in seed yield can be attributed to the combined effects of boric acid and salicylic acid on various physiological processes, including cell division, nutrient transport, and hormonal regulation, as well as their roles in gene expression.

The results in the above table indicated a significant increase in seed yield due to the interaction between varieties, boric acid, and salicylic acid. The highest seed yield, reaching 90.80 grammes per $plant^{-1}$, was achieved when 100 $mg.L^{-1}$ of salicylic acid was combined with 0 $mg.L^{-1}$ of boric acid for the Spanish variety, compared to the lowest seed yield of 19.11 grammes per $plant^{-1}$ for the local variety when 200 $mg.L^{-1}$ of salicylic acid was combined with 0 $mg.L^{-1}$ of boric acid.This increase in seed yield can be attributed to the combined effects of boric acid and salicylic acid on enhancing various physiological processes and promoting optimal growth conditions, resulting in higher seed production.

Table(4) impact of Varieties, boron spraying, salicylic acid, and their interactionYileds (grammes.Plant^{-1})

Average Interaction between Boron and varieties	**Concentrations of Salicylic (mg.L^{-1})**			**Concentrations of Boron (mg.L^{-1})**	**Varieties**
	200	100	0		
25.19^{e}	19.11^{l}	36.33^{h}	20.13^{l}	0	**Local**
27.12^{d}	24.88^{j}	34.30^{i}	22.17^{k}	25	
37.08^{c}	24.42^{j}	37.41^{h}	49.40^{g}	50	
82.60^{a}	84.09^{b}	90.80^{a}	72.92^{c}	0	**Lue Deotono**
61.07^{b}	61.68^{e}	55.84^{f}	65.69^{d}	25	
61.77^{b}	65.97^{d}	54.45^{f}	64.90^{d}	50	
	46.69^{c}	51 .52^{a}	49.20^{b}	**Average effect of Salicylic concentrations**	

Average Interaction between Salicylic and varieties

Average effect of varieties	**Concentrations of Salicylic (mg.L^{-1})**			**Varieties**
	200	100	0	
29.80^{b}	22.81^{e}	36.02^{c}	30.57^{d}	**Local**
68.48^{a}	70.58^{a}	67.03^{b}	67.84^{b}	**Lue Deotono**

Average Interaction between Salicylic and Boron

Average effect of Boron concertration	**Concentrations of Salicylic (mg.L^{-1})**			**Concentrations of Boron (mg.L^{-1})**
	200	100	0	
^{a} 53.90	51.60^{c}	63.57^{a}	46.53^{d}	0
44.09^{c}	43.28^{f}	45.07^{de}	43.93^{ef}	25
49.43^{b}	45.19^{de}	45.93^{d}	57.15^{b}	50

Cholophyll Contains

Table 5 illustrates the impact of varieties, boron application, salicylic acid, and their interaction on the chlorophyll content of the pea plant. The chlorophyll content significantly decreased with increasing concentrations of salicylic acid. The highest chlorophyll content, reaching 22.00 mg.g^{-1} fresh weight, was observed when 0 mg.L^{-1} of salicylic acid was applied, compared to the lowest content of 16.13 mg.g^{-1} fresh weight when 200 mg.L^{-1} of salicylic acid was applied.

The results in the above table indicate the significant effect of varieties on chlorophyll content, where the local variety showed the highest chlorophyll content, reaching 21.09 mg. g^{-1} fresh weight, compared to the Spanish variety, which exhibited the lowest chlorophyll content at 16.82 mg.g^{-1} fresh weight. This difference can be attributed to the genetic variations between the two varieties.

However, the results in Table 5 indicate the significant impact of boric acid concentrations on chlorophyll content. The concentration of 50 mg.L^{-1} of boric acid showed the highest chlorophyll content, reaching 19.55 mg.g^{-1} fresh weight, compared to the concentration of 0 mg.L^{-1}, which resulted in a chlorophyll content of 17.71 mg.g^{-1} fresh weight. This increase in chlorophyll content can be attributed to the role of boric acid in stimulating carbon metabolism, the photosynthetic process, and nitrogen assimilation, which aligns with the findings of Mady & Abu-Alyazi (2012).

The results also revealed the impact of the interaction between boric acid and varieties. In the case of the 50 mg.L^{-1} boric acid concentration, the local variety outperformed the Spanish one in terms of chlorophyll content, with the local variety showing the highest chlorophyll content at 21.4 mg.g^{-1} fresh weight, compared to the lowest value of 15.01 mg.g^{-1} fresh weight observed in the Spanish variety at 0 mg.L^{-1} concentration.

However, in the case of the two-way interaction between varieties and salicylic acid concentrations, a significant decrease in chlorophyll content was observed. At the 0 mg.L^{-1} salicylic acid concentration, the local variety exhibited the highest chlorophyll content at 26.22 mg.g^{-1} fresh weight, compared to the lowest value of 15.55 mg.g^{-1} fresh weight recorded in the Spanish variety at the 200 mg.L^{-1} salicylic acid concentration.

The results revealed a significant difference in chlorophyll content due to the two-way interaction between boron acid and salicylic acid concentrations. At a concentration of 50 mg.L^{-1} boron acid and 0 mg.L^{-1} salicylic acid, the highest chlorophyll content was recorded at 27.11 mg/g^{-1} fresh weight, compared to the lowest value of 15.51 mg.g^{-1} fresh weight obtained at a concentration of 50 mg.L^{-1} boron acid and 100 mg.L^{-1} salicylic acid.

The results of the three-way interaction between varieties and the concentrations of boric acid and salicylic acid showed a significant difference. The highest chlorophyll content was observed at a concentration of 50 mg.L^{-1} of boric acid and 0 mg.L^{-1} of salicylic acid, reaching 36.59 mg.g^{-1} fresh weight for the local variety compared to the lowest value of 12.76 mg.g^{-1} fresh weight for the Spanish variety at a concentration of 0 mg.L^{-1} boric acid and 200 mg.L^{-1} salicylic acid.

Table (5) impact of Varieties, boron spraying, salicylic acid, and their interaction Cholophyll Contains(mg.g $^{-1}$ fresh weight)

Average Interaction between Boron and varieties	**Concentrations of Salicylic (mg.L^{-1})**			**Concentrations of Boron (mg.L^{-1})**	**Varieties**
	200	100	0		
20.95^{ab}	18.35^{c-f}	22.85^{bc}	21.66^{d-g}	0	**Local**
20.84^{a}	17.31^{d-g}	24.79^{b}	20.43^{cd}	25	
21.48^{ab}	14.45^{efg}	13.40^{fg}	36.59^{a}	50	
15.01^{c}	12.76^{g}	17.86^{def}	14.4^{efg}	0	**Lue Deotono**
18.05^{b}	16.3^{d-g}	17.35^{d-g}	20.5^{bcd}	25	
17.93^{b}	17.59^{d-g}	17.78^{d-g}	18.43^{cde}	50	
	16.13^{b}	19.01^{a}	22.00^{a}	**Average effect of Salicylic concentrations**	

Average Interaction between Salicylic and varieties				
Average effect of varieties	Concentrations of Salicylic (mg.L^{-1})			Cultivars
	200	100	0	
21.09[a]	16.71[b]	20.35[a]	26.22[a]	**Local**
16.82[b]	15.55[b]	17.18[b]	17.74[b]	**Lue Deotono**
Average Interaction between Salicylic and Boron				
Average effect of Boron concertration	**Concentrations of Salicylic (mg.L^{-1})**			**Concentrations of Boron (mg.L^{-1})**
	200	100	0	
17.71 [b]	15.55[c]	20.36[b]	17.21[c]	0
19.39[a]	16.81[c]	20.86[b]	20.52[b]	25
19.55[ab]	16.02[c]	15.51[c]	27.11[a]	50

References

1. Abdulaziz, N.A. & Khalaf, J.M.(2023, November).Study of Effect of Foliar Spraying with Salicylic Acid and Organic Nutrient (Disper chlorophyll) on some Vegetative and Chemical Characteristics of Three Date Palm Cultivars (Phoenix dactylifera L.).In IOP Conference Series:Earth and Environmental Science(Vol.1158, No.4 ,p 042045).IOP Publishing.
2. Al-Dabbagh, I .J.J and Bashir,H .A. A .(2017).The effect of foliar feeding with boron and salicylic on the production and quality characteristics of two genotypes of (*Vigna radiate L*) .Al-Anbar Journal of Agricultural Sciences,15(1),7497-1992.
3. Al-Khafahi, A.M,saadalah and Maysoon, J.H .(2003).The effect of salt water on potassium adsorption in some Iraqi sedimentary soils. Iraqi Journal of Agricultural Sciences, 17(1) 34.
4. ALI , A ;M .A. Nadeem , A. T. M Tahir and M. A. Hussam (2007).Effect of different Potash Levels on the growth ,yield and protein contents chickpea(Cicer arietinum L.) .Pakstan journal of botany,39 (2) 523.
5. Alrawi , M .M .A , Mohammed . Z .K .Al-Mharib , Abbas M.Alwan and Ahmed R.Naser (2023) .Respones Seeds Production of Broad Bean to Foliar Spray with Magnesium and Boron .Iraqi Journal of Agricultural Sciences 54(1) :229-234.
6. Al-wattar,M .J. M and Al-Hamdani, K .M. (2021). Efficiency of Salicylic Acid Application on growth and yield of chickpea (*Cicer arietinum L.*). Euphrates Journal of Agriculture Science-13 (4): 124-135.
7. Carmen, M. A; Z. J. Carmen; S.Salvador ; N. Diego ; R. M. Maria Teresa, and T.Maria (2005).Detection for agronomic traits in faba bean (*Vicia Faba L.*). Agric.Conspectus Sci., 70(3) :17-20.
8. Fadil ,A. H. .and Jader, J.J. (2020). The Effect of Foliar Spraying with Boron and Chelating Iron on Growth and yield of Broad Bean((*Vicia Faba L.*).Plant Archives Vol.20, Supplement 1,pp 425-430.
9. Hussein, S.A.& Al-Doori, M.F.(2021). The Effect of Spraying With Calcium, Boron and

Benzyl Adenine on The Quantity and Quality of Yield for Strawberry Plants (Fragaria Ananassa Duch) CV.Rubygem .In IOP Conference Series:Earth and Environmental Science (Vol. 910,No.1, p012066)).IOP Publishing.

10. Kundson, L.L., Tabbitts ,T.W.,and Edwards ,G .E .(1977).Measurement of ozone injury by determination of leaf chlorophyll concentration .plant physiology ,60(4),606-608.
11. Mady, M. A. and Abou El-Yazied ,A (2012). Efffect of Boron and Yeast Extract Folair Application on Growth,Pod setting and both green Podand seed yield of broad bean (*Vicia Faba L*). Jounral of Applied Sciences Research ,8(2) :1240-1251.
12. Mengel .K and Arneke .W.W. (1982).Effect of potassium on the water potential ,the pressure potential, the osmotic potential and cell elongation in leaves of (Phaseolus vulgaris) .Plant physiology,54 (4),402.
13. Lateef, M .A .A., Fadil, N .N.,& Mohammed ,B .K. (2021, November).Effect of Spraying With Cal-Boron and Potassium Humate and Maturity Stage on Fruit Quantity,Quality Characteristics of Apricot Pruns Armeniaca L.CV . “Royal”. In IOP Conference Series:Earth and Environmental Science(Vol.910,No.1, p012038).IOP Publishing.
14. Natalia Gutierrez., C. M ,Avail., M.T, Moreno., and A.M,Torres(2008). Development of SCAR markers linked to zt-2, 0ne of the genes controlling absence of tannins in faba bean ,Aust J of Agric .Res .,59 pp62-68.
15. Prakash, R.R.K Yadav, Mohit Gupta and Satya Prakash. (2019).Effect of foliar spray of plant growth regulators on growth and yield of mung bean (*Vinga radiate L.*) . Journal of pharmacognosy and phytochemistry , 8(6):1092-1094.
16. Rasheed, S. M. S .(2018) . Effect of Salicylic and Ascorbic acid on Growth ,Green yield of two Broad bean Gultivars(*Vicia Faba L* .).ZANCO Journal of Pure and Applied Sciences ,The official scientific journal of Salahaddin University –Erbil ,ZIPAS.30(5);71-88.
17. Sadik , K. S ; A .A Al-Taweel ;N.S.Dhyeab and M.Z Khalaf (2011) . New computer program for estimating leaf area of several vegetable crop .Amer-Eur J .of Sust. Agric , 5(2) : 304-309.