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Article

Effect of spraying boron and vitamin B6 nanominerals on mung bean growth (Vigna radiate L.)

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Abstract

A field experiment was carried out in the experimental field of the Department of Field Crops Sciences - College of Agricultural Engineering Sciences - University of Baghdad during the summer season of 2021 to study the effect of spraying nano-mineral boron and vitamin B6 on the growth of mung bean crop. The experiment was carried out in the order of the factorial trials according to the RCBD randomized complete block design and with three replications. The first factor included spraying nano-boron at two concentrations (100 and 150 mg. l^{-1}) and metallic boron at a concentration of 100 mg. l^{-1}, as well as the comparison treatment (spraying with water only). In comparison, the second factor included spraying Vitamin B6 in three concentrations (100, 150 and 200 mg. l^{-1}) and the comparison treatment (spraying with water only). The results indicated that the concentration of 100 mg. l^{-1} boron nanoparticles exceeded by giving it the highest averages for plant height, number of bacterial nodes, number of branches, number of leaves, leaf content of chlorophyll, number of flowers, number of pods, the lowest average for the percentage of precipitation and the highest average for the fertility rate, compared to the control treatment that gave the lowest averages. The results also showed that the concentration exceeded 200 mg. l^{-1} of vitamin B6 by giving it the highest average for each of the plant height, number of bacterial nodes, number of branches, number of leaves, leaf content of chlorophyll, number of flowers, number of pods, the lowest drop percentage and the highest fertility rate as compared to the comparison treatment that gave the lowest averages. The interaction significantly affected the concentrations of boron and vitamin B6, as the combination gave 100 mg. l^{-1} of nano-boron with 200 mg. l^{-1} of vitamin B6, the highest average for plant height and number of bacterial nodules reached 151cm and 12.53 plant $node^{-1}$ compared to the comparison treatment, which gave the lowest average. Combining 100 mg. l^{-1} of nano-boron with 100 mg· l-1 of vitamin B6 gave the highest average number of branches and flowers compared to the comparison treatment, which gave the lowest average.

Keywords: boron, nanospray, vitamin B6, mung bean.

Introduction

Mung bean is one of the important summer leguminous crops as it is a cheap source of protein, as the percentage of protein in its seeds is estimated at (29-20)%, and it contains carbohydrates, vitamins and mineral elements, and it is rich in the amino acid lysine, which most seeds of other leguminous crops lack, which makes

the crop of nutritional importance It is also used as animal feed because its dry leaves contain protein ranging[1] between (13-21%). the importance of the crop, its productivity is still low for several reasons, including the falling off of newly formed flowers and pods, reaching more than 75% due to the decrease or failure of the pollination and fertilization process, and this negatively affects production[2]. Therefore, researchers turned to find ways to provide the elements and vitamins of great importance to the plant by spraying them on the vegetative system, including boron, which has an important role in the division and formation of new cells active for growth such as new leaves and buds through the transfer of active hormones to the ends of the plant and helps in the development and contract of flowers and cell division As well as its role and contribution to the transfer of carbohydrate compounds to the active areas of growth during the reproductive stage of the plant, increasing the efficiency of plant absorption and the formation of pectin, which is important for building the cell wall and forming the pollen tube, and increasing and success the percentage of the fertility rate[3] Despite the importance of boron, it is a slow element Movement in the plant and it must be available during the stages of plant growth using nanotechnology that operates at the lowest possible size and quantity of minutes and increases the transmission and absorption of nutrients because it shows properties of materials that differ from the original materials when they are in their traditional dimensions of more than 100 nanometers and have the ability to provide elements more than It is provided by ordinary particles due to its production of particles of small size and large surface area that lead to increased practicality Photosynthesis and an increase in the absorption surface and thus lead to an increase in production at the qualitative and quantitative levels[4] As for vitamin B6, which is one of the important vitamins in the formation of natural hormones inside the plant and the formation of the amino acid tryptophan, which affects the formation of auxin and contributes to the activation of roots, vegetative growth and the development of flowers and has the ability to increase production by regulating physiological processes and activating vital activities within cells and improving the efficiency of representation Photosynthesis improves cell growth and differentiation and increases plant nutrient uptake[5,6] observed that the treatment of mung bean crop with borax achieved a significant increase in plant height, number of branches, number of leaves and number of bacterial nodules, which reached 53.60 cm, 6.76 plant branch^{-1}, 21.16 plant leaf^{-1}and8.80 plant node^{-1}compared to the comparison treatment that It gave the lowest averages of 42.26 cm, 6.20 plant branch^{-1}, 18.93 plant leaf^{-1} and 5.53 plant node^{-1}sequentially. It was found[7] when experimenting to know the effect of spraying with nano and metallic boron at concentrations (0, 90, 180) mg. l^{-1} a significant increase in the characteristics of vegetative growth, as the combination gave 90 mg. l^{-1} nano-boron with 90 mg. l^{-1}mineral boron, the highest average. The height of the plant and the number of branches reached 101.83 cm and 24.33 plant branch^{-1} in sequence. In contrast, the comparison plants (without spraying) gave the lowest averages of 83.73 cm and 17 plant branch^{-1}. While[8] indicated when they conducted an experiment spraying four concentrations of boron (0,25, 50, 75) mg. l^{-1} on the yield of beans, the superiority of plants treated with a concentration of 75 mg.l^{-1} by giving them the highest averages for vegetative growth characteristics, including an increase in the number of leaves and the content of Chlorophyll leaves and early flowering reached 84.97 plant leaf^{-1}, 44.03 spads sequentially. In contrast, the lowest average number of days from planting up to 50% flowering was 90.8 days compared to the comparison treatment that gave the lowest averages of 69.80 plant leaf^{-1}and 35.67 spad and more. Days from planting up to 50%

flowering reached 99.03 days. Evidence of[9] when experimenting during the two study seasons 2019-2020 to study the effect of spraying vitamin B6 on the bean yield in three stages (spraying in the growth stage of four to six leaves, spraying at the beginning of flowering and spraying in the stage of vegetative growth and flowering) as well as the comparison treatment Spraying with water only) was superior to the spraying of vitamin B6 in the vegetative growth stage by giving it the highest average plant height of 117.77 cm and 108.41 cm compared to the comparison treatment that gave the lowest average of 115.30 cm and 99.75 cm for both seasons. In contrast, the spraying of vitamin B6 was superior in the vegetative growth and flowering stage by giving it the highest average. The number of branches and leaf content of chlorophyll and the number of pods reached 9.1 plants branch^{-1},8.5 plant branch^{-1},29.27 mg g^{-1} wet weight leaves, 34.17 mg g^{-1} wet weight leaves, 18.67 plant pods$^{-1,}$ 26.78 plant pods^{-1} for both seasons by measurement With the comparison treatment that gave the lowest averages of 7.5 plant branch^{-1}, 7.3 plants branch^{-1}, 26.29 mg g^{-1} wet weight leaves, 20.65 mg g^{-1} wet weight leaves,14.22 plant pods^{-1} and 18.11 plant pods^{-1} sequentially.

Materials and Methods

A field experiment was carried out in the experimental field of the Department of Field Crops - College of Agricultural Engineering Sciences - University of Baghdad / Al-Jadriya, located within latitude 33 north and longitude 44 east, during the summer season of 2021, to study the effect of spraying nano, mineral boron and vitamin B6 on the growth of mung bean crop. The experiment was carried out by arrangement of factorial trials according to the RCBD randomized complete block design and with three replications. The first factor included the spraying of nano boron at two concentrations (100 and 150) mg. l^{-1} and metallic boron at a concentration of (100) mg. l^{-1}, as well as the comparison treatment (spraying with water only). The second factor included spraying vitamin B6 with three concentrations (100, 150 and 200) mg. l^{-1} and the control treatment (spraying with water only). At the rate of two sprays, the first was in the vegetative growth phase (2 to 4 leaves), and the second was when 75% of the plants of the experimental unit were in flower. The titration irrigation was carried out, and the experiment land was left for 5 days to dry the Soil. The land was prepared for planting by plowing well with a turntable plow, smoothing it with disc harrows and leveling it. Then, the experimental land was divided into experimental units. The area of the experimental unit was 6 m (2 m x 3 m), and a distance of 30 cm was left between each experimental unit to ensure that the treatments were not mixed during spraying. The experimental unit includes 7 lines. The distance between one line and another is 40 cm, and the distance between one plant and another is 30 cm so the plant density will be 83333 plants-1. Al-Dab fertilizer containing 18%N and 46%P was added at a rate of 140 kg ha^{-1} in one batch before planting according to the recommendations[11]. The seeds of the local variety (Khadhrawi) were planted on 7-15-2021 with a depth of 2 cm. The field was interwoven to avoid birds. After emergence, the plants were thinned out in the stage of 3-4 leaves, leaving one plant in the hole. Crop service operations were carried out, including hoeing, weeding, and irrigation as needed. The spraying process was carried out with mineral and nano boron and vitamin B6 according to the concentrations used in the early morning using a 16-liter dorsal sprayer. 4 drops of Al-Zahi were added as a diffuser to reduce the surface tension and increase the spray solution's efficiency in penetrating the leaf's outer surface.

Preparation of mineral boron:
The boric, which was in the form of powder, was prepared with a boron ratio of 99.5% boric acid by dissolving 4 gm in a liter of water to obtain a concentration of 1000 mg. l^{-1} as a standard solution and using the dilution equation, the concentration was prepared 100 mg. l^{-1} according to the following dilution law:
The volume is taken from the standard solution = (required concentration × required volume) / (concentration of the standard solution)
Preparation of nano-boron:
The nano-fertilizer was used for boron, a powder of Iranian origin that is completely soluble in water, consisting of 9% nano-boron, and it was taken at 100 mg. l^{-1} and 150mg.l^{-1}.

Preparation of vitamin B6:
The solution was prepared according to the required concentration in the laboratory of the Department of Field Crops - College of Agricultural Engineering Sciences - University of Baghdad by dissolving 4 g of vitamin B6, which was in the form of a powder, in water with the addition of 5 ml of 70% ethanol alcohol as an aid to dissolution, then completing the volume to One liter to get 1000 mg .l^{-1} as a standard solution and by using the dilution equation the concentrations (100, 150 and 200) were prepared as mg.$l^{-1}$and according to the following dilution law:
The volume is taken from the standard solution = (required concentration x required volume) / (concentration of the standard solution).

Studied traits:
Plant height (cm): represents the final average height of the five randomly selected plants and was measured by a graduated ruler from the soil surface level to the highest top of the main plant at harvest.

The number of bacterial nodules (plant node^{-1}) was calculated as an average of five plants chosen randomly from each experimental unit at harvest. The roots were extracted for the five samples referred to above, and the root nodules were counted with white color, which indicates their activity. Then, the average was extracted based on one plant[11].

Number of branches (plant branch^{-1}): The lateral branches on the main stem of each plant at harvest were calculated as an average of five plants from each experimental unit.

Number of Leaves (plant Leaf^{-1}): The number of leaves at harvest was calculated for an average of five plants per experimental unit.

Chlorophyll percentage in leaves (mg g^{-1} wet weight leaves): Chlorophyll a, b and total in leaves were measured at 100% flowering stage according to the method of Zaehringer et al., described in Goodwia (1976) using a spectrophotometer and it was measured the Central Laboratory for Soil, Water and Plant Analyzes / Department of Soil and Water Resources - College of Agriculture - University of Baghdad / Al-Jadriya.

Number of days from planting to flowering of 100% of plants: The number of days from planting day to flowering of 100% of the plants of the experimental unit was calculated.

Number of flowers (plant flower^{-1}): The number of flowers was calculated as an average of five plants randomly selected from each experimental unit from the beginning of their appearance until the stage of maturity and an average of five times a week.

The number of pods per plant (plantpod^{-1}) was calculated at harvest by dividing the total pods produced by the number of randomly selected plants, five plants from each experimental unit, and their average was recorded.

Precipitation percentage (%): It was calculated from the following equation: Precipitation percentage = 100% - effective fertility percentage (%).

Effective fertility percentage (%): represents the number of pods produced in a plant divided by the total number of flowers.
The data were statistically analyzed according to the RCBD randomized complete block design using the statistical program Genstat, and the arithmetic averages were compared using the L.S.D. test at a probability^{12} level of 0.05.

Results

Plant height (cm) and number of bacterial nodes (plant node^{-1}):

The results in Table 1 indicated that the concentration of 100 mg.l^{-1} of nano-boron was significantly superior by giving it the highest average plant height of 139.33 cm and an increase of 16% compared to the comparison treatment, which gave the lowest average plant height of 119.92 cm and the highest average number of bacterial nodules reached 10.24plant node^{-1}, with an increase of 40.08% compared to the comparison treatment, which gave the lowest average number of bacterial knots amounted to 7.31plant node^{-1}—enzymatic activity and enhancing the photosynthesis process, thus leading to an increase in the speed of reactions. As for the effect of spraying with vitamin B6 on plant height and number of bacterial nodules, the concentration significantly exceeded 200 mg. l^{-1} by giving it higher. The average height of the plant was 138.50 cm, with an increase of 14.46% compared to the comparison treatment, which gave the lowest average of 121 cm, and the concentration exceeded 200 mg. l^{-1} of vitamin B6.

Plant height (cm)					**number of bacterial nodules (plant node^{-1})**					
Boron concentration(mg .l^{-1})	**Vitamin B6 Concentration (mg. l^{-1})**				**Mean**	**Vitamin B6 Concentration (mg. l^{-1})**				**Mean**
	0	100	150	200		0	100	150	200	
0	110.33	117.33	121	131	119.92	4.47	10.10	4.67	10.00	7.31
100 metallic boron	118.33	123.33	131	137.67	127.58	9.20	9.00	9.27	8.00	9.75
100 Boron nano	129	132	145	151	139.33	11.87	5.70	10.87	12.53	10.24
150 Boron nano	126.33	130	132	134.33	130.67	4.07	7.40	12.13	8.27	7.97
L.S.D0.05	1.97				0.99	2.37				1.19
Mean	121	125.6	132	138.5		7.40	8.05	9.23	9.70	

		7		0						
L.S.D0.05	0.99					1.19				

Table1. Effect of spraying nano and mineral boron and vitamin B6 on the mung bean crop's height and number of bacterial nodules.

Significantly, the highest average number of bacterial nodules amounted to 9.70 plant node^{-1}, with an increase of 31.08% compared to the control treatment, which gave the lowest average of 7.40 plant node^{-1}. The increase is attributed to the role of vitamin B6 in regulating the process of photosynthesis and the primary substance for cell elongation and increasing the size of the vegetative system. It contributes to the development and activation of roots and their ability to absorb nutrients, form root nodes and increase their number because there is a relationship between bacterial nodes and the root system, and this result agrees with what he found. As for the interaction, the combination exceeded 100 mg. l^{-1} of nano-boron with 200 mg.l^{-1} of Vitamin B6 was significant by giving it the highest average plant height of 151 cm and the highest average number of bacterial knots amounted to 12.53 plant node^{-1} compared to the comparison treatment that gave the lowest average plant height of 110.33 cm and the lowest average number of bacterial knots amounted to 4.07 plant node^{-1}.

Number of branches (plant branch^{-1}) and number of leaves (plant Leaf^{-1}):
The results in Table 2 show that the concentration of 100 mg.l^{-1}of nano-boron was significantly superior by giving it the highest average number of branches that reached 13.58 plant branch^{-1} with an increase of 12% compared to the comparison treatment that gave the lowest average number of branches reached 12. 09 plant branch^{-1} and the highest average number of leaves. It reached 112.73 plant Leaf^{-1}, with an increase of 19.22% compared to the comparison treatment, which gave the lowest average number of leaves, which amounted to 94.55 plant Leaf^{-1}. Spraying boron by the nano method led to a high reaction speed. It increased the absorption of nutrients due to their absorption by the stomata and their diffusion through the cell membranes and capillary bases into the cells due to their large surface area and diameters ranging from (1-100) nanometers, which led to changes. Physiological and biological led to an increase in the efficiency of the leaves in carrying out a process.

Number of branches (plant branch^{-1})						**Number of Leaves (plant Leaf^{-1})**				
Boron concentration(mg .l^{-1})	**Vitamin B6 Concentration (mg. l^{-1})**				**Mean**	**Vitamin B6 Concentration (mg. l^{-1})**				**Mean**
	0	100	150	200		0	100	150	200	
0	9.47	12.83	13.20	12.88	12.09	92.00	96.30	94.67	95.23	94.55
100 metallic boron	11.27	12.20	12.60	12.47	12.13	70.20	106.00	109.67	99.00	96.22
100 Boron nano	10.53	15.73	13.20	14.87	13.58	86.27	114.00	129.67	121.00	112.73
150 Boron nano	10.13	10.68	12.80	15.27	12.22	85.47	96.97	86.73	127.00	99.12
L.S.D0.05	0.99				0.50	3.50				1.75
Mean	10.35	12.86	12.95	13.87		83.48	103.3	105.1	110.6	

							2	8	4	
L.S.D0.05	0.50					1.75				

Table 2. Effect of spraying nano and mineral boron and vitamin B6 on the number of branches and leaves of the mung crop.

As for vitamin B6, the concentration exceeded 200 mg. l^{-1} significantly by giving it the highest average number of branches, amounting to 13.87 plant branch^{-1}and an increase of 34% compared to the comparison treatment that gave the lowest average number of branches reached 10.35 plant branch^{-1}and the highest average number of leaves reached 110.64 plant Leaf^{-1} with an increase of 32.53% and the lowest average number of leaves was 83.48 plant Leaf^{-1}. The increase may be due to the role of vitamin B6 and its impact on vital and metabolic processes, including increasing the efficiency of photosynthesis and improving plant absorption of nutrients, which contributes to the growth and differentiation of cells and thus leads to an increase in the vegetative total and an increase in the number of branches and the number of leaves[5] and this result is consistent with what was found[31] The interaction had a significant effect, as the combination of 100 mg.$l^{-1}$of nano-boron with 100 mg.$l^{-1}$of vitamin B6 gave the highest average number of branches amounted to15.73 plant branch^{-1}compared to the comparison treatment, which gave the lowest average of 9.47 plant branch^{-1}. As for the number of leaves, the combination exceeded 100 mg. l^{-1}Nano-boron with 150 mg. $l^{-1}$of Vitamin B6 by giving it the highest average number of leaves amounted to 129.67 plant Leaf^{-1}compared to the comparison treatment that gave the lowest average of 92.00 plant Leaf^{-1}.

Leaf content of chlorophyll (mg g^{-1} wet weight leaves) and number of days from planting up to 100% flowering:

The results of Table 3 showed that there was a significant superiority, as the concentration of 100 mg. $l^{-1}$of nano-boron gave the highest average content of chlorophyll in leaves, which amounted to 1.867 mg g^{-1} wet weight leaves, with an increase of 19.60% compared to the comparison treatment, which gave the lowest average of 1.561 mg g^{-1} wet weight leaves. As for vitamin B6, it had a significant effect, as the concentration exceeded 200 mg. $l^{-1}$of the vitamin by giving it the highest average content of chlorophyll in leaves, which amounted to 1.980 mg g^{-1} wet weight leaves, with an increase of 50.90% compared to the comparison treatment that gave the lowest average of 1.270 mg g^{-1} wet weight leaves. The reason for the increase in the content of chlorophyll in leaves is due to the importance of vitamin B6 and its role in increasing the chloroplasts, which is positively reflected in the increase in chlorophyll content in leaves[5]. It had a significant effect, as the combination gave 150 mg. $l^{-1}$of nano-boron with 200 mg. l^{-1} of vitamin B6, the highest average content of chlorophyll in leaves was 2.341 mg g^{-1} wet weight leaves compared to the control treatment that gave the lowest average of 0.642 mg g^{-1} wet weight leaves. The results of Table 3 indicated that there was a significant difference, as the concentration of 100 mg. $l^{-1}$of mineral boron gave the least number of days to reach 100% flowering for mung bean plant, which amounted to 88.25 days, compared to the comparison treatment, which gave the greatest number of days until reaching 100% flowering, which amounted to 92.91 days. The reason may be due to the role of boron in giving it the least number of days up to 100% flowering because it speeds up the revitalization of vital processes and prepares the new growth sites with the elements necessary for the growth and integration of the plant and this result is consistent with what he found[34]As for vitamin B6, the concentration of 150 mg.$l^{-1}$was significantly superior by giving it

the lowest number of days up to 100% flowering, which amounted to 86.33 days, compared to the comparison treatment, which gave the most number of days up to 100% flowering, which amounted to 94.08 days. The reason for this is due to the importance of vitamin B6 in maintaining the growth and development of flowers, improving physiological processes inside the plant, and activating vital processes, which urges them to speed up flowering[21,23] As for the interaction between the concentrations of boron and vitamin B6, it had a significant effect, as the combination gave 100 mg.l^{-1}of mineral boron with 150 mg.l^{-1}, the least number of days up to 100% flowering, which amounted to 82 days, compared to the comparison treatment, which gave the most number of days, which reached 100 days.

Chlorophyll percentage in leaves (mg g^{-1} wet weight leaves)					**Number of days from planting to flowering of 100% of plants**					
Boron concentration(mg .l^{-1})	**Vitamin B6 Concentration (mg. l^{-1})**				**Mean**	**Vitamin B6 Concentration (mg. l^{-1})**				**Mean**
	0	100	150	200		0	100	150	200	
0	0.642	1.840	1.912	1.852	1.561	100	90.00	86.33	95.33	92.91
100 metallic boron	1.608	1.631	1.774	1.655	1.667	89.33	89.00	82.00	92.67	88.25
100 Boron nano	1.940	1.967	1.487	2.075	1.867	91.00	92.33	92.67	93.00	92.25
150 Boron nano	0.888	1.591	1.811	2.341	1.657	96.00	92.67	84.33	94.00	91.75
L.S.D0.05	0.926				0.463	6.38				3.19
Mean	1.270	1.757	1.746	1.980		94.08	91.00	86.33	93.75	
L.S.D0.05	0.463					3.19				

Table 3. Effect of spraying nano and mineral boron and vitamin B6 on the chlorophyll content of leaves and the number of days from planting up to 100% flowering of the mung plant.

Number of flowers(plant flower^{-1})and the number of pods (plant pod^{-1}):
The results in Table 4 indicated that there was a significant superiority, as the concentration of 100 mg.l^{-1}of nano-boron gave the highest average number of flowers that amounted to 137.44 plant flower^{-1}and with an increase of 9% compared to the comparison treatment that gave the lowest average number of flowers amounted to 126.06 plant flower^{-1}and the highest average of the number of pods reached 92.34 plant pod^{-1}, with an increase of 72% compared to the comparison treatment, which gave the lowest average number of pods amounted to 74.45 plant pod^{-1}. In order to stay longer, spraying boron in the nano method contributes to stimulating and encouraging hormones that activate the photosynthesis process inside the plant and significantly helps in the development of physiological and biological processes.

Number of flowers (plant flower^{-1})					**The number of pods per plant (plant pod^{-1})**					
Boron (concentration mg .l^{-1})	**Vitamin B6 Concentration (mg. l^{-1})**				**Mean**	**Vitamin B6 Concentration (mg. l^{-1})**				**Mean**
	0	100	150	200		0	100	150	200	
0	122.83	124.40	129.17	127.94	126.09	70.93	78.90	71.56	76.40	74.45

100 metallic boron	107.53	134.43	133.33	132.96	127.06	53.67	84.32	86.08	83.68	76.93
100 Boron nano	115.50	151.33	139.52	143.40	137.44	64.31	90.40	120.67	94.00	92.34
150Boron nano	110.67	117.22	130.39	149.00	126.82	57.39	80.41	66.24	116.67	80.18
L.S.D0.05	5.36				2.68	3.26				1.63
Mean	114.13	131.85	133.10	138.33		61.57	83.51	86.14	92.68	
L.S.D0.05	2.68					1.63				

Table 4. Effect of spraying nano and mineral boron and vitamin B6 on the number of flowers and pods of the mung bean plant.

The results also show that there is a significant superiority between the concentrations of boron and vitamin B6, as the combination gave100 mg. $l^{-1}$of nano-boron with 100 mg. $l^{-1}$of vitamin B6 had the highest average number of flowers of 151.33 plant flower^{-1}compared to the comparison treatment that gave the lowest average of 122.83 plant flower^{-1}. As for the number of pods, the results showed a significant superiority between the concentrations of boron and vitamin B6 if the combination was given 100 mg. l-1 of nano boron with 150 mg. l-1 of vitamin B6. The highest average number of pods was 120.67 plant pods^{-1} compared to 100 mg—l^{-1} Mineral boron treatment, which gave the lowest average of 53.67 plant pods^{-1}.

3.5. Precipitation and Effective Fertility Ratio (%):

The results in Table 5 confirmed that there is a significant superiority, as the concentration of 100 mg. $l^{-1}$of nano-boron gave the lowest precipitation rate of 33.43% compared to the comparison treatment, which gave the highest precipitation rate of 40.94% and the highest fertility rate of 66.57% compared to the comparison treatment, which gave the lowest fertility rate of 59.06%. The results of the table also show that there is a significant superiority when spraying vitamin B6 at a concentration of 200 mg.l^{-1}it gave the lowest precipitation rate of 33.37% and the highest fertility rate of 66.63% compared to the comparison treatment, which gave the highest precipitation rate of 46.12% and the lowest fertility rate of 53.88% The reason for reducing the percentage of precipitation and increasing the fertility rate may be due to the role of vitamin B6 and its ability to encourage and increase vital reactions and the formation of auxin important in the flowering process and increase the effectiveness of carbon metabolism for plant growth[5] The results also indicated that there was a significant superiority between the concentrations of boron and vitamin B6 if the combination gave 100 mg.l^{-1} of nano boron with 150 mg.$l^{-1}$of vitamin B6. The lowest precipitation rate was 20.09%, and the highest fertility rate was 79.91% compared to the treatment of 100 mineral boron, which gave a percentage of the highest precipitation rate was 49.99%, and the lowest fertility rate was 50.01%.

Plant height (cm)		**number of bacterial nodules (plant node^{-1})**		
Boron concentration	**Vitamin B6 Concentration (mg. l^{-1})**	**Mean**	**Vitamin B6 Concentration (mg. l^{-1})**	**Mean**

(mg .l-1)	0	100	150	200		0	100	150	200	
0	42.23	38.92	42.33	40.28	40.94	57.77	61.08	57.67	59.72	59.06
100 metallic boron	49.99	37.22	35.95	37.02	40.05	50.01	62.78	64.05	62.98	59.96
100 Boron nano	44.13	35.39	20.09	34.46	33.52	55.87	64.94	79.91	65.54	66.57
150 Boron nano	48.14	38.55	43.46	21.17	37.97	51.86	61.45	56.54	78.29	62.04
L.S.D0.05	2.90				1.45	2.93				1.47
Mean	46.12	37.52	35.46	33.37		53.88	62.56	64.54	66.63	
L.S.D0.05	1.45					1.47				

Table 5. The effect of spraying nano and mineral boron and vitamin B6 on the percentage of precipitation and the effective fertility rate of mung bean plant.

Discussion

When boron and nutrients are provided in the necessary quantities and appropriate concentrations, their spread in the roots and leaves increases the size of the vegetative system. It helps in the division and elongation of cells and the formation of bark and has a relationship with plant hormones that affect the growth of the tops of the stems.

It also improves the relationship between the number of nodes and the size of the root group. When it unites with sugar, it moves to the parts of the plant and forms new and active cells. It transfers active hormones to the extremities and its ability to benefit from the nitrogen obtained from the rhizobia. It has a role in building proteins and amino acids related to the increase and formation of Bacterial nodes [13]. This result agrees with [13 ،16, ،17, ،18 ،19].

However, Carbon metabolism and the transfer of carbohydrates from the source to the sink help form active sites for growth and increase the number of nodes on the stem and buds to develop into new branches [24 ،25، 26 ، 27 ، 28 ، 29]. The reason for the increase in leaf content of chlorophyll is due to the size of boron nanoparticles and their ability to penetrate cell pores and cell membranes and spread quickly to reach the functional work center and affect the process of respiration and carbon metabolism and the protoplasmic building process that enters into the synthesis of nucleic acids R.N.A. and D.N.A. necessary to increase chloroplasts and stimulate the enzymatic activities of chlorophyll synthesis and photosynthesis, and this is reflected positively on plant growth [30]; [31,] and this result is consistent with what was found [32].

Growth hormone Cytokinin has an important role in the process of fertilization and flowering, and this is reflected positively in the increase in the number of flowers because when boron is lacking, the newly formed flowers and pods Aborted and damaged due to competition for food[36,37,38] The results of the table also show that there is a significant superiority when spraying vitamin B6 at a concentration of 200 mg.l^{-1}, which gave the highest average number of flowers amounted to 138.33 plant flower^{-1}with an increase of 21.20% and the highest average number of pods reached 92.68 plant pod^{-1} with an increase of 50.52% compared to the comparison treatment that gave the lowest average number of flowers reached 114.13 plant

flower-1and the lowest average number of pods reached 61.57 plant pod-1. The reason for the increase may be due to the importance of vitamin B6 and its relationship to vital processes in addition to its role and ability to encourage and form the critical auxin in the flowering process and in improving and increasing fertilization and plant growth, and this led to increase in the number of pods and flowers38,39.

Moreover, the reason for reducing the precipitation rate and increasing the fertility rate may be due to the abundance of nano-boron sufficiently in the sensitive stages of plant growth and the properties that nanoparticles possess, the most important of which is ease of absorption, small size, large surface area and their ability to penetrate the cell wall, which leads to the encouragement and success of the nodes and the formation of ATP and the increase in the speed of sugars And moving them to the active growth areas because the abundance of food reduces competition between estuaries and flowers, and thus the percentage of precipitation decreases, the percentage of fertility increases and production increases. This result is consistent with what was confirmed by [40].

Conclusion

Among the results shown above, adding nano-boron instead of metallic boron is recommended because of its positive results in the growth characteristics of the mung bean crop and because of the characteristics of nanoparticles and increase the absorption surface due to their small size. It is possible to assimilate it more efficiently by the plant and enter it directly into cells and tissues. Plant and preferably spray vitamins to enhance foliar nutrition to support and improve the growth of mung.

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