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RESPONSE OF GROWTH AND YIELD OF MUNG BEAN (*VIGNA RADIATA* L.) TO FOLIAR APPLICATION WITH B1 VITAMIN (THIAMIN AND BORON)

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Abstract

Two field experiments were conducted in the spring and fall seasons of 2018 in the Sofiya area - Al-Ramadi district - Anbar province to study the effect of foliar application with four concentrations of thiamine (0, 150, 300, 450 $mg.L^{-1}$) and four concentrations of boron (0, 25, 50, 75 $mg.L^{-1}$) on growth, yield and quality characters of the mung bean crop (*Vigna radiata* L). The layout of the experiment was factorial experiments pattern using randomized complete block design (RCBD) with three replicates. The results showed that the concentration of 450 $mg.L^{-1}$ of thiamin (Vit. B1) gave the highest values of leaf area reached (713.9 and 726.5 cm^2), the number of pods per plant reached (44.07 and 45.92 $pod.plant^{-1}$), seed yield (1069.0 and 1086.7 $kg.ha^{-1}$) and protein percentage (26.33 and 25.87%) in both seasons respectively, the same concentration also gave lowest number of days from planting to 50% flowering, while the concentration of 300 $mg.L^{-1}$ gave the highest concentration of boron in leaves. The concentration of 75 $mg.L^{-1}$ of boron gave the highest mean of leaf area reached (601.6 and 610.9 cm^2), boron concentration in leaves, number of pods per plants (36.78 and 38.56 $pod.plant^{-1}$), number of seeds per pod and seed yield in fall season only (964.0 $kg.ha^{-1}$) and protein percentage (25.62 and 24.99%) in both seasons respectively. It also gave a lowest number of days from planting to 50% flowering. The interaction between the concentrations of thiamine and boron gave significant differences in the leaf area, the number of days from planting to 50% flowering and the number of pods per plant in fall season.

Key words **:** *Vigna radiate*, foliar application, B1 vitamin.

Introduction

The mung bean crop (*Vigna radiata* L.) is one of the leguminous crops grown in large areas and plays a distinct role in securing part of the requirements of human food security in light of the increasing numbers of the world's population, where the seeds contain a high percentage of protein ranging from 19-29%, carbohydrates ranging from 62-65% and other elements in different proportions as well as use of plants and seeds as animal feed. It is characterized by a short growth season (90-130) days and has a wide environmental range, as well as its high ability to increase soil fertility and improve its properties by stabilizing atmospheric nitrogen by rhizobium bacteria nodes (Ali *et al.*, 1990) and (Allahmoradi *et al.*, 2011). Despite the importance of this crop, but the rate of productivity in Iraq is still low compared to global production rate. Therefore, it is necessary to study all possible means that lead to raising productivity and improving quality, especially foliar application with vitamins and essential elements through use of diluted solutions and spray them on the vegetative plant parts at the appropriate dates and concentrations to meet the requirements of them. Thiamine B1 is one of the vitamins dissolved in water and has an important role in the biological activities of the plant cell and plays a large role in the resistance of the plant to the environmental stresses. This vitamin is easy to use and cheaply and quickly absorbed by the plant and is found in areas active in the growth of the plant, especially the leaves and then moved to the roots through the bark (Abu Alyazid, 2011). It is important in metabolic processes as a co-factor in Kreb's cycle (Thiamin Pyrophosphate) which stimulates and regulates plant growth (Bedour and Rawia, 2011). The Boron element is a micro-nutrient that plays a major role in the growth of flowering, cell division, pollen growth, increasing fertilization and transfer of carbohydrates to active areas growth during the reproductive phase of the plant. as well as its importance in the formation of protein through its role in the stabilization of air nitrogen in the soil with the presence of natural rhizobium bacteria or added to the soil with seeds (Bonilla *et al.*, 2009) and (Shaaban, 2010).

Based on the above, the aim of this study is to determine the best concentration of thiamine and boron and the best combination between them to achieve the best growth and the highest productivity and the best quality of mung bean crop.

Materials and Methods

Two field experiments were conducted in the spring and fall seasons of 2018 in the Sofiya area - Al-Ramadi district - Anbar province to study the effect of foliar application with four concentrations of thiamine (0, 150, 300, 450 $mg.L^{-1}$) and four concentrations of boron (0, 25, 50, 75 $mg.L^{-1}$) on growth, yield and quality characters of the mung bean crop (*Vigna radiata L*). using H_3BO_3 (17%B) as a source of boron. The layout of the experiment was factorial experiments pattern using randomized complete block design (RCBD) with three replicates. Experimental units and replicates were separated by a distance of 2m. The concentrations of thiamine were sprayed after 35 days of germination. While the boron concentrations were sprayed as first batch at the beginning of the flowering and the second at the beginning of the formation of the pods. The control treatment was sprayed with distilled water only. The plants were sprayed before sunset using a 15 liter knapsack sprayer and added 0.15 $ml.L^{-1}$ of Al-Zahi substance as a diffuser to reduce the surface tension of the water and ensure the total wetness of the leaves and increase the efficiency of the spray solution to penetrate the outside surface of the leaves (Abudahi *et al.*, 2001). The soil of the experiment was prepared by plowing, smoothing, pulverization and preparation of a furrows and then divided into experimental units, the experimental unit consisted of four furrows with length of the 4m and the distance between them 75cm and between seeds holes 25cm to become the experimental unit area 12m^2 (Almashadani, 2015). The first irrigation was conducted and the seeds were then grown in spring season on 26/4/2018 and the fall season on 16/8/2018 in the upper third of the furrow and at a depth of 2-3cm and using 4-5 seeds per hole. The seeds were covered with a light layer of soil. The irrigation process was done immediately after planting then irrigation process continued according to the need of the plant and the failed holes were replanting after one week of germination. Then the plants thinning was done to ensure the survival of one plant per hole. The weeds were removed from the experiment soil twice manually. The soil of the experiment was fertilized with the superphosphate fertilizer (46% P_2O_5) with 75 $kg.ha^{-1}$ before planting, while the nitrogen fertilizer was added as urea (46% N) with 40 $kg.ha^{-1}$ by two batches, the first at the planting and the second at the beginning of the flowering period (Ali, 2012).

Studied characters

1. Leaf area (cm^2. $Plants^{-1}$): The leaf area was measured in the pods formation stage according to equation (Baskaran *et al.*, 2009).

$LA = L \times W \times 0.66$

LA= leaflet area (cm^2).

L= leaflet length (cm).

W= maximum width of leaflet (cm).

In order to calculated the total leaf area the area of the total leaf is multiplied by the number of leaves in the plant.

2. Number of days from planting to 50% flowering: was calculated when the plants reached 50% of flowering.

3. Boron concentration in leaves (mg B kg^{-1} dry matter): Determined by digestion and then concentrations were read using a spectrophotometer (Bingham, 1982).

4. Pods number per plant: counted as the average number of pods in the ten plants taken from each experimental unit.

5. Number of seeds per pod: counted as the average number of seeds in the ten pods taken from each experimental unit.

6. Seed yield ($kg.ha^{-1}$): was counted by taking the rest of the plants in the experimental unit and add to the ten plants that were used in the study of previous characters and calculated based on experimental unit area and then converted to $kg.ha^{-1}$.

7. Seeds protein percentage (%): the determination of the protein percent was conducted by estimating the percent of nitrogen in the seeds using micro Kjeldhal device according to (AOAC, l990). Then the percentage of nitrogen was multiplied by 6.25 to obtain the protein seeds percent.

Statistical analysis: the experimental data were analyzed using the method of variance analysis using the Genstat program, using the least significant difference (LSD) at a 5% probability level to compare the treatments averages.

Table 1: Effect of foliar nutrition with thiamine and boron and interaction between them in the leaf area of the plant.

Fall Season						Spring Season					
Boron Mg L^{-1}					Thiamine Mg L^{-1}	Boron Mg L^{-1}					Thiamine Mg L^{-1}
Average	75	50	25	0		Average	75	50	25	0	
343.0	376.0	397.0	449.0	391.2	0	333.3	364.3	388.6	422.0	382.1	0
481.0	493.0	494.0	564.0	508.0	150	470.3	486.0	516.0	556.0	507.1	150
592.0	608.0	636.0	666.7	625.7	300	580.3	601.0	624.6	656.0	615.5	300
692.0	714.0	736.0	764.0	726.5	450	681.6	699.0	722.3	752.6	713.9	450
527.0	547.8	565.8	610.9		Average	516.4	537.5	562.9	601.6		Average
T= 12.06 B= 12.06 T×B= 24.12					L.S.D. 0.05	T= 5.085 B= 5.085 T×B= 10.170					L.S.D. 0.05

Results and discussion

Leaf area (cm^2.$plant^{-1}$)

The results of table 1, showed a significant increase in the values of the leaf area with increasing the level of foliar application with thiamin. The concentration of 450 mg.L^{-1} gave the highest value reached 713.9 and 726.5 cm^2 respectively, followed by the concentration of 300 mg.L^{-1} which gave 615.5 and 625.7 cm ^{2} respectively. While the control treatment recorded the lowest value of the leaf area reached 382.1 and 391.2 cm^2 in both seasons respectively. The increase in leaf area at high concentrations of thiamin may be due to the role of thiamin in increasing growth through its role in the meristematic cells activities of the vegetative group. This material effectively contributes to the increase of photosynthesis and the biological reactions within the plant cell, thus increasing cell division and duplication, which leads to increase the leaf area of the plant. This result is in agreement with results of (El-Tayeb, 1995) and (Hamada and Khulaef, 2000).

The concentrations of boron significantly affected the leaf area. The concentration 75 mg.L^{-1} gave the highest values reached 601.76 and 610.9 cm^2, while the lowest values obtained from control treatment which was 516.42 and 527cm^2 in both seasons respectively, the increase of leaf area values with increasing the level of foliar application with boron may be due to the positive role of boron in increasing the division of leaf cells and the and increase its number, which was positively reflected in the increase of leaf area (Dell and Huang, 1997) and (Allen and Pilbeam, 2006) or maybe the reason is that the concentration of 75 mg.L^{-1} gave the highest number of branches per plant and this was reflected positively in increasing the number of leaves in the plant and then increase the leaf area. These results are consistent with results of (Aldulaimi and Almohamdi, 2014).

There was a significant interaction between the of thiamin and boron concentrations which sprayed on the leaf plant in the leaf area, where the interaction treatment (450 mg.L^{-1} thiamine with a concentration of 75 mg.L^{-1} of boron), gave the highest values of this character reached 752.6 and 764.0 cm^2.$Plant^{-1}$ in both seasons respectively.

Number of days from planting to 50% flowering

The results of table 2, showed a significant effect of foliar application with thiamin on the number of days from planting to 50% flowering. The treatment of 450 mg.L^{-1} gave minimum number of days to reach 50% flowering reached 40.46 and 35.83 days compared to control treatment plants which required the largest number of days to reach 50% flowering reached 44.33 and 40.41 days in both seasons respectively. This may be due to that the plants sprayed with high concentrations of thiamin gave a large leaf area according results of (Table 1), which increased the net output of photosynthesis and this

Table 2: Effect of foliar nutrition with thiamine and boron and interaction between them of The Number of days from planting to 50% flowering in the plant.

Fall Season						Spring Season					
Boron Mg L^{-1}					Thiamine Mg L^{-1}	Boron Mg L^{-1}					Thiamine Mg L^{-1}
Average	75	50	25	0		Average	75	50	25	0	
43.66	40.00	40.66	37.33	40.41	0	46.33	44.67	43.33	43.00	44.33	0
41.33	38.66	38.33	35.00	38.33	150	43.00	42.67	42.67	43.67	43.00	150
39.66	37.33	35.66	35.33	37.00	300	42.33	41.33	40.33	40.67	41.17	300
37.33	36.00	35.66	34.33	35.83	450	42.00	42.00	40.33	37.57	40.46	450
40.50	38.00	37.58	35.50		Average	43.42	42.67	41.67	41.21		Average
T= 0.572 B= 0.572 T×B= 1.144					L.S.D. 0.05	T= 1.509 B= 1.509 T×B= N.S.					L.S.D. 0.05

Table 3: Effect of foliar nutrition with thiamine and boron and interaction between them of Boron concentration in leaves (mg B kg-1 dry matter).

Fall Season						Spring Season					
Boron Mg L^{-1}					Thiamine Mg L^{-1}	Boron Mg L^{-1}					Thiamine Mg L^{-1}
Average	75	50	25	0		Average	75	50	25	0	
13.47	14.60	16.13	17.03	15.31	0	12.97	14.27	15.63	16.50	14.84	0
14.30	16.07	17.47	17.47	16.32	150	13.60	14.73	15.33	16.03	14.93	150
14.60	17.57	17.77	18.97	17.22	300	13.57	16.27	16.90	17.67	16.10	300
14.77	15.60	17.30	17.40	16.27	450	13.60	14.70	16.37	16.43	15.28	450
14.28	15.96	17.17	17.72		Average	13.43	14.99	16.06	16.66		Average
T= 0.457 B= 0.457 T×B= N.S.					L.S.D. 0.05	T= 0.765 B= 0.765 T×B= N.S.					L.S.D. 0.05

led to the early arrival of plants to flowering due to the increased the flowering activities. This results is in agreement with results of (Hadeel, 2018).

Increased levels of foliar application with boron to a significant difference in the period from planting to 50% flowering reaching 41.21 and 35.50 days in plants sprayed with a high concentration of boron at concentration 75 mg.L^{-1} which did not differ significantly from the plants sprayed with a concentration of 50 mg.L^{-1} in the spring season only. While significantly different compared to control treatment which gave the highest duration of this character amounted to 43.42 and 40.50 days in both seasons respectively. This may be due to the role of the boron in increasing the activity of biological processes that help to accelerate the process of flowering in the plant, because this element facilitates the transfer of sugars in the plant through its interaction with sugars to produce the sugar complex with boron, whose movement through the cellular membranes easier than the movement of sugar molecules alone, which led to the processing of the new creation in the plant with nutrients necessary for growth (Fangsen, 2007). This may have led to early flowering and thus reduced the number of days from planting to 50% flowering. The results also showed that there was a significant difference between the interaction treatments between thiamine and boron concentrations in number of days from planting to 50% in the fall season only. The interaction between the high concentration of thiamin 450 mg.L^{-1} and high concentration of boron 75 mg.L^{-1} gave the lowest number of days to reach 50% flowering reached 34.33 days.

Boron concentration in leaves (mg B kg^{-1} dry matter)

The results of table 3, show that the concentration treatment of 300 mg.L^{-1} showed the highest concentration of boron in the leaves was 16.10 and 17.22 mg.L^{-1} (dry matter) which differed significantly from the other concentrations in which the control treatment recorded lowest value reached 14.84 and 15.31 mg.L^{-1} (dry matter). This may be due to that the high concentrations of thiamin lead to increased osmotic pressure in plant cells, especially leaves and this results in a decrease in the water potential of leaves cells, which increases their ability to absorb nutrients, including boron and thus increase its concentration. This result is consistent with results of (Schalan, 2010).

All levels of boron treatments showed a significant increase of boron concentration in leaves compared to the control treatment, the high concentration of treatment 75 mg.L^{-1} gave the highest value of this character reached 16.66 and 17.72 mg.L^{-1} (dry matter) in both seasons respectively followed by treatment of concentration 50 mg.L^{-1} which gave 16.06 and 17.17 mg.L^{-1} (dry matter). While the control treatment gave the lowest concentration

Table 4: Effect of foliar nutrition with thiamine and boron and interaction between them of Boron concentration in leaves (mg B kg-1 dry matter).

Fall Season						Spring Season					
Boron Mg L^{-1}					Thiamine Mg L^{-1}	Boron Mg L^{-1}					Thiamine Mg L^{-1}
Average	75	50	25	0		Average	75	50	25	0	
23.76	25.13	26.93	28.23	26.01	0	22.73	24.73	25.27	26.53	24.82	0
30.26	31.33	33.73	35.80	32.78	150	28.43	29.60	32.33	33.53	30.97	150
37.63	39.40	41.53	42.93	40.37	300	35.43	38.43	40.17	41.50	38.88	300
44.53	45.40	46.46	47.30	45.92	450	42.63	43.60	44.50	45.57	44.07	450
34.05	35.31	37.16	38.56		Average	32.31	34.09	35.57	36.78		Average
T= 0.532 B= 0.532 T×B= 1.065					L.S.D. 0.05	T= 0.828 B= 0.828 T×B= N.S.					L.S.D. 0.05

Table 5: Effect of foliar nutrition with thiamine and boron and interaction between them of Number of seeds per pod.

Fall Season						Spring Season					
Boron Mg L^{-1}					Thiamine Mg L^{-1}	Boron Mg L^{-1}					Thiamine Mg L^{-1}
Average	75	50	25	0		Average	75	50	25	0	
4.00	5.00	7.00	6.99	5.75	0	4.13	5.27	6.80	6.83	5.76	0
6.43	7.40	7.50	7.52	7.21	150	5.83	7.20	7.27	7.30	6.90	150
6.10	7.60	7.73	7.73	7.29	300	6.07	7.50	7.57	7.63	7.19	300
7.17	7.90	8.10	8.93	8.02	450	6.70	7.80	8.13	8.20	7.71	450
5.92	6.97	7.58	7.79		Average	5.68	6.94	7.44	7.49		Average
T= 0.786 B= 0.786 T×B= N.S.					L.S.D. 0.05	T= 0.958 B= 0.958 T×B= N.S.					L.S.D. 0.05

of boron in leaves was 13.43 and 14.28 mg.L^{-1} (dry matter). The increase of leaf area after foliar application with high concentration with boron (Table 1) may have increased the surface area exposed to the boron spray and increased absorption, this reflected on the increased its concentration in the leaves. This result is consistent with results of (Aldabbagh, 2017).

Pods number per plant

The results of table 4, indicate that the increase of thiamin concentrations has a significant increase in the number of pods in the plant, the concentration 450 mg.L^{-1} was superior by giving the highest mean of this character reached 44.07 and 45.92 pod.plant^{-1} followed by treatment of concentration 300 mg.L^{-1} which gave 38.88 and 40.37 pod.plant^{-1} while the control treatment recorded the lowest number of pods in the plant was 24.82 and 26.01 pod.plant^{-1} in both seasons respectively. This may be due to the important role of thiamin in the biological processes of the plant cell and plant resistance to environmental stress. also it is important in metabolic processes and is an important co-factor in Kreb's cycle (Thiamin Pyrophosphate) cycle, which activates and regulates plant growth. This was positively reflected in the increase in the number of pods in plants (19). This result was in agreement with results of (Abu Alyazid, 2011) and (Hadeel, 2018). The foliar application with boron significantly affected the number of pods in the plant. The highest concentration 75 mg.L^{-1} gave the highest value of this character was 36.78 and 38.56 pod.plant^{-1} by 13.38 and 13.24% compared to control treatment which gave the lowest number of pods in the plant was 32.31 and 34.05 pod.plant^{-1} in both seasons respectively. The increase in the number of pods in the plant when the increase of boron concentration may be due to the role of boron in the increase of flower fertility and pollens production and increase the process of fertilization in addition to its role in increasing the transmission of photosynthesis products to places of need in the plant, (Issa, 1990) show that the number of pods in the plant is a function of the rate of photosynthesis and the transmission of its products. This result is consistent with results of (Alsabbagh, 2015) and (Hamza *et al.*, 2016).

The results of table 4, showed that the interaction between the high concentrations of thiamin and boron resulted in increasing the number of pods in the plant in the fall season only. The interaction treatment between the concentration 450 mg.L^{-1} thiamin with a concentration of 75 mg.L^{-1} of boron gave the highest value of this character reached 47.30 pod.plant^{-1}.

Number of seeds per pod

The results of table 5, indicate that the high concentration of thiamin 450 mg.L^{-1} gave the highest number of seeds per pod reached 7.71 and 8.02 seed.pod^{-1} and did not differ significantly from the concentration of 300 mg.L^{-1}, which gave 7.19 and 7.29 seed.pod^{-1}. While the control treatment recorded the lowest number of this

Table 6: Effect of foliar nutrition with thiamine and boron and interaction between them of seeds yield in the plant.

Fall Season						Spring Season					
Boron Mg L^{-1}					Thiamine Mg L^{-1}	Boron Mg L^{-1}					Thiamine Mg L^{-1}
Average	75	50	25	0		Average	75	50	25	0	
643.3	731.0	697.4	772.7	711.1	0	588	688	718	723	679	0
661.4	712.8	707.5	857.5	734.8	150	779	789	791	796	789	150
880.5	915.7	940.9	1058.9	949.0	300	796	859	878	912	861	300
1030.5	1000.7	1148.7	1166.9	1086.7	450	1004	1058	1087	1125	1069	450
803.9	840.0	873.6	964.0		Average	792	848	868	889		Average
T= 53.40 B= 53.40 T×B= N.S.					L.S.D. 0.05	T= 154.7 B= N.S. T×B= N.S.					L.S.D. 0.05

Table 7: Effect of foliar nutrition with thiamine and boron and interaction between them of seeds protein percentage (%).

Fall Season						Spring Season					
Boron Mg L^{-1}					Thiamine Mg L^{-1}	Boron Mg L^{-1}					Thiamine Mg L^{-1}
Average	75	50	25	0		Average	75	50	25	0	
22.70	22.84	23.33	23.44	23.08	0	24.39	24.34	24.64	24.61	24.50	0
23.64	23.91	24.01	25.22	24.19	150	25.00	24.98	25.00	25.26	25.06	150
24.42	24.46	24.57	24.98	24.61	300	25.49	25.59	25.62	25.96	25.66	300
26.20	25.41	25.56	26.31	25.87	450	25.98	26.03	26.64	26.67	26.33	450
24.24	24.15	24.37	24.99		Average	25.21	25.24	25.48	25.62		Average
T= 1.017 B= 1.017 T×B= N.S.					L.S.D. 0.05	T= 0.322 B= 0.322 T×B= N.S.					L.S.D. 0.05

character 5.76 and 5.75 seed.pod^{-1} in both seasons respectively. The superiority of the high concentrations of thiamin in this character may be due to its superiority in the number of pods in the plant (Table 5), which was positively reflected in the increase in the number of seeds in pod. This result is consistent with results of (Faisal *et al.*, 2012). The foliar application with boron significantly affected the number of seeds per pod. The concentration 75 mg.L^{-1} gave the highest mean of this character reached 7.49 and 7.79 seed.pod^{-1} with an increase of 31.87 and 31.59% compared to the control treatment which gave the lowest values of seeds per pod reached 5.68 and 5.92 seed.pod^{-1} in both seasons respectively.

This may be due to the important role of boron in stimulating the biological and reproductive processes in the flowering stage, as well as increase the percentage of germination and stabilization of pollen tubers and reduce the abortion of eggs as well as its role in increasing the transfer of carbohydrates to areas of effective growth during the reproductive stage of the plant causing an increase in fertilization and then increase of seeds number per pod accordingly, because the percentage of fertility in flowers affected by several factors, including the genetic origin and nutrition (Allen and Pilbeam, 2006). This result is consistent with the results of other researchers who found a significant effect of boron in increasing the number of seeds per pod (Hossain and Khaled, 2017).

Seed yield (kg.ha^{-1})

The results of table 6, showed that the seed yield increased significantly with the increase in the level of foliar application with thiamin until it reached its highest average at the high concentration of 450 mg.L^{-1} which gave 1069 and 1086.7 kg.ha^{-1} followed by the concentration of 300 mg.L^{-1}, which gave 861 and 949 kg.ha^{-1} while the control treatment gave the lowest value of total seed yield was 679 and 711.1 kg.ha^{-1} in both seasons respectively. The increase in seed yield by increasing the concentration of foliar application with thiamin was a reflection of its significant effect in increasing the components of the crop, namely the number of pods in the plant and the number of seeds per pod (tables 4 and 5) respectively, which increased the total seed yield in the area unit. (Faisal *et al.*, 2012). The results of the same table showed that boron had a significant effect on the total seed yield in the fall season only. The high concentration of boron 75 mg.L^{-1} gave the highest value of this character reached 964 kg.ha^{-1} by 19.92% compared to control treatment which gave the lowest value of total seed yield reached 803.9 kg.ha^{-1}. This may be due to that the high concentration of boron 75 mg L^{-1} gave the highest average of crop components such as the number of pods in the plant (Table 4) and the number of seeds by pod (Table 5). This is positively reflected on the increase in total yield because seed yield is a function of its components. These results are consistent with the results of (Kaisher *et al.*, 2010) and (Makhlef, 2010).

Seeds protein percentage (%)

The results of table 7, indicated that the treatment of a high concentration of thiamin 450 mg.L^{-1} gave the highest protein concentration in the seeds reached 26.33 and 25.87% which differed significantly from the treatments of other concentrations, where the control treatment gave the lowest percentage of this character reached 24, 50 and 23.08% in both seasons respectively. This may be due to the positive role of thiamin in increasing the leaf area (Table 2) which increased the efficiency of photosynthesis and stimulate the enzymes responsible for protein creating, especially the nitrate reductase, which leads to the reduction of nitrates to nitrite and then to ammonium and then increase the protein percentage in seeds, because ammonium enters the formation of amino acids, which is the basic unit of protein production (Issa, 1990) and (Nedic *et al.,* 2001). This results is consistent with results of (Kozik, 2008) and (Abbod and Houri, 2017).

The results showed that there were significant differences between treatments of foliar application with boron in this character in the spring season only. Also the results showed that there was an increase in the percentage of protein in seeds with increased levels of boron and reached the highest percentage at a high concentration 75 mg.L^{-1} which was 25.62% and did not differ significantly from the concentration of 50 mg.L^{-1}, which gave 25.48%. While the control treatment gave the lowest protein percent in the seeds amounted to 25.21%. The increase in the percentage of protein is due to the important role of boron in the process of protein synthesis through its role in the determination of biological nitrogen fixation (Abodahi and Alayounis, 1988) as well as its effect in the process of DNA and RNA creation which is very important in the process of protein synthesis (Mahler, 2004). This result is consistent with results of (Singh, 2014).

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