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Research Article

Effect of Spraying with Boron and Phosphate Fertilization on Yield Traits Parameters in Two Dry White Bean Varieties (*Phaseolus vulgaris* L.)*

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Abstract

The study was carried out in the vegetable field of the Department of Horticulture and Landscape Engineering/College of Agriculture and Forestry/University of Mosul during the agricultural season spring 2021, to study the effect of spraying with boron and phosphate fertilization on flowering and seed production of two dry white bean varieties *Phaseolus vulgaris* L. Using two cultivars (Argentine, Iranian), and boron as boric acid (0, 25 and 50 mg.l^{-1} boron) and three levels of phosphate fertilizer as P_2O_5 (0, 20 and 40 kg.ha.$^{-1}$). The result indicated that Iranian cultivar was superior than Argentine in seed diameter (cm) and weight of 100 seeds. While the Argentine cultivar was significantly variable than Iranian in number of pods/plant, average weight of pod, number of seed per pod , seed length, number of seeds per plant, seeds weight per plant and seeds yield kg/ha.$^{-1}$, while boron at 25mg.l^{-1} gave a high significant value in number of pod per plant, number of seeds per plant, in other hands the concentration of boron at 50 mg.l^{-1} was significantly in average weight of pod, weight of 100 seeds, The interaction between cultivars argentine and 25 and 50 mg.l^{-1} boron caused significantly variability in pod number per plant, dry weight of pod, seeds number per pod, seed length , seeds number per plant seeds weight per plant and total seeds yield per ha. While interaction between argentine varieties and 20 and 40 kg/ha. of P_2O_5 was superiors in most traits. The interaction between boron at 50 mg/l. and 20 kg/ha. P_2O_5 gave significant value for number of pod per plant, pod weight, seeds weight/plant and total seeds yield/ha.

Introduction

The bean plant Phaseolus is one of the plants of the leguminous family Fabceae and its scientific name is (*Phaseolus vulgaris* L.), and the original habitat of the bean is South America (Hassan et al., 2003). The bean plant is one of the crops with a short growing season, where the time period from the emergence of germination (the emergence of seedlings) until the date of maturity and harvest is about 65 to 110 days, it gives a yield for the production of green pods and for the production of dry seeds at the end of June, and the second autumnal date is used only for the production of green pods starting from the end of August or the beginning of September and gives the yield of green pods in October and the second (Al-Rikabi and Al-Mishaal, 1981). The bean yield is consumed either in the form of green pods Physiologically immature or in the stage of physiological maturity at the stage of seed formation (dry crop), is important source of protein, calories, vitamins, minerals and fiber (Akcin, 1988). The dry seeds contain 20% protein (Fageria et al. 2011). It is an important food source, especially in developing countries, especially Iraq. Beans are leguminous vegetables. grown in different regions of the world, beans are sensitive to soil salinity and high concentrations of boron. Growth and dry yield (seed production) in beans are affected by many agricultural factors that have a direct impact on this, including good and suitable varieties for growth in the production area. In addition to nutrients, including the use of the element boron B, which is one of the small micro-elements and its characteristics are the small size of its atoms and the strength of its attraction in drawing electrons, and its presence in nature is rare and is found mainly in the form of crystals such as sodium crystals (borax) and pure borax, which contains 11.36% of boron, while B_2O_3 contains 26.55% (Al Rais, 1988). And its components are one of the important requirements used in genetic diversity in the community and clan. Early studies in beans showed that the genetic variation of seed yield and its components is an important factor in the breeding program (Dursum (2007), and Salehi et al., 2008). Boron also plays a major role in the process of pollination, fertilization, and also in increasing the rate of knots in flowers as a result of its effect on the vitality of pollen grains. It also has an important role in the developing tops, as it enters the processes of cell division and gathers in the leaves and reproductive organs (Al-Ta'i, 1989). Boron is one of the necessary micronutrients in plant growth and productivity and has a role in transporting food from the leaves to the storage areas. (H3BO3) or it may be adsorbed in the form of borates on the surfaces of clay colloids or dissolved in the soil solution (Al-Sahhaf, 1989). In addition, the phosphorous element, which is more concentrated in the seeds and fruits than in the leaves, plays a major role in the completion and maturity of the seeds in the pods at the stage of physiological maturity (Mohammed, 1985). Adams (1967) indicated that seed yield is a quantitative trait that is related to the characteristics of the number of pods per plant, the number of seeds per pod and the weight of seeds, as well as the interaction of quantitative yield components with physiological and morphological factors in the plant (Wallace et al. 1993). Santalla et al. (2002) in their study of a group of bean genotypes showed that there were significant differences among them in the characteristics of the pod represented by the length, diameter, weight and number of seeds per pod. Papa and Gepts (2003) showed that the studied bean cultivars varied in the color and shape of the seeds. Santalla et al. (2004) also found that bean cultivars varied among themselves in the characteristics of the number of seeds/pod, pod weight, pod length and diameter, dry seed yield, and seed length and width. From the study carried out by Sicard et al. (2005) to assess genetic diversity in beans, where they studied 23 strains or genetic composition and found that these structures differed among themselves in the characteristics of pod length and seed weight. Elias et al. (2007) indicated that the seed size in beans varies from one variety to another. Harmankaya et al. (2008) mentioned in their study of six genotypes of beans are differences among them in the characteristics of the weight of 100 seeds and the number of seeds per pod. Arunga et al. (2010) cited in their study For 25 genotypes of beans, these genotypes have varied in each of the number of days, number of pods, weight of pods for each plant, pod length and pod diameter. Iqbal et al. (2010) indicated that the studied bean cultivars differed significantly among themselves in the number of pods/plant, pod length, number of seeds/pod, and weight of 100 seeds. Palmero (2011) showed that when studied 17 genotypes of beans, they differed significantly in each of the length and diameter of the seed and the weight of 100 seeds. The results of Kazemi et al. (2012) showed in Iran on two cultivars of white beans, where the Shokofa cultivar was superior in seed yield kg/ha, seed yield/plant and harvest index over Danshekadeh cultivar the two cultivars did not differ significantly in number of branches/plant, and number of branches/plant. Pods/plant, number of seeds/pod, average weight of 1000 seeds (seed index) and biological yield (kg/ha). Yoseph et al., (2014) that the genotypes of beans varied in the characteristics of the number of pods/plant, the number of seeds/pod and seed yield. Lanna et al., (2016) in Brazil found that, when studying the physiological characteristics of beans and their response to water stress, they did not differ significantly in the characteristics of the number of seeds/pod and the number of pods/plant, but they differed significantly in the weight of 100 seeds, where perola gave the highest for this trait. Darkwa et al., (2016) in Ethiopia, in their studied evaluating 11 genotypes in beans, are significant differences for these structures for seed yield, number of pods/plant, and number of seeds/pod under high moisture soil conditions. Alemu et al., (2017) in Ethiopia, in their study to evaluate the association and path analysis of the yield of green pods and its components in the 36 genotypes of bean genotypes, indicated that there were significant differences in pod length and the diameter of the pod and the yield of Green pods/plant and were significant for 50% of germination traits and number of pods/plant. Darkwa et al., (2016) in Ethiopia, in their study evaluating 11 genotypes in beans, that there are significant differences for these structures for seed yield, number of pods/plant, and number of seeds/pod under high moisture soil conditions. Bagheri et al., (2017) obtained that bean cultivars vary among themselves in the number of seeds/pod and weight of pods/plant. Esho (2019) at Iraq where he studied the evaluation and performance of genetic parameters in 12 genotypes of beans, differed significantly among them in the diameter of the dry pod, the number of seeds/pod, the weight of the seeds/experimental unit, the length and diameter of the seed, the weight of 100 seeds and the yield of dry seeds / Hectare. Jasim and Esho (2020) indicated the genotypes of beans differed significantly between them in the number of pods/plant, the number of seeds per pod, the length and diameter of the seed, the weight of 100 seeds, the seed yield per plant and the seed yield per dunum. Goldbach et al., (2001) indicated that when the boron element was sprayed on the bean plant, it led to a significant increase in the yield of seeds and its components per unit area. Harmankaya et al., (2008) showed in their study that adding boron to soil and spraying on bean plants led to significant increases in the number of pods per plant, the number of seeds per pod, the weight of 100 seeds, and an increase in seed yield per unit area. Abd El-Azeem et al., (2014)) indicated that when spraying boron at concentrations of 50 ppm, it caused significant increases in the number of pods in peas, pod weight/plant, pod weight and dry seed yield compared to untreated plants. Jasim and Obaid (2013) found that the levels of fertilization by spraying with boron, marine extracts, phosphate and potassium caused increases in dry pods weight, number of seeds/pod, weight of 100 seeds, seed yield/plant and total yield per unit area, and that boron treatment led to significant increases in all studied traits, the interaction between the factors caused significant effects on dry weight of pods, number of seeds/pod, weight of 100 seeds, seed yield/plant, seed yield per unit area, and protein. Hemantaranjan et al., (2016) obtained from their study when treating bean plants with concentrations (0, 2 and 3 mg boron/kg of soil) that a concentration of 2 mg/kg of soil gave the best results in seed yield for each plant per unit area and in seed characteristics. El_Dahshouri (2017) showed that seed yield and yield components in dry beans increased significantly by spraying each of calcium and boron before or after flowering compared to control treatments during the growing season and seed yield was significantly increased by using 2500 calcium and 250 boron compared to untreated plants. Hamouda et al. (2018) found that when they studied the effect of levels of zinc and boron 250 ppm, 500 ppm the results indicated that spraying with zinc and boron had a significant positive effect on the components of the yield are represented by the number of seeds/pod, the weight of 100 seeds, and the seed yield per feddan compared with the untreated treatments. AL_Edany and AL_Lamy (2019) obtained in their study the effect of organic fertilizer and spraying with boron on the seed yield and its components in bean plant, where they used four levels of organic fertilizer which are (0,25,50,75) g/liter with boron spraying at levels (0,25,50). The addition of organic fertilizers led to significant increases in the number of pods/plant, pod length, number of seeds/pod, weight of 100 seeds, and total seed yield. The addition of boron to significant increases in yield traits gave a concentration of 75 ml/liter. Significant increases in number of pods/plant, pod length, weight of 100 seeds, number of seeds/pod and total yield. Several studies on boron spraying on bean plants indicated that there were significant increases in the number of seeds per pod, the weight of 100 seeds, and the seed yield per plant and per unit area (Camacho-Cristobal et al. 2008 on bean plant; Salehein and Rahman 2012, on bean plant; El- Waraky et al. 2013 in peas; and Mumtaz et al., 2014 on bean plant). Gajanan et al. (1990) studied by using phosphate rock, which tops the phosphate fertilizer in acidic soils 5.5 using 4 concentrations of phosphate, which is without phosphate - phosphate rocks - and phosphate sulfate that the yield of gournat increased by 6.15, 6.06, 7.24, 5.78 tons/hectare of grain yield. Also, Dwivedi et al. (1994) reported an increase in the number of seeds per pod of bean plant by increasing the levels of added phosphate from 50 to 150 kg P_2O_5/ha. Saxena an Verma (1994) obtained an increase in the number of seeds/pod by increasing the levels of phosphate fertilizer added from 0 to 120 kg/ha P_2O_5. and 60:90:120 N: P_2O_5 kg/ha in three levels gave the highest seed yield of 1.51 tons/ha. Rana and Singh (1998) indicated that the weight of the seeds/plant responded to the levels of phosphate fertilizer added, and the highest seed yield resulted when adding 100 kg P_2O_5/ha. Rana et al. (1998) indicated that when using four levels of N (0.40,80,120 kg/ha) and three levels of phosphate (0.50,100 kg/ha) caused significant increases in seed yield that were significant at the level of 100 kg P_2O_5/ha. Roy and Parthasarathy (1999) also indicated that the seed yield was high when 120 kg of phosphate was added compared to low levels, and in general, the increase in N-P-K levels or the increase in the ratio of nitrogen to phosphorus caused an increase in the yield of pods. Veeresh (2003) indicated a significant increase in the number of pods of bean plant when adding 75 kg P_2O_5/ha compared to the zero control. Singh et al., (2008) showed that the addition of phosphorous and inoculation with Rhizobia caused increases in seed yield in beans and in the yield indicators represented in the number of pods/plant, weight of 100 seeds and seed yield per unit area. Girma (2009) showed that nitrogen and phosphorous levels up to 27 kg/ha N, 69 P_2O_5 kg/ha, and 150 kg dap/ha caused increases in seed yield in beans. Kajumula et al. (2012) when adding levels of phosphorus 0-40-160 mg/kg phosphorous, a significant increase in seed yield under phosphorous levels was found, as it was found when adding 160 mg/kg phosphorous led to a significant increase in the number of pods/plant. The number of seeds / pod and seed yield kg / hectare, but it caused a decrease in the weight of 100 seeds, and the genotypes used varied among themselves in each of the number of pods/plant, number of seeds/pod, weight of 100 seeds, and seed yield kg / hectare as the composition outperformed the BAT477 genotype was determined in both the number of pods/plant and seed yield kg/ha, and the ANT22 genotype was superior to the rest of the genotype in terms of 100-seed weight. Rahman et al. (2014) indicated that spraying with N-P-K fertilizer at a concentration of 20:20:20 caused a significant increase in both the number of pods/plant, the number of seeds/plant, and the number of seeds/pod. Amare et al. (2014) indicated that phosphorous levels were increased from 0 to 40 kg P_2O_5/ha, caused significant increases in the weight of 1000 bean seeds. Deresa (2018) indicated when using 6 concentrations of N.P.S (0, 50, 100, 200, 250) kg/ha for three varieties of beans Nasir, lbado, Angar that there were significant increases in both the number of lateral branches/plant and the number of total pods at the level of 250 kg of N.P.S/ha, and the Angar cultivar gave a significant increase in the characteristics of the number of lateral branches and the number of pods/plant compared with the other two cultivars. As for the interaction between the cultivars, levels of N.P.S. the results showed that Naser cultivar with the level of 150 kg N.P.S gave higher plant height, while Abado cultivar at the level of 200 kg gave the highest increases in weight of 100 seeds and the highest seed yield recorded for Anger cultivar at the level of 250 kg N.P.S. Dejene et al. (2018) found when they used four levels of phosphorus (0, 10, 20, 30) kg/ha with four levels of CaCo3 (0, 0.9, 1.8, 2.7) tons/ha and found significant increases in the number of pods/plant and weight. 100 seeds and seed yield kg/ha for bean plant, where the concentration of 30 kg/ha of phosphorous gave the highest significant increases for these traits. Chekanai et al. (2018) found that the addition of nitrogen and phosphorous at a level of 20 kg/ha at the flowering stage caused increases in the activity of the number of bacterial nodules/plant and in seed yield and the interaction between N and P caused increases in seed yield. Also, Zebire and Gelgelo (2019) showed when using phosphorous fertilizer at levels (0, 23, 46 and 69 kg/ha) that the level of 46 kg/ha of phosphate fertilizer caused a significant increase in the number of pods per plant and the number of seeds per pod. Asefa (2019) found that when using different levels of phosphorous fertilizer (0, 23, 46) kg/ha, these treatments caused an increase in plant yield.

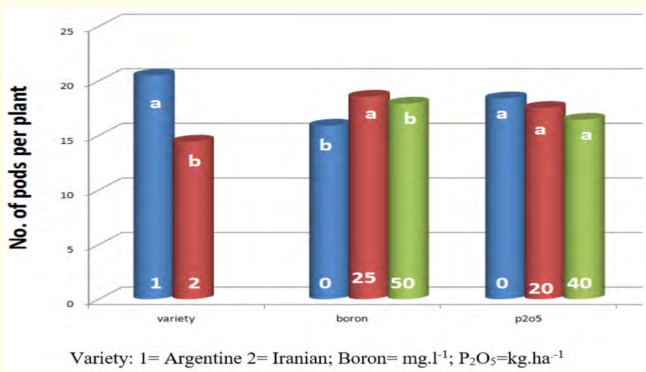
And due to the lack of studies and research on the appropriate varieties for dry production of beans for the environmental conditions in the city of Mosul, in addition to the effect of some mineral nutrients such as boron and phosphorous on the productivity of dry beans in the beans under the conditions of the city of Mosul, Iraq, we decided to carry out this study.

Materials and Methods

The study was carried out in the vegetable field of the Department of Horticulture and Landscape Engineering/College of Agriculture and Forestry/University of Mosul during the agricultural season spring 2021, the experimental field was divided by manual plow into experimental units. In terms of the area of the experimental unit (2.4 m^2) with the cultivation of an experimental unit at the beginning of each sector that was used as guard plants, the seeds of the two varieties of Argentine and Iranian dry beans were planted on 3/17/2021, where the seeds were placed in the hole from one to two seeds and covered with soil , by using o Drip irrigation system, to study the effect of spraying with boron and phosphate fertilizer on characteristics yield parameters in two white bean cultivars. The seeds of two Argentine and Iranian white bean cultivars (Esho, 2019) and three levels of boric acid were used, which are 0, 25 and 50 mg/L. And three levels of phosphate fertilizer P_2O_5 at 0, 20 and 40 kg/ha., so the experiment included 18 experimental units (2 x 3 x 3), and with three replications for each experimental unit, as the boron spraying process was carried out after the appearance of the second and third true leaf, and the second A second after 15 days from the first spray, and the third after 20 days from the second. As for phosphate fertilization, it was added once to all experimental units and to each repeater on 4/21/2021. The data were taken as an average of ten plants randomly from each experimental unit and for the three replicates on the characteristics of yiled parameters: number of pods per plant, the weight of the pod at extraction of seeds (gm), yield of pods per plant for seed extraction (gm), number of seeds per pod, length and diameter of seed (cm), weight of 100 seeds (gm), seeds yield per plant (gm) and for unit area kg/ha. The data were statistically analyzed by electronic computer and the (SAS, 2001) program was used in the statistical analysis and the averages were tested at the 5% probability level for Duncan's polynomial test (Steel and Torrie, 1980).

Results and Discussion

It is noted from Figure (1) that the cultivars have significantly outperformed each other in the number of pods per plant, where the Argentine cultivar significantly outperformed the Iranian variety, reaching 20.48 pods.plant^{-1}. As for spraying with boron, the concentration of 25 mg.l^{-1} gave the highest significant difference and reached 18,55 pods.plant^{-1}. As for fertilizing with phosphate fertilizer levels, it did not reach the significant level on the number of pods per plant It appears from Table (1) that the two interaction coefficients between the Argentine cultivar at a concentration of 25 mg.L^{-1} boron gave the highest number of pods per plant amounted to 23,28 and the lowest number of pods per plant was for the Iranian variety at a concentration of 25 mg.L^{-1} amounted to 13,82, The dual interaction coefficients between the Argentine cultivar and the different levels of phosphate fertilizer were significantly superior to the Iranian variety and the different levels of phosphate fertilizer. We note from table (1) that the dual interaction coefficients between the concentration of 25 mg.L^{-1} of boron and the concentration of 0 kg P_2O_5.ha^{-1} of phosphate gave the highest number of pods per plant, reaching 20.17 and did not reach the significant level with a concentration of 50 mg.L^{-1} of boron and 20 kg P_2O_5.ha^{-1} of phosphate, which also gave the highest significant difference, which amounted to 19.28 compared with the lowest number of pods per plant at a concentration of 0 mg.l^{-1} of boron and a concentration of 20 kg P_2O_5.ha^{-1} of phosphate, which amounted to 14.72, while the interaction The triple among the factors under study, the Argentine cultivar with a concentration of 25 mg.l^{-1} of boron and a concentration of 20 kg P_2O_5.ha^{-1} of phosphate gave the highest number of pods per plant amounting to 24,63 compared to the Iranian variety, which gave the lowest value in that at a concentration of 25 mg.l^{-1} of boron and 20 kg of P_2O_5. ha^{-1} of phosphate amounted to 12,53.



Variety: 1= Argentine 2= Iranian; Boron= mg.l^{-1}; P_2O_5=kg.ha.$^{-1}$.

Figure 1: Effect of spraying with boron and phosphate fertilizer on the number of pods per plant when extracting seeds for two white bean cultivars.

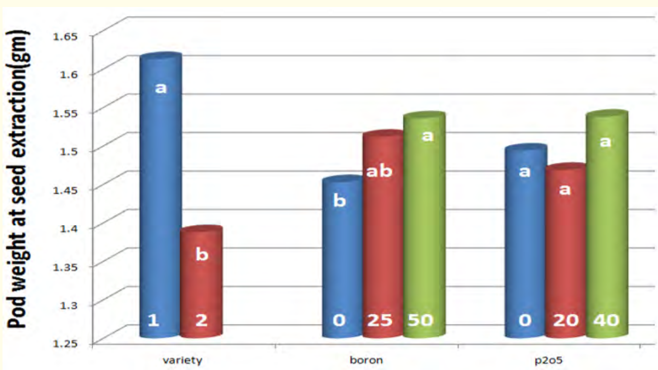
Variety	***Boron (mg.l^{-1})***	***P_2O_5 (kg.ha^{-1})***			***Variety x Boron***
		0	***20***	***40***	
Argentine	0	18.57a-d	16.80bd	18.40a-d	17.92bc
	25	24.21a	24.63a	21.00a-c	23.28a
	50	22.20ab	20.97a-c	17.53b-d	20.23ab
Iranian	0	14.17d	12.63d	14.83cd	13.88d
	25	16.13b-d	12.53d	12.80d	13.82d
	50	15.10cd	17.60a-d	14.10d	15.60cd

Interaction Boron x P_2O_5)	0	16.37ab	14.72b	16.62ab	
	25	20.17a	18.58ab	16.90ab	
	50	18.65ab	19.28a	15.82ab	
Interaction (variety x P_2O_5	Argentine	21.66a	20.80a	18.98a	
	Iranian	15.13b	14.26b	13.91b	

*The means at same alphabet are not significantly different from each other according to Duncan's polynomial test at the 5% probability level.

Table 1: The interaction between boron and phosphate fertilizer on the number of pods per plant when extracting seeds for two white bean cultivars*.

It is noted from Figure (2) that the Argentine variety has significantly superior in the average dry gourd weight, which reached 1.61296 gm, compared with the Iranian variety, which gave the lowest average dry gourd weight. We also notice from Figure (2) that spraying with boron had a significant effect on the average weight of the dry pod, as it gave the concentration 50 $mg.L^{-1}$ higher than the average weight of the dry pod, which amounted to 1.54 g. It is noted from the same figure that there is no significant effect of phosphate fertilization levels on this trait. It appears from table (2) that the bilateral interaction of the Argentine cultivar and spraying with different concentrations of boron produced the highest average weight of dry pod and it differed significantly with the same concentrations of the Iranian cultivar, and the treatment of the bilateral interaction between the Argentine cultivar and the different levels of phosphate fertilizer was superior compared to the Iranian variety and the different levels of phosphate fertilizer. Different from the phosphate fertilizer used, we notice from table (2) the interaction between the concentration of 50 $mg.L^{-1}$ of boron and 20 kg $P_2O_5.ha^{-1}$ of phosphate gave the highest significant difference in the mean dry weight of the pod, which amounted to 1.59 g, as for the triple interaction between the factors Under study, where the Argentine cultivar with a concentration of 50 $mg.l^{-1}$ of boron and 20 kg of $P_2O_5.ha^{-1}$ of phosphate gave the highest average dry pod weight of 1.68 gm compared with the rest of the treatments, while the lowest average weight of dry pod gave the Iranian variety at a concentration of 0 $mg.l^{-1}$ boron and 20 kg $P_2O_5.ha^{-1}$ of phosphate amounted to 1.22 g.



Variety: 1= Argentine 2= Iranian; Boron= $mg.l^{-1}$; P_2O_5=$kg.ha.^{-1}$.

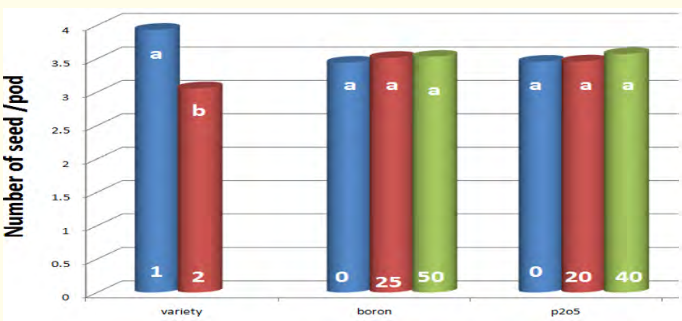
Figure 2: Effect of spraying with boron and phosphate fertilizer on the average weight of the pod (gm) when extracting seeds for two white bean cultivars.

Variety	*Boron (mg.l^{-1})*	*P_2O_5 (kg.ha^{-1})*			*Variety x Boron*
		0	*20*	*40*	
Argentine	0	1.53a-d	1.55a-d	1.63ab	1.57a
	25	1.67a	1.60a-c	1.63a-c	1.64a
	50	1.56a-d	1.68a	1.67a	1.63a
Iranian	0	1.37d-f	1.22f	1.42c-e	1.34b
	25	1.38d-f	1.27ef	1.51a-d	1.39b
	50	1.45b-e	1.50a-d	1.37d-f	1.44b
Interaction Boron x P_2O_5)	0	1.45a-c	1.38c	1.53ab	
	25	1.53ab	1.44bc	1.57ab	
	50	1.51a-c	1.59a	1.52a-c	
Interaction (variety x P_2O_5	Argentine	1.59a	1.61a	1.64a	
	Iranian	1.40b	1.33b	1.43b	

*The means at same alphabet are not significantly different from each other according to Duncan's polynomial test at the 5% probability level.

Table 2: The interaction between boron and phosphate fertilizer on the average weight of the pod (gm) when extracting seeds for two white bean cultivars*.

Figure (3) indicated that the Argentine cultivar gave the highest number of seeds per pod, reaching 3.93, and it differed significantly with the Iranian variety. The figure also shows that no significant differences were found in the number of seeds per pod at all levels of boron spray and phosphate fertilization. It appears from table (3) that the binary interaction of the Argentine cultivar at a concentration of 25 mg.L^{-1} gave the highest significant difference of 3.99, as it appears from the same table that the binary interaction between the cultivars and phosphate fertilization on this trait gave the Argentine cultivar a concentration of 40 kg P_2O_5.ha^{-1} From phosphate, the highest significant difference for the number of seeds per pod was 4.00, and the lowest number of seeds for the Iranian variety at a concentration of 20 kg P_2O_5.ha^{-1} amounted to 2.99, and there was no significant effect of the effect of the binary interaction between spraying with different levels of boron and different levels of phosphate fertilization. As for the triple interaction between the factors under study, there were significant effects, where the Argentine variety with a concentration of 50 mg.L^{-1} boron and 40 kg P_2O_5.ha^{-1} of phosphate gave the highest significant difference in the number of seeds per pod, which amounted to 4.07.



Variety: 1= Argentine 2= Iranian; Boron= mg.l^{-1}; P_2O_5=kg.ha.$^{-1}$.

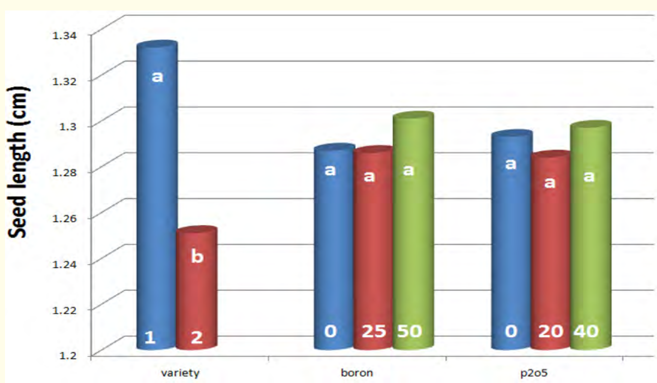
Figure 3: Effect of spraying with boron and phosphate fertilizer on the number of seeds in the pod when extracting seeds for two white bean cultivars.

Variety	*Boron (mg.l^{-1})*	*P_2O_5 (kg.ha^{-1})*			*Variety x Boron*
		0	*20*	*40*	
Argentine	0	3.73a	3.77a	3.96a	3.82a
	25	3.95a	4.06a	3.97a	3.99a
	50	3.95a	3.94a	4.07a	3.99a
Iranian	0	3.04b	2.93b	3.23b	3.06b
	25	3.02b	2.89b	3.21b	3.04b
	50	3.05b	3.18b	2.98b	3.07b
Interaction Boron x P_2O_5)	0	3.39a	3.35a	3.60a	
	25	3.48a	3.48a	3.59a	
	50	3.50a	3.56a	3.53a	
Interaction (variety x P_2O_5	Argentine	3.88a	3.92a	4.00a	
	Iranian	3.04b	2.99b	3.14b	

*The means at same alphabet are not significantly different from each other according to Duncan's polynomial test at the 5% probability level.

Table 3: The interaction of boron and phosphate fertilizer on the number of seeds in the pod when extracting seeds for two white bean cultivars*.

Figure (4) shows that the Argentine cultivar was significantly superior in terms of seed length of 1.33 cm compared with the Iranian variety, which gave the lowest seed length. It also did not reach the significance level for all levels of boron spray and all levels of phosphate fertilization in the length of the seed. Table (4) shows the binary interaction between the Argentine cultivar at a concentration of 50 mg.L^{-1} in the seed length, which reached 1.34cm, while the lowest seed length was for the Iranian variety at a concentration of 25 mg.L^{-1}, which amounted to 1.25 cm , It also appears from the same table that the binary interaction between the Argentine cultivar at a concentration of 40 kg P_2O_5.ha^{-1} of phosphate gave the highest seed length, while the lowest seed length of the Iranian variety at a concentration of 20 kg P_2O_5.ha^{-1}, which amounted to 1.24 cm, did not show any significant differences. In seed length at all levels of boron spray and all levels of phosphate fertilization for all treatments. As for the triple interaction between the factors under study, the Argentine variety with a concentration of 50 mg.l^{-1} boron and 20 kg P_2O_5.ha^{-1} of phosphate gave the highest seed length, which gave 1.35 cm, while the lowest seed length was for the Iranian variety at a concentration of 25 mg.l^{-1} boron and 20 kg P_2O_5.ha^{-1} of phosphate, which reached 1.23 cm.



Variety: 1= Argentine 2= Iranian; Boron= mg.l^{-1}; P_2O_5=kg.ha.$^{-1}$.

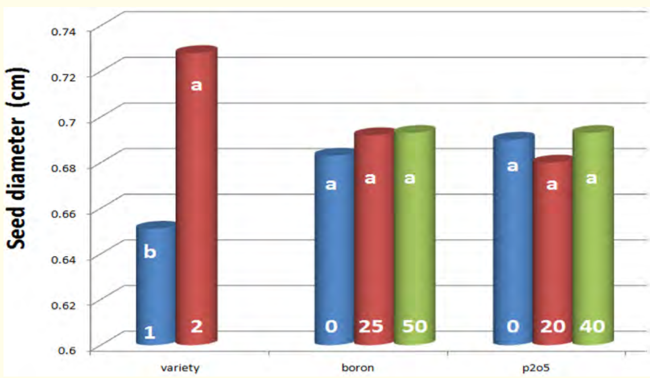
Figure 4: Effect of spraying with boron and phosphate fertilizer on seed length (cm) of two white bean cultivars.

Variety	*Boron (mg.l-1)*	*P_2O_5 (kg.ha-1)*			*Variety x Boron*
		0	*20*	*40*	
Argentine	0	1.33a	1.33a	1.32ab	1.33a
	25	1.33a	1.31a-c	1.33a	1.33a
	50	1.34a	1.35a	1.34a	1.34a
Iranian	0	1.25d	1.24d	1.25d	1.29b
	25	1.25d	1.23d	1.26cd	1.25b
	50	1.23cd	1.24d	1.27b-d	1.26b
Interaction Boron x P_2O_5)	0	1.29a	1.29a	1.29a	
	25	1.29a	1.27a	1.30a	
	50	1.30a	1.30a	1.31a	
Interaction (variety x P_2O_5	Argentine	1.33a	1.33a	1.33a	
	Iranian	1.25b	1.24b	1.26b	

*The means at same alphabet are not significantly different from each other according to Duncan's polynomial test at the 5% probability level.

Table 4: The interaction between boron and phosphate fertilizer on seed length (cm) of two white bean cultivars*.

Figure (5) shows that the Iranian variety was significantly superior in seed diameter, which reached 0.73 cm. As for the effect of spraying with boron, it gave the concentration 25 mg.L^{-1} and the concentration 50 mg.L^{-1}, which gave the highest significant difference in seed diameter compared to the concentration 0 mg.L^{-1}, which gave the lowest seed diameter. There were no significant differences in the diameter of the pod for all levels of phosphate fertilizer.



Variety: 1= Argentine 2= Iranian; Boron= mg.l^{-1}; P_2O_5=kg.ha.$^{-1}$.

Figure 5: Effect of spraying with boron and phosphate fertilizer on seed diameter (cm) for two white bean cultivars.

Table (5) shows the binary interaction between the Iranian variety at a concentration of 25 and 50 mg.L^{-1} boron, the highest seed diameter, which was 0.73 cm. It is also noted from Table (20) that the bilateral interaction between the Iranian variety and all phosphate levels was significantly superior in seed diameter compared with the Argentine variety for the same levels.

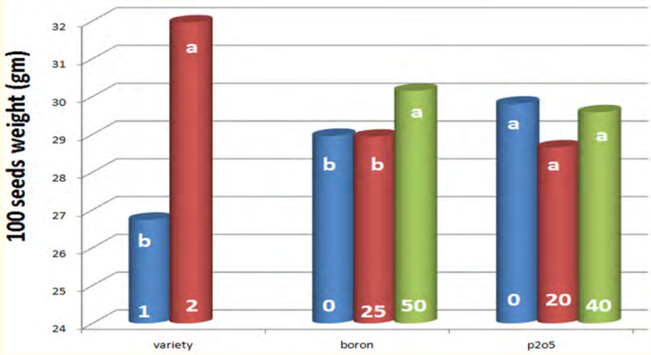
Variety	*Boron (mg.l^{-1})*	*P_2O_5 (kg.ha^{-1})*			*Variety x Boron*
		0	*20*	*40*	
Argentine	0	0.65d	0.64d	0.65d	0.65c
	25	0.65d	0.65d	0.65d	0.65c
	50	0.65d	0.65d	0.66d	0.65c
Iranian	0	0.72bc	0.71c	0.72bc	0.72b
	25	0.73a-c	0.72bc	0.75a	0.73a
	50	0.74ab	0.73ab	0.72bc	0.73a
Interaction Boron x P_2O_5)	0	0.69a-c	0.68c	0.69a-c	
	25	0.69a-c	0.69bc	0.70a	
	50	0.69ab	0.69ab	0.69ab	
Interaction (variety x P_2O_5	Argentine	0.65b	0.65b	0.65b	
	Iranian	0.73a	0.72a	0.73a	

*The means at same alphabet are not significantly different from each other according to Duncan's polynomial test at the 5% probability level.

Table5: The interaction between boron and phosphate fertilizer on seed diameter (cm) for two white bean cultivars*.

Figure (6) shows the superiority of the Iranian variety in weight of 100 seeds over the Argentine variety in this trait. Also, the boron spray treatment at a concentration of 50 mg.l^{-1} was significantly superior in weight of 100 seeds to the rest of the treatments and it reached 30,15 g. not all levels of phosphate fertilization reached the significant level by affecting the weight of 100 seeds. Table (6) shows that the dual interaction treatment between the Iranian cultivar at a concentration of 50 mg.L^{-1} wt produced the highest weight of 100 seeds, which reached 33.13 g, compared with the Argentine cultivar, which gave the lowest weight of 100 seeds at a concentration of 25 mg.L^{-1}, which amounted to 26,49 g. From the same table, it appears that the highest weight of 100 seeds resulted from the dual interaction treatment between the Iranian variety with a concentration of 0 kg P_2O_5.ha^{-1} and a concentration of 40 kg P_2O_5.ha^{-1} of phosphate, which amounted to 32.68 and 32.42 g, respectively.

As it appears from table (6) that the dual-concentration treatment of 50 mg.L^{-1} boron and 0 kg P_2O_5.ha^{-1} of phosphate gave the highest significant difference, which amounted to 30,83 g, and the lowest weight for 100 seeds resulted from the binary interaction treatment between 0 mg L^{-1} of boron and a level of 20 kg P_2O_5.ha.$^{-1}$ of phosphate fertilizer amounted to 27,81 g. The triple interaction between the factors under study shows that the highest significant difference resulted from the interaction between the Iranian variety at a concentration of 50 mg.l^{-1} boron and 0 kg P_2O_5.ha^{-1} of phosphate in 100-seed weight, which amounted to 34.65 g compared with the Argentine cultivar that gave The least significant difference at the concentration of 25 mg.l^{-1} boron and 20 kg P_2O_5.ha^{-1} of phosphate fertilizer was 25,31 g.



Variety: 1= Argentine 2= Iranian; Boron= $mg.l^{-1}$; P_2O_5=$kg.ha.^{-1}$.
Figure 6: Effect of spraying with boron and phosphate fertilizer on the weight of 100 seeds (gm) for two white bean cultivars.

Variety	***Boron ($mg.l^{-1}$)***	***P_2O_5 ($kg.ha^{-1}$)***			***Variety x Boron***
		0	***20***	***40***	
Argentine	0	26.67de	26.17e	26.81de	26.55c
	25	27.17de	25.31e	27.00de	26.49c
	50	27.00de	28.09ce	26.44de	27.18c
Iranian	0	32.45ab	29.60b-d	32.06ab	31.37b
	25	30.93bc	30.60bc	32.62ab	31.38b
	50	34.65a	32.17ab	32.57ab	33.13a
Interaction Boron x P_2O_5)	0	29.56ab	27.88b	29.44ab	
	25	29.05ab	27.96b	29.81ab	
	50	30.83a	30.19ab	29.51ab	
Interaction (variety x P_2O_5	Argentine	26.94c	26.52c	26.75c	
	Iranian	32.68a	30.79b	32.42a	

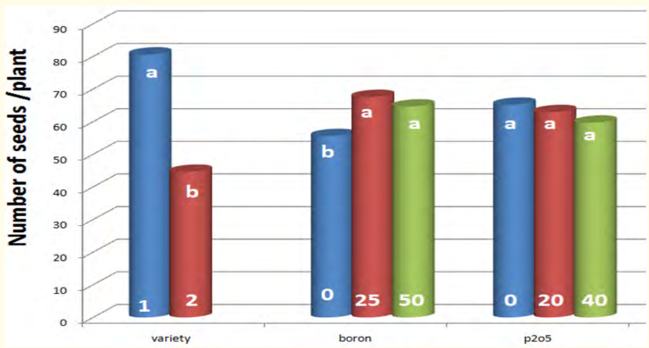
*The means at same alphabet are not significantly different from each other according to Duncan's polynomial test at the 5% probability level.

Table 6: The interaction between boron and phosphate fertilizer on the weight of 100 seeds (gm) for two white bean cultivars*.

Figures (1, 2, 3, 4, 5 and 6) showed that the cultivars varied among themselves in the traits of number of pods/plant, average weight of pod , length and diameter of the seed, the number of seeds per pod, and the weight of 100 seeds, as the Argentine variety achieved significant increases in the traits number of pod/plant , average weight of pod, seed length, and in the number of seeds per pod, While the Iranian cultivar was superior in seed diameter and 100-seed weight characteristics, these results may explain the genetic differences between the two cultivars in vegetative growth traits and pod traits that were discussed previously, as well as differences in the efficiency and adaptation of the two cultivars to the environmental conditions prevailing in the study area and an overlap between factors genetic and environmental influences on these traits are consistent with (Chung and Goulden 1971; Santalla et al. 2004; Elias et al., 2007; Harmankaya et al., 2008; Iqbal et al., 2010; Kamfwa et al 2015; Bagheri et al 2017; Lanna et al 2016; Esho 2019; Jasim and Esho 2020) who show in their studies that bean cultivars and genotypes vary with regard to the characteristics of the length and diameter of the seed, the number of seeds in the pod. The plants that were sprayed with a concentration of 25 and 50 $mg.l^{-1}$ of boron also produced increases in these traits (Harmankaya et al., 2008; Sharaf et al. 2009; Jasim and Obiad, 2013; El-Afifi et al. 2016; El-Dahshouri

2017; and Al-Edany and Al-Lamy 2019). The level of 20 or 40 kg of phosphate fertilizer P_2O_5 achieved the highest values in the length and diameter of the seed and in the number of seeds per pod. This result may explain the role of the important element phosphorus in plant growth, as it is included in the composition of the nucleic acids DNA and RNA carrying genetic factors in the plant, which have A direct effect on these traits, and phosphorous plays a major role in the metabolic processes that take place inside the plant to complete its life cycle. This result is consistent with (Dwivedi et al. 1994; Saxena and Verma 1994; Khan et al. 2003; Shivananda and Iyengar 2004; Singh et al. 2008; Al-Assafi 2010; Kajumula and Tryphone 2012; Rahman et al. 2014; Ayalew 2017; Chekanai 2018; Deresa 2018; and Dejene et al. 2016) whom indicated in their scientific study that Phosphate fertilizer levels lead to increases in the characteristics of seed length and diameter, the number of seeds per pod and the weight of 100 seeds. It also appears from the results of tables (3, 4, 5 and 6) that the Iranian bean cultivar intertwined with boron concentrations achieved the highest significant values in both seed diameter and 100-seed weight, while the Argentine variety with boron concentrations had increases in the trait. The number of seeds per pod and seed length. Phosphate fertilizer levels overlapping with the Argentine cultivar also achieved the highest significant values in the characteristics of seed length, number of seeds per pod. As for the bilateral interaction coefficients between the boron element and the levels of phosphate fertilizer, and the triple interaction coefficients between the studied factors have produced significant differences among them on these traits, the explanation of this may be due to the moral effect of the cumulative, cumulative and singular positive effect and also to the presence of an additional cumulative effect for each factor of The studied factors when they overlap together and the physiological role of boron and phosphate fertilizers.

It is noticed from Figure (7) that the Argentine cultivar has significantly outperformed the Iranian cultivar in the number of seeds per plant and produced the highest value of 80,613 seeds/plant.



Variety: 1= Argentine 2= Iranian; Boron= $mg.l^{-1}$; P_2O_5=$kg.ha.^{-1}$.

Figure 7: Effect of spraying with boron and phosphate fertilizer on the number of seeds per plant for two white bean cultivars.

Also, spraying with boron at a concentration of 25 $mg.L^{-1}$ and 50 $mg.L^{-1}$ gave the highest significant difference in the number of seeds for each plant. Not all levels of phosphate fertilizer reached the level of significance for this characteristic, Table (7) shows that the bilateral interaction between the Argentine cultivar produced the highest significant difference at a concentration of 25 $mg.L^{-1}$ boron and it reached 92.79 compared with the Iranian cultivar, which gave the least number of seeds for each plant at a concentration of 25 $mg.L^{-1}$ boron and It reached 42,40. It is also noted that the bilateral interaction between the Argentine cultivar gave the highest number of seeds for each plant at all concentrations of boron used in the study.

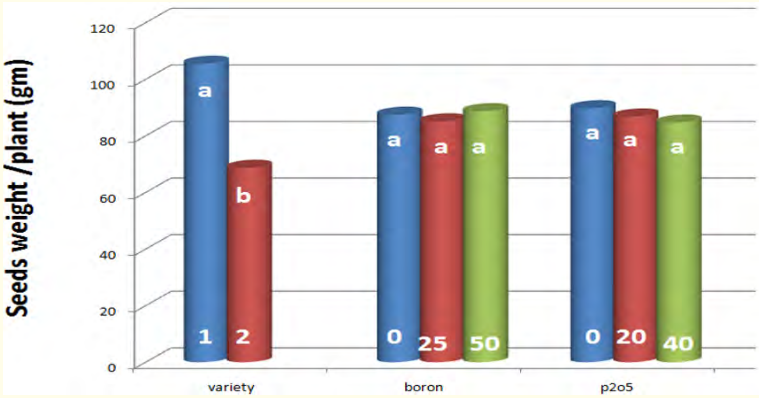
Variety	***Boron ($mg.l^{-1}$)***	***P_2O_5 ($kg.ha^{-1}$)***			***Variety x Boron***
		0	***20***	***40***	
Argentine	0	68.70b-e	63.34cf	72.92b-d	68.32c
	25	95.41a	99.97 a	82.99 a-c	92.79a
	50	88.21ab	82.63bc	71.33b-d	80.72b
Iranian	0	43.61fg	37.35g	47.90e-g	42.95d
	25	48.47e-g	37.35g	41.39fg	42.40d
	50	46.94 e-g	57.16d-g	41.76fg	48.62d
Interaction Boron x P_2O_5)	0	56.16ab	50.39b	60.41ab	
	25	71.94a	68.66a	62.19ab	
	50	67.58a	69.90a	56.55ab	
Interaction (variety x P_2O_5	Argentine	84.11a	81.98a	75.75a	
	Iranian	46.34b	43.96b	43.68b	

*The means at same alphabet are not significantly different from each other according to Duncan's polynomial test at the 5% probability level.

Table 7: The interaction between boron and phosphate fertilizer on the number of seeds per plant for two white bean cultivars*.

It is noticed from Table (7) that the dual interaction treatment at a concentration of 25, 50 $mg.L^{-1}$ boron and 0, 20 kg $P_2O_5.ha^{-1}$ of phosphate gave the highest significant difference in the number of seeds for each plant, which amounted to 71.94 and 69.90 g, respectively. As for the triple interaction between the factors under study, it is noted from the same table that the Argentine variety at a concentration of 25 $mg.L^{-1}$ boron and 20 kg $P_2O_5.ha^{-1}$ of phosphate produced the highest significant difference among all treatments, reaching 99.97 gm compared with the lowest significant difference of the variety Iranian at a concentration of 0 and 25 $mg.l^{-1}$ boron and 20 kg $P_2O_5.ha^{-1}$ of phosphate, which amounted to 37,35 and 37.35 g, respectively.

Figure (8) shows a significant superiority of the Argentine variety over the Iranian variety in the weight of seeds for each plant amounted to 105.50 g. As for the effect of boron concentrations and phosphate fertilizer levels, it did not reach the significant level on the characteristic of seed weight for each bean plant. It appears from table (8) that the dual interaction treatment between Argentine cultivar and spraying with different concentrations of boron produced the highest seed weight for each plant, and this differed with the same concentrations and for the Iranian variety. Also, the two interaction treatments between the Argentine variety and different levels of P_2O_5 phosphate fertilizer per hectare were significantly superior at the probability level of 5% compared with the Iranian variety and different levels of the phosphate fertilizer used. gloom.



Variety: 1= Argentine 2= Iranian; Boron= mg.l^{-1}; P_2O_5=kg.ha.$^{-1}$.

Figure 8: Effect of spraying with boron and phosphate fertilizer on the weight of seeds for each plant of two white bean cultivars.

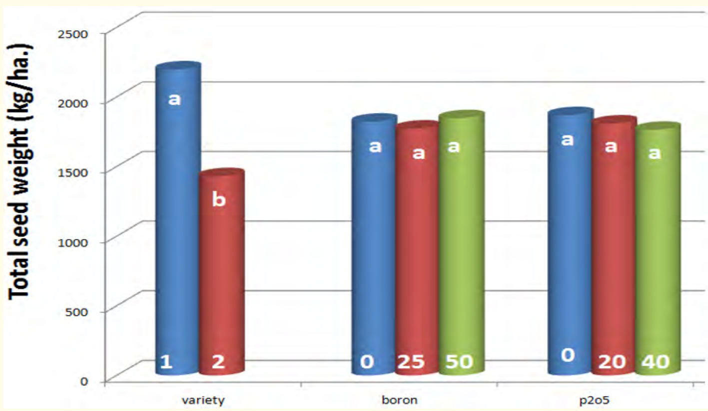
Table (8) also shows a significant superiority of the two interaction treatments at a concentration of 50 mg.L^{-1} boron and 20 kg P_2O_5.ha^{-1} of phosphate, which amounted to 98.53 g. as for the triple interaction treatments for the factors under study, it is noted that the Argentine variety for the concentration of 50 mg.L^{-1} boron and 20 kg P_2O_5.ha^{-1} of phosphate gave the highest significant difference for this trait, reaching 113.13 g, and the lowest weight resulted from the triple interaction treatment between the Iranian variety and 50 mg.l^{-1} of boron and 40 kg of P_2O_5.ha^{-1} amounted to 53.00 gm.

Variety	***Boron (mg.l^{-1})***	***P_2O_5 (kg.ha^{-1})***			***Variety x Boron***
		0	***20***	***40***	
Argentine	0	107.13ab	99.67a-c	101.8ab	102.87a
	25	111.00a	97.33a-d	111.40a	106.58a
	50	112.40a	113.13a	95.67a-d	107.07a
Iranian	0	67.80c-e	67.33c-e	81.13a-c	72.09b
	25	66.13c-e	59.60e	65.20de	63.64b
	50	74.07b-e	83.93a-c	53.00e	70.33b
Interaction Boron x P_2O_5)	0	87.47ab	83.50 ab	91.47ab	
	25	88.57ab	78.47ab	88.30ab	
	50	93.23ab	98.53a	74.33b	
Interaction (variety x P_2O_5	Argentine	110.18a	103.38a	102.96a	
	Iranian	69.33b	70.29b	66.44b	

*The means at same alphabet are not significantly different from each other according to Duncan's polynomial test at the 5% probability level.

Table 8: The interaction between boron and phosphate fertilizer on the weight of seeds for each plant of two white bean cultivars*.

Figure (9) shows that there is a significant superiority of the Argentine variety in the total seed yield over the Iranian variety, which produced 2197.99 kg.ha^{-1}. Also, there was no significant differences when spraying concentrations of boron and phosphate fertilizer levels at all concentrations. Table (9) shows that the binary interaction treatment between the Argentine cultivar and all boron concentrations gave the highest total seed yield in it, compared with the binary interaction treatments between the Iranian variety and all boron concentrations. And the dual interaction treatment between the Argentine variety and all the concentrations of phosphate fertilizer used has produced the highest value in it, compared with the Iranian variety, which produced the lowest yield in that at all levels of the phosphate fertilizer used in the study. Also, the binary interaction at a concentration of 50 mg.l^{-1} boron and 20 kg P_2O_5.ha^{-1} of phosphate gave the highest significant difference for the total seed yield, which was 2052.8 kg.ha^{-1} compared with the least significant difference that resulted from using a concentration of 50 mg. L^{-1} boron and 40 kg P_2O_5.ha^{-1} of phosphate amounted to 1548.6 kg.ha^{-1}. As for the triple interaction, we note that the Argentine cultivar with a concentration of 50 mg.l^{-1} boron and 20 kg P_2O_5.ha^{-1} of phosphate gave the highest total seed yield, which reached 2356.9 kg.ha^{-1}, and the least significant difference was for the Iranian variety at 50 mg.l^{-1}. Boron and 40 kg of P_2O_5.ha^{-1} of phosphate amounted to 1104.2 kg.ha^{-1}.



Variety: 1= Argentine 2= Iranian; Boron= mg.l^{-1}; P_2O_5=kg.ha.$^{-1}$.

Figure 9: Effect of spraying with boron and phosphate fertilizer on seed yield (kg/ha) for two white bean cultivars.

Variety	***Boron (mg.l^{-1})***	***P_2O_5 (kg.ha^{-1})***			***Variety x Boron***
		0	***20***	***40***	
Argentine	0	2231.9ab	2076.4a-c	2120.8ab	2143.1a
	25	2312.5a	2027.8a-d	2320.8a	2220.4a
	50	2341.7a	2356.9a	1993.1a-d	2230.6a
Iranian	0	1412.5c-e	1402.6c-e	1690.31a-e	1501.8b
	25	1377.8c-e	1241.7e	1358.3de	1325.9b
	50	1543.1b-e	1748.6a-e	1104.2e	1465.3b
Interaction Boron x P_2O_5)	0	1822.2ab	1739.6ab	1905.6ab	
	25	1845.1ab	1634.7ab	1839.6ab	
	50	1942.4ab	2052.8a	1548.6b	
Interaction (variety x P_2O_5	Argentine	2295.4a	2153.7a	2144.9a	
	Iranian	1444.4b	1464.3b	1384.3b	

*The means at same alphabet are not significantly different from each other according to Duncan's polynomial test at the 5% probability level.

Table 9: The interaction between boron and phosphate fertilizer on seed yield (kg/ha) for two white bean cultivars*.

From the figures we note (6, 7, 8 and 9) that the plants of bean cultivars have achieved a significant and different increase among themselves in the number of seeds per plant, the weight of seeds per plant, the seed yield of the experimental unit and the total seed yield per unit area, as the variety outperformed The Argentine over the Iranian in the number of seeds per plant, the weight of the seeds per plant, the seed yield of the experimental unit and the total seed yield. The explanation of these results for the superiority of the Argentine variety in these traits may be due to the influence of genetic factors carried by this variety in addition to the variety's adaptation to environmental conditions. Prevalent in the research implementation area in addition to the cultivar's growth strength, the number of pods per plant (Figure 4) respectively. This finding is consistent with several researchers (Adams 1967; Chandhla 2001; Sicard et al 2005; Arunga et al 2010; Kazemi et al 2012; Mulugeta et al 2013; Yoseph et al 2014; Kamfwa et al 2015; Correa et al. 2016; Brusamarello et al. 2017; Bagheri et al. 2017; Esho 2019; and Jasim and Esho 2020) who indicated in their studies that bean cultivars vary among themselves in the characteristics of the number of seeds per plant, seed weight per plant and The seed yield of the experimental unit and the total seed yield per unit area. Also, spraying bean plants with a concentration of boron achieved significant increases in the number of seeds per plant (Fig. 10), but it did not reach the significant level on the other traits. This result was consistent with (Singh et al. 1989; Goldbach et al. 2001; Camacho-Cristobal et al. 2008; Sharaf et al. 2009; El-Yazied and Mady 2012; Jasim and Obiad 2013; Abd El-Azeem et al. 2014; Mumtaz et al. 2014; Hemantaranjan et al. 2016; El-Afifi et al., 2016; and Al-Edany and Al-Lamy 2019) whose indicated in their studies that there was an increase in the characteristics of the number of seeds per plant, the seed yield per plant and the unit area in the bean plant. But on the other hand, it appears that the levels of phosphate fertilizer did not reach the significant level in these traits, noting that the level of 40 kg of P_2O_5 produced the highest non-significant values in it. This result was consistent with (Gemechu 1990, Dwivedi et al.,1994; Gupta et al., 1996; Rana et al. 1998; Roy and Parthasarathy 1999; Singh et al. 2008; Al-Assafi 2010; Kajumula and Tryphone 2012; Morad et al. 2013; Rahman et al. 2014; Kakon et al. 2016; Dejene et al. 2016; Ayalew 2017; Deresa et al. 2018; and Zebire and Gelgelo 2019). And the binary and triple interaction coefficients between the studied factors resulted in significant increases on these traits, as they varied among themselves by their effect on these traits. Explanation of this to the moral effect of the cumulative, cumulative and positive singular effect, as well as the presence of an additional cumulative effect for each of the studied factors when they overlap together, and the physiological role of boron and phosphate fertilizers.

Conclusion

Through the results obtained from this study, we conclude that the Iranian variety was better than the Argentine in some traits of the yield and its components, boron at a concentration of 50 mg/liter, and 20 kg P_2O_5 per ha. gave the best results for most of the studied traits, and he interaction between the Argentine variety and phosphate levels, or with boron concentrations, gave the best results for the studied traits.

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References

1. Al-Rikabi FH and Al-Mishal Abd J. Vegetable Production. Ministry of Higher Education and Scientific Research, Institute of Technical Institutes, Iraq (1981). (In Arabic)
2. Al Rayes Abd H. Plant Nutrition (parts 1 and 2). Dar Al-Kutub for Printing and Publishing, Republic of Iraq (1988): 253. (In Arabic)
3. Al-Sahhaf FH. Applied Plant Nutrition. University of Mosul - Ministry of Higher Education and Scientific Research - House of Books for Printing and Publishing, Iraq (1989). (In Arabic)
4. Al-Ta'I Taha Ahmed Alwan. Fertilizers and Soil Conditioners. Translator (Authorized by Roy Ig Follett, Larry S. Murphy and Roy L. Donahue). Ministry of Higher Education and Scientific Research, University of Salah al-Din, Directorate of Dar al-Kutub for

Printing and Publishing, University of Mosul (1989): 816. (In Arabic)

5. Muhammad Ezz-Al-Din Sultan. Vegetable seeds Production, Ministry of Higher Education and Scientific Research, University of Mosul, Directorate of Dar al-Kutub for Printing and Publishing, University of Mosul (1985). (In Arabic)
6. Al-Assafi RD. "Effect of phosphor us on improving yield and its components of cowpea selected by honeycomb". The Iraqi Journal of Agricultural Sciences 41.6 (2010): 21-28.
7. Abd El-Azeem KS., et al. "Evaluation of Faba Bean (Vicia faba L.) performance under various micronutrients foliar applications and plant spacing". Life Sci. J 11.10 (2014): 1298-1304.
8. Abd-Elaziz AA., et al. "Effects of Spacing, Humic Acid and Boron on Growth, Seed Production and Quality of Broad Bean (Vicia faba var major L.)". Alex. J. Agric. Sci 64.3 (2019): 207-217.
9. Adams MW. "Basis of yield component compensation in crop plants with special reference to the field bean, Phaseolus vulgaris". Crop Sci 7 (1967): 505-510.
10. Al-Edany AM and AL-Lamy SH. "Effect of organic manure and spraying with boron in seed yield and its components for broad bean (Vicia faba L.)". Plant Archives 19 (2019): 1229-1233.
11. Alemu YS. Alamirew and Dessalegn L. "Correlation and Path Analysis of Green Pod Yield and Its Components in Snap Bean (Phaseolus Vulgaris L.) Genotypes". International Journal of Research in Agriculture and Forestry 4.1 (2017): 30-36.
12. Amare G, A Demelash and Tuma A. "The response of haricot bean varieties to different rates of phosphorus at arbaminch, southern Ethiopia". ARPN Journal of Agricultural and Biological Science 9.10 (2014): 344-350.
13. Arunga EE, HA Van Rheenen and Owuoche JO. "Diallel analysis of Snap bean (Phaseolus vulgaris I.) varieties for important traits". African Journal of Agricultural Research 5.15 (2010): 1951-1957.
14. Asefa DZ and Gelgelo S. "Effect of phosphorus fertilizer levels on growth and yieled of haricot bean (Phaseolus vulgaris. L.) in south ommo zone, ethiopia (Vicia Faba Var Major L) Agric. Sci. Digest 39.1 (2019): 55-58.
15. Ayalew A. "Effects of varieties and micronutrients fertilization on the production of quality bean in selected areas of southern Ethiopia". food Science and Quality Management 6.1 (2017): 178-169.
16. Bagheri M, D Kahrizi and Zebarjadi A. "Study on genetic variation and morpho - phenolgic traits in common bean (Phaseolus vulgaris L.)". Biharean Biologist, Oradea Romania 11.1 (2017): 43-47.
17. Brady NC and Weil RR. "The Nature and Properties of Soils". Thirteenth edition, Prentice Hall, New Jersey (2002): 960.
18. Brusamarello AP., et al. "Performance of bean (Phaseolus vulgaris L.) genotypes in the second-season under high and low technology management in Parana, Brazil". Plant Breeding and Plant Genetic Resources. Acta Agron 66.3 (2017): 436-441.
19. Camacho-Cristobal JJ, J Rexach and Gonzalez-Fontes A. "Boron in plants: deficiency and toxicity". Journal of Integrative Plant Biology 50 (2008): 1247-1255.
20. Chandhla J. "Optmisation of dry bean (Phaseolus vulgaris L.) production under green house conditions". M.Sc. (Agronomy) (2001).
21. Chekanai V, R Chikowo and Vanlauwe B. "Response of common bean (Phaseolus vulgaris L.) to nitrogen, phosphorus and rhizobia inoculation across variable soils in Zimbabwe". Agriculture, Ecosystems and Environment 266 (2018): 167-173.
22. Chung JH and Goulden DS. "Yield components of haricot beans (Phaseolus vulgaris L.) grown at different plant densities". New Zealand Journal Agricultural Research 14.1 (1971): 227-234.
23. Corrêa AM., et al. "Selection of common bean (Phaseolus vulgaris L.) genotypes using a genotype plus genotype x environment interaction biplot". Genetics and Molecular Research 15.3 (2016): 179-189.
24. Darkwa K., et al. "Evaluation of common bean (Phaseolus vulgaris L.) genotypes for drought stress adaptation in Ethiopia". The Crop Journal 4 (2016): 367-376.
25. Davies BE. ed. Applied soil trace elements Chichester and Sons (1980): 156-176.
26. Dejene T, T Tana and Urage E. "Response of Common Bean (Phaseolus vulgaris L.) to Application of Lime and Phosphorus on Acidic Soil of Areka, Southern Ethiopia". Journal of Natural Sciences Research 6.19 (2016): 131-142.
27. Deresa S. "Response of common bean (Phaseolus vulgaris L.) varieties to rates of blended NPS fertilizer in Adola district, Southern Ethiopia". African Journal of Plant Science 12.8 (2018): 164-179.

28. Dursun A. "Variability, heritability and correlation studies in bean (Phaseolus vulgaris L.) genotypes". World J. Agric. Sci 5 (2007): 12-16.
29. Dwivedi DK., et al. "Response of french bean (Phaseolus vuigaris L.) to population density and nitrogen levels under mid upland situation in north-east alluvial plains of Bihar". Indian Journal of Agronomy 39 (1994): 581-583.
30. El-Afifi ST., et al. "Effect of different levels of NPK fertilizers with the foliar application of iron, zinc and bron on vegetative growth and yield of cowpea". J. Plant Production, Mansoura Univ 7.12 (2016): 1245-1254.
31. El-Dahshouri MF., HA Hamouda and Anany TG. "Improving seed production of common bean (Phaseolus vulgaris L.) plants as a response for Calcium and Boron". Agric Eng Int: CIGR Journal Open access (2017): 211-219.
32. Elias HT., et al. "Genetic variability in traditional black bean germplasm in Santa Catarina". Brazilian Agricultural Research 42 (2007): 1443-1449.
33. El-Waraky YB, AM Masoud and Knany RE. "Effect of balanced manuring by mineral NPK and bio-fertilizer on peas productivity and protein content". Journal of Plant Production, Mansoura Univ 4.12 (2013): 1813-1827.
34. El-Yazied AA and Mady MA. "Effect of boron and yeast extract foliar application on growth, pod setting and both green pod and seed yield of broad bean (Vicia Faba L.)". Journal of American Science 8.4 (2012): 517-533.
35. Esho KB. "Study the genetic parameters in Phaseolus". International Journal of Advances in Science Engineering and Technology 7.1 (2019): 25-30.
36. Fageria NK, VC Baligar and Jones CA. "Mineral Nutrition of Field Crops". In Growth and, 3rd, Boca Raton, Fl.: CRC Press (2011).
37. Gajanan GN., et al. "Relative efficiency of rock-phosphate against superphosphate in rainfed crops". Current Research 19.12 (1990): 202-203.
38. Gemechu Gedeno. "Haricot bean (Phaseolus vulgaris L.) Agronomic Research at Bako. Research on Haricot Bean in Ethiopia: An Assessment of Status, progress, priorities and strategis". Proceedings of a national workshop held in Addis Ababa (1990): 114.
39. Girma A. "Effect of NP fertilizer and moisture conservation on the yield and yield components of haricot bean (Phaseolus vulgaris L.) in the Semi-arid zones of the Central Rift Valley in Ethiopia". Advances in Environmental Biology 3.3 (2009): 302-307.
40. Goldbach HE., et al. "Rapid response of roots to boron deprivation". Journal of Plant Nutrition and Soil Science. (Zeitschriftfuer Pflanzenernaehrung und Bodenkunde) 164.2 (2001): 173-181.
41. Gupta PK., et al. "Effect of moisture regime and fertility level on growth, yield, nutrient and turnover and moisture use by French bean (Phaseolus vulgaris L.)". Indian Journal of Agricultural Sciences 66.6 (1996): 343-347.
42. Hamouda HA, TG Anany and El-Bassyouni MSS. "Growth and yield of dry bean (Phaseolus vulgaris L.) as affected by zn and b foliar application". Middle East Journal of Agriculture Research 7.2 (2018): 639-649.
43. Harmankaya M., et al. "Response of common bean (Phaseolus vulgarisL.) cultivars to foliar and soil applied boron in boron- deficient calcareous soils". African Journal of Biotechnology 7.18 (2008): 3275-3282.
44. Hemantaranjan A., et al. "Growth, Flowering and Yield of (Phaseolus Vulgaris l.) as influenced by micronutrient boron". Journal of. Bio Innovation 5 (2016): 31-41.
45. Iqbal AM., et al. "Combining ability studies over environments in Rajmash(Phaseolus vulgaris L.) in Jammu and Kashmir, India". Journal of Plant Breeding and Crop Science 2.11 (2010): 333-338.
46. Janeczek E, Kotecki A and Kozak M. "Effect of foliar fertilısation with microelements on commonbean (Phaseolus vulgaris L.) development and seed yielding". Electronic J. Polish Agric. Univ. Agron 7.1 (2004): 18-29.
47. Jasim AH and Obaid AS. "Effect of foliar fertilizers spray, boron and its interaction on dry seeds yield of Bbroad Bean (Vicia faba L.) yield". Sci. Pape. Seri. B. Hort 3 (2013): 271-276.
48. Jasim E, AbdA and Esho KB. "Correlation and path coefficient analysis in some varieties of phaseolus (Phaseolus vulgaris L.)". International Journal of Science and Research (IJSR) 9.8 (2020): 948-952.
49. Kajumula SM and Tryphone GM. "Evaluation of common bean (Phaseolus vulgaris L.) genotypes for adaptation to low phosphorus". International Scholarly Research NetworkISRN Agronomy (2012): 9.
50. Kakon SS., et al. "Effect of nitrogen and phosphorus on growth and seed yield of french bean". Bangladesh J. Agril. Res 41.4 (2016):

759-772.

51. Kamfwa K, KACichy and Kelly JD. “Genome-wide association study of agronomic traits in common bean”. The Plant Genome 8.2 (2015): 181-192.
52. Kazemi E., et al. “Variblity of grain yield and yield components of white bean (Phaseolus vulgaris L.) cultivars as affected by different plant density in western iran”. J. Agric & Environ Sci 12.1 (2012): 17-22.
53. Khan BM., et al. “Impact of different levels of phosphorus on growth and yield of mung bean genotypes”. Asian Journal of Plant Sciences 2.9 (2003): 677-679.
54. Kolawole GO, G Tian and Singh BB. Differential response of cowpea lines to application of pfertilizer In C.A. Facokun, SA Tarawali, BB Singh, PM Komawa and M Tamo. Challenges and Opportunities for Enhancing Sustainable. Proceedings of the World Cowpea Production Cowpea the Conference 111 held at International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria (2002): 319-329 .
55. Lanna AC., et al. “Physiological characterization of common bean (Phaseolus vulgaris L.) genotypes, water- stress induced with contrasting response towards drought”. Australian Journal of Crop Science (AJCS) 10.1 (2016): 1-6.
56. Lima MS.de., et al. “Characterization of genetic variability among common bean genotypes by morphological descriptors”. Crop Breeding and Applied Biotechnology 12 (2012): 76-84.
57. Morad M., et al. “Effects of seed inoculation by Rhizobium strains on yield and yield components in common bean cultivars (Phascolus vulgaris L.)”. International Journal of Biosciences 3 (2013): 134-141.
58. Mulugeta AT, MA Hussein and Habtamu Z. “Inheritance of primary yield component traits of common beans (Phaseolus vulgaris L.): number of seeds per pod and 1000 seed weight in an 8x8 diallel cross population”. International Scholarly and Scientific Research & Innovation 7.1 (2013): 158-167.
59. Mumtaz A Ganie., et al. “Influence of sulphur and boron supply on nutrient content and uptake of French bean (Phaseolus vulgaris L.) under inceptisols of North Kashmir”. African Journal of Agricultural Research 9.2 (2014): 230-239.
60. Palmero D., et al. “Diversity and health traits of local landraces of runner bean (Phaseolus coccincus L.) from Spain”. Journal of Food, Agriculture & Environment 9.1 (2011): 290-295.
61. Pandey N, B Gupta and Pathak GC. “Enhanced yield and nutritional enrichment of seeds of (Pisum sativum L.) through foliar application of zinc”. Scientia Horticulture 164 (2013): 474-483.
62. Papa R and Gepts P. “Asymmetry of gene flow and differential geographical structure of molecular diversity in wild and domesti cated common bean (Phaseolus vulgaris L.) from Mesoamerica”. Theor. Appl. Genet. 106 (2003): 239-250.
63. Rahman I., et al. “Growth and yield of phaseolus vulgaris as influenced by different nutrients treatment in mansehra”. International Journal of Agronomy and Agricultural Research 4.3 (2014): 20-26.
64. Rana NS and Singh R. Effect of nitrogen and phosphorus on growth and yield of French bean (Phaseolus vuigaris L)”. Indian Journal of Agronomy 43 (1998): 367-370.
65. Roy NR and Parthasarathy VA. “Note on phosphorus requirement of French bean (Phaseolus vulgaris, L.) varieties planted at different dates”. Indian J. Horticulture 56.4 (1999): 317-320.
66. Salih HO. “Effect of foliar fertilization of Fe, B and Zn on nutrient concentration and seed protein of cowpea “Vigna Unguiculata”. IOSRJ. Agricultural Veterinary. Science 6 (2013): 42-46.
67. Salehi M, M Tajik and Ebadi AG. “The study of relationship between different traits in common bean (Phaseolus vulgaris L.) with multivariate statistical methods. American-Eurasian”. J. Agric. & Environ. Sci 3.6 (2008): 806-809.
68. Santalla M, P Rodino and De Ron M. “Allozyme evidence supporting southwestern Europe as a secondary centre of genetic diversity for the common bean”. Theor. Appl. Genet 104 (2002): 934-944.
69. Santalla M., et al. “Genetic diversity of argentinean common bean and its evolution during domestication”. Euphytica 135 (2004): 75-87.
70. SAS. Statistical Analysis System. SAS Insttitute. Inc. Cary, N.C. 27511, USA (1999).
71. Saxena K and Verma VS. “Growth and yield of French bean (Phaseolus vulgaris L.) as affected by NPK fertilization”. Haryana Jour-

nal of Agronomy 10 (1994): 211-214.

72. Sharaf AM, Farghal II and Sofy MR. "Response of broad bean and lupin plants to foliar treatment with boron and zinc. Aust". Journal of Basic and Applied Sciences 3.3 (2009): 2226-2231.
73. Shivananda TN and Iyengar BRV. "Phosphorus management in french bean (Phaseolus Vulgaris L.)". Plant Mineral Nutrition and Pesticide Management 2 (2004): 79-109.
74. Sicard D., et al. "Genetic diversity of (Phaseolus vulgaris L.) and P. coccineus L. landraces in central Italy". Plant Breeding, Berlin 124 (2005): 464-472.
75. Singh RP, Gupta SC and Yadav AS. "Effect of levels and sources of phosphorus and PSB on growth and eld of blackgram". Legume Research 31.2 (2008): 139-141
76. Steel RGD and Torrie JH. "Principles and Proccedures of Statistics. A Biometrical Approach". McGraw Hill Book Company Inc., New York, USA (1980).
77. Tryphone GM and Nchimbi-Msolla S. "Diversity of common bean (Phaseolus vulgaris L.) genotypes in iron and zinc contents under screenhouse conditions". African Journal of Agricultural Research 5.8 (2010): 738-747.
78. Veeresh NK. "Response of French bean (Phaseolus vulgaris L.) to fertilizer levels in Northern Transitional Zone of Karnataka". M.Sc. (Agri) Thesis, Univ. Agric. Sci., Dharwad (2003): 37-79.
79. Wallace DH., et al. "Photo- period gene control over partitioning between reproductive and vegeta- tive growth". Thcor. Appl. Genet 86 (1993): 6-16.
80. Yoseph T., et al. "Evaluation of common bean (Phaseolus vulgaris L.) varieties, for yield and yield components". Journal of Biology, Agric. and Healtheare 4.17 (2014): 22-26.
81. Zebire DA and Gelgelo S. "Effect of phosphorus fertilizer levels on growth and yield of haricot bean (Phaseolus vulgaris L.) in South Ommo Zone, Ethiopia". Agric. Sci. Digest 39.1 (2019): 55-58.

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