International Journal of Aquatic Science
ISSN: 2008-8019
Vol 13, Issue 01, 2022

Effect of planting distances and phosphate fertilization on two cultivars of broad bean (*Vicia faba L*)

Ahmed Mohamed Lahmoud[1], Wafaa M. Laftta[2]

[1]*Al-Musaib Technical College, Al-Furat Al-Awsat Technical University*
[2]*Agriculture college, Al-Qasim Green University. Iraq*

Emails: ahmed.lahmood@atu.edu.iq, wafa.a@agre.uoqasim.edu.iq

Abstract: A field experiment was conducted during the two winter seasons of the year (2021-2022) in an agricultural field in the Al-Mahaweel District of Babylon province. To study the effect of planting distances and phosphate fertilization on two cultivars of broad bean, The Randomized Complete Block Design (RCBD) was used in the implementation of the experiment, in the order of the split-split plots. The experiment included the study of three factors: (the first factor is two cultivars of broad beans (the cultivate Haba Luz De Otono of Spanish origin V1 and the cultivar Extra Hative aGraine violette of Italian origin V2).As for the sub plot, they included three planting distances, which are (D030, D140, and D250 cm), while the sub-sub plot included three levels of phosphate fertilization, which are (F140, F280, F2160) kg/ha, thus the number of experimental units was (18) experimental units and with three replications. The results were as follows: The cultivar V2 significantly excelled in all traits (plant height 75.31 cm, number of leaves 168.49 leaves. plant^{-1}, one leaf area 32.23 cm^2, chlorophyll in leaves 46.08 spad, average plant dry weight 24.75 g, percentage of nitrogen, phosphorous and potassium in leaves). 3.49,0.34,4.49)%, the average number of green seeds per pod 5.09 seeds. pod^{-1}, the average weight of 100 green seeds 158.78 g,The phosphate fertilization treatment was also significantly excelled in most of the studied traits, while the planting distance D2 treatment was significantly excelled in the traits of plant height 75.53 cm, number of leaves 184.60 leaves, plant $^{-1}$, one leaf area 34.63 cm ^{2},Average chlorophyll in leaves 47.46 spad, average dry weight of the plant 26.49 g, percentage of nitrogen, phosphorous, and potassium in leaves (3.56, 0.36, 4.89)%, the average number of green seeds per pod 5.33 seeds.pod^{-1}, the average weight of 100 green seeds 151.54 g. While the interaction F2D2V2 treatment was significantly excelled in most of the studied traits.

Keywords: phosphate, broad bean, Vicia faba L

1. INTRODUCTION

Broad bean is one of the important crops of Fabaceae family because its seeds contain a high percentage of protein, ranging between 23-37% (Stan ' 1997). In addition to containing quantities of sugary and starchy materials and some vitamins (Required et al., 1989).Broad bean are used as feed for animals, whether plant residues after harvesting or using their dried seeds as a source of protein in concentrated diets (Al-Fakhri, 1981), In addition to its important role in soil improvement to fix nitrogen through root ganglia bacteria that coexist

with it. Studies indicate that the Mediterranean basin is the original country of Broad bean (Sumerfield and Roberts, 1985) and China is one of the largest countries in its production and consumption of Broad bean, followed by Ethiopia, where China's production of Broad bean (2.7 million tons / year), and this is equivalent to 65% of the production The world, followed by Ethiopia, with a production of 9% of the world production, and then Egypt, which produces the equivalent of 262 thousand tons per year. Broad beans are consumed in these countries as a main food for the poor and (Stat, 2003), In Iraq, the production rates are low per unit area, reaching 10,876 tons as dry pods and 144.3 thousand tons as green pods, in a total cultivated area of 12510 dunums, and average productivity of 869.2 kg/dunums for dry pods (Central Statistical Organization, Directorate of Agricultural Statistics, 2018). The fluctuation of production is noted, and this is due to many factors, including the lack of use of scientific and practical techniques that lead to an increase in production per unit area, including the use of seeds of traditional cultivars and a lack of processing nutrients, As the Broad bean crop and its productivity are affected by many environmental, nutritional and genetic factors (cultivars) and due to the increasing world population and the lack of an equal increase in food production, especially vegetables, All this prompted researchers to develop cultivars with high productivity and nutritional value (Cieslarova et al., 2012). The vegetative density directly affects the height of the plant, and they vary according to the genotypes of the cultivated cultivars. The diameter and length of the internodes in a variety may allow an increase in the nodes, and its effect by increasing the vegetation cover is less, and (Attiya et al, 1983) indicated that the yield of a single plant decreases as the vegetative density increases. Several studies have been conducted in this field, including a study (Kakahy et al., 2012), as their study included the effect of the distance between plants on the yield of beans under the drip irrigation system using three cultivars: Spanish, Turkish and local with three planting distances of 20, 25 and 30 cm. The Spanish variety gave The highest average number of seeds/pod was (3.12 seeds/pod).(Yucel, 2013) found in studying the best distance for the production of barley cultivars in Mediterranean conditions, as four local cultivars were used and four interstitial distances (5, 10, 15 and 20 cm)As there were no local differences between the cultivars of yield traits and some of its components, the distance between (10,12 cm) was found to be the best for the length of the crop in those conditions.In addition, (Derogar and Mojaddam, 2014) found a study on the effect of plant density on the yield and its components in barley. In Iran, three plant densities were used (8, 12 and 16 plants/m^2) The results showed that the plant density of 12 plants / m2 resulted in a qualitative increase in seed yield for the Barekat cultivar compared with other cultivars, and this plant density also led to an increase in the number of pods per plant and the weight of 100 seeds. Phosphorous is one of the important elements in plant nutrition for its role in the vital processes that take place inside the plant, which can only take place with its presence, such as the synthesis of nucleic acids, phospholipids, cell division processes, and the transfer and release of energy. It is also necessary for flowering and seed formation processes (Tisdale et al:1971 "Orabi et al.1981), Phosphorous increases the speed of root growth, especially root hairs, and increases their density, which contributes to their deepening in the soil, and this increases the efficiency of the plant in absorbing water and nutrients (Russell'1973).Therefore, this study was conducted with the aim of evaluating some traits of vegetative growth and yield and its components for two cultivars of bean at different distances from furrow and with different percentages of phosphate fertilizer added.

2. MATERIALS AND METHODS

The experiment was conducted in one of the agricultural fields in Al-Mahawil District of Babylon province, during the agricultural season (2021-2022).Samples were taken from the field soil at the beginning of the planting season at a depth of m (0-30 cm) in order to know the physical and chemical properties of field soil as shown in Table (1). The field was tillage perpendicular and then the process of smoothing and leveling the field to a suitable bed for the seeds, and then the field was divided into length plot ((2.5m) and width (3m) to become the area of the experimental unit (7.5m) and nitrogen fertilizer was added in the form of urea (N46%) with an amount of 50Kg Hectares in the form of one batch before planting. The field was planted on 10/15/2021, with three seeds per pit. The irrigation process was conducted immediately after planting, and the irrigation continued according to the needs of the plant. Cultivation was done on lines and the distance between one pit and another was 25 cm. Crop service operations included manual control several times and throughout the growing season. Acetoprid insecticide was used to control insects at a rate of 0.5 ml. L^{-1} .The design used in this experiment is (randomized complete block design) R.B.C.D) in the order of the split-split plots. The experiment included the study of three factors: (The first factor is two cultivars of green broad beans (the Haba Luz De Otono variety of Spanish origin V1 and the cultivar Extra Hative aGraine violette). Italian Origin V2)As for the sub-plot, they included three planting distances, which are (D030, D140, and D250 cm), while the sub-sub plot included three levels of phosphate fertilization, which are (F140, F280, F2160) kg/ha, thus the number of experimental units was (18) experimental units and with three replications. Ten plots were taken from each experimental unit and randomly assigned to study the following traits. Ten plants were taken from each experimental unit and randomly assigned to study the following traits.

1 - Average plant height (cm): measured using metric tape, starting from the level of the soil surface to the end of the main branch.

2- The average number of leaves. $Plant^{-1}$: It is the number of leaves on the plant, which was calculated as an average of their number in the ten plants taken at random.

3- Dry weight of the plant (g. $plant^{-1}$)

The samples were dried at a temperature of 70 °C until the weight was stable, then the dry weight was taken for each treatment.

4- Average leaf area (cm^2):

The measurement was made using a digital planimeter after photographing it on a white sheet to measure this trait in the laboratories of the College of Agriculture, Al-Qasim Green University, and it was measured in cm2 by taking three papers at random.

5- Average chlorophyll content of leaves (SPAD unit)(micrograms.cm^{-2}):

The chlorophyll content in leaves was estimated by using a SPAD 502-type chlorophyll meter by taking the reading for 3 leaves per experimental unit (plant) and measured in SPAD UNIT.

6- Leaves total nitrogen content

Calculated by Microclidal

7- The phosphorous content of the leaves

Estimated using blue and modified ammonium molybdate by John (1970)

8- Potassium content of leaves:

These elements were estimated using a Flame-Photometer.

9 - Average number of green seeds. pod^{-1}

It was calculated after neglecting the pods of the plant, then counting the number of seeds, and then dividing the number of seeds by the number of pods in the plant.

10 - Average weight of 100 green seeds (g)

It was calculated by taking a random sample of green, ripe seeds.

The data were statistically analyzed and the averages were compared using the least significant difference (LSD) with a probability of 0.05.

Table (1) shows the chemical and physical properties of the experiment

Values	Traits
	Soil Separators (g. kg $^{-1}$)
184.0	sand
479.0	silt
337.0	clay
Silty clay	soil texture
7.92	PH
3.20	ECe Ds .m^{-1}
7.1	Organic matter g.kg $^{-1}$
23.0	Calcium carbonate g.kg^{-1}

3. RESULTS AND DISCUSSION

1- Average plant height (cm)

The results in tables (2) showed a significant effect of the cultivars on the plant height traits, The Italian cultivar V2 gave the highest mean of plant height, which was 75.31 cm, compared to the Spanish cultivar V1, which gave 71.14 cm. The results also showed that planting distances had a significant effect on plant height, treatment D2 significantly excelled and gave the highest value of 76.11 cm, compared to the control treatment which gave 72.07 cm. Phosphate fertilization also had a significant effect on plant height, where the treatment F2 was significantly excelled and gave the highest value of 81.67 cm, compared to the control treatment, which gave 67.12 cm.The bi-interaction between cultivar and phosphate fertilization and planting distances also gave the highest values. The results shown in Table (2) indicated that there were no significant differences in plant height traits for the triple interaction between cultivar, potassium fertilization, and planting distances.

Table (2) Effect of cultivars, planting distances, phosphate fertilization levels, and the interaction between them on the plant height (cm) of the broad bean crop.

average	**Phosphate fertilization levels**			**planting distances**	**cultivars**
	F2	**F1**	**F0**	**D**	**V**
69.89	76.34	70.65	62.68	**D0**	**V1**
72.67	79.34	73.34	65.32	**D1**	
74.56	82.00	75.00	66.68	**D2**	
74.12	80.34	74.68	67.34	**D0**	**V2**
79.89	89.00	79.68	71.00	**D1**	
76.45	83.00	76.68	69.67	**D2**	
	81.67	75.01	67.12	**average**	
interaction between cultivar		**Triple interaction**		**Phosphate**	**LSD**

and planting distances 0.958		Ns.		**fertilization levels** 0.663	**0.05**
average	**cultivar × Phosphate Fertilization**				
71.14	77.94	71.79	63.68	**V1**	
75.31	82.36	75.99	67.59	**V2**	
	Ns.			**LSD0.05**	
average	**planting distances × Phosphate fertilization levels**				
72.07	78.35	72.66	65.20	**D0**	
76.11	83.68	76.52	68.14	**D1**	
75.53	82.59	75.81	68.18	**D2**	

2- The average number of leaves. plant $^{-1}$

The results in table (3) showed a significant effect of the cultivars on the number of leaves, as the Italian cultivar V2 gave the highest average of 168.49 leaves.plant^{-1}, compared to the Spanish cultivar V1 which gave 165.54 leaves.plant^{-1}.The results also showed that the planting distances had a significant effect on the number of leaves, where the treatment D2 was significantly excelled and gave the highest value of the number of leaves, which amounted to 184.60 leaves.plant^{-1}, compared to the comparison treatment, which gave 158.72 leaves.plant^{-1}.Phosphate fertilization also had a significant effect on the number of leaves, as the treatment F2 significantly excelled and gave the highest value of 205.21 leaves.plant^{-1}, compared to the control treatment, which gave 146.28 leaves.plant^{-1}.The bi-interaction between cultivar, phosphate fertilization and planting distances also gave the highest values. The results in Table (3) indicate that there is a significant effect of the combined experiment factors, The interaction treatment (F2D2V2) was significantly excelled and gave the highest values for the number of leaf traits, which amounted to 231.53 leaves.plant^{-1}, while the interaction treatment gave the lowest average number of leaves, which amounted to 141.04 leaves.plant^{-1}.

Table (3) The effect of cultivars with planting distances and levels of phosphate fertilization and the interaction between them on the average number of leaves. Plant $^{-1}$ for broad bean crop.

average	**Phosphate fertilization levels**			**planting distances**	**cultivars**
average	**F2**	**F1**	**F0**	**D**	**V**
155.99	173.32	153.60	141.04	D0	
170.75	206.43	160.46	145.37	D1	**V1**
183.52	228.36	172.43	149.77	D2	
161.41	183.14	157.65	143.44	D0	
172.44	208.49	161.40	147.43	D1	**V2**
185.63	231.53	174.75	150.61	D2	
	205.21	163.38	146.28	**average**	
interaction between cultivar planting distances 0.771		**Triple interaction** **2.001**		**Phosphate fertilization levels** 0.708	**LSD 0.05**

average	**cultivar × Phosphate Fertilization**			
165.54	194.39	159.52	142.70	**V1**
168.49	198.89	161.89	144.69	**V2**
0.387	1.001			**LSD0.05**
average	**planting distances × Phosphate fertilization**			
158.72	178.26	155.64	142.26	**D0**
171.62	207.48	160.95	146.44	**D1**
184.60	229.97	173.61	150.21	**D2**
0.545	1.415			**LSD0.05**

3- Average leaf area (cm^2)

The results in tables (4) showed that there was a significant effect of the cultivars on the characteristic of the area of one leaf, where the Italian cultivars V2 gave the highest average of the traits of the one leaf area , which amounted to 32.23 cm^2, compared to the Spanish cultivar V1 which gave 30.58 cm^2.The results also showed that the planting distances had a significant effect on the one leaf area where the treatment D2 was significantly excelled and gave the highest value of the one leaf area reaching 34.63 cm^2 compared to the control treatment which gave 30.30 cm^2.Phosphate fertilization also had a significant effect on the one leaf area , where the treatment F2 significantly excelled and gave the highest value of 39.02 cm2 compared to the control treatment which gave 26.12 cm^2.The bi-interaction between cultivar, phosphate fertilization, and planting distances also gave the highest values for the area of one leaf. The results are shown in Table (2) indicated that there were no significant differences in plant height trait for the triple interaction between cultivar, potassium fertilization, and planting distances.

Table (4) The effect of cultivars, planting distances, levels of phosphate fertilization, and the interaction between them on the average one leaf area (cm^2) of the broad bean crop

average	**Phosphate fertilization levels**			**planting distances**	**cultivars**
average	**F2**	**F1**	**F0**	**D**	**V**
29.64	33.78	30.44	24.69	D0	**V1**
31.24	37.22	30.91	25.58	D1	
33.86	41.09	32.47	27.99	D2	
30.94	37.50	30.90	24.41	D0	**V2**
33.51	40.74	33.64	26.15	D1	
35.34	43.77	34.36	27.90	D2	
	39.02	32.12	26.12	**average**	
interaction between cultivar and planting distances Ns.		**Triple interaction** Ns.		**Phosphate fertilization levels** 1.634	**LSD 0.05**
average	**cultivar × Phosphate fertilization levels**				

30.58	35.79	30.69	25.26	**V1**
32.23	39.16	32.36	25.17	**V2**
1.634	0.929			**LSD0.05**
average	**planting distances × Phosphate fertilization levels**			
30.30	35.65	30.69	24.57	**D0**
32.39	38.98	32.29	25.89	**D1**
34.63	42.47	33.42	27.99	**D2**
0.548	1.314			**LSD0.05**

2- Chlorophyll content in leaves (SPAD)

The results in tables (5) showed a significant effect of the cultivars on the rate of chlorophyll in the leaves, as the Italian cultivar, V2 gave the highest average the rate of chlorophyll in the leaves reaching 46.08 SPAD, compared to the Spanish cultivar V1 which gave 44.57 SPAD.The results also showed that the cultivation distances had a significant effect on the rate of chlorophyll in the leaves, where the treatment D2 was significantly excelled and gave the highest value of the rate of chlorophyll in the leaves amounting to 47.46 SPAD, compared to the control treatment which gave 44.94 SPAD .Phosphate fertilization also had a significant effect on the average of chlorophyll in the leaves .The treatment F2 significantly excelled and gave the highest value of 52.97 SPAD, compared to the control treatment which gave 38.19 SPAD.The bi-interaction between cultivar, phosphate fertilization, and planting distances also gave the highest values. The results are shown in Table (3) indicate a significant effect of the combined experiment factors. The interaction treatment (F2D2V2) was significantly excelled and gave the highest values of chlorophyll rate in leaves that amounting to 55.57 SPAD, while the interaction treatment gave the lowest rate of chlorophyll in leaves that amounting to 36.77 SPAD

Table (5) Effect of cultivars, planting distances, levels of phosphate fertilization, and the interaction between them on the average percentage of chlorophyll and unit (SPAD) of the broad bean crop

average	**Phosphate fertilization levels**			**planting distances**	**cultivars**
	F2	**F1**	**F0**	**D**	**V**
44.47	50.26	46.38	36.77	D0	**V1**
45.85	53.48	46.89	37.18	D1	
46.50	53.05	48.06	38.39	D2	
45.43	51.06	47.27	37.96	D0	**V2**
47.80	54.40	49.86	39.15	D1	
48.42	55.57	50.00	39.69	D2	
	52.97	48.08	38.19	**average**	

interaction between cultivar and planting distances Ns.	**Triple interaction** Ns.	**Phosphate fertilization levels** 0.662	**LSD 0.05**

average	**cultivar × Phosphate fertilization levels**			
44.57	51.54	45.72	36.45	**V1**
46.08	52.75	47.63	37.87	**V2**
0.620	Ns.			**LSD0.05**
average	**planting distances × Phosphate fertilization**			
44.94	50.65	46.83	37.35	**D0**
46.81	53.94	48.33	38.16	**D1**
47.46	54.30	49.04	39.05	**D2**
0.817	1.324			**LSD0.05**

The average dry weight of the plant (g)

The results in table (6) showed a significant effect of the cultivars on the average dry weight of the plant, where the Italian cultivar V2 gave the highest average dry weight of the plant, which amounted to 24.75, compared to the Spanish cultivar V1 which gave 24.14 g.The results also showed that the planting distances had a significant effect on the average dry weight of the plant, where the treatment D2 was significantly excelled and gave the highest value of the average dry weight of the plant amounting to 26.49 g, compared to the control treatment that gave 23.50 g

Phosphate fertilization also had a significant effect on the plant's dry weight, where the F2 treatment significantly excelled and gave the highest value of 30.00, compared to the control treatment which gave 19.90 g. The bi-interaction between cultivar, phosphate fertilization, and planting distances gave the highest values for the average dry weight of the plant.The results in Table (6) also indicated that there were no significant differences in plant height of the triple interaction between cultivar, potassium fertilization, and planting distances.

Table (6) The effect of cultivars, planting distances, phosphate fertilization, and the interaction among them on the average dry weight of the plant (gm) of the broad bean crop.

average	**F2**	**F1**	**F0**	**D**	**V**
23.18	28.09	22.39	19.05	D0	
24.27	28.80	24.40	19.60	D1	**V1**
26.10	31.41	25.89	21.00	D2	
23.85	28.83	23.46	19.25	D0	
25.04	30.04	24.95	20.14	D1	**V2**
27.23	32.86	28.43	20.40	D2	
	30.00	24.92	19.90	**average**	
interaction between cultivar and planting distances Ns.		**Triple interaction** Ns.		**Phosphate fertilization levels** 0.573	**LSD 0.05**
average	**cultivers × Phosphate fertilization levels**				

24.14	29.04	23.38	20.00	**V1**
24.75	29.96	24.79	19.49	**V2**
0.417	Ns.			**LSD0.05**
average	**planting distances × Phosphate fertilization levels**			
23.50	28.45	22.93	19.13	**D0**
24.66	29.46	24.67	19.86	**D1**
26.49	32.11	27.16	20.21	**D2**
0.944	1.146			**LSD0.05**

The percentage of nitrogen in the leaves (%)

The results in a table (7) showed a significant effect of the cultivars on the percentage of nitrogen in the leaves, where the Italian cultivar V2 gave the highest average of the percentage of nitrogen in the leaves was 3.49, compared to the Spanish cultivar V1, which gave 3.43%.The results also showed that the cultivation distances had a significant effect on the percentage of nitrogen in the leaves, where the treatment D2 was significantly excelled and gave the highest value of the percentage of nitrogen in the leaves amounting to 3.56%, compared to the control treatment that gave 3.43%, as well as the effect of phosphate fertilization significantly on the percentage of nitrogen in the leaves,The treatment F2 significantly excelled and gave the highest value of 3.69%, compared to the control treatment which gave 3.28%. The bi-interaction between the cultivar, phosphate fertilization and planting distances gave the highest values for the percentage of nitrogen in the leaves.The results in Table (7) indicated that there was a significant effect of the combined experiment factors, where the interaction treatment (F2D2V2) was significantly excelled and gave the highest values for the percentage of nitrogen in the leaves amounted to 3.77%, while the interaction treatment gave the lowest percentage of nitrogen in the leaves that amounted to 3.19 %

Table (7) The effect of cultivars, planting distances, levels of phosphate fertilization, and the interaction among them on the average percentage of nitrogen in the leaves of the broad bean crop.

average	**Phosphate fertilization levels**			**planting distances**	**cultivars**
average	**F2**	**F1**	**F0**	**D**	**V**
3.39	3.57	3.40	3.19	D0	**V1**
3.46	3.65	3.46	3.26	D1	
3.55	3.78	3.53	3.34	D2	
3.46	3.65	3.47	3.27	D0	**V2**
3.50	3.69	3.54	3.29	D1	
3.56	3.77	3.59	3.34	D2	
	3.69	3.49	3.28	**average**	
interaction between cultivar and planting distances		**Triple interaction** 0.019		**Phosphate fertilization levels**	**LSD 0.05**

0.007				0.007	
average	**cultivar × Phosphate fertilization levels**				
3.43	3.63	3.43	3.23	**V1**	
3.49	3.69	3.50	3.27	**V2**	
0.002	0.010			**LSD0.05**	
average	**planting distances × Phosphate fertilization levels**				
3.43	3.60	3.45	3.24	**D0**	
3.48	3.68	3.50	3.27	**D1**	
3.56	3.77	3.57	3.33	**D2**	
0.005	0.014			**LSD0.05**	

Percentage of phosphorous in leaves (%)

The results in tables (8) showed a significant effect of the cultivars on the percentage of phosphorous in the leaves, where the Italian cultivar V2 gave the highest rate of the percentage of phosphorous in the leaves amounting to 0.34%, compared to the Spanish cultivar V1, which gave 0.33%.The results also showed that the planting distances had a significant effect on the percentage of phosphorus in leaves, where treatment D2 was significantly excelled and gave the highest value of percentage of phosphorous in leaves amounted to 0.36%, compared to the control treatment that gave 0.32%. Phosphate fertilization also significantly affected the percentage of phosphorous in leaves,The treatment F2 was significantly excelled and gave the highest value of 0.45%, compared to the control treatment which gave 0.23%. The bilateral interaction between cultivar, phosphate fertilization, and planting distances gave the highest values for the percentage of phosphorous in leaves.The results in Table (8) indicated that there was a significant effect of the combined experiment factors, as the interaction treatment (F2D2V2) was significantly excelled and gave the highest values for the percentage of phosphorous in the leaves amounted to 0.47%, while the interaction treatment gave the lowest percentage of phosphorous in the leaves that amounted to 0.20%

Table (8) The effect of cultivars, planting distances, levels of phosphate fertilization, and the interaction between them on the average percentage of phosphorous in the leaves of broad bean crop.

average	**Phosphate fertilization levels**			**planting distances**	**cultivars**
average	**F2**	**F1**	**F0**	**D**	**V**
0.32	0.43	0.33	0.20	D0	**V1**
0.34	0.44	0.34	0.24	D1	
0.35	0.45	0.36	0.25	D2	
0.328	0.43	0.34	0.21	D0	**V2**
0.35	0.45	0.35	0.24	D1	
0.37	0.47	0.37	0.26	D2	

	0.45	0.35	0.23	**average**	
interaction between cultivar and planting distances Ns.		**Triple interaction** Ns.		**Phosphate fertilization levels** 0.006	**LSD 0.05**
average	**cultivar × Phosphate fertilization levels**				
0.33	0.43	0.33	0.22	**V1**	
0.34	0.44	0.34	0.23	**V2**	
0.005	Ns.			**LSD0.05**	
average	**planting distances × Phosphate fertilization levels**				
0.32	0.43	0.33	0.21	**D0**	
0.35	0.45	0.35	0.24	**D1**	
0.36	0.46	0.36	0.25	**D2**	
0.007	Ns.			**LSD0.05**	

Percentage of potassium in leaves (%)

The results of table (9) showed a significant effect of the cultivars in the percentage of potassium in the leaves, as the Italian variety V2 gave the highest average percentage of potassium in the leaves amounted to 4.49%, compared to the Spanish variety V1 which gave 4.42%.The results also showed that the planting distances had a significant effect on the percentage of potassium in the leaves, as the treatment D2 was significantly excelled and gave the highest value of the percentage potassium in the leaves amounted to 4.89%, compared to the control treatment which gave 4.29%Phosphate fertilization also had a significant effect on the percentage of potassium in the leaves, as the F2 treatment was significantly excelled and gave the highest value of 5.40, compared to the control treatment which gave 3.87%.The bilateral interaction between cultivar, phosphate fertilization and planting distances gave the highest values of potassium percentage in leaves.The results in Table (9) indicated that there was a significant effect of the combined experiment factors, where the interaction treatment (F2D2V2) was significantly excelled and gave the highest values for potassium in the leaves, which amounted to 5.75%.Whereas, the interaction treatment gave less potassium in the leaves, which amounted to 4.25%.

Table (9): The effect of cultivars, planting distances, levels of phosphate fertilization, and the interaction between them, on the average percentage of potassium in the leaves of the bean crop.

average	**Phosphate fertilization levels**			**planting distances**	**cultivars**
average	**F2**	**F1**	**F0**	**D**	**V**
4.26	4.91	4.36	3.50	D0	**V1**
4.62	5.53	4.50	3.83	D1	
4.84	5.70	4.59	4.22	D2	
4.31	4.97	4.40	3.56	D0	

4.65	5.55	4.55	3.86	D1	**V2**
4.89	5.75	4.66	4.25	D2	
	5.40	4.51	3.87	**average**	
interaction between cultivar and planting distances 0.005		**Triple interaction** 0.020		**Phosphate fertilization levels** 0.007	**LSD 0.05**
average	**cultivar × Phosphate fertilization levels**				
4.42	5.22	4.35	3.69	**V1**	
4.49	5.28	4.44	3.74	**V2**	
0.008	0.010			**LSD0.05**	
average	**planting distances × Phosphate fertilization levels**				
4.29	4.95	4.38	3.53	**D0**	
4.64	5.54	4.53	3.85	**D1**	
4.89	5.73	4.63	4.24	**D2**	
0.004	0.014			**LSD0.05**	

The average number of green seeds per pod (seed.pod^{-1})

The results in table (10) showed a significant effect of the cultivars on the average number of green seeds per pod, as the Italian cultivar V2 gave the highest average of the number of green seeds per pod of 5.09 seeds.pod-1, compared to the Spanish cultivar V1 which gave 4.41 seeds.pod^{-1}. .The results also showed that the planting distances had a significant effect on the average number of green seeds per pod, where the treatment D2 was significantly excelled and gave the highest value of the average number of green seeds per pod amounting to 5.33 seeds.pod^{-1}, compared to the control treatment which gave 4.59 seeds.pod^{-1}.Phosphate fertilization also had a significant effect on the average number of green seeds per pod, as the F2 treatment significantly excelled and gave the highest value of 5.59 seeds.pod^{-1}, compared to the control treatment that gave 3.8 seeds.pod^{-1}.The bi-interaction between cultivar, phosphate fertilization and planting distances gave the highest values for the number of green seeds for each pod.The results in Table (10) indicate that there is a significant effect of the combined experiment factors,The interaction treatment (F2D2V2) significantly excelled and gave the highest values for the average number of green seeds for each pod, which amounted to a 7.12 seed.pod $^{-1}$, while the interaction treatment gave less to the average number of green seeds for each pod, which amounted to 3.82.

Table (10) The effect of cultivars and phosphate fertilization levels of phosphate fertilization and the interaction between them on the average number of green seeds per pod of a broad bean crop.

average	**Phosphate fertilization levels**			**planting distances**	**cultivars**
average	**F2**	**F1**	**F0**	**D**	**V**
4.38	4.37	4.94	3.82	D0	**V1**
4.37	4.85	4.73	3.53	D1	

5.37	5.37	7.00	3.75	D2	
4.80	5.58	4.91	3.91	D0	
5.29	6.22	5.79	3.87	D1	**V2**
5.60	7.12	5.78	3.91	D2	
	5.59	5.53	3.80	**average**	
interaction between cultivar and planting distances Ns.		**Triple interaction** Ns.		**Phosphate fertilization levels** 0.290	**LSD 0.05**
average	**cultivar x phosphate fertilization**				
4.41	4.76	4.88	3.59	**V1**	
5.09	6.06	5.35	3.87	**V2**	
	0.410			**LSD0.05**	
average	**planting distances × Phosphate fertilization levels**				
4.59	4.98	4.93	3.86	**D0**	
4.83	5.54	5.26	3.70	**D1**	
5.33	6.25	5.90	3.83	**D2**	
0.253	0.579			**LSD0.05**	

The average weight of 100 green seeds (g)

The results in a table (11) showed a significant effect of the cultivars on the average weight of 100 green seeds (g), as the Italian cultivar V2 gave the highest average number of green seeds per pod amounting to 158.78 g, compared to the Spanish cultivar V1 which gave 155.14 g.The results also showed that the planting distances had a significant effect on the average number of green seeds per pod, where treatment D was significantly excelled and gave the highest value of the average number of green seeds per pod, which amounted to 5.33, compared to treatment D2, which gave 160.57.Phosphate fertilization also had a significant effect on the average number of green seeds per pod, as treatment F0 was significantly excelled and gave the highest value of 161.01 g, compared to treatment F2 which gave 147.42 g. The bi-interaction between cultivar, phosphate fertilization and planting distances also gave the highest values.The results in Table (11) also indicated that there were no significant differences in plant height traits of the triple interaction between cultivar, potassium fertilization, and planting distances.

Table (11) The effect of cultivars, planting distances, levels of phosphate fertilization, and the interaction among them on the average weight of 100 gm of green seed of broad bean crop.

average	**Phosphate fertilization levels**			**planting distances**	**cultivars**
average	**F2**	**F1**	**F0**	**D**	**V**
158.80	149.09	161.39	165.92	D0	
151.93	145.22	153.49	157.09	D1	**V1**
150.00	143.09	151.95	154.95	D2	

162.33	155.09	163.15	168.75	D0	**V2**
154.81	146.99	157.82	159.62	D1	
153.09	145.02	154.52	159.72	D2	
	147.42	157.05	161.01	**average**	
interaction between cultivar and planting distances Ns.		**Triple interaction** Ns.		**Phosphate fertilization levels** 1.357	**LSD 0.05**
average	**cultivar × Phosphate fertilization levels**				
155.14	147.25	156.78	161.40	**V1**	
158.78	150.73	160.65	164.95	**V2**	
0.518	Ns.			**LSD0.05**	
average	**planting distances × Phosphate fertilization levels**				
160.57	152.09	162.27	167.34	**D0**	
153.36	146.09	155.65	158.35	**D1**	
151.54	144.05	153.24	157.34	**D2**	
1.442	Ns.			**LSD0.05**	

4. DISCUSSION

From the above, the results of the vegetative growth characteristics shown in Table (2-11) indicate that the cultivars had a significant effect on the vegetative growth during the first and second study seasons.The Italian cultivar excelled over the Spanish cultivar in all growth indicators and gave the highest averages for this trait. This may be attributed to the different genetic structures of the two cultivars and the interaction of genetic factors with the surrounding environment (Hamdoun, 2013).The Italian cultivar was significantly superior to the yield traits, and the reason for this excelled could be due to the varietal differences in the genetic structure.cultivars differ physiologically in the representation of many raw materials formed by their biological processes, which affects their morphological formation, which is reflected in their production capacity and the extent to which they are affected by environmental factors (Abu Dahi and Younes, 1988).The results in Table (2-11) showed the phosphate fertilizer F2 significantly excelled in all the studied traits, and the reason may be due to the role of phosphate fertilizer in improving plant metabolism and growth as a result of the role of phosphorus in the formation of amino acids important to give plants energy in the process of photosynthesis. Phosphorous contributes to the formation of coenzymes and oxidation-reduction reactions important for vital reactions in plants. Phosphorous is found in high concentrations in meristematic regions where plant growth is active, as phosphorous is involved in the representation of nuclear proteins.Maintains a mellow green color in the leaves, veins, and stems of plants and trees. Helps to speed up the ripening of fruits and increase their size and the appearance of flowers on the tops of plants more quickly. Phosphorous works in cooperation with natural fertilizers to improve plant productivity and increase agricultural yields.(Al-Laila and Al-Amri, 2019).As well as a cycle in the absorption

of nutrients, and increasing their concentration in the leaves for nitrogen and phosphorous in the leaves, which leads to improving the nutritional and physiological status of the plant, In addition, the presence of potassium in the fertilizer mixture effectively contributes to the movement and transfer of carbohydrates from the places of manufacture (the source) in the leaves to the storage places (sink) in the branches, stems, and fruits, as well as the role of potassium in encouraging the starch synthetase enzyme, which increases the starch synthesis and thus increases the efficiency of the photosynthesis process and the increase in its products,Also, the presence of zinc in the fertilizer mixture helps in the process of forming the chlorophyll molecule due to its direct impact on the processes of formation of amino acids, carbohydrates, and energy compounds (Abu Dahi and Younis, 1988) or as a result and quality within the fertilizer combination potassium, which plays an important role in the formation of green matter through the activation of enzymes Responsible for chlorophyll synthesis (Yassin, 2001)

5. REFERENCES

1- Central Statistical Organization (2018). Crops and vegetable production. Agricultural Statistics Directorate, Planning Commission - Council of Ministers - Republic of Iraq

2- alfakhrii; Abdullah Qasim (1981). Dry agriculture: its foundations and elements of its investment. Dar Al-Kutub for Printing and Publishing. Mosul University: 388 p.

3- matlub, Adnan Nasser, Ezzedine Sultan Muhammad and Karim Saleh Abdoul (1989). Vegetable production (second part). Ministry of Higher Education and Scientific Research; University of Al Mosul.

4- FAO <2003> Data base :Rome:Italy

5- Stan,B.(1997).Aiberta update_PMAPC(1997).Manitoba Agric. And Food :1_15.

6 – Summerfield, Rg.and . E.H.Roberts (1985).Grain Legume crops. Sollins print.pp.199-266

7-Stan,B.(2003).Alberta update-PMAPC(2003). Manioba Agric.and Food;1-15.

8- Attiya,H.J,R.J.Field and G.D. Hill.(1983). Effect of PP333and TIBA growth regulators on development and yield coponent of spring sown fild beans (*vicia faba l.)* proceedings Agronomy Society of N.Z.13P81-86.

9- Yucel DO (2013). Optimal intra-row spacing for production of local faba beam (*Vicia faba L.Major) cultivars in the* mediterranean condition. Pak. J. Bot., 45(6):1933-1938.

10-Jassim, K.K. 1979. A study on some physico chemical behavior of phosphorus in soils from Sulaimaniyah Governorate. M. Sc. Thesis,Sulaimaniyah University.

11-Simom Etta, Tunesi, V.Poggi,and C. Gessa.1999. Phosphate adsorption and precipitation in calcareous soil: The role of calciun ions in solution and carponate minerals.Nutrient cyclinj in Ajroecsystems.53:219-227.

12-Hassan ,N.A., F.Aziz., T.AI,Timmi, S.Asker,and E.Rabban.1977.Limits of phosphorus availability in Iraqi soils. The Agric. Magazine No.34.

13-Kuo,S.1990.Phosphate sorption inplisations on phosphate soil test and uptake by corn.Sil Sci.Soc. Am.J.54..131-135.

14-Lu,D.Q.,S.H.Chein,j.Henao,and d.Somponges.1987.Evaluation of short –term efficacy of DAP ver sys urea plus single super phosphate on a calcareous soil. Agron . J.79:896-900.

Cieslarova.J.;M. Hybli; M. Griga and p. Smykal (2012) . Molecular analysis of temporal genetic structuring in pea (*pisum sativum sativum L.*) cultivars breed in the Czech republic and in former Czechoslovakia since the mid-20th century. Czec . Genet. Plant Breed. 48(2) : 61 – 73.