Ann. For. Res. 66(1): 4470-4488, 2023
ISSN: 18448135, 20652445

ANNALS OF FOREST RESEARCH
www.e-afr.org

EFFECT OF PHOSPHOROUS AND THIAMINE ON THE VEGETATIVE GROWTH TRAITS OF TWO BROAD BEAN CULTIVARS

Ali Sahib Muhammad Alo Al-Sultani, Ahmed Mohamed Lahmoud Al-Mamouri
Al-Musayyib Technical College, Al-Furat Al-Awsat Technical University.

Abstract. Two field experiments were conducted in Al-Nile sub-district (7 km north-east of Babylon province) during the two agricultural seasons (2021) and (2022) in order to study the response of two types of bean cultivars to phosphorous and thiamine and with three replications, where the main plots included the cultivars (Italian Franchi, Spanish Fito),As for the sub plot, it included phosphorous fertilization at four levels (0, 80, 160, 240 kg.ha^{-1}), while the sub-sub plot were sprayed with thiamine at a concentration (0, 100 , 200 mg.L^{-1}). The results were statistically analyzed using Genestat program and the averages were compared on the basis of the least significant difference LSD 0.05. The results can be summarized as follows:

1- The studied cultivars differed significantly in the indicators of vegetative growth, yield and quality for all of both seasons of the study, where the Franchi cultivar was significantly excelled on the Fito cultivar in the studied traits by registering the highest averages for the studied traits, where the chlorophyll content in the leaves reached (35.64 and 38.48 (SPAD), leaf area (31.78 and 34.29) cm²,The number of branches per plant (6.91 and 7.02) per plant^{-1}, plant height (114.41 and 122.75) cm, pod length (21.76 and 22.00) cm, green pod weight (57.71 and 59.46) gm for both seasons.

2- The treatment of adding phosphorus (240 kg $^{-1}$) was significantly excelled on the rest of the additions in terms of vegetative growth, yield and quality indicators for all of both seasons, where it recorded the highest averages for the studied traits, including the content of chlorophyll in leaves (37.98 and 41.86) SPAD, Leaf area (39.78 and 40.16) cm², number of branches per plant (7.27 and 7.52) per plant^{-1}, plant height (109.28 and 114.88) cm, pod length (23.02 and 23.96) cm, green pod weight (60.67 and 60.26) g for both seasons.

3- The addition of thiamine caused a significant increase in all indicators of vegetative growth, yield and quality, especially the concentration (200 mg L^{-1}) by recording the highest averages for the studied traits, where the chlorophyll content in the leaves reached (35.52 and 38.55) SPAD, leaf area (32.65 and 33.99) cm²,The number of branches per plant is (6.54 and 6.70) per plant^{-1}, the plant height (104.27 and 109.76) cm, the pod length (24.77 and 25.97) cm, the weight of the green pod is (53.37 and 54.21) gm for both seasons.

4- The triple interaction treatment (Franchi cultivar, 240 kg h^{-1} and 200 mg l^{-1}) was significantly excelled in all indicators of vegetative growth, yield and quality, where the studied traits gave the highest averages for the studied traits, where the chlorophyll content in the leaves reached (40.50 and 44.00) SPAD, leaf area (20.19 and 20.47 cm²),The number of branches per plant (8.57 and 8.77), one plant branch, plant height (129.17 and 130.40) cm, pod length (29.47 and 30.03) cm, green pod weight (70.33 and 71.13) g for both seasons.

1.INTRODUCTION

The Fabaceae family is one of the largest and most diverse families and includes soybeans, chickpeas and lentils, which are examples of legumes commonly consumed by humans and used as animal feed. The broad bean (Vicia faba), commonly known as the field broad bean, is one of the oldest and most popular cultivated plants on the planet and has the highest productive potential of all leguminous crops (Mekky et al (2020).broad bean seeds contain a high percentage of protein ranging between 26-33% and also contain amino acids, 0.55-1.06% dietary fibre, iron, zinc, in addition to antioxidants, saponins and some phenolic compounds (Labba, et al, 2021). Foliar Nutrition is an effective method to supply plants with nutrients and vitamins through the vegetative parts to contribute to the growth and development of the plant. This method is economical by reducing the need for large quantities of nutrients, especially large ones, compared to other methods. It is necessary to emphasize that nutrition through the shoots is a supplement to nutrition through the soil and not a substitute for it (El-naggar et al, 2009) Phosphorous is one of the basic and necessary nutrients for plant growth and development. It has been called the Key of Life because of its main and direct role in most of the processes that take place within plant cells, as these processes cannot occur without phosphorous. When the plant absorbs phosphorous, the phosphorus is distributed within all living cells within the plant tissues to participate in the vital processes of the plant. In the absence of phosphorous, the average of carbohydrate formation, such as starch, the formation of sugars, and the production of cellulose, is affected. It also contributes to the process of cell formation and division. Thiamine is one of the important vitamins for growth, and it is one of the water-soluble vitamins. Vitamin B1 is considered a growth hormone that moves from one part of the plant to other parts, that is, it is covered in the leaves and then transmitted to the root (Blokhina, etal 2003 It encourages the roots in its role in the root meristem sections and adding thiamine to the plant has an important role in increasing growth by its effect in increasing the cytokinins and gibberellins(Youssef et al,2004) Based on the foregoing, the study aimed to know the effect of phosphate fertilization and thiamine spraying on the vegetative growth traits of two cultivars of broad bean.

Materials and methods

Experiment location :

A field experiment was conducted during the two agricultural seasons (2020-2021) and (2120-2022) in Al-Nile sub-district (5 km) northeast of Babylon province to know the response of two cultivars of barley to phosphorous and thiamine.

Soil Analysis:

The soil of the experiment was analyzed before planting by taking random samples from the soil of the field to a depth of (0-30 cm) to conduct an analysis of the physical and chemical properties of soil in the laboratories of the Ministry of Agriculture, Department of Agriculture of Babylon province, shown in Table (1).

Table (1) Some physical and chemical traits of the experimental field before planting

units	values	Traits
_____	**7.8**	**pH**

Ds.m^{1-}	**4.5**	**ECe**
%	**1.13**	Organic matter
ppm	**52**	nitrogen
ppm	**7**	phosphorous
ppm	**188**	potassium
)Centimol. Kg^{-1} soil(	**21.08**	**CEC**
g.cm^3	**1.13**	bulk density
%	60.0	sand
%	**24.5**	silt
%	**15.5**	clay
Sandy loam	**Sandy loam**	texture

The tillage operations were conducted using the Moldboard plows, after which the levelling and smoothing operations were conducted, and the land was divided according to the design used.The planting was conducted on lines, with a distance between one line and another 50 cm, and the experimental unit was a board (2 * 3 m) with six lines, a length of 2 m for one line. One plant in pit after reaching the height of the plant (10-15) cm(Aady, 2012). so the total of the experimental units is (72) experimental units. The process of nitrogen fertilization was conducted with an amount of 80 kg N H-1 in the form of urea fertilizer (46% N) and at one batch (15) days after planting. The form of triple superphosphate fertilizer (21%P) in one batch before planting (Al-Hassani, 2018). .

Experiment design:

The experiment (the split plots experiment) was conducted according to the randomized complete block design (R.C.B.D) with three replications.

While phosphorous fertilization was placed in the subplots, while spraying with thiamine occupied the subplots.Experimental factors: The experiment of the split plot to study included three factors, which are:

The first factor:

Two cultivar of broad beans and occupied the main

1- Franchi . cultivar

2- Fito cultivar

The second factor:

Fertilization with phosphorous at four levels and occupied the sub plot

1.0 (kg.ha^{-1})

2. 80 (kg. ha^{-1})

3. 160 (kg. ha^{-1})

4. 240 (kg. ha^{-1})

The third factor:

The sub-sub plot included three concentrations of thiamine

1. control
2. 100 (mg. L^{-1})
3. 200 (mg. L^{-1})

studied traits

vegetative growth traits

Determination of chlorophyll content in leaves

The chlorophyll content was measured when the plant reached the stage of full flowering 100% and at the average of five leaves for each plant and for five plants from the middle lines using the SPAD device.

leaf area (cm2(

The leaf area was measured by the Leaf Area device as an average of 100 leaves per plant for five plants that were randomly taken from the midlines of each experimental unit, then calculated and averaged and multiplied by the average number of plant leaves (Al-Hassani, 2018.(

Number of branches per plant (branch 1(-

The average number of branches on the main stem of the harvested plants was calculated for each experimental unit.

plant height (cm(

Ten plants were taken randomly from the midlines of each experimental unit, and the height of the plant was measured from the ground level to the highest leaf in the plant, and the measurement was usually done by measuring tape at the stage of plant maturity (Al-Hassani, 2018.(

Pod length (cm(

The length of the pod was calculated by means of a tape measure at the stage of maturity, as (10) pods were taken randomly for each experimental unit (Al-Hassani, 2018.(

green pod weight (gm(

The weight of the green pod was calculated using the electronic scale at the ripening stage, where (10) pods were taken for each experimental unit (Al-Hassani, 2018.(

Results and discussion

:1-4The effect of cultivars, phosphorus and thiamine on the vegetative growth traits of broad bean crops

- 1-1-4Total Chlorophyll (SPAD(

The results in tables (2 and 3) showed a significant effect of the study factors and the bi- and triple interactions, where the Italian cultivar Franchi gave the highest average of total chlorophyll (35.64 and 38.48) SPAD for both seasons, respectively, compared with the French cultivar Fito, which gave (33.88). SPAD for the first season and (36.54) SPAD for the second season.The addition of phosphate fertilizer had a significant effect on the total chlorophyll traits, where the treatment (240 kg h^{-1}) was significantly excelled and gave the highest value of (37.98 and 41.86) SPAD for both seasons, respectively, compared to the treatment without fertilizer, which gave (31.47 and 32.83). SPAD for both seasons.The addition of thiamine has an effect on traits of total chlorophyll, where the treatment excelled (200 mg.L-1) by giving it the highest average in the trait

of total chlorophyll, which reached (35.52) SPAD for the first season and (38.55) SPAD for the second season compared to the control treatment without spraying, which gave The lowest average for this trait was (34.03) SPAD for the first season and (36.47) SPAD for the second season The bi- interaction between the cultivar and phosphorous fertilization achieved a significant effect on the total chlorophyll trait, where the combination Franchi 240 kg ha^{-1} excelled by recording the highest SPAD average of (39.19 and 42.47) for both seasons, respectively, compared to the combination Fito 0 kg ha^{-1}, which gave a value of (30.30 and 31.52) SPAD for both seasons, respectively .The interaction between the cultivar and spraying with thiamine had a significant effect on the total chlorophyll , where the bi- interaction between the Franchi cultivar and spraying with thiamine 200 mg L^{-1} gave the highest rate of (36.49) SPAD for the first season and (39.38) SPAD for the second season, while the interaction gave the cultivar The French and the control treatment without spraying had the lowest average (33.32 and 35.43) SPAD for both seasons, respectively.The interaction between phosphorous and thiamine led to significant differences for this trait, where the combination (240 kg h^{-1}) and spraying with thiamine 200 mg l^{-1} gave the highest average for this trait amounted to (38.88) SPAD for the first season and (43.38) SPAD for the second season in While the combination Fito with no spraying gave the lowest SPAD average of (30.63 and 31.83) for both seasons, respectively.The triple interaction between cultivars, phosphate fertilization and spraying with thiamine achieved a significant improvement in the trait in the combination (Franchi cultivar, 240 kg h^{-1} and 200 mg l^{-1}), as it gave the highest rate of (40.50) SPAD for the first season and (44.00) SPAD for the second season. Comparison with the comparison treatment of Fito, 0 phosphorus and spraying with water, which reached (32.13 and 33.33) SPAD for both seasons respectively.

Table (2) Effect of cultivars, phosphorus and thiamine on total chlorophyll (SPAD) for the 2021 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 $mg.L^{-1}$		
32.64	33.13	32.67	32.13	0kg.ha-1	Franchi
34.19	34.83	34.17	33.57	80kg.ha-1	
36.54	37.50	36.70	35.43	160kg.ha-1	
39.19	40.50	38.93	38.13	240kg.ha-1	
30.30	31.63	30.13	29.13	0kg.ha-1	Fito
33.41	33.77	33.77	32.70	80kg.ha-1	
35.04	35.53	34.90	34.70	160kg.ha-1	
36.78	37.27	36.67	36.40	240kg.ha-1	
0.200	**0.361**			**LSD 0.05**	
Cultivars × thiamine concentration					
35.64	36.49	35.62	34.82	Franchi	
33.88	34.55	33.87	33.23	Fito	

0.021	**0.180**			**LSD 0.05**
phosphate fertilization × thiamine concentration				
31.47	32.38	31.40	30.63	0kg.ha-1
33.80	34.30	33.97	33.13	80kg.ha-1
35.79	36.52	35.80	35.07	160kg.ha-1
37.98	38.88	37.80	37.27	240kg.ha-1
0.142	**0.255**			**LSD 0.05**
	35.52	34.74	34.03	average
	0.127			**LSD 0.05**

Table (3) Effect of cultivars, phosphorus and thiamine on the percentage of total chlorophyll (SPAD) for the 2022 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
34.13	34.73	34.33	33.33	0kg.ha-1	Franchi
37.44	38.37	37.67	36.30	80kg.ha-1	
39.86	40.43	39.90	39.23	160kg.ha-1	
42.47	44.00	42.20	41.20	240kg.ha-1	
31.52	33.13	31.10	30.33	0kg.ha-1	Fito
35.32	35.80	35.80	34.37	80kg.ha-1	
38.07	39.13	38.07	37.00	160kg.ha-1	
41.26	42.77	41.00	40.00	240kg.ha-1	
0.322	**0.628**			**LSD 0.05**	
Cultivars × thiamine concentration					
38.48	39.38	38.53	37.52	Franchi	
36.54	37.71	36.49	35.43	Fito	
0.592	**0.314**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					
32.83	33.93	32.72	31.83	0kg.ha-1	
36.38	37.08	36.73	35.33	80kg.ha-1	
38.96	39.78	38.98	38.12	160kg.ha-1	
41.86	43.38	41.60	40.60	240kg.ha-1	
0.227	**0.444**			**LSD 0.05**	
	38.55	37.51	36.47	average	
	0.222			**LSD 0.05**	

leaf area (cm^2)

Statistical results in tables (4 and 5) indicate that there are significant differences in the leaf area of broad beans, where the Franchi cultivar was significantly exceled on the Fito cultivar by giving it the highest average leaf area of (31.78 and 34.29) cm² for both seasons, while the Fito cultivar gave the lowest mean and value (29.45 and 28.85) for both seasons, respectively.The addition of phosphorous also significantly affected the leaf area (cm²), as the treatment of addition (240 kg ha^{-1}) was distinguished by giving it the highest average value (39.78 and 40.16) for both seasons, respectively, compared to the treatment of no addition (0 kg ha^{-1}), which recorded the lowest average. (23.04 and 24.14) for both seasons, respectively.The results of the two tables showed that thiamine had a significant effect on of leaf area (cm²), as spraying with (200 mg L^{-1}) gave the highest rate of leaf area (cm²) of (32.65 and 33.99) for both seasons, respectively, compared to the no-spray treatment. Which gave (28.70 and 29.65) for both seasons, respectively.The results of the same table show that the two-cultivar interaction with phosphorus had a significant effect on (traits), as the plants within the combination (Franchi cultivar and 240 kg h^{-1}) achieved the highest mean of (44.42 and 46.20), while the plants (Fito cultivar and 240 kg e^{-1}) the lowest average and its value is (35.14 and 34.12).As for the bi-interaction between the cultivar and thiamine, significant differences appeared between the combinations, with (Franchi + 200 mg L^{-1}) significantly excelled on the rest of the other combinations and achieved the highest average leaf area (cm²) of (34.25 and 36.37 cm²) for both seasons, respectively. While the combination (Fito + 0 thiamine) recorded the lowest mean (27.82 and 27.29 cm²) for both seasons, respectively.The bi-interaction between phosphorus and thiamine led to a significant increase in this trait, where the combination (240 kg h^{-1} phosphorus + 200 mg l^{-1} thiamine) was significantly excelled on the rest of the other combinations and recorded the highest average leaf area (cm²) of (42.66 and 43.34). cm²) for both seasons, while the mixture (0 kg e^{-1} phosphorus + 0 mg l^{-1} thiamine) recorded the lowest mean (21.43 and 22.06 cm²) for both seasons.The results of the same table indicate that there are significant differences in the leaf area (cm²) of the broad beans as a result of the interaction between the factors of the study combined, where the combination (Franchi + 240 kg e^{-1} + 200 mg l^{-1} thiamine) was significantly excelled on the other combinations by recording the highest average of (47.88 and 50.24 cm²) for both seasons, compared to the combination (Fito + 0 kg h^{-1} phosphorus + 0 mg l^{-1} thiamine), which recorded the lowest average of (20.19 and 20.47 cm²) for both seasons.

Table (4) Effect of cultivars, phosphorus and thiamine on leaf area (cm²) for the 2021 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
23.94	25.87	23.29	22.66	0kg.ha-1	Franchi
25.19	26.84	24.49	24.25	80kg.ha-1	
33.58	36.42	33.52	30.81	160kg.ha-1	
44.42	47.88	44.82	40.56	240kg.ha-1	

22.15	24.53	21.72	20.19	0kg.ha-1	Fito
28.85	29.79	29.79	26.98	80kg.ha-1	
31.66	32.48	31.93	30.58	160kg.ha-1	
35.14	37.43	34.45	33.54	240kg.ha-1	
0.674	**0.864**			**LSD 0.05**	
Cultivars × thiamine concentration					
31.78	34.25	31.53	29.57	Franchi	
29.45	31.06	29.47	27.82	Fito	
0.428	**0.432**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					
23.04	25.20	22.51	21.43	0kg.ha-1	
27.02	28.31	27.14	25.61	80kg.ha-1	
32.62	34.45	32.72	30.70	160kg.ha-1	
39.78	42.66	39.64	37.05	240kg.ha-1	
0.477	**0.611**			**LSD 0.05**	
	32.65	30.50	28.70	average	
	0.306			**LSD 0.05**	

Table (5) Effect of cultivars, phosphorus and thiamine on leaf area (cm²) for the 2022 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
25.00	26.09	25.25	23.66	0kg.ha-1	Franchi
29.56	32.83	28.64	27.20	80kg.ha-1	
36.39	40.28	34.00	34.88	160kg.ha-1	
46.20	50.24	46.01	42.35	240kg.ha-1	
23.29	26.31	23.09	20.47	0kg.ha-1	Fito
28.20	28.55	28.55	27.49	80kg.ha-1	
29.78	30.64	29.78	28.92	160kg.ha-1	
34.12	36.44	33.65	32.27	240kg.ha-1	
1.335	**1.825**			**LSD 0.05**	
Cultivars × thiamine concentration					
34.29	37.36	33.48	32.02	Franchi	
28.85	30.48	28.77	27.29	Fito	
1.487	**0.912**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					
24.14	26.20	24.17	22.06	0kg.ha-1	

28.88	30.69	28.60	27.35	80kg.ha-1
33.08	35.46	31.89	31.90	160kg.ha-1
40.16	43.34	39.83	37.31	240kg.ha-1
0.944	**1.290**			**LSD 0.05**
	33.92	31.12	29.65	average
	0.645			**LSD 0.05**

:6-1-4number of branches (branch.plant $^{-1}$)

The statistical results in tables (6 and 7) indicate that there are significant differences in the number of branches of the broad beans, where the Franchi cultivar was significantly superior to the Fito cultivar by giving it the highest average of the trait amounted to (6.91 and 7.02) a plant branch $^{-1}$ for both seasons, while the cultivar Fito gave The lowest mean was (5.66 and 5.86) for the $^{-1}$ plant branch for both seasons, respectively.The addition of phosphorous also significantly affected the (trait), where the treatment of addition (240 kg ha^{-1}) was distinguished by giving it the highest average value of (7.27 and 7.52) for a branch of the plant^{-1} for both seasons, respectively, compared to the treatment of no addition, which recorded the lowest average of (5.23 and 5.38). for both seasons.The results of the two tables showed that thiamine had a significant effect on the trait of the number of branch in the plant, as spraying the broad beans with (200 mg L^{-1}) gave the highest mean for the trait and amounted to (6.54 and 6.70) per branch^{-1} compared to the no-spray treatment that gave (6.03 and 6.17) branch.plant $^{-1}$ for both seasons .The results of the same table showed that the bi-interaction of the cultivar and phosphorus had a significant effect on the number of branch of broad beans, where the plants within the combination (Franchi cultivar and 240 kg h^{-1}) achieved the highest average of (7.93 and 8.12) branch^{-1} for both seasons, respectively, while Plants (Fito cultivar and 240 kg $^{-1}$) recorded the lowest mean of (4.47 and 4.60) branch .plant^{-1} for both seasons, respectively.As for the bi-interaction between the cultivar and thiamine, significant differences appeared between the combinations, with (Franchi + 200 mg L^{-1}) significantly excelled on the rest of the other combinations and achieved the highest mean for the trait (7.23 and 7.34) branch.plant^{-1} for both seasons, while it recorded The combination (Fito + 0 thiamine) was the lowest average value of (5.43 and 5.63) a branch of $^{-1}$ for both seasons, respectively.The bi- interaction between phosphorus and thiamine led to a significant increase in this trait, as the combination (240 kg h^{-1} phosphorus + 100 mg l^{-1} thiamine) was significantly excelled on the rest of the other combinations and recorded the highest average of (7.67 and 7.97) a branch . plant^{-1} for both seasons, while the combination (0 kg ha^{-1} phosphorus + 0 mg l^{-1} thiamine) recorded the lowest average of (4.97 and 5.10) for a branch of the plant^{-1} for both seasons, respectively.The results of the same table indicate that there are significant differences in the number of branches as a result of the interaction between the factors of the study combined, as the combination (Franchi + 240 kg .ha^{-1} + 200 mg l^{-1} thiamine) was significantly excelled on the other combinations by recording the highest average of (8.57 and 8.77) branch.plant^{-1}, compared to the combination (Fito + 0 kg.ha^{-1} phosphorus + 0 mg L^{-1} thiamine), which recorded the lowest mean of (4.27 and 4.40) a plant branch^{-1} for both seasons, respectively.

Table (6) Effect of cultivars, phosphorus, and thiamine on the number of branch per plant (branch $^{-1}$) for the 2021 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
6.00	6.27	6.07	5.67	0kg.ha-1	Franchi
6.53	6.61	6.50	6.48	80kg.ha-1	
7.17	7.47	7.10	6.93	160kg.ha-1	
7.93	8.57	7.77	7.47	240kg.ha-1	
4.47	4.70	4.43	4.27	0kg.ha-1	Fito
5.46	5.63	5.63	5.10	80kg.ha-1	
6.11	6.30	6.17	5.87	160kg.ha-1	
6.60	6.77	6.57	6.47	240kg.ha-1	
0.136	**0.204**			**LSD 0.05**	
Cultivars × thiamine concentration					
6.91	7.23	6.86	6.64	Franchi	
5.66	5.85	5.70	5.43	Fito	
0.063	**0.102**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					
5.23	5.48	5.25	4.97	0kg.ha-1	
5.99	6.12	6.07	5.79	80kg.ha-1	
6.64	6.88	6.63	6.40	160kg.ha-1	
7.27	7.67	7.17	6.97	240kg.ha-1	
0.096	**0.144**			**LSD 0.05**	
	6.54	6.28	6.03	average	
	0.072			**LSD 0.05**	

Table (7) Effect of cultivars, phosphorus, and thiamine on the number of branch per plant (branch $^{-1}$) for the 2022 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
6.17	6.40	6.30	5.80	0kg.ha-1	Franchi
6.60	6.70	6.60	6.50	80kg.ha-1	
7.20	7.50	7.27	6.83	160kg.ha-1	
8.12	8.77	7.90	7.70	240kg.ha-1	
4.60	4.80	4.60	4.40	0kg.ha-1	Fito
5.61	5.73	5.73	5.37	80kg.ha-1	

6.29	6.50	6.37	6.00	160kg.ha-1
6.92	7.17	6.87	6.73	240kg.ha-1
0.050	**0.114**			**LSD 0.05**
Cultivars × thiamine concentration				
7.02	7.34	7.02	6.71	Franchi
5.86	6.05	5.89	5.63	Fito
0.052	**0.057**			**LSD 0.05**
phosphate fertilization × thiamine concentration				
5.38	5.60	5.45	5.10	0kg.ha-1
6.11	6.22	6.17	5.93	80kg.ha-1
6.74	7.00	6.82	6.42	160kg.ha-1
7.52	7.97	7.38	7.22	240kg.ha-1
0.035	**0.081**			**LSD 0.05**
	6.70	6.45	6.17	average
	0.040			**LSD 0.05**

plant height (cm)

The results of tables (8 and 9) indicated that there was a significant effect of the study factors and the bi and triple interactions, where the Italian cultivar Franchi gave the highest mean for plant height of (114.41 and 122.75) cm for both seasons, compared with the French cultivar Fito, which gave (90.84). cm for the first season and (93.02) cm for the second season.The addition of phosphate fertilizer had a significant effect on the plant height, where the treatment (240 kg h^{-1}) was significantly excelled and gave the highest value of (109.28 and 114.88) cm for both seasons, respectively, compared to the treatment without fertilizer, which gave (98.06 and 101.38) cm. for both seasons. The addition of thiamine has an effect on the trait, as the treatment (200 mg.L-1) excelled by giving it the highest average in (104.27) cm for the first season and (109.76) cm for the second season, compared to the control treatment without spraying, which gave the lowest rate for this trait was (101.10) cm for the first season and (106.08) cm for the second season.The bi-interaction between the cultivar and phosphorus fertilization achieved a significant effect on the plant height, where the combination (Franchi cultivar + 240 kg h^{-1}) excelled and reached the highest rate (123.09 and 130.40) cm for both seasons, respectively, compared to the combination (Fito cultivar + 0 kg). e^{-1}), which gave a value of (85.41 and 86.99) cm for both seasons, respectively.The interaction between the cultivar and spraying with thiamine had a significant effect on the trait of plant height, as the bilateral interaction between the cultivar (Franchi) and spraying with thiamine 200 mg L^{-1}) gave the highest mean for the trait, which reached (116.63) cm for the first season and (124.53) cm for the second season, while it gave The French cultivar interaction and the control treatment without spraying had the lowest average (89.52 and 91.28) cm for both seasons, respectively.The interaction between phosphorous and thiamine led to significant differences for this trait, where the combination (240 kg h^{-1} + spraying with thiamine

200 mg l^{-1}) gave the highest mean for this trait which reached (112.87) cm for the first season and (118.17) cm for the second season in When the comparison combination gave the lowest mean for this trait, which was (97.40 and 99.37) cm for both seasons, respectively.The triple interaction between cultivars, phosphate fertilization and spraying with thiamine achieved a significant improvement in the trait in the combination (Franchi cultivar + 240 kg h^{-1} + 200 mg l^{-1}) as it gave the highest rate of (129.17) cm for the first season and (130.40) cm for the second season. Comparison with the control treatment (Fito cultivar + 0 phosphorus + spraying with water), which reached (85.41 and 86.99) cm for both seasons, respectively.

Table (8) Effect of cultivars, phosphorus and thiamine on plant height (cm) for the 2021 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
110.70	111.10	110.73	110.27	0kg.ha-1	Franchi
110.66	110.83	110.73	110.40	80kg.ha-1	
113.18	115.40	112.90	111.23	160kg.ha-1	
123.09	129.17	121.30	118.80	240kg.ha-1	
85.41	86.67	85.03	84.53	0kg.ha-1	Fito
89.73	90.53	90.53	88.13	80kg.ha-1	
92.74	93.90	93.00	91.33	160kg.ha-1	
95.48	96.57	95.80	94.07	240kg.ha-1	
0.685	**0.887**			**LSD 0.05**	
Cultivars × thiamine concentration					
114.41	116.63	113.92	112.68	Franchi	
90.84	91.92	91.09	89.52	Fito	
0.441	**0.443**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					
98.06	98.88	97.88	97.40	0kg.ha-1	
100.19	100.68	100.63	99.27	80kg.ha-1	
102.96	104.65	102.95	101.28	160kg.ha-1	
109.28	112.87	108.55	106.43	240kg.ha-1	
0.484	**0.627**			**LSD 0.05**	
	104.27	102.50	101.10	average	
	0.314			**LSD 0.05**	

Table (9) Effect of cultivars, phosphorus and thiamine on plant height (cm) for the 2022 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
115.78	117.07	116.53	113.73	0kg.ha-1	Franchi
119.81	121.40	120.00	118.03	80kg.ha-1	
125.00	126.33	125.07	123.60	160kg.ha-1	
130.40	133.33	129.70	128.17	240kg.ha-1	
86.99	89.30	86.67	85.00	0kg.ha-1	Fito
91.17	92.00	92.00	89.50	80kg.ha-1	
94.58	95.67	94.53	93.53	160kg.ha-1	
99.36	103.00	98.00	97.07	240kg.ha-1	
0.648	**0.691**			**LSD 0.05**	
Cultivars × thiamine concentration					
122.75	124.53	122.83	120.88	Franchi	
93.02	94.99	92.80	91.28	Fito	
0.415	**0.345**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					
101.38	103.18	101.60	99.37	0kg.ha-1	
105.49	106.70	106.00	103.77	80kg.ha-1	
109.79	111.00	109.80	108.57	160kg.ha-1	
114.88	118.17	113.85	112.62	240kg.ha-1	
0.458	**0.488**			**LSD 0.05**	
	109.76	107.81	106.08	average	
	0.244			**LSD 0.05**	

: pod length (cm)

The results of tables (10 and 11) showed that the Frenchi cultivar was significantly excelled and gave the highest number of branches for both seasons, which reached (21.76 and 22.00) cm, respectively, while the Fito cultivar gave the lowest length of pods in the plant, which amounted to (17.05 and 17.95) cm for both seasons, respectively.The same results also showed that phosphate fertilization at a concentration of 240 kg H-1 was significantly excelled on other concentrations and gave the highest rate of pods length for both seasons, which reached (23.02 and 23.96) cm, respectively, followed by the concentration of 160 kg ha-1, which gave the length of pods for both seasons, respectively, amounted to (20.21). and 20.72), while the control treatment without adding the lowest length of pods in the plant was (16.05 and 16.34) cm for both seasons, respectively.The treatment of thiamine spraying with a concentration of 200 mg L-1 was significantly excelled on the rest of the other treatments and gave the highest rate of pod length in the plant, which reached (24.77 and 25.97) cm for both seasons, respectively, while the comparison

treatment without spraying gave the lowest amount for both seasons (18.35 and 18.86) respectively.The results of tables (17 and 18) also showed the effect of the bi-interaction between cultivars and phosphate fertilization in increasing the number of pods. (27.09 and 27.61) cm for both seasons, respectively, while the interaction treatment (Fito + cultivar without addition) gave the lowest mean for the trait, which was (15.04 and 15.47) cm for both seasons, respectively.The results of the same table also showed that the interaction treatment between (cultivar Franchi + spraying thiamine at a concentration of 200 mg.L-1) had a significant effect on the trait of the length of the pods and gave the highest rate of (23.27 and 23.51) cm for both seasons, while the interaction treatment was recorded (cultivar Fito). (+without spraying thiamine) the lowest average pod length was (16.43 and 17.21) cm for both seasons, respectively. While the interaction treatment between (phosphate fertilization 240 kg H-1 + spraying thiamine at a concentration of 200 mg L-1) gave the highest rate for both seasons, which amounted to (24.77 and 25.97) cm, respectively, while the control treatment gave the lowest rate of (15.35 and 15.62).) cm for both seasons in succession.The results of tables (17 and 18) showed that the triple overlap (Franchi cultivar + phosphate fertilization 240 kg H-1 + spraying thiamine at a concentration of 200 mg L-1) was significantly excelled on the rest of the other overlap treatments, and gave the highest rate of (29.47 and 30.03) cm for both seasons, respectively. Where the interaction (Fito cultivar + without spraying thiamine + without adding phosphate) gave the lowest mean for both seasons, which was (14.20 and 14.57) cm, respectively.

Table (10) Effect of cultivars, phosphorus and thiamine on pod length (cm) for the 2021 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
17.06	17.67	17.00	16.50	0kg.ha-1	Franchi
20.06	21.80	20.27	18.10	80kg.ha-1	
22.82	24.13	22.83	21.50	160kg.ha-1	
27.09	29.47	26.77	25.03	240kg.ha-1	
15.04	15.63	15.30	14.20	0kg.ha-1	Fito
16.61	16.87	16.87	16.10	80kg.ha-1	
17.59	17.90	17.63	17.23	160kg.ha-1	
18.96	20.07	18.63	18.17	240kg.ha-1	
0.229	**0.536**			**LSD 0.05**	
Cultivars × thiamine concentration					
21.76	23.27	21.72	20.28	Franchi	
17.05	17.62	17.11	16.43	Fito	
0.299	**0.268**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					

16.05	16.65	16.15	15.35	0kg.ha-1
18.33	19.33	18.57	17.10	80kg.ha-1
20.21	21.02	20.23	19.37	160kg.ha-1
23.02	24.77	22.70	21.60	240kg.ha-1
0.162	**0.379**			**LSD 0.05**
	20.44	19.41	18.35	average
	0.189			**LSD 0.05**

Table (11) Effect of cultivars, phosphorus and thiamine on pod length (cm) for the 2022 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
17.21	17.83	17.13	16.67	0kg.ha-1	Franchi
20.27	22.03	20.53	18.23	80kg.ha-1	
22.92	24.13	22.97	21.67	160kg.ha-1	
27.61	30.03	27.33	25.47	240kg.ha-1	
15.47	16.20	15.63	14.57	0kg.ha-1	Fito
17.51	17.83	17.83	16.87	80kg.ha-1	
18.52	18.93	18.50	18.13	160kg.ha-1	
20.31	21.90	19.77	19.27	240kg.ha-1	
0.166	**0.460**			**LSD 0.05**	
Cultivars × thiamine concentration					
22.00	23.51	21.99	20.51	Franchi	
17.95	18.72	17.93	17.21	Fito	
0.143	**0.230**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					
16.34	17.02	16.38	15.62	0kg.ha-1	
18.89	19.93	19.18	17.55	80kg.ha-1	
20.72	21.53	20.73	19.90	160kg.ha-1	
23.96	25.97	23.55	22.37	240kg.ha-1	
0.117	**0.325**			**LSD 0.05**	
	21.11	19.96	18.86	average	
	0.163			**LSD 0.05**	

Green pod weight (gm):

The results in tables (12 and 13) showed that the cultivars had a significant effect on the weight of the green pod in both seasons. and 45.84) gm for the two seasons, respectively.The results also showed that phosphate fertilization had a significant effect on increasing the weight of the green pod. The addition of phosphorus at a concentration of 240 kg H-1 was significantly excelled on the rest of the other concentrations and gave the highest rate for the two seasons, which reached (60.67 and 60.26) gm, respectively, while the comparison without adding the lowest rate was recorded. (44.83 and 46.37) grams for both seasons, respectively. As for the spraying of thiamine, the spray treatment with a concentration of 200 mg L-1 was significantly excelled on the rest of the other treatments and gave the highest average weight of the green pod for the two seasons, which reached (53.37 and 54.21) gm, respectively. While the control treatment without spraying gave the lowest mean for both seasons (49.86 and 58.23) gm, respectively.The results also showed that the bi-interaction between cultivars and phosphate fertilization had a significant effect on increasing the weight of the pod for the two seasons. 68.31 gm , while the combination of interference (Fito + without addition) gave the lowest average of (38.86 and 40.38) gm for both seasons, respectively.The results of the same table also showed that the interaction between (Franchi cultivar + spraying thiamine at a concentration of 200 mg L-1) had a significant effect on the weight of the green pod and gave the highest rate of (59.60 and 61.32) gm for the two seasons, respectively, while the interaction treatment recorded (Cultivar Fito + without spraying). Thiamine), the lowest rate was (43.33 and 44.74) gm, respectively.While the interaction between (phosphate fertilization 240 kg H-1 + spraying thiamine at a concentration of 200 mg L-1) gave the highest rate for both seasons, which amounted to (63.78 and 62.18) gm, respectively, while the combination (without adding phosphate fertilizer + without spraying thiamine) gave the lowest. The mean was (44.40 and 45.25) grams for the two seasons, respectively.The results of tables (19 and 20) showed that the triple interaction between the experimental factors had a significant effect on increasing the weight of the green pod. The other mixtures gave the highest mean of (70.33 and 71.13) gm for both seasons, respectively, while the overlapping (Fito cultivar+ without spraying thiamine + without adding phosphate) gave the lowest weight of green pods for both seasons, which amounted to (38.30 and 39.50) gm, respectively.

Table (12) The effect of cultivars, phosphorus and thiamine on the weight of Green pods(g) for the 2021 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
50.81	51.30	50.63	50.50	0kg.ha-1	Franchi
53.26	53.93	53.33	52.50	80kg.ha-1	
59.34	62.83	58.73	56.47	160kg.ha-1	
67.41	70.33	65.80	66.10	240kg.ha-1	

38.86	39.40	38.87	38.30	0kg.ha-1	Fito
41.66	42.53	42.53	39.90	80kg.ha-1	
47.18	49.40	48.07	44.07	160kg.ha-1	
53.93	57.23	53.50	51.07	240kg.ha-1	
0.743	**1.247**			**LSD 0.05**	
Cultivars × thiamine concentration					
57.71	59.60	57.13	56.39	Franchi	
45.41	47.14	45.74	43.33	Fito	
0.067	**0.624**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					
44.83	45.35	44.75	44.40	0kg.ha-1	
47.46	48.23	47.93	46.20	80kg.ha-1	
53.26	56.12	53.40	50.27	160kg.ha-1	
60.67	63.78	59.65	58.58	240kg.ha-1	
0.525	**0.882**			**LSD 0.05**	
	53.37	51.43	49.86	average	
	0.441			**LSD 0.05**	

Table (13) The effect of cultivars, phosphorus and thiamine on the weight of Green pod(g) for the 2022 season

Cultivars × phosphate fertilization	Thiamine spray concentrations			phosphate fertilization	Cultivars
	200 mg.L-1	100 mg.L-1	0 mg.L-1		
52.36	53.63	52.43	51.00	0kg.ha-1	Franchi
56.14	57.20	56.07	55.17	80kg.ha-1	
61.02	63.30	61.17	58.60	160kg.ha-1	
68.31	71.13	68.33	65.47	240kg.ha-1	
40.38	41.57	40.07	39.50	0kg.ha-1	Fito
43.28	44.53	43.00	42.30	80kg.ha-1	
47.51	49.07	47.30	46.17	160kg.ha-1	
52.20	53.23	52.37	51.00	240kg.ha-1	
0.356	**0.683**			**LSD 0.05**	
Cultivars × thiamine concentration					
59.46	61.32	59.50	57.56	Franchi	
45.84	47.10	45.68	44.74	Fito	
0.230	**0.341**			**LSD 0.05**	
phosphate fertilization × thiamine concentration					

46.37	47.60	46.25	45.25	0kg.ha-1
49.71	50.87	49.53	48.73	80kg.ha-1
54.27	56.18	54.23	52.38	160kg.ha-1
60.26	62.18	60.35	58.23	240kg.ha-1
0.252	**0.483**			**LSD 0.05**
	54.21	52.59	51.15	average
	0.241			**LSD 0.05**

conclusions

In the light of the results obtained, the Franchi cultivar was the most responsive to the addition of phosphorus and spraying of thiamine, which reflected positively in increasing all vegetative growth indicators.

References

Al-Hassani, Ali Rahim Karim (2018). The effect of foliar feeding with proline and a mixture of nutrients on the growth and yield of broad bean (Vicia Faba L.) cultivars. PhD thesis, Department of Field Crops, College of Agriculture, Al-Muthanna University.

Al-Rawi, Khasha'a Mahmoud and Abdulaziz Muhammad Khalafallah (2000). Design and analysis of agricultural experiments. Dar Al-Kutub for printing and publishing. University of Al Mosul . Ministry of Higher Education and Scientific Research. The Republic of Iraq.

Al-Touki, Warqaa Baqer Aliwi (2015). Response of genotypes of the broad bean crop, Vicia faba L., to planting dates in Al-Muthanna Governorate. Master Thesis, College of Agriculture - Al-Muthanna University.

Al-Qatrani, Sarah Ali Talib. (2016). Effect of distribution of plants in the field on the growth and yield of broad bean Vicia Faba L. Master's thesis - Department of Field Crops - College of Agriculture - University of Basra

Al-Abedi, Jalil Aspahi. (2011). Guide to the use of chemical and organic fertilizers in Iraq. The General Authority for Agricultural Extension and Cooperation - Ministry of Agriculture - Iraq, p. 89.

The annual report of the Iraqi Central Statistical Organization. 2019

Al-Obeidi, Wissam Jihad Hussain. 2020. Molecular study of Rhizobium sp. isolated from the root nodules of some leguminous plants in Nineveh Governorate / Iraq.

Al-Hassani, Ali Rahim Karim (2018). The effect of foliar feeding with proline and a mixture of nutrients on the growth and yield of broad bean (Vicia Faba L.) cultivars. PhD thesis, Department of Field Crops, College of Agriculture, Al-Muthanna University.

Al-Nuaimi, Saad Allah Najm Abdullah. 1999. Fertilizers and soil fertility. College of Agriculture, University of Mosul. Book House for printing and publishing. Mosul

Aady, A. Y. (2012). 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): 517-534.

Altieri, M. A. (1999). The ecological role of biodiversity in agroecosystems. In Invertebrate Biodiversity as Bioindicators of Sustainable Landscapes (pp. 19-31). Elsevier

Blokhina, O. ; E. M. Virolainen and K. V. Fagerstedt . 2003 . Antioxidants , Oxidative damage and Oxygen deprivation stress . A Review . Ann. Bot., 91:179-194

El-naggar , A.H . 2009 . Response of *Dionthus caryophylus* L . plants to paliar nutrition word jornal of . Agric . Sci , 5 (5) : 622 – 630.

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 .

Herridge D.F., Peoples M. B., Boddey R.M. (2008). Global inputs of biological nitrogen fixation in agricultural systems. Plant and Soil, 311(1-2), pp. 1–18.

Labba, I. C. M., Frøkiær, H., & Sandberg, A. S. (2021). Nutritional and antinutritional composition of fava bean (Vicia faba L., var. minor) cultivars. *Food Research International*, *140*, 110038.

Mekky R.H., Thabet M.M., Rodríguez-Pérez C., Elnaggar D.M.Y., Mahrous E.A., SeguraCarretero A., Abdel-Sattar E. (2020). Comparative metabolite profiling and antioxidant potentials of seeds and sprouts of three Egyptian cultivars of Vicia faba L. Food Research International, 136, 109537.

Youssef , A. A. ; M. H. Mahgoub and I. Talaat .2004. Physiological and biochemical aspects of *Mathiola* L. plant under the effect of putrecine and Kinetin treatments . Egypt. J. App. Sci , 19 (9B).

Klippenstein, S. R., Khazaei, H., Vandenberg, A., & Schoenau, J. (2022). Nitrogen and phosphorus uptake and nitrogen fixation estimation of faba bean in western Canada. *Agronomy Journal*, *114*(1), 811-824.

A.O.A.C. 1980. Official Methods of Analysis. 13th Edn. The Association of Official Analytical Chemists. Washington, DC. p. 13

Singh, D. I., and Stoskof, N.C.(1971).Harvest Index in cereals. Agron. J. 63 No:224-226.