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Evaluation of the performance of several cultivars of bean (*Vicia faba* L.) for yield and its components under three different cultivation distances

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ABSTRACT

varieties (Local, Yildiz, Sciabola verde, Aquadulce 2, Lue Deotono, Aquadulce), and the land was divided according to the design of randomized complete blocks (RCBD) with three replications. The factor of the distances between the rows was distributed on the main panels and the factor of the varieties on the secondary panels, and the results indicated that by increasing the distance between the rows, the average of the studied traits increased, as the distance exceeded 30) cm in leaf area, number of seeds per pod, weight of 100 seeds, total yield (kg/ha), protein percentage in seeds (%), and distance (70) cm in number of pods per plant. Leafy and Aquadulus 2 for the number of pods per plant and the total yield (kg/ha), Chabla Single for the number of seeds per pod, Leodotono for the weight of 100 seeds, and the local variety for the percentage of protein in seeds (%), and the overlap between the varieties was P and the distances were significant, as the interaction between Aquadulus cultivar at distance D2 had the highest leaf area and the cultivar Leodotino at distance D3 in the number of pods per plant and the interaction between the cultivar Chabla Individual at the distance D1 was the highest in the trait of the number of seeds in the pod and the interaction between the cultivar Yildiz at the distance D2 the highest average weight of 100 Seed and the interaction between the cultivar Chabla Farida at the distance D2 in the trait of the total yield (kg/ha), and the interaction between the cultivar Leodutunu and the distance D3 was the highest in this trait in the percentage of protein in the seeds.**(%)** .

تقييم أداء عدة أصناف من الباقلاء (*Vicia faba* L) لصفات الحاصل ومكوناته تحت ثلاث مسافات زراعية مختلفة

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الخلاصة

اجريت هذه الدراسة في مركز محافظة كركوك في مزارع احد الفلاحين للموسم الزراعي 2021/2020 واشتملت الدراسة على عاملين الاول المسافة بين المروز حيث استخدمت المسافات الاتية (30-50-70 سم) والعامل الثاني مجموعة من الأصناف (محلي ، Yildiz، Sciabola Verde، Aguadulce 2، Lue Deotono، Aguadulce) ، وقسمت الارض حسب تصميم القطاعات العشوائية الكاملة (RCBD) بثلاث مكررات وزع عامل المسافات بين المروز على الالواح الرئيسية وعامل الاصناف على الالواح الثانوية ، واشارت النتائج انه بزيادة المسافة بين المروز زاد من معدل الصفات المدروسة أذ تفوقت المسافة (30) سم في صفة المساحة الورقية وعدد البذور في القرنة ووزن 100 بذرة والحاصل الكلي (كغم /هـ) ونسبة البروتين في البذور(%) والمسافة (70) سم في صفة عدد القرنات في النبات ، واختلفت الاصناف معنويا أذ تفوق الصنف اكوادولس في صفة المساحة الورقية والصنف اكوادولس2 في صفتي عدد القرنات في النبات والحاصل الكلي (كغم /هـ) والصنف شابلا فردي في صفة عدد البذور في القرنة والصنف ليودوتونو في صفة وزن 100 بذرة والصنف المحلي في صفة نسبة البروتين في البذور(%) ، وكان التداخل بين الاصناف والمسافات معنويا أذ تفوق التداخل الصنف اكوادولس عند المسافة D_2 اعلى مساحة للورقة والصنف ليودوتونو عند المسافة D_3 في صفة عدد القرنات في النبات والتداخل بين الصنف شابلا فردي عند المسافة D_1 الأعلى في صفة عدد البذور في القرنة والتداخل بين الصنف يلدز عند المسافة D_2 اعلى معدل لوزن100 بذرة والتداخل بين الصنف شابلا فردى عند المسافة D_2 في صفة الحاصل الكلي (كغم /هـ) والتداخل بين الصنف ليودوتونو والمسافة D_3 كان الأعلى في هذه صفة نسبة البروتين في البذور(%) .

الكلمات المفتاحية: الاداء، مسافات الزراعة، الباقلاء.

INTRODUCTION

Broad bean is one of the important crops of the legume family, and studies indicate that the Mediterranean basin is the original home of the broad bean.(Sumerfield and Roberts , 1985) China is one of the largest countries in the production and consumption of beans, followed by Ethiopia. China's production of beans reaches (2.7 million tons / year), and this is equivalent to 65% of the global production, followed by Ethiopia with a production of 9% of the global production, and then Egypt, which produces the equivalent of 262 thousand tons. for the year and beans are consumed in these countries as a main food for the poor class (FAO ,2003). while in Iraq, the cultivated area has reached (9382) dunums and the total production amounted to (4947) thousand tons of seeds with a productivity rate of 527.4 kg/dunum (Central Statistical Organization, 2021). The importance lies in the fact that its seeds contain a high percentage of protein ranging from 23-37% (Yucel DO, 2013). as well as They contain quantities of sugary, starchy materials and some vitamins (Matlub *et al.* 1989). and are used as animal feed, whether plant residues after harvest or the use of their dried seeds as a source of protein in rations, in addition to their important role in improving soil properties to fix atmospheric nitrogen through It kills the root ganglia bacteria that coexist with it (Raeed and Saifuldeen, 2020).

The studies indicated that the plant density directly affects the plant height and its decline and varies according to the genetic structures of the cultivated varieties. The diameter and length of the internodes in a variety may allow an increase in the nodes and be affected by the increase in vegetation cover less. (Attiya and G.D.Hill ,1983). mentioned that the yield of a single plant decreases as the plant cover decreases. The plant density increased. Several studies were conducted in this field, including the study of (Kakahy *et al.* 2012). where their study included the effect of the distance between plants on the yield of beans under the drip irrigation system using three varieties: Spanish, Turkish and local with three planting distances of 20, 25 and 30 cm. The Spanish cultivar gave the highest average number of seeds/pod (3.12 seeds/pod). (Yucel DO, 2013). mentioned in his study the best distances for the production of local bean cultivars in Mediterranean conditions, where he used four local cultivars and four interstitial distances 5, 10, 15 and 20 cm, as there were no significant differences between the cultivars of yield traits and some of its components. The spacing between 10-12 cm is the best for the length of the crop in these conditions, as found by (Derogar and Mojaddam, 2014). in their study the effect of plant density on yield and its components in the bean in Iran where three plant densities were used 8, 12 and 16 plants / m2 the results showed that the plant density of 12 plants/m2 led to a significant increase in seed yield for Barekat cultivar compared to other cultivars. In a study conducted by (Osman, *et al.* 2013).in the experimental field of the College of Agriculture, Sudan University of Science and Technology, to evaluate four different varieties of broad beans for two seasons, as no significant differences were observed for both sites in terms of production and number of pods/plants, while significant differences were observed in the number of seeds. Indicated (Abbas, *et al.* 2014). when they studied some new genotypes in the growth of the bean and the different cultivation distances in Egypt, where the varieties Assiut - 159, Assiut - 125, Assiut - 215, Roomy - 3, Roomy - 8 were used, where the results showed the superiority of the variety Assiut - 125 in general. The weight of dry seeds is 2.1 tons / feddan, while the variety Roomy - 3 has the highest green yield of 10.5 tons / feddan. Accordingly, this study aims to evaluate the yield characteristics and components of six types of barley at different distances between the crops.

MATERIALS AND METHODS

This study was conducted in the center of Kirkuk governorate in the farms of a farmer for the agricultural season 2020/2021. The study included two factors, the first is the distance between the meadows, where the following distances were used (30-50-70 cm) and the second factor was a group of varieties (Local, Yildiz, Sciabola verde, Aquadulce 2, Lue Deotono, Aquadulce), the land was prepared by two orthogonal plowing, and then the soil was smoothed to prepare a suitable bed for seeds, and superphosphate fertilizer was added to the soil before planting at a rate of 70 kg. Hectare-1(Al-Mayouf, 1982) . The land was cut into experimental units according to the design of the sectors Complete randomization (RCBD) with three repetitions distributes the factor of the distances between the spikes on the main boards and the varieties on the secondary boards so that the number of experimental units is (18) experimental

units. 25-30 cm. After the emergence of seedlings, the process of thinning was carried out so that each hole contained one plant. The bush was manually controlled twice during the season and the plants were directly fertilized with urea fertilizer (44 kg / ha) in two batches, the first after germination and the second at the beginning of the stage Flower knots (Bouras, *et al* .2006). The irrigation process was carried out according to the needs of the plant and the following characteristics were studied:

1- Leaf area: the leaf area was measured according to (Al-Jubouri, 2016). by means of a special computer program for this purpose, where the plant leaves were scanned by a Scanner with a measuring ruler to determine the distance and then the area was measured.
2- Number of pods per plant: This trait was measured by calculating the average number of pods per plant of the measured experimental unit.
3- The number of seeds in a pod: This characteristic of the seeds of the plants that was measured was measured divided by the number of their pods according to the following equation: The number of seeds in a pod = the number of seeds in the plant / the number of pods of the same plant.
4- Weigh 100 seeds: 100 seeds were taken from each experimental unit and weighed.
5- Total yield of dry seeds (kg/ha): Five randomly selected plants were harvested and after finding the total plant and then their average yield.
6- Percentage of protein: The percentage of protein in the seeds was calculated using the Micro kgeldahl method, according to (A.O.A.C. 1980). The dry seeds were ground and 0.4 gm of each refiner was taken for all varieties. Then the samples were digested by the wet method using concentrated sulfuric acid and pyrochloric acid in a large capacity glass flask. 50 mm and after completion of digestion, the total nitrogen was calculated from the following equation:
   Protein percentage = Total nitrogen content x 6.25

RESULTS AND DISCUSSION

Table (1) shows the analysis of variance for the studied traits represented by the mean of the squares for the two study sites, as the distances and varieties differed significantly at the 1% level, and for all the studied traits, that one of the most important fundamentals in the high production of the crop is to find appropriate genotypes characterized by their high content of the yield and its components and grown in different environments. Circumstances in addition to the fact that the activity and interaction of genotypes depend first on internal factors and secondly on external factors through their effects on the yield and its components (Al-Jubouri,2016).

Table (1) analysis of variance for the studied traits represented by means of squares (M.S).

sources of difference (S.O.V)	degrees of freedom (d.f)	The number of pods in the plant	The number of seeds in the pod	Weight (100) seeds gm	total seed yield kg/ha
Replicators	2	0.333	0.275	52.462	53583.8
planting distances	2	148.899**	0.350**	345.129**	72640388.1**
Variety	5	21.729**	0.349**	1348.329**	13451795.8**
planting distances * variety	10	14.905**	0.935**	537.996**	4929031.5**
experimental error	34	0.174	0.034	4.208	159602.0

**،*significant at 1% and 5% probability level, respectively and NS = not significant

The results of Table (2) showed that the leaf area was significantly affected, as the distance D2 outperformed it, as it gave (155.90 cm2), followed by the leaf area at the distance D3 (117.24 cm2), and the distance D1 gave the least area of the leaf, which amounted to (100).34 cm2. It is also noted that the cultivars differed significantly among themselves, as Aquadulus cultivar was significantly superior in this trait, as it gave 158.83 cm², followed by the two cultivars Yildiz (142.73 cm²). And the lowest variety was single chabla, reaching 102.62 cm². The leaf area is among the important characteristics that affect the yield, as the dry matter is manufactured in which the efficiency of the leaf can be identified by increasing the daily growth rate of the unit weight in the plant from the leaf area (Yan and Wallace, 1998) and these results are in agreement with. (Al-Jubouri, 2016).

It is also noted that the overlap was significant between the cultivars and planting distances in both locations for the leaf area characteristic. The Aquadulus cultivar at the distance D2 showed the highest leaf area of (240.42 cm2), and the local variety at the distance D1 was the lowest in the leaf area, which amounted to (89.88 cm2). The result agrees with (Raeed and Saifuldeen 2020). and (Saifuldeen and Raeed, 2020) and (Saifuldeen and Raeed ,2021).

Table (2) Effect of cultivars and planting distances and the interaction between them on the characteristic of leaf area (cm2)

Variety	D3	D2	D1	variety rate
local variety	105.1	161.72	89.88	
Yildiz	96.24	200.62	131.33	118.9
single chabla	96.45	111.24	100.17	142.73
Aquadules2	143.37	95.87	95.31	102.62
Liudotouno	121.15	125.56	90.45	111.51
Aquadules	141.16	240.42	94.92	112.38
distance rate	117.24	155.90	100.34	158.83
L.S.D%5	**to interfere =0.069**	**planting distances =0.028**	**variety= 0.040**	

We note from Table (3) that the planting distance had a significant effect on the number of pods in the plant, where the distance D3 outperformed and was the highest, reaching (16.74 pods), while the distance D1 was the least of the distances in the number of pods in the plant, where it was (10.72 pods). The reason for this may be due to the ease of movement of insects and the occurrence of pollination in large distances than in small distances that limit the movement of insects and thus reduce the rate of pollination, especially that the proportion of cross pollination in this crop ranges between 42-36% (Al-Jubouri, 2016). As well as competition for Environmental requirements between plants under the studied cultivation distances, and these results are consistent with what was found by (Dahmardeh and Ramroodi, 2010) It was also found that the cultivars had a significant effect on the average number of pods per plant. Acuadolus 2 was superior to the average number of pods per plant, as it gave (15.75 pods), while the local variety was the lowest in the number of pods per plant (10.87 pods). We also note that there is a significant overlap between the cultivars and planting distances in the number of pods in the plant. The interaction was superior to the cultivar Leodotono at the distance D3 and reached (18.41 pods), while the Leodotono was the lowest of the cultivars and gave (7.37 pods) at the distance D1, which means that the response of the cultivars varies with different cultivation distances.

Table (3) The effect of cultivars, planting distances, and the interaction between them on the characteristic of the number of pods in a plant

planting distances / Variety	D1	D2	D3	variety rate
local variety	8.11	9.16	15.36	10.87
Yildiz	8.13	12.61	17.74	12.82
single chabla	12.74	13.58	15.36	13.89
Aquadules2	13.66	17.33	16.27	15.75
Liudotouno	7.37	12.32	18.41	12.7
Aquadules	14.31	13.22	17.34	14.95
distance rate	10.72	13.03	16.74	
L.S.D%5	**to interfere =0.694**	**planting distances =0.281**		**variety= 0.400**

Table (4) shows that the planting distance has a significant effect on the number of seeds per pod, as the distance D2 followed by the distance D3 excelled in this trait in the Hawija site, as it reached (6.35 and 6.21 seeds/pod) respectively, while the distance D1 was the lowest when it reached (5.77 seed/pod) and the result agrees with (Raeed and Saifuldeen 2020). and (Saifuldeen and Raeed, 2020). and (Saifuldeen and Raeed ,2021) While the cultivars showed significant differences in this trait, the single chapla cultivars were superior to (6.78 seeds/pod), followed by the local cultivar Welds and Leodotono in this trait of the number of seeds per pod, as they reached (6.01, 6.41 and 6.03 seeds/pod) respectively, while the cultivar was Aquadulus 2 is the lowest in this trait, reaching (5.64 seeds / pod), and the reason for this may be due to the fact that this trait is affected by the genetic nature of each variety and that this trait is a fixed genetic trait mostly with (Bakry, *et al.* 2011) It is also noted that the interaction between planting distances and cultivars had a significant effect on the number of seeds per pod, as the cultivar gave an individual chabla at the distance D1 the highest in this trait, reaching (7.35 seeds/pod), while the cultivar Aquadulus was the lowest at the distance D1, reaching (5.28 seeds). / Pod.

Table (4) Effect of cultivars and planting distances and the interaction between them on the characteristic of the number of seeds in the pod

planting distances / variety	D1	D2	D3	variety rate
local variety	5.47	7.25	6.51	6.41
Yildiz	5.48	6.83	5.74	6.01
single chabla	7.35	5.89	7.12	6.78
Aquadules2	4.78	6.39	5.75	5.64
liudotouno	6.29	5.37	6.43	6.03
aquadules	5.28	6.38	5.72	5.79
distance rate	5.77	6.35	6.21	
L.S.D%5	**to interfere**	**planting distances**		**variety= 0.400**

	=0.310	**=0.124**

The results of Table (5) indicate that the character of the weight of 100 seeds was significantly affected by the planting distance, as the distance D2 gave the highest average in the character of the weight of 100 seeds, which amounted to 106.67 g), while the distance D gave the lowest values, which amounted to (98.83 g). As for the cultivars, they were significantly superior in both locations. In Hawija, the cultivar Leodotino gave the highest average of 100-seed weight (118.94 g), while Aquadulus 2 had the lowest cultivar, giving (84.23 g) per 100-seed weight. To reduce competition for food and thus cause a high deposition of nutrients in seeds as well as increase the distance between plants leads to the efficiency of light interception of sunlight and thus increase the efficiency of photosynthesis. These results are in agreement with (Thalji, 2006). and (Bakry, *et al.* 2011).

Table (5) Effect of cultivars and planting distances and the interaction between them on the trait of weight (100) seeds/g of dry seeds

planting distances / variety	**D1**	**D2**	**D3**	**variety rate**
local variety	119.67	103.67	108.34	110.56
Yildiz	104.34	99.34	126.35	110.01
single chabla	89.11	102.67	103.35	98.37
Aquadules2	68.67	107.67	76.36	84.23
liudotouno	126.12	112.34	118.36	118.94
aquadules	85.11	114.34	99.32	99.59
distance rate	98.83	106.67	105.34	
L.S.D%5	**to interfere =3.418**	**planting distances =1.394**		**variety= 1.974**

It is also noted that the interaction between planting distances and cultivars was significant in the weight of 100 seeds, as Yildiz cultivar at the distance D2 gave the highest average of 100-seed weight of (126.35 g), followed by the cultivar Leodutuno at the distance D1

of (126.12 g), while the Aquadulus 2 cultivar had the lowest at the distance D1 It gave (68.67 g).Table (6) shows that the characteristic of the total yield of dry seeds was significantly affected by the planting distance, as it gave the distance D2 in the characteristic of the total yield of dry seeds (kg / ha) the highest rate and reached (8731.44 kg / ha), while the distance D1 was the lowest in this The trait amounted to (4796.92 kg / ha), that the increase in the total yield came due to its superiority in the components of the yield as well as its superiority in the characteristic of leaf area (Table 2), which led to an increase in the number of branches per unit area, and this helps to produce more pods, which is reflected in the yield in a way Especially positive if the nutrients are sufficiently available to the plant and these results are in agreement with (Dahmardeh, 2010). It is noted that the average yield of dry seeds varies according to the varieties studied. The differences between the varieties were significant, as Aquadulus 2 gave the highest varieties in this trait, reaching (7505.16 kg / ha), with an insignificant difference from the varieties Chabla Individual and Aquadulus, which amounted to (7302.16 and 7443.37 kg). /e) While the local cultivar had the lowest values, amounting to (4,975.29 kg/ha), and the reason for this discrepancy between cultivars is due to its different genetic structures. It is also noted from Table (6) a significant effect of the interaction of planting distances and cultivars on the average of this trait, as the Chabla Individual cultivar outperformed the rest of the cultivars in this trait at the distance D2 amounting to (11249.16 kg/ha), while the local variety was the least in the average of this at the distance D1 It reached (4008.83 kg/ha) and the result agrees with (Raeed and Saifuldeen 2020). and (Saifuldeen and Raeed, 2020). and (Saifuldeen and Raeed ,2021).

Table (6) Effect of cultivars and planting distances and the interaction between them on the trait of weight (100) seeds/g of dry seeds

planting distances / variety	**D1**	**D2**	**D3**	**variety rate**
local variety	4481.56	6630.16	3814.16	4975.29
Yildiz	4024.7	7077.16	4123.5	5075.12
single chabla	4836.5	11249.16	5820.83	7302.16
Aquadules2	4008.83	9669.83	8836.83	7505.16
liudotouno	6288.16	7896.5	5525.83	6570.16
aquadules	5141.8	9865.83	7322.5	7443.37
distance rate	4796.92	8731.44	5907.27	
L.S.D%5	**to interfere= 666.084**		**planting distances =271.927**	**variety= 384.563**

Table (7) indicates that the planting distances had a significant effect on the percentage of protein in seeds (%), as the distance D2 in the characteristic of the percentage of protein gave the highest rate and reached (28.49%), followed by the distance D2 with an insignificant difference of (28.42%), while the distance D1 was the lowest in this trait was (27.16) %. While the cultivars showed significant differences for the percentage of protein in seeds (%), the local was also the highest in the percentage of protein in seeds, amounting to (29.29%), while the cultivar Chabla Individual gave the lowest rates for this trait, giving (24.36%). It is mainly due to the genetic

structure of the variety as the protein content is under genetic control (Al-Jubouri, 2016).and the result agrees with (Raeed and Saifuldeen 2020). and (Saifuldeen and Raeed, 2020). and (Saifuldeen and Raeed ,2021). The table also indicates that there is a significant interaction between planting distances and cultivars, as the cultivar Leodotono was the highest in this trait at the distance D3 and reached (29.68%), while the cultivar Chabla Single was the lowest of these percentages at the distance D1 amounting to (23.65) %.

Table (7) Effect of cultivars and planting distances and the interaction between them on the trait of weight (100) seeds/g of dry seeds

planting distances / variety	D1	D2	D3	variety rate
local variety	28.65	29.62	29.6	29.29
Yildiz	27.7	28.59	28.59	28.29
single chabla	23.65	24.62	24.81	24.36
Aquadules2	27.6	28.54	28.6	28.24
liudotouno	27.75	29.58	29.68	29.00
aquadules	27.61	29.61	29.67	28.96
distance rate	27.16	28.42	28.49	
L.S.D%5	**to interfere= 0.322**	**planting distances= 0.130**		**variety= 0.185**

CONCLUSIONS

The genotype of Aquadules2 is superior to the other varieties, especially in the trait of yield.Increasing the distance between the grooves increased the average of most of the studied traits, especially the distance (30) cm.

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