Agriculture College – Wasit University

Dijlah Journal of Agricultural Sciences

ISSN 2790 – 5985

e ISSN 2790 – 5993

Dijlah J. Agric. Sci., Special Issue:378-389, 2024

The effect of plant densities and cultivars on yield characateristics and compoents of faba bean (*vicia fabal*)

Aseel Ali Abdulrazzaq* and Zainb Karem Kadhum Al Shugeairy

Dept. of field Grops. coll. Of Agric. Engineering Sci. University Of Baghdad , Iraq

Corresponding Author: aseel.ali120a@coagri.uobaghdah.edu.Iq

Abstract:

The experimental panels were fertilized collectively with triple superphosphate fertilizer (21% P) at a rate of 35 kg P ha-1 (Ali, 2012), while nitrogen fertilizer in the form of urea (46% N) was added at a rate of 50 kg N ha-1 (Ali et al., 2014), divided into two applications: the first at planting and the second at the beginning of flowering. Planting was done on 3/11/2021 by manually sowing seeds in rows at a depth of 5 cm with three seeds per hill, then thinning to one plant per hill after plants reached the two-leaf stage. Crop management services including irrigation, weeding, and fertilization were performed as needed, and harvesting was conducted upon signs of maturity. The study results showed the following: The New Zealand variety excelled in individual plant yield, achieving the highest average of 70.56 g plant^{-1}. This variety also outperformed in other traits such as grain weight (161.47 g), 100-seed weight (152.50 g), and number of seeds per pod (3.62 seeds pod^{-1}), with a total plant yield of 6.27 tons ha^{-1}. On the other hand, the Spanish variety excelled in the number of pods per plant with 17.69 pods plant^{-1}. There was a significant interaction between plant densities and varieties. The local variety excelled in seed number per pod at density D2, reaching 5.33 seeds pod-1, while the Spanish variety excelled at density D1 in the number of pods per plant with 19.47 pods plant-1. The Dutch variety outperformed at density D1 in individual plant yield (90.13 g plant^{-1}), pod length at density D3 (16.60 cm), and total yield at density D1 (9.01 tons ha^{-1}). Plant density D2 excelled in seed number per pod (3.91 seeds pod^{-1}), pod weight (194.05 g), and dry plant weight (731.85 g plant^{-1}. From this study, it can be concluded that: Plant densities D1, D2, and D3 differed significantly in the studied traits. The New Zealand variety is suitable for the prevailing environmental conditions in the central region at the study site, especially due to its superior total seed yield of 6.27 tons ha^{-1}, attributed to its performance in yield-related traits such as pod number, seed number per pod, pod weight, and 100-seed weight.

Keywords: *Plants, density, pods, seeds, weight, number*

تأثير الكثافات النباتية والأصناف في صفات المحصول ومكونات الباقلاء (*Vicia fabal*)

اسيل علي عبد الرزاق و زينب كريم كاظم

قسم المحاصيل الحقلية- كلية علوم الهندسة الزراعية- جامعة بغداد- العراق

الخلاصة

طبقت تجربة حقلية في الموسم الشتوي لعام 2021 - 2022 في محطة أبحاث A التابعة لكلية علوم الهندسة الزراعية – جامعة بغداد بهدف تقيم أداء أصناف مختلفة من الباقلاء واختبارها تحت ثلاث كثافات نباتية مختلفة، وتقدير بعض المعالم الوراثية لكل كثافة ، وتحديد اي الأصناف تعطي حاصلاً عالياً تحت تأثير الكثافات الثلاثة. نفذت التجربة بترتيب الألواح المنشقة Split plot Design تضمنت الألواح الرئيسة (Main plots) ثلاث كثافات نباتية 88888 و53333 و38095 نبات هـ-1 وبالترميز D1و D2 و D3 والألواح الثانوية (Sub-plots) تضمنت معاملات أربعة أصناف من الباقلاء (الهولندي و الاسباني و النيوزلندي و المحلي) تم الحصول على البذور للتراكيب الوراثية من مكتب الدكتور عماد ابو تراب للتجهيزات الزراعية- بغداد – جميلة حيث جهزت البذور من مصادر لشركات رصينة وهي شركة Fito (للتركيب الوراثي الاسباني) وشركة PV (Popvried seed) (للتركيب الوراثي الهولندي) و شركة(CANTERB URY seed) (للتركيب الوراثي النيوزلندي) . وتم تجهيز بذور الصنف المحلي من نفس المكتب المذكور اعلاه .

الكلمات المفتاحية: ***النبات،الكثافة، البذور، وزن البذور، عدد البذور***

Introduction

Broad beans, belonging to the legume family Fabaceae, are winter crops known for their high nutritional value and significant contribution to human health. Their seeds contain a high percentage of protein (21%), starch (48%), fats (3%), and glucose (2%) (Al-Rawi et al., 2023). The importance of this crop lies in its role in improving soil properties by fixing atmospheric nitrogen through root nodules' symbiosis with Rhizobium bacteria in the plant roots. This process converts atmospheric nitrogen into ammonia, which is then transformed into ammonium nitrates by other bacteria, providing plants with the nitrogen they need for protein synthesis and growth. The vitality of microorganisms in the soil directly correlates with soil health, reducing water stress and disease prevalence (Amalfitano et al., 2018). However, broad bean cultivation has seen a decrease in cultivated area and productivity, with an average production of 470 tons per 1005 dunums in Iraq (Agricultural Statistics Directorate, 2020). This decline is attributed to several factors, including water scarcity, outdated agricultural practices, lack of attention from growers, and reliance on low-yield varieties. The genetic and physiological variability among varieties leads to differences in growth behavior and yield under varying environmental conditions and management practices. Competitive interactions within the same variety significantly impact plant growth factors (Sadiq & Mohammed, 2022a). Controlling competition among plants by adjusting plant densities is crucial for determining final seed yield. Altering plant density affects water and nutrient use efficiency and photosynthetic processes, influenced by plant hormones and the genetic adaptability of varieties to environmental conditions (Al-Ani & Abdulhamid, 2017). Estimating genetic, environmental, and phenotypic variance in studied traits depends on the genetic variation and inheritance of desired traits (Elsahookie et al., 2021). Yield is a complex quantitative trait, so focusing on traits with high heritability related to yield is essential for plant breeders. The study aims to:Identify genetic combinations that yield high results under different plant densities.

Materials and methods

A field experiment was conducted during the winter season of 2021-2022 at Research Station A, Faculty of Agricultural Engineering Sciences, University of Baghdad. The aim was to evaluate the performance of different pea varieties under three different plant densities and estimate some genetic characteristics for each density, identifying which varieties yield high under the influence of the three densities. The experiment was implemented using a Split-plot Design, with main plots containing three plant densities: 88888, 53333, and 38095 plants ha-1, coded as D1, D2, and D3, respectively. The sub-plots included four pea varieties (Dutch, Spanish, New Zealand, and local), and seeds were obtained from Dr. Emad Abu Turab Agricultural Supplies Office in Baghdad, sourced from reputable companies such as Fito (for the Spanish genetic composition), PV (Popvried seed) (for the Dutch genetic composition), and Canterbury Seed (for the New Zealand genetic composition). The local variety seeds were also prepared by the same office mentioned above. The seeds were tested for germination in Petri dishes in a laboratory to ensure their germination rate and viability. The experimental land was plowed twice using a reversible moldboard plow, and the soil was prepared using a Rotovater before leveling it. The land was divided into three replicates, with a total of 36 experimental units. Each experimental unit measured 2m x 3m = 6m2 and included 5 rows with a spacing of 75 cm between rows and 15 cm, 25 cm, and 35 cm between hills for D1, D2, and D3 densities, respectively. Planting rows were opened manually, and before planting, all experimental plots were fertilized with triple superphosphate fertilizer (21% P) at a rate of 35 kg P ha-1 as a single application before planting (Ali, 2012). Nitrogen fertilizer in the form of urea (46% N) was added at a rate of 50 kg N ha-1 (Ali et al., 2014) split into two applications, the first at planting and the second at the beginning of flowering. Planting was done on 3/11/2021, which was the first irrigation date for the field.Seeds were manually sown within the rows at a depth of 5 cm with three seeds per hill, then thinned to one plant per hill after the plants reached the two-leaf stage. Crop management operations such as irrigation, weeding, and fertilization were performed as needed, and plants were harvested upon reaching maturity.

Characteristics of the product and its components

The studied traits and their components are as follows

Number of pods per plant: Calculated by counting the number of pods from five randomly selected plants per experimental unit and recording the average.Pod length (cm): Measured by randomly selecting ten pods from the plants used to count pods and using a measuring tape to measure the length from the base to the tip of the pod at harvest stage, then recording the average. Number of seeds per pod: Assessed by taking ten pods randomly from each experimental unit's plants used for pod counting, counting the number of seeds in each pod, and recording the average. 100-seed weight (grams): Determined by weighing 100 seeds randomly selected from the total seeds of each experimental unit and recording the weight using a sensitive scale. Dry plant weight (grams per plant): Calculated as the average dry weight of five randomly selected plants from each experimental unit, placed in bags and air-dried until constant weight, then weighed using a sensitive scale. Dry pod weight (grams): Obtained by randomly selecting ten pods from each experimental unit, weighing them using a sensitive scale, and recording the average. Individual plant yield (grams per plant): Calculated from five randomly selected samples from each experimental unit, measuring the yield of dry seeds per single plant, and recording the average. Total plant yield (tons ha-1): Calculated based on the average yield of five randomly selected plants from each experimental unit, multiplied by plant density, then divided by 106 to convert units from grams ha-1 to tons ha-1. Harvest index (%): Calculated at the harvest stage by dividing the economic yield (seed yield) by the biological yield of the plant (total dry plant weight excluding roots) using the following equation: Harvest index (%) = ((Economic yield) / (Biological yield excluding roots)) x 100.

Results and Discussions

The length of the pod (cm)

The data in Appendix (1) and Table (1) indicated that the trait of pod length was significantly influenced by the variation in varieties. The Dutch variety excelled by giving the highest average for the trait, reaching 14.20 cm with an increase rate of 16.10%. As for the Spanish variety, which gave the lowest average, it reached 12.33 cm. The reason for the difference in pod length between varieties may be attributed to genetic factors. The variation in pod length due to genetic factors has been mentioned in several previous studies, including (Abbas, 2012), (Hadi et al., 2018), and (Alwan, 2022). Significant differences in the trait were also observed due to plant densities, where density D3 gave the highest average for the trait at 13.98 cm compared to density D2, which gave the lowest average at 12.68 cm, followed by density D1, which gave an average trait length of 12.85 cm. The superiority of density D3 in pod length may be attributed to its superiority in increasing the products of photosynthesis and transporting them to the pods, leading to increased cell division and elongation of pod cells, and consequently, increased pod length. This result is consistent with the findings of (Al-Janabi, 2023). There is a significant interaction effect between varieties and densities, as the Dutch variety gave the highest average for the trait at 16.60 cm at density D3, while the Spanish variety gave the lowest average for the trait at 11.47 cm at density D1.

Table (1): Effect of Plant Densities, Varieties, and Their Interactions on Pod Length (cm) for the Season 2021-2022

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	16.60	13.20	12.80	14.20
Spanish	13.20	12.33	11.47	12.33
Local	12.47	12.93	13.80	13.07
New Zealand	13.67	12.27	13.33	13.09
L.S.D**5%**	0.90			0.52
Average of Densities	13.98	12.68	12.85	
L.S.D**5%**	0.43			

The number of pods per plant

The data in Appendix (1) and Table (2) showed that the trait of the number of pods per plant was significantly influenced by the variation in varieties. The Spanish variety excelled and gave the highest average for the trait, reaching 17.69 pods per plant with an increase rate of 17.07% compared to the local variety, which did not differ significantly from the Spanish variety. The Dutch variety gave the lowest average for the trait at 15.11 pods per plant, which did not differ significantly from the New Zealand variety, which gave the highest average at 15.44 pods per plant. The difference in the number of pods per plant may be attributed to the fact that the trait is linked to the fertilization rate, which affects flower drop in the varieties studied. These results are consistent with (Afifi et al., 2010), (Derogar and Mojaddam, 2014), (Dhari and Al-Baldawi, 2017), and (Mahmoud et al., 2017). It is noted that there was no significant effect of plant densities on the trait of the number of pods per plant. There was also a significant interaction effect between varieties and plant densities, as the Spanish variety at density D1 gave the highest average for the trait at 19.47 pods per plant and did not differ significantly from densities D2 and D3 for the Dutch variety. These results are consistent with the findings of (Khudair, 2020).

Table (2): Effect of Plant Densities, Varieties, and Their Interactions on the Number of Pods per Plant (pods per plant) for the Season 2021-2022

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	12.73	17.80	14.80	15.11
Spanish	15.73	17.87	19.47	17.69
Local	18.13	14.93	18.80	17.29
New Zealand	16.00	17.33	13.00	15.44
L.S.D5%	1.68			0.97
Average of Densities	15.65	16.98	16.52	
L.S.D5%	N.S			

The number of seeds per pod

The data in Appendix (1) and Table (3) indicated the absence of a significant effect of varieties on the trait of the number of seeds per pod. Significant differences were observed in the trait of the number of seeds per pod due to the effect of plant densities. Density D2 gave the highest average for the trait at 3.91 seeds per pod compared to density D3, which gave the lowest average at 3.17 seeds per pod. The reason could be that lower plant density per unit area stimulates the efficiency of metabolic products and increases their distribution among sinks, leading to an increase in the number of seeds per pod. These results are consistent with (Gezahegn et al., 2016), (Al-Ani and Abdul Hamid, 2017), and (Sadiq and Mohammed, 2022), who indicated that lower plant density per unit area leads to the transfer and accumulation of photosynthetic products in seeds during the growth and filling stage, reducing the chance of ovule abortion due to less competition among plants for growth factors, thereby increasing the number of seeds per pod. There is also a significant interaction effect between varieties and plant densities, as the local variety at density D2 gave the highest average for the trait at 5.33 seeds per pod and did not differ significantly from density D3 for the Dutch, Spanish, and New Zealand varieties, as well as from density D1 for the Spanish variety. These results are consistent with the findings of (Gezahegn et al., 2016).

Table (3): Effect of Plant Densities, Varieties, and Their Interactions on the Number of Seeds per Pod (seeds per pod) for the Season 2021-2022

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	2.53	3.50	4.60	88.60
Spanish	2.93	3.87	3.87	84.13
Local	2.93	5.33	2.93	88.60
New Zealand	4.27	2.93	3.67	97.25
L.S.D5%	0.56			4.25
Average of Densities	3.17	3.91	3.77	
L.S.D5%	0.33			

The dry weight of pods (grams)

The data in Appendix (1) and Table (4) indicated that the trait of pod weight in the plants was significantly affected by the differences in varieties. The New Zealand variety excelled significantly, giving the highest average for the trait at 161.47 grams, with an increase of 19.45% and 17.86% compared to the Dutch and local varieties, respectively, which gave the lowest averages for the trait at 135.17 and 137.00 grams, respectively, and differed significantly from them. The variation in pod weight among varieties may be attributed to the efficiency of the source and sink, which is consistent with (Mojaddam & Derogar, 2014), (Al-Fahdawi, 2014), and (Hadi et al., 2018). Significant differences were also observed in the trait of pod weight due to the effect of plant densities, where density D2 gave the highest average for the trait at 164.05 grams, compared to density D3, which gave the lowest average for the trait at 138.18 grams. The superiority of plant density D2 can be attributed to its superiority in the number of pods per plant and the number of seeds per pod (Table 2 and 3). There was also a significant interaction effect between varieties and plant densities, as the New Zealand variety at density D3 gave the highest average for the trait at 181.20 grams and differed significantly from all other treatments except density D2 for the same variety. The Dutch variety had the lowest value at plant density D1, at 112.30 grams. These results are consistent with those found by (Al-Ani & Abdul-Hameed, 2017).

Table (4). The Effect of Plant Densities, Varieties, and Their Interactions on the Dry Weight of Pods per Plant (grams) for the Season 2022 - 2021

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	119.30	173.90	112.30	135.17
Spanish	136.90	164.70	169.30	156.97
Local	115.30	146.00	169.70	137.00
New Zealand	181.20	171.60	131.60	161.47
L.S.D5%	12.51			7.22
Average of Densities	138.18	164.05	140.73	
L.S.D5%	12.78			

The weight of 100 seeds (grams)

The data in Appendix (1) and Table (5) showed that the trait of 100 seed weight was significantly affected by the differences in varieties. The New Zealand variety excelled significantly by giving the highest average for the trait at 152.50 grams, with an increase of 63.85%, 50.14%, and 9.99% compared to the Spanish, local, and Dutch varieties, respectively, which achieved the lowest averages for the trait at 93.07, 101.57, and 138.73 grams, respectively. The variation in 100 seed weight among varieties is attributed to their differences in efficiency in supplying the plant with essential nutrients for growth during the photosynthesis process, especially in the reproductive stage of the plant, which increases the percentage of pods and leads to an increase in seed weight per pod. This result is consistent with studies conducted by (Daur et al., 2010), (Al-Issawi & Khirbit, 2011), (Kubure et al., 2016), and (Zaidan, 2018). Additionally, it is noted that there was no significant effect of plant densities on the trait of 100 seed weight, and there was no significant interaction effect between varieties and plant densities for the mentioned trait. These results are in agreement with a study conducted by Al-Ani and Abdul-Hameed.

Table (5). The Effect of Plant Densities, Varieties, and Their Interactions on the Weight of 100 Seeds per Plant (grams) for the Season 2022 - 2021

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	140.50	148.70	127.00	138.73
Spanish	92.50	90.80	95.90	93.07
Local	100.50	104.70	99.50	101.57
New Zealand	155.20	150.30	152.00	152.50
L.S.D5%	N.S			8.76
Average of Densities	122.18	123.63	118.60	
L.S.D5%	N.S			

The dry weight of plants (grams per plant)

The data in Appendix Analysis of Variance (1) and Table (6) indicated that the trait of dry plant weight was significantly affected by the differences in varieties. The Spanish variety excelled significantly by giving the highest average for the trait at 729.60 grams per plant and did not differ significantly from the Dutch variety, achieving an increase of 33.61% compared to the New Zealand variety, which gave the lowest average for the trait at 546.03 grams per plant and differed significantly from the other varieties. The variation in dry plant weight among varieties is attributed to the increase in dry matter in the plant, which is consistent with (Al-Fahdawi, 2013), (Naser et al., 2013), and (Alwan, 2022). Significant differences were also observed in the trait of dry plant weight due to the effect of plant densities, where density D2 gave the highest average for the trait at 731.85 grams per plant compared to density D1, which gave the lowest average for the trait at 550.90 grams per plant. The reason is that lower plant density per unit area reduces competition among plants for essential growth requirements, leading to increased efficiency of photosynthesis in providing plants with accumulated dry matter, improving their growth, and consequently increasing the dry plant weight. This result is consistent with the findings of (Al-Batawi, 2015), who indicated significant differences in the trait of dry plant weight due to the effect of plant density.

Additionally, there was a significant interaction effect between varieties and plant densities, as the Spanish variety at density D2 gave the highest average for the trait at 916.10 grams per plant and differed significantly from all other interactions except for the same plant density for the Dutch variety. Also, the New Zealand variety achieved the lowest average for the trait at density D1, at 491 grams per plant, and differed significantly from all other interactions. These results are in agreement with the findings of (Al-Batawi, 2015).

Table (6). The Effect of Plant Densities, Varieties, and Their Interactions on the Dry Weight of Plants per Plant (grams per plant) for the Season 2022 - 2021

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	699.30	890.90	562.50	717.57
Spanish	659.60	916.10	613.10	729.60
Local	749.20	528.40	536.80	604.80
New Zealand	554.90	592.00	491.20	546.03
L.S.D5%	77.06			44.49
Average of Densities	665.75	731.85	550.90	
L.S.D5%	53.21			

The yield of individual plants (grams per plant)

The data in Appendix (1) and Table (7) indicated that the trait of individual plant yield was significantly affected by the differences in varieties. The New Zealand variety excelled significantly by giving the highest average for the trait at 70.56 grams per plant, with an increase of 9.64% compared to the Spanish variety, which gave the lowest average for the trait at 60.58 grams per plant, and differed significantly from the other varieties except for the local variety. The reason for the superiority of the New Zealand variety lies in its superiority in traits such as pod number, seed number per pod, pod weight, and 100-seed weight (Tables 2, 3, 4, and 5), which reflected in an increase in individual plant yield. This is consistent with the findings of (Al-Jubouri et al., 2017) and (Alwan, 2022).Additionally, there were no significant differences in individual plant yield due to the effect of plant densities, which is consistent with (Yucel, 2013). However, there was a significant interaction effect between varieties and plant densities, as the Dutch variety gave the highest average for the trait at 90.13 grams per plant at density D1 and differed significantly from all other interactions. These results are consistent with the findings of (Al-Jubouri et al., 2017) and Alwan (2022).

Table (7). The Effect of Plant Densities, Varieties, and Their Interactions on Individual Plant Yield (grams per plant) for the Season2022-2021

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	49.73	55.20	90.13	65.02
Spanish	58.07	68.00	55.67	60.58
Local	63.20	73.07	54.53	63.60
New Zealand	79.67	64.27	67.73	70.56
L.S.D5%	8.53			4.92
Average of Densities	62.67	65.14	67.02	
L.S.D5%	N.S			

The total yield per hectare (tons per hectare)

The data in Appendix (1) and Table (8) indicated that the trait of total seed yield was significantly affected by the differences in varieties. The New Zealand variety excelled significantly by giving the highest average for the trait at 6.27 tons per hectare, with an increase of 16.54%, 10.97%, and 8.47% compared to the Spanish, local, and Dutch varieties, respectively, which gave the lowest averages for the trait at 5.38, 5.65, and 5.78 tons per hectare, respectively. The reason for the superiority of the New Zealand variety in the total seed yield trait is attributed to its suitability for the prevailing environmental conditions in the central region of the study site compared to the other varieties, in addition to its superiority in yield traits and components such as pod number, seed number per pod, pod weight, and 100-seed weight (Tables 3, 4, 5, 6). This result is consistent with the findings of Wahid et al. (2017), Al-Jubouri et al. (2017), and Alwan (2022), who confirmed significant differences between varieties reflected in the total plant yield trait. Additionally, there was no significant effect of plant densities on this trait. Furthermore, there was a significant interaction effect between varieties and plant densities, as the Dutch variety achieved the highest average for the trait at density D1, reaching 8.01 tons per hectare. These results are consistent with the findings of Al-Jubouri et al. (2017) and Alwan (2022).

Table (8) Effect of Plant Densities, Varieties, and Their Interactions on Total Yield (ton/ha) for the Season 2021-2022.

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	4.42	4.91	8.01	5.78
Spanish	5.16	6.04	4.95	5.38
Local	5.62	6.50	4.85	5.65
New Zealand	7.08	5.71	6.02	6.27
L.S.D5%	0.76			0.44
Average of Densities	5.57	5.79	5.96	
L.S.D5%	N.S			

The Harvest Index (%)

The Harvest Index is an important trait that plant breeders work to develop, as it is linked to the dry seed yield and biological yield (total plant dry weight excluding roots), both of which are influenced by genetic makeup and prevailing environmental conditions. It is one of the indicators used to estimate crop efficiency in distributing dry matter. The data in Appendix (1) and Table (9) showed that the Harvest Index trait was significantly affected by the differences in varieties. The Spanish variety excelled significantly, giving the highest average for the trait at 58.97%, excluding the Dutch variety, with an increase of 49.85% compared to the New Zealand variety, which gave the lowest average for the trait at 29.57%. This variation among varieties in the Harvest Index trait is attributed to the superiority of the Spanish variety in terms of dry weight yield and total yield, as shown in Tables (6, 8). This is consistent with findings by Al-Qushma (2015), who indicated that improved variety performance in yield increase is associated with an increase in the Harvest Index value.It is noted that there was no significant effect of plant densities on the Harvest Index trait.

However, there was a significant interaction effect between varieties and plant densities. The Spanish variety excelled significantly, achieving the highest average for the trait at 67.20% at density D3. This was significantly different from all other interactions, with the lowest being in the interaction between the New Zealand variety and density D2, giving 19.80%.

Table (9). Effect of Plant Densities, Varieties, and Their Interactions on Harvest Index (%) for the Season 2021-2022.

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	**40.40**	**46.60**	**44.90**	**5.78**
Spanish	**67.20**	**53.50**	**56.20**	**5.38**
Local	**27.10**	**33.40**	**44.90**	**5.65**
New Zealand	**41.50**	**19.80**	**27.40**	**6.27**
L.S.D5%	**12.42**			**0.44**
Average of Densities	**44.05**	**38.33**	**43.35**	
L.S.D5%	**N.S**			

Conclusions:

Plant densities D1, D2, and D3 showed significant differences in the studied traits.

The suitability of the New Zealand variety for the prevailing environmental conditions in the central region at the study site, along with its superiority in total seed yield, reaching 6.27 tons/ha, as it excelled in traits such as pod number, seed number, 100-seed weight, and pod weight.

Suggestions:

We propose studying the ratio of effective fertilization in flowers and the ratio of their shedding in the varieties.

References:

Afifi, M.H.M., F.M. Mohamed, and S.H.A. Shaaban. (2010). Yield and nutrient uptake of some faba bean varieties grown in newly cultivated soil as affected by foliar application of humic acid. J. of plant production, 1(1), 77-85.

Amalfitano, C., Gomez, L.D., Frendo, P., De Pascale, S., Pepe, O., Simister, R., Ventorino, V., Agrelli, D., Borrelli, C., McQueen-Mason, S.J., and Caruso, G. (2018). Plant–Rhizobium symbiosis, seed nutraceuticals, and waste quality for energy production of (Vicia faba L.) as affected by crop management. Chemical and Biological Technologies in Agriculture, 5, 1-13.

Daur, I., H. Sepetoglu, Kh.B. Marwat, and M.N. Geverek (2010). Nutrient removal, performance of growth and yield of faba bean (Vicia faba L.). Pak. J. Bot., 42(5), 3477-3484.

Derogar, N., and Mojaddam, M. (2014). Effect of plant density on grain yield and yield components in faba bean. International Journal of Plant, Animal, and Environmental Sciences, 4(2), 92-96.

Elsahookie, M.M., and Daoud, A.A. (2021). Genome and plant breeding. Ministry of Agriculture - Republic of Iraq, p. 364.

Gezahegn, A.M., Tesfaye, K., Sharma, J.J., and Belel, M.D. (2016). Determination of optimum plant density for faba bean (Vicia faba L.) on vertisols at Haramaya, Eastern Ethiopia. Cogent Food & Agriculture, 2(1), 1224485.

Kubure, T.E., Raghavaiah, C.V., and Hamza, I. (2016). Production potential of faba bean (Vicia faba L.) genotypes in relation to plant densities and phosphorus nutrition on vertisols of the central highlands of West Showa Zone, Ethiopia, east Africa. Advances in Crop Science and Technology, 4(2), 2-9.

Naser, A.S., El-Hendawy, S., and Schmidhalter, U. (2013). Influence of Varied Plant Density on Growth, Yield, And Economic Return Of Drip-Irrigated Faba Bean. Turkish Journal of Field Crops, 18(2), 185-197.

Sadiq, S.M., and Mohammed, A.A. (2022a). Response of faba bean to planting distance between plants and Spraying with nano and traditional boron. Iraqi Journal of Market Research and Consumer Protection, 14(1), 84-93.

Yucel, D.O. (2013). Optimal intra-row spacing for production of local faba bean (Vicia faba L. major) cultivars in the Mediterranean condition. Pak. J. Bot., 45(6), 1933-1938.

Appendix 1. Analysis of Variance (ANOVA) based on Mean Squares (M.S) for plant densities, varieties, and their interaction in the studied traits for the winter agricultural season 2021-2022.

The number of pods per plant	The length of the pod (cm)	The number of seeds per pod	The dry weight of pods (grams)	d.f	s.o.v
0.5033	0.4044	0.0136	19.91	2	Repetitions
5.4933 n.s	6.0044**	1.8603**	242.48**	2	Density (D)
1.7217	0.1411	0.0869	127.08	4	Error (a)
15.0737*	5.3344**	0.0677 n.s	1638.32**	3	Varieties(B)
17.3659**	4.1022**	3.1055**	1680.16**	6	B×D
0.9541	0.2763	0.1062	1680.16	18	Error (b)

The weight of 100 seeds (grams)	The yield of individual plants (grams per plant)	The dry weight of plants (grams per plant)	The total yield per hectare (tons per hectare)	The Harvest Index (%)	d.f	s.o.v
138.43	3.62	3005	0.0286	82.07	2	Repetitions
81.06n.s	57.1n.s	100581**	0.4512 n.s	116.79n.s	2	Density (D)
32.47	53.8	2204	0.4194	23.12	4	Error (a)
7397.18**	157.15**	71286**	1.2412**	1482.08**	3	Varieties(B)
113.55n.s	655.37**	38567**	5.1782**	227.16*	6	B×D
78.26	24.71	2018	0.1952	52.45	18	Error (b)
Total	35					

*significant at the 5% level

** significant at the 1% level3.62

N.S. is not significant