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Study of the effect of (*Vicia faba* L.) cultivars at three different plant densities on vegetative growth characteristics

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Abstract:

The study was conducted in the field of the College of Agricultural Engineering Sciences at the University of Baghdad – Jadriya during the winter season of 2021-2022. The main objective was to assess genetic characteristics of pea varieties (Dutch, Spanish, New Zealand, and local) under different plant densities of 88888, 53333, and 38095 plants ha-1, denoted as D1, D2, and D3, respectively.The experimental design employed a Split-Plot Design with three replications based on a Randomized Complete Block Design (RCBD). The main plots consisted of three plant densities, while the secondary plots included the different varieties. Prior to planting, the seeds were subjected to laboratory germination tests to ensure germination percentage and viability.The field was prepared with two orthogonal plowings, followed by soil smoothing and leveling. The experimental field was then divided into three replicates, resulting in a total of 36 experimental units. Each unit covered an area of 6 m2 and was comprised of five rows. Plant spacings for the three plant densities (D1, D2, and D3) were 75 cm between rows and 15 cm, 25 cm, and 35 cm between plants, respectively. The experimental lines were manually opened, and before planting, all experimental plots were fertilized with a single application of triple superphosphate fertilizer (21% P) at a rate of 35 kg P ha-1, following Ali (2012). Nitrogen fertilizer in the form of urea (46% N) was added at a rate of 50 kg N ha-1, divided into two applications: the first at the time of planting and the second at the beginning of flowering, as per Ali et al. (2014).The planting was carried out on November 3, 2021, with seeds sown manually in rows at a depth of 5 cm, with three seeds per furrow. Thinning was performed to retain one plant per furrow after the plants reached the two-leaf stage. Crop management practices, including irrigation, weeding, and hoeing, were conducted as needed. Harvesting was performed when signs of maturity appeared.

Keywords: *Plants, Growth, varietie*

دراسة تأثير الأصناف (*Vicia faba* L) بثلاث كثافات نباتية مختلفة في صفات النمو الخضري

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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 النبوزلندي) . وتم تجهيز بذور الصنف المحلي من نفس المكتب المذكور اعلاه .

الكلمات المفتاحية: ***النبات، النمو، الاصناف***

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.
- Determine the highest heritability ratio for traits under different plant densities.

Materials and methods

A field experiment was conducted during the winter season of 2021-2022 at Research Station A, affiliated with the College of Agricultural Engineering Sciences at the University of Baghdad. The experiment aimed to evaluate the performance of different broad bean varieties under three different plant densities, estimate some genetic parameters for each density, and determine which varieties yield high results under these densities.The experiment was designed using a Split-plot Design, with main plots consisting of three plant densities: 88888, 53333, and 38095 plants per hectare, coded as D1, D2, and D3, respectively. Sub-plots included four broad bean varieties: Dutch, Spanish, New Zealand, and local. Seeds for the genetic combinations were obtained from Dr. Imad Abu Turab's Agricultural Supplies Office in Baghdad, sourced from reputable companies including Fito (Spanish genetic composition), PV (Popvried seed) (Dutch genetic composition), and CANTERBURY seed (New Zealand genetic composition). Seeds for the local variety were also obtained from the same office. The seeds were tested for germination viability in special Petri dishes to ensure their viability. The experimental area was prepared by plowing with a reversible moldboard plow and tilled with a Rotovator before being divided into three replications with 36 experimental units each. Each experimental unit measured 2 meters by 3 meters (6 square meters) and consisted of 5 rows with inter-row spacings of 75 cm and interplant spacings of 15 cm, 25 cm, and 35 cm for densities D1, D2, and D3, respectively. Planting was done manually, with seeds sown at a depth of 5 cm with three seeds per row, later thinned to one plant per row after reaching the two-leaf stage. Crop management practices including irrigation, weeding, and fertilization were carried out as needed. Harvesting was done upon maturity indicators. Before planting, all experimental plots were fertilized with triple superphosphate fertilizer (21% P) at a rate of 35 kg P per hectare as a single application, while nitrogen fertilizer in the form of urea (46% N) was applied at a rate of 50 kg N per hectare in two split applications, first at planting and second at the beginning of flowering. The planting date was on 2021/11/3, which marked the first irrigation date for the field.

Characteristics of vegetative growth

The plant height (in centimeters) :was measured by using a special ruler to measure from the soil surface to the top of each plant branch. This measurement was taken one week before harvest, where five randomly selected plants were taken from the middle rows of each experimental unit, and their averages were calculated.The number of branches on each plant (Branches per plant -1): was calculated by counting the lateral branches of the five randomly selected plants from each experimental unit. This count was done one week before the harvest stage, and the average number of branches per plant was extracted for each unit.

The number of leaves per plant (Leaf per plant -1) was calculated by counting the leaves of five randomly selected plants from each experimental unit. This count was done when the plants reached the 100% flowering stage, and the average number of leaves per plant was recorded. The crop growth rate (g/m^2/day) :was calculated by dividing the dry matter weight per square meter by the number of days from planting to physiological maturity, following the method described by Elsahookie (2009).

Results and Discussions

The plant height (in centimeters)

analysis revealed significant differences among varieties. The local variety showed the highest average plant height at 99.29 cm, with an increase of 8.34%. In contrast, the New Zealand variety had the lowest average height at 91.64 cm. This variation in plant height can be attributed to genetic differences among varieties in stem length and number, influenced by their ability to produce higher levels of the auxin IAA (indole-3-acetic acid), which affects plant height. Additionally, significant differences were observed in plant height due to plant densities. The D2 plant density had the highest average height at 101.15 cm compared to D3 density, which had an average height of 84.47 cm. This difference can be attributed to intense competition among plants for growth requirements, especially light, at higher plant densities. This competition leads plants to elongate their stems to access sufficient light. Moreover, increased shading between plants at higher densities encourages the production of plant hormones responsible for stem elongation, such as auxins and gibberellins, resulting in increased plant height. Furthermore, there was a significant interaction effect between varieties and plant densities. For instance, the local variety at D1 density showed the highest average height for this trait at 110 cm. These findings are consistent with previous studies by Yucel (2013), Mohamed and Ibrahim (2015), Jabr (2019), Alwan (2022), and Sadiq and Mohammed (2022b), which also reported significant differences in plant height when using diverse broad bean varieties.

Table 1. The Effect of Plant Densities, Varieties, and Their Interactions on Plant Height (cm) for the Season 2021-2022

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	94.25	90.40	98.27	94.25
Spanish	77.20	102.13	95.87	91.73
Local	81.33	106.53	110.00	91.64
New Zealand	85.27	105.53	84.13	2.54
L.S.D**5%**	4.41			99.29
Average of Densities	84.47	101.15	97.07	
L.S.D**5%**	1.48			

Number of Branch (Branch Plant^{-1})

The data from Appendix (1) and Table (2) indicated that the trait of branch number was significantly affected by the different varieties. The local variety excelled, giving the highest average for the branch number at 9.56 branches/plant-1, with an increase of 26.46% compared to the Dutch variety, which had the lowest average for the trait at 7.56 branches/plant-1. The Dutch variety did not differ significantly from the New Zealand and Spanish varieties, which recorded 9.53 and 9.44 branches/plant-1, respectively. The variation among the varieties in this trait may be attributed to their content of cytokinins, consistent with findings by (Al-Hamdani, 2012), (Al-Hamdani & Al-Nuaimi, 2013), and (Zaidan, 2018). Significant differences were also observed in branch number due to the effect of plant densities. Density D3 achieved the highest average for this trait at 10.40 branches/plant-1, with an increase of 28.07% compared to plant density D2, which had the lowest average for the trait at 8.55 branches/plant-1. The superiority of plant density D3 may be attributed to the efficiency of sunlight penetration, which breaks down the IAA-oxidase enzyme responsible for breaking down the IAA hormone, leading to increased vegetative growth and reduced competition among plants for growth factors. This results in increased nutrient and water flow to lateral buds, promoting their distribution and consequently increasing the number of branches due to elevated cytokinin levels (Atiya & Jado, 1999). These results align with findings by Yucel (2013), Mohammed & Ibrahim (2015), and Sadiq & Mohammed (2022).

Table (2) in Appendix (1) showed a significant interaction between plant densities and varieties, where the Spanish variety exhibited the highest average at plant density D3, reaching 11.33 branches/plant-1.

Table (2). The Effect of Plant Densities, Varieties, and Their Interactions on Branch Number (Branch/Plant-1) for the Season 2021-2022

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	8.33	7.00	7.33	7.56
Spanish	10.67	9.00	8.67	9.44
Local	11.33	9.33	8.00	9.56
New Zealand	11.27	8.87	8.47	9.53
L.S.D5%	0.60			9.53
Average of Densities	10.40	8.55	8.12	
L.S.D5%	0.56			

Number of leaves (leaf Plant^{-1})

The data from Appendix (1) and Table (3) indicated that the trait of leaf number was significantly affected by the different varieties. The New Zealand variety excelled, giving the highest average for this trait at 97.25 leaves/plant-1, with an increase of 15.59% compared to the Spanish variety, which had the lowest average for the trait at 84.13 leaves/plant-1. The Spanish variety did not differ significantly from the local and Dutch varieties, which recorded 88.60 leaves/plant-1 each. The increase in leaf number in the New Zealand variety resulted from the increase in source efficiency to utilize a larger amount of light.

Significant differences were also observed in leaf number due to the effect of plant densities, attributed to the increase in branch number at lower densities. This result aligns with findings by (Al-Ani & Abdul-Hameed, 2017) and Sadiq & Mohammed (2022b). Additionally, there was a significant interaction between varieties and plant densities, where the New Zealand variety at density D2 gave the highest average for this trait at 121.27 leaves/plant-1. This is because leaf number is an important trait, and increasing it means increasing source efficiency in utilizing more light, which enhances the efficiency of photosynthesis, a crucial biological process for plants. Leaf number is also influenced by the plant's genetic composition and environmental factors, consistent with findings by (Alwan, 2022).

Table (3). The Effect of Plant Densities, Varieties, and Their Interactions on Leaf Number (Leaf/Plant-1) for the Season 2021-2022

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	88.33	84.87	92.60	88.60
Spanish	80.80	85.13	86.47	84.13
Local	84.33	92.13	89.33	88.60
New Zealand	86.40	121.27	84.07	97.25
L.S.D5%	7.36			4.25
Average of Densities	84.97	95.85	88.12	
L.S.D5%	1.70			

Crop Growth Rate (CGR)(gm $^{-2}$ day^{-1})

The data from Appendix (1) and Table (4) indicated that the crop growth rate trait was significantly affected by the different varieties. The Spanish variety outperformed significantly, giving the highest average for this trait at 4.31 g m-2 day-1, which did not differ significantly from the Dutch variety that achieved 4.27 g m-2 day-1, compared to the New Zealand variety, which gave the lowest value for the trait at 3.38 g m-2 day-1. The reason for the superiority of the Spanish variety lies in its ability to accumulate and save dry matter more effectively than the New Zealand variety, consistent with findings by Abdulaziz (2009), who indicated that the chlorophyll content in leaves changes between the budding stage and the grain filling stage, leading to an increase in crop growth rate with the availability of growth factors, environmental conditions, and biological factors surrounding the plant, which the plant's occupied land area could provide the necessary requirements for growth. The results of Table (4) showed significant differences in the crop growth rate trait due to the effect of plant densities. Density D3 gave the highest average for this trait at 4.42 g m-2 day-1 compared to density D1, which gave the lowest average for the trait at 3.62 g m-2 day-1. The reason for this is the role of plant density per unit area in determining the growth path and quality within a certain period of plant life. It affects the balance between growth environment factors, including the plant itself, such as chlorophyll in leaves. Increasing the number of plants per unit area at high densities increases competition among plants for growth requirements, making photosynthesis less effective at the individual plant level. However, in the case of fewer plants per unit area, this reduces competition among plants for growth requirements and increases the efficiency of photosynthesis for the plant. This result is consistent with Abdulaziz's findings (2009). Additionally, there was a significant interaction effect between varieties and plant densities, where the Dutch variety gave the highest average for the trait at 4.79 g m-2 day-1 at density D3. It differed significantly from other interactions except for treatment D3 for the Spanish variety and achieved the lowest when D1 density for the New Zealand variety was considered.

Table (4). The Effect of Plant Densities, Varieties, and Their Interactions on Crop Growth Rate (g m-2 day-1) for the Season 2021-2022

Varieties	Densities			Varieties Average of Varieties
	D3	D2	D1	
Dutch	4.79	4.15	3.85	4.27
Spanish	4.68	4.10	4.16	4.31
Local	4.77	3.37	3.41	3.85
New Zealand	3.43	3.63	3.07	3.38
L.S.D5%	0.36			0.21
Average of Densities	4.42	3.81	3.62	
L.S.D5%	0.33			

Conclusions

Genetic structures showed varying responses to plant densities due to their genetic nature.

Plant densities D1, D2, and D3 significantly differed in the studied traits.

Suggestions

We recommend studying the formation of bacterial nodules within the studied plant densities and varieties.

It is recommended to study the lodging percentage within the studied plant densities and varieties.

References

Abdul Aziz, Mohammed. (2009). "Analysis of Growth in Common Beans under the Influence of Plant Density (a)." Journal of Tishreen University for Research and Scientific Studies - Biological Sciences Series, Volume 31, Issue 1.

Al-Ani, Lana Jamal Wahid, & Ziyad Abdul Jabbar Abdul Hameed. (2017). "Response of Several Genetic Structures of Lentils to Plant Densities." Journal of Al-Anbar University for Agricultural Sciences, 15(1), 83-94.

Al-Hamdani, Shamil Younis Hassan, & Mohammed Hani Mohammed Al-Naimi. (2013). "Genetic Degradation and Some Genetic Markers for Growth and Yield of Second-Generation Hybrids in Lentils." Journal of Agricultural Sciences, 5(1), 347-383.

Al-Hamdani, Shamil Younis Hassan. (2012). "Crossbreeding and Analysis of Coalition Ability for Yield and Its Components in Lentils." Al-Rafidain Agriculture Journal, 40(2), 55-67.

Alwan, Ali Hussein. (2022). "Study of Some Genetic Markers for Various Lentil Genetic Structures and Evaluation of Their Phenotypic Performance under Different Levels of Phosphorus." Master's Thesis, University of Baghdad, College of Agricultural Engineering Sciences, Department of Field Crops.

Atiya, Hatem Jabbar, & Khudair Abbas Jadooa. (1999). "Plant Growth Regulators - Theory and Application." Ministry of Higher Education and Scientific Research, University of Baghdad, p. 296.

Ibrahim, Raed Hamdi. (2011). "Response of Two Lentil Varieties to Zinc Spraying." Al-Kufa Journal of Agricultural Sciences, 3(2), 85-92.

Jabr, Yassin Nouri. (2019). "Genetic Stability of Growth and Productivity Traits in Lentil Genetic Structures." Master's Thesis, University of Tikrit, College of Agriculture, Department of Field Crops.

Mohammed, Youssef Ali, & Ali Nasr Ibrahim. (2015). "Effect of Plant Density on Some Productive Characteristics of Two Varieties of Common Beans under Syrian Coastal Conditions."

Journal of Tishreen University for Research and Scientific Studies, Biological Sciences Series, 37(6), 253-268.

Sadiq S. M. and Mohammed A. A (2022b). The Effect of Distance between Plants and Spraying of Nano and Traditional Boron on Some Growth Characters and Seed Content of Protein of Faba Bean (Vicia faba L.) . NeuroQuantology . 20 (5) ; 1233-1240

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.

Zaidan, Ghassan Jayed. (2018). "Effect of Foliar Spray with Azomin Organic Nutrient Solution on the Growth of Three Lentil Varieties Grown in Gypsum Soil under Irrigation System." Tikrit University Journal of Agricultural Sciences, 18(1), 75-80.

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

Crop Growth Rate (CGR)(gm $^{-2}$ day^{-1})	Numbers of leaves^{-1}	Numbers of branchs^{-1}	Plant height (cm)	d.f	s.o.v
0.18181	3.75	0.3378	4.338	2	Repetitions
2.07022**	376.35**	17.6478**	907.534**	2	Density (D)
0.08494	2.24	0.2488	1.709	4	Error (a)
1.71042**	270.94**	8.6252	115.533**	3	Varieties(B)
0.35935**	348.11	0.8552**	271.017**	6	B×D
0.04415	18.40	0.1219	6.600	18	Error (b)

* significant at the 5% level

** significant at the 1% level

N.S. is not significant