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Effect of Planting Date and Variety on Growth Dynamics and Yield of Faba Bean *(Vicia faba L.)* under Semi-Arid Climate Conditions of Diyala, Iraq

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ABSTRACT

The autumn season of 2024–2025 to evaluate the effects of planting date and variety on the growth and yield of Faba bean (*Vicia faba* L.). The study was designed as a factorial experiment with two factors: the first factor was planting date, including two levels (10 October 2024 and 20 October 2024), and the second factor was four faba bean varieties: Italian, Dutch Monash, Spanish, and Iraqi Local. The experiment was arranged in a randomized complete block design (RCBD) with three replications.The results showed that planting on 10 October 2024 significantly outperformed 20 October 2024 in several growth and yield parameters, including the number of branches per plant (5.70 branches plant^{-1}), pods per plant (6.00 pods plant^{-1}), pod length (19.33 cm), and individual plant yield (91.75 g plant^{-1}). Among the varieties, the Spanish cultivar exhibited superior performance in pod number per plant (6.52 pods plant^{-1}), pod length (20.00 cm), 100-seed weight (327.50 g), and individual plant yield (105.00 g plant^{-1}). The Dutch Monash variety excelled in the number of branches per plant (5.87 branches plant^{-1}) and seeds per pod (5.16 seeds pod^{-1}).Significant interactions between planting date and variety were observed. Specifically, the Spanish variety sown on 10 October 2024 recorded the highest pod number per plant (9.42 pods plant^{-1}), 100-seed weight (368.33 g), and individual plant yield (158.33 g plant^{-1}). Similarly, the Dutch Monash variety planted on the same date showed the highest number of branches per plant (6.68 branches plant^{-1}) and pod length (21.66 cm). These results highlight the importance of selecting an appropriate combination of planting date and variety to maximize growth and productivity of faba bean under semi-arid conditions.

***Keywords*:** Planting dates, varieties, Faba bean. Climate Change, Semi-Arid.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important grain legume crops cultivated worldwide due to its high nutritional value and its role in sustainable agricultural systems. The seeds contain a high percentage of protein (approximately 25–30%), in addition to carbohydrates, vitamins, and essential minerals, making faba bean a major source of plant protein for human consumption and animal feeding, particularly in developing countries ,Therefore in most countries of the world, *Vicia faba* L. called the meat of the poor people**[1] [2]**. Moreover, faba bean contributes significantly to soil fertility through biological nitrogen fixation, thereby improving soil structure and reducing dependence on synthetic nitrogen fertilizers, which enhances the sustainability of cropping systems, It has a main role in regulating the crop rotation **[3,4]** Faba bean is a winter crop, meaning it requires low temperatures for germination and growth and is greatly affected by changes in temperature and environmental conditions. The development and productivity of faba bean are strongly influenced by environmental conditions, especially temperature, which is closely associated with planting date. **[5]**. wrong planting dates may expose plants to unfavorable climatic conditions during critical growth stages such as flowering and pod formation, leading to flower abortion, poor pod set, and ultimately yield reduction. It has been observed that high temperatures during flowering period lead to damage to the flowers and failure to form pods **[4]** High temperatures during the reproductive stage have been reported to negatively affect pollen viability and fertilization efficiency, resulting in a lower number of pods and seeds per plant. Several recent studies have confirmed that sowing date significantly affects the yield and yield components of faba bean across different environments **[7,8] .** In addition to planting date, varietal differences play a crucial role in determining crop

performance. Faba bean varieties differ genetically in growth habit, branching capacity, pod characteristics, seed size, and adaptability to environmental stresses. suitable varieties that are well adapted to local environmental conditions is considered one of the most effective strategies for improving yield stability under changing climatic conditions. Significant genetic variation has been reported among faba bean cultivars in response to different planting dates, suggesting that the interaction between genotype and environment plays a decisive role in determining productivity **[9].** In recent years, climate change has posed significant challenges to agricultural production in semi-arid regions, including Iraq, where fluctuations in temperature and rainfall patterns have become more frequent. Such climatic variability can strongly affect winter legume crops such as faba bean, particularly when planting dates are not well aligned with optimal environmental conditions. Recent studies have emphasized that adjusting sowing time and selecting climate-resilient varieties are key adaptation strategies to mitigate the negative impacts of climate change on legume production **[10]**. The current studies has focused on raising production efficiency by using high-yielding varieties and non-traditional farming methods **[11]**. Furthermore, choosing the appropriate varieties plays a fundamental role not only in increasing the yield but also in increasing the crop's ability to adapt to environmental changes. Adopting good varieties has an important impact on the sustainability of the agricultural ecosystem and enhancing food security **[12]**. Despite the economic and agricultural importance of broad beans *Vicia faba* L., studies addressing the complementary impact of planting dates and variety performance under the prevailing environmental conditions in Diyala Governorate, Iraq, remain limited. Therefore, this study aimed to evaluate the effect of different planting dates and broad bean varieties, as well as their interaction, on growth characteristics and yield under local field conditions. The findings seek to identify the optimal planting date and the most productive variety, thereby contributing to improved broad bean productivity and enhanced agricultural sustainability crop production under conditions of climate variability.

Materials and Methods

A factorial experiment was carried out in the field of the Department of Field Crops Sciences, College of Agriculture, University of Diyala during the autumn 2024-2025. The first factor included four varieties of *Vicia faba* L. (Italian, Dutch Monash, Spanish Fito, and local Iraqi) which was designated as V_1, V_2, V_3, and V_4 respectively. The second factor was the planting date which were coded as D_1 (first date 10 Oct), second date D_2 (20 Oct). The experiment was conducted using a Randomized Complete Block Design (RCBD) with three replicates. A total of 24 experimental units were established, each with an area of 3 m². Soil preparation and crop management practices were carried out, and faba bean seeds were sown in rows.spacing between rows and another was 50 cm, while between one hole and another was 30 cm. Chemical fertilizers were used in the recommended quantities, with nitrogen fertilizer in the form of urea (N 46 applied at 50 kg ha^{-1} after the plants reached a suitable height (15 cm). Triple superphosphate fertilizer was added with plowing and land preparation at a rate of 200 kg ha^{-1} **[13]** The planting was done with two seeds in each hole and drip irrigation was used and irrigation process was carried out according to the plant's needs. Thinning was carried out 25 days after planting, leaving one plant in the hole, and manual hoeing and weeding was carried out 30 days after planting. The studied characteristics: plant height (cm), number of branches.$plant^{-1}$, pod length (cm), number of pods.$plant^{-1}$, number of seeds.pod^{-1}, weight of 100 seeds (g), yield per plant (g). The data obtained were analyzed using the SAS statistical analysis program **[14]**, and the Least Significant Difference (LSD) test was used to compare the means of the studied treatments under a probability level of 0.05 **[15]** Soil samples used in the experiment were collected at a depth of (0-30) cm. Some of their physical and chemical properties were measured as shown in Table (1). The soil was analyzed in the laboratory of the Department of Soil Science and Water Resources - College of Agriculture - University of Diyala, where the physical and chemical properties of the soil were analyzed based on the methods described according to **[16]**.

Table (1). physical and chemical properties of the experimental soil

Characteristics	Unit	Value
Sand	$g.kg^{-1}$	811
Slime	$g.kg^{-1}$	129
Clay	$g.kg^{-1}$	61
Cation exchange capacity	$cmol.kg^{-1}$	15.40
Electrical conduction EC	$(ds.m^{-1)}$	4.3
Soil pH	-	7.4
Organic matter	%	0.46
Gypsum	$g.kg^{-1}$	0.142
Nitrogen	Mg kg^{-1}	27.5
Phosphors	Mg kg^{-1}	30.2

Potassium	Mg kg^{-1}	130.2
Soil texture		Sandy mixture

Results and discussion

Plant height

Plant height is one of the important indicators of vegetative growth, as a result from cell division and elongation when the plant grows normally without external influence or stresses. The results in table (2) showed that was no significant effect of planting dates, varieties, and the interaction between them on plant height trait. The non-significant effects between the average traits may be attributed to the fact that some varieties did not have a negative impact in competition for nutrients and light, and this is due to the large size of the plant and its rapid growth **[11]**.

Table (2): Effect of planting dates and varieties on plant height (cm)

plant date	Varieties				Means
	Italian (V_1)	Dutch Monash (V_2)	Spanish Fito (V_3)	Local Iraqi (V_4)	
D_1	86.02	103.67	87.31	110.47	96.87
D_2	72.79	95.10	82.44	84.51	83.71
Means	79.40	99.39	84.88	97.49	
L.S.D 0.05	Plant date N.S	Varieties N.S	Interaction (D × V) N.S		

Number of branches plant^{-1}

Branching is of great importance in crop production and is a major component of yield of field crops, as *Vicia faba* L. varieties are affected by genetic nature in determining the plant's ability to grow, branch and give the highest possible number of effective vegetative branches **[17].** Table (3) shows that the planting date has a significant effect on the average number of branches per plant, as the first date D_1 (10 Oct 2024) gave the highest average for this trait, which was 5.70 branches.plant^{-1}Compared to the second date D_2 (20 Oct 2024), which gave the lowest average of 4.68 branches per.plant^{-1} . This significant difference in planting dates may be due to the fact that planting earlier or later than the appropriate planting date leads to the plant being exposed to drought, unsuitable temperatures, insect attacks, or disease **[18]**. These findings align with previous research that highlights the first third of October as the ideal sowing window for achieving optimal growth and yield in faba bean cultivation **[19] [20]**. It was noted from the results of Table (3) that the Dutch Monash (V_2) variety was superior by giving the highest average number of branches, which reached 5.87 branches.plant^{-1}. While the Spanish Fito (V_3) variety recorded the lowest average for the trait, which reached 4.31 branches.plant^{-1}. This is attributed to the difference in the genetic structures of each variety in terms of their ability to grow and divide cells **[11]**. As for the interaction between planting dates and varieties, there were significant differences in the trait of the number of branches in the plant, as the first date D_1 and variety Dutch Monash (V_2) gave the highest average of 6.68 branches.plant^{-1}. Compared to the second date D_2 and variety Local Iraqi (V_4), which gave an average of 3.42 branches.plant^{-1}.

Table (3): Effect of planting dates and varieties on the trait of the number of branches in the plant

plant date	Varieties				Means
	Italian (V_1)	Dutch Monash (V_2)	Spanish Fito (V_3)	Local Iraqi (V_4)	
D_1 (10 Oct 2024)	4.94	6.68	4.63	6.57	5.70
D_2 (20 Oct 2024)	6.24	5.06	4.00	3.42	4.68
Means	5.59	5.87	4.31	4.99	
L.S.D 0.05	plant date 0.45	Varieties 0.64	Interaction (D × V) 0.91		

Pods number pods plant^{-1}

The results in table (4) show that planting dates have a significant effect on the average number of pods per plant. The first date D_1 (10 Oct 2024) giving the highest average of 6.00 pods per.plant^{-1}. Compared to the second date D_2 (20 Oct 2024), which gave an average of 4.86 pods per.plant^{-1}. The pods number is one of the most important components of the yield that is greatly affected by planting dates. Environment and genetic interference greatly affects this component. The plant's response to environmental conditions depends on the nature of its genetic structure and the extent of its interaction with environmental conditions. This significant difference between the dates is due to the difference in temperatures Rewrite as: The decrease in the number of pods observed at the D_2 planting date (20 October 2024) can be attributed to unfavorable environmental conditions, including high temperatures, infestation by insects and worms, disease infection, and other abiotic and biotic stresses. These factors negatively affected vegetative growth, which in turn reduced the number of flowers and pods per plant [18] The increased in the number of pods at the first date of D_1 (10 Oct 2024) may be due to good vegetative growth, the expansion of the leaf area. Thus the boost in efficiency of photosynthesis, and transfer of its products from the source to the developing organs, which affects the raise in the number of flowers that set fruit and produce pods later **[21]**. The results in the same table showed a significant effect between the varieties. Variety Spanish Fito (V_3) gave the highest average number of pods per plant, reaching 6. pods.plant^{-1}.Compared to variety Local Iraqi (V_4), which gave the lowest average number of pods per plant, reaching 4.89 pods per. plant^{-1}. The reason for the difference between the varieties of *Vicia faba* L. in the number of pods per plant is due to the fruit buds that the plant forms The superiority is due to the igher fertilization rateof the Spanish Fito (V compared to the other varieties of the varieties. This finding is consistent with the results reported by **[22]**.The interactions had a significant effect on the number of pods per plant. The first interaction treatment and Spanish Fito (V_3) variety gave the highest average number of pods per plant, reaching 9.42 pods per.plant^{-1}. Compared to the second interaction treatment and Spanish Fito (V_3) variety, which recorded the lowest average number of pods per plant, reaching 3.63 pods per.plant^{-1}.

Table (4): Effect of planting dates and varieties on the number of pods in the plant

plant date	Varieties				Means
	Italian (V_1)	Dutch Monash (V_2)	Spanish Fito (V_3)	Local Iraqi (V_4)	
D_1 (10 Oct 2024)	3.62	5.06	9.42	5.89	6.00
D_2 (20 Oct 2024)	6.86	5.07	3.63	3.90	4.86
Means	5.24	5.07	6.52	4.89	
L.S.D 0.05	Plant date 0.47	Varieties 0.67	Interaction (D × V) 0.95		

Seeds number per pod

The seeds number per pod is one of the most important components of yield in *Vicia faba* L. and represents the number of fertilized ovules that have succeeded in producing seeds. It is also one of the most desirable traits in selection because of its importance in increasing the seed yield per plant. The results shown in Table (5) indicate that the planting date had a non-significant effect on the number of seeds per pod, as the first planting date gave an average of 4.75 seeds per .pod^{-1}. Compared to the second planting date which gave an average of 4.41 seeds per.pod^{-1}. The same table shows significant differences between the *Vicia faba L.* varieties. Variety Dutch Monash (V_2) gave the highest average yield of 5.16 seeds per.pod^{-1}, whereas variety V4 gave the lowest average yield of 3.83 seeds.pod^{-1}. This is consistent with **[11]**. The interaction was significant, as the second planting date and variety Dutch Monash (V_2) achieved the highest average number of seeds per pod, reaching 6.00 seeds per. pod^{-1}. While the same planting date and variety Local Iraqi (V_4) recorded the lowest average for the studied trait, at 3.33 seeds per. pod^{-1}. This highlights the importance of selecting the appropriate combination of sowing date and variety to maximize reproductive success and seed yield in faba bean under semi-arid conditions.

Table (5): Effect of planting dates and varieties on the number of seeds per pod

plant date	Varieties				Means
	Italian (V_1)	Dutch Monash (V_2)	Spanish Fito (V_3)	Local Iraqi (V_4)	
D_1	5.66	4.33	4.66	4.33	4.75
D_2	4.33	6.00	4.00	3.33	4.41
Means	5.00	5.16	4.33	3.83	
L.S.D 0.05	plant date N.S	Varieties 0.61	Interaction (D × V) 0.86		

Pod length

The results shown in table (6) that the planting date has a significant effect on the average length of the pod. The first date D_1 (10 Oct 2024) gave the highest average for this trait, which reached 19.33 cm. Compared to the second date D_2 (20 Oct 2024), which gave an average of 17.24 cm. This significant difference between the dates is due to the unfavorable environmental conditions, especially the temperatures in the 20/10 date compared to the D_1 (10 Oct 2024) date, where the temperatures are suitable during the flowering period **[6]**. The difference in pod length may be due to the influence of environmental conditions, especially the temperatures to which the plants were exposed, whether during the vegetative growth period or during the flowering and fruiting periods. The D_1 (10 Oct 2024) variety plants were superior in terms of vegetative and flowering growth and fruit set, and this is reflected in the quantity of the yield and the length of the pods. Plant growth and flowering are the result of genetic factors that interact with environmental factors. Genetic factors produce flowering inhibitors under high temperature conditions, while they produce flowering inducers under low temperature conditions **[23]**. The results shown in the same table significant differences between the *Vicia faba* L. varieties. Variety Spanish Fito (V_3) gave the highest average of 20.00 cm whereas variety Local Iraqi (V_4) gave the lowest average of 16.66 cm. This difference may be due to the morphological and physiological differences and the nature of growth between the varieties of *Vicia faba L.* and to the ability of the cells to elongate **[24** In addition, the reason for the variation in the length of the pod is due to differences in components of yield of varieties, and this is in agreement with **[7]**.

The interactions had a significant effect on pod length trait. The first interaction treatment and Dutch Monash (V_2) variety gave the highest average pod length of 21.66 cm. Compared to the second interaction treatment and Dutch Monash (V_2) variety, which recorded the lowest average pod length of 15.66 cm.

Table (6): Effect of planting dates and varieties on the pod length (cm)

plant date	Varieties				Means
	Italian (V_1)	Dutch Monash (V_2)	Spanish Fito (V_3)	Local Iraqi (V_4)	
D_1	18.00	21.66	20.33	17.33	19.33
D_2	17.66	15.66	19.66	16.00	17.24
Means	17.83	18.66	20.00	16.66	
L.S.D 0.05	plant date 0.60	Varieties 0.85	Interaction (D × V) 1.20		

Weight of 100 seeds

Table (7) shows that planting dates have a non-significant effect on the 100-seed weight (g) trait. The first date D_1 (10 Oct 2024) gave an average of 252.50 g compared to the second date D_2 (20 Oct 2024), which gave an average of 249.50 g. The results in the same table refer to significant differences between the *Vicia faba* L. varieties. Variety Spanish Fito (V_3) gave the highest average of 327.50 g while variety Dutch Monash (V_2) gave the lowest average of 177.50 g. The influence of this trait is governed by several factors that depend on the nature of the genetic structure and environmental factors. The increase in photosynthesis and the accumulation of nutrients from the source to the destination in the seeds, as well as the long duration of vegetative growth and flowering, gave the opportunity to form seeds of a larger size. These results were consistent with **[25]**.

The results showed that the interaction of the study factors had a significant effect on increasing seed weight. The interaction treatment of the first date and variety Spanish Fito (V_3) gave an advantage in this trait, which recorded an average of 368.33 g. Compared to the interaction treatment of the second date and variety Dutch Monash (V_2), which

recorded the lowest average weight for 100 seeds, which was 171.66 g.

Table (7): Effect of planting dates and varieties on the trait of 100 seed weight (g)

plant date	Varieties				Means
	Italian (V_1)	Dutch Monash (V_2)	Spanish Fito (V_3)	Local Iraqi (V_4)	
D_1	241.66	183.33	368.33	216.66	252.50
D_2	316.66	171.66	286.66	223.00	249.50
Means	279.16	177.50	327.50	219.83	
L.S.D 0.05	plant date N.S	Varieties 12.94	interaction (D × V) 18.30		

Individual plant yield

The results shown in table (8) that the planting date has a significant effect on the yield of the single plant. The first date gave the highest average yield of 91.75 g.plant^{-1}. Compared to the second date, which gave an average yield of 83.25 g.plant^{-1}. This may be because first date is better than second date in terms of growth indicators, which are represented in plant height, number of branches, number of pods, pod length, and weight of 100 seeds (Tables 2, 3, 4, 6, 7). The reason for the superiority of the first date is also due to lengthening of period from flowering to maturity. Which may have been a reason for the increased in the weight of seeds and pods, as the preparation for circulation materials to the estuary increased, so it is expected that the seeds and pods will tend to be heavy. The increased comes from enhance in the number and size of endosperm cells in the seeds from the first days after fertilization, thus obtaining an efficient reservoir that take in a larger quantity of nutrients, and its weight increased accordingly **[26]**.

The results in table (8) indicated significant differences between the varieties. Variety Spanish Fito (V_3) gave the highest average plant yield of 105.00 g.plant^{-1}. Compared to variety Italian (V_1), which gave the lowest average plant yield of 58.66 g.plant^{-1}. The superiority of the Spanish Fito (V_3) variety in the yield of single plant is attributed to the superiority of variety in number of pods per plant, length of pod, and weight of 100 seeds (Tables 4, 6, and 7). The results are consistent with **[25]**. The interventions also had a significant effect. The first intervention treatment and the Spanish Fito (V_3) variety gave the highest average for the trait, which amounted to 158.33 g.plant^{-1}. Compared to the first intervention treatment and the Italian (V_1) variety, which gave the lowest average yield per plant, which amounted to 27.66 g.plant^{-1}.

Table (8): Effect of planting dates and varieties on the yield trait of an individual plant (g)

plant date	Varieties				Means
	Italian (V_1)	Dutch Monash (V_2)	Spanish Fito (V_3)	Local Iraqi (V_4)	
D_1	27.66	70.00	158.33	111.00	91.75
D_2	89.66	99.33	51.66	92.33	83.25
Means	58.66	84.66	105.00	101.66	
L.S.D 0.05	plant date 6.06	Varieties 8.58	Interaction (D × V) 12.13		

Conclusion

This study confirms that early planting (D_1: Oct 10) significantly enhances the growth and yield of *Vicia faba L.* compared to late planting, due to more favorable environmental conditions.Among the varieties, the Spanish variety (V_3) showed the highest genetic potential for pod count, seed weight, and overall yield, while the Dutch Monash (V_2) excelled in branching and seeds per pod. The significant interaction between factors revealed that combining early sowing with the Spanish variety (V_3 × D_1) maximizes reproductive success and productivity in semi-arid environments. Consequently, selecting the optimal variety-date combination is essential for achieving peak faba bean performance.

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تأثير مواعيد الزراعة والأصناف في ديناميكية النمو والإنتاج لمحصول الباقلاء (*Vicia faba L.*) المزروع تحت الظروف المناخية شبه الجافة في محافظة ديالى، العراق.

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الخلاصة

اجريت هذه الدراسة خلال الموسم الخريفي ***2024–2025*** بهدف تقييم تأثير مواعيد الزراعة والاصناف في نمو وإنتاجية محصول الباقلاء ***(Vicia faba L.)*** المزروع تحت الظروف شبه الجافة في محافظة ديالى، طبقت التجربة وفق تصميم القطاعات العشوائية الكاملة ***(RCBD)*** وبنظام التجارب العاملية، بعاملين هما ، العامل الأول موعدي الزراعة (10 و 20 أكتوبر 2024) وتضمن العامل الثاني أربعة أصناف من محصول الباقلاء هي صنف إيطالي ، والهولندي (موناش)، والإسباني، والصنف المحلي العراقي، وبثلاثة تكرارات. أظهرت النتائج المتحصل عليها من الدراسة تفوق الزراعة بالموعد المبكر ***10***أكتوبر 2024 معنويًا على الزراعة المتأخرة في ***20***أكتوبر 2024 في عدد من صفات النمو والحاصل، عدد الفروع (5.70 فرع نبات$^{-1}$)، وعدد القرون (6.00 قرن نبات$^{-1}$)، وطول القرن (19.33 سم)، وحاصل النبات الواحد (91.75 غرام نبات$^{-1}$.اما على مستوى الأصناف فقد تفوق الصنف الإسباني معنويًا في عدد القرون (6.52 قرن نبات$^{-1}$)، وطول القرن (20.00 سم)، ووزن 100 بذرة (327.50 غرام)، وحاصل النبات الواحد (105.00 غرام نبات$^{-1}$)، في حين تميّز الصنف الهولندي (موناش) بتحقيق أعلى عدد فروع بلغ (5.87 فرع نبات$^{-1}$) وعدد بذور في القرن (5.16 بذرة قرن$^{-1}$) وقد أظهر التداخل بين مواعيد الزراعة والاصناف تاثير معنوي في اغلب الصفات المدروسة إذ اعطى الصنف الإسباني المزروع في ***10***أكتوبر 2024 أعلى عدد قرون (9.42 قرن نبات$^{-1}$)، ووزن 100 بذرة (368.33 غرام)، وحاصل نبات(158.33 غرام نبات كما واعطى الصنف الهولندي (موناش) المزروع في التاريخ نفسه أعلى عدد فروع بلغ (6.68 فرع نبات$^{-1}$) وأطول قرون (21.66 سم). تبين هذه النتائج المتحققة أهمية الاختيار المانسب لموعد الزراعة واختيار الصنف كاحد اهم العوامل التي تساهم بشكل كبير في في تحسين نمو وإنتاجية محصول الباقلاء تحت الظروف المناخية شبه الجافة في محافظة ديالى .

الكلمات المفتاحية: مواعيد الزراعة ، الاصناف ، الباقلاء . مناطق شبه الجافه ، الظروف المناخية.