



Influence of Planting Date and Seeding Rate on Some Growth Characteristics and Seed Yield of *Lathyrus sativus* L.

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ABSTRACT

Background: A field experiment was conducted during winter season of 2023 in the College of Agriculture fields - University of Karbala to investigating the influence of planting date and seeding rate on some growth characteristics, seed yield and its components of grass pea.

Methods: A randomized complete block design (RCBD) according to a split-plot arrangement at three replications was used. The main plots contained three planting dates (25/11, 5/12 and 15/12), whereas the sub plots contained three seeding rates (60, 80 and 100 kg ha⁻¹).

Result: The findings clarified that the first planting date (25/11) significantly excelled in the plant height (67.88 cm), number of branches (522.3 branches m⁻²), number of pods (10.43 pods plant⁻¹), number of seeds (3.91 seeds pod⁻¹) and seed yield (3.984 Mg ha⁻¹). The planting at a seeding rate of 60 kg ha⁻¹ significantly excelled in the number of pods (10.06 pods plant⁻¹) and the number of seeds (3.37 seeds pods⁻¹), while the planting at a seeding rate of 100 kg ha⁻¹ was significantly superior in plant height (65.46 cm), number of branches (528.6 branches m⁻²) and seed yield (4.346 Mg ha⁻¹). Significant interaction between studied factors was observed on most of the studied characteristics.

Key words: Climatic conditions, Grass pea, Productivity, Sustainability, Vital competition.

INTRODUCTION

Grass pea (*Lathyrus sativus* L.) is one of the important winter leguminous crops, especially in developing countries, as it has been used since ancient times as human food due to the protein content of its seeds, which ranges between 25-30%, in addition to its use as animal fodder (Jafar *et al.*, 2021). The crop is distinguished by its ability to fix atmospheric nitrogen, which will improve soil properties. It is also characterized by its tolerance to various environmental stresses (Girma and Korbu, 2012). The crop is grown in many countries for the purpose of seeds producing and green and dry forages, but in Iraq, its cultivation is still very limited on an experimental scale, although it is possess well yield ability (Rafaat *et al.*, 2021).

Climate change in recent years poses a real threat to agricultural production and food security. Therefore, there is a need to address these changes and mitigate their negative influences by diversifying crops that are characterized by stable productivity and resistance to adverse environmental conditions, such as grass pea, which contributes to food security due to its high nutritional value, high yield and ability to improve soil properties. A better understanding of the agronomic importance of the planting date will certainly lead to improved management strategies for grass pea cultivation in different locations of the world, as determining the appropriate date of planting is one of the factors affecting crop productivity because it has an important role in providing environmental elements that the crop needs during its growth stages (Thakuria *et al.*, 2018). Moreover, the planting date consists of controlling temperature and

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lighting as one of the important inputs, along with careful management of the crop to achieve a balance between the source and sink and then obtain the growth stages at the highest rates, which will be reflected in the seed yield and its components (Ghosh *et al.*, 2018). Rafaat *et al.* (2021) noted that there were significant differences between the planting dates (15/10, 1/11 and 15/11) in seed yield and its components of grass pea, as the 15/10 planting date achieved the highest results of the number of seeds per pod and grain yield, while the 1/11 planting date achieved the highest number of pods per plant. Ghosh *et al.* (2018) clarified that the sowing of grass pea on 16th November

produced the highest grain yield (99.44 g m⁻²) compared with delayed sowing dates.

Also, the growth and productivity of crops is affected by crop management techniques, including number of plants per unit area, as they are a determining factor in the use of available environmental resources by controlling the rate and efficiency of interception of solar radiation through the photosynthesis process and its metabolic products and the effect of this on seed yield (Ali *et al.*, 2026), as well as its effect on competition between plants and its relationship to plant growth and the formation of its organs, as well as the depletion of nutrients from the soil (Sadiq and Mohammed, 2022). Abdullah and Rafaat (2020) noted that there was a significant difference between seeding rates (80, 100, 120 and 140 kg ha⁻¹) in the studied characteristics of grass pea, as the seeding rate at a 100 kg ha⁻¹ gave the highest average of plant height and the seeding rate at a 120 kg ha⁻¹ gave the highest average of 100-seeds weight, whereas the 140 kg ha⁻¹ gave the highest averages of pods number and seed yield.

As a result of the lack of previous studies on this crop, therefore this research was conducted to investigating the influence of planting date and seeding rate on some growth characteristics and seed yield and its components of grass pea and to select the planting date and seeding rate that are more suitable for the central region of Iraq.

MATERIALS AND METHODS

A field experiment was conducted from 25/11/2023 to 16/5/2024 in the College of Agriculture Fields - University of Karbala, in a clay loam soil as shown their physical and chemical properties in Table 1 and climatic conditions shown in Table 2, to investigating the Influence of planting date and seeding rate on some growth characteristics, seed yield and its components of grass pea.

The experiment was conducted according to a randomized complete block design within a split-plot arrangement with three replications. The main plots contained three planting dates (25/11, 5/12 and 15/12), while the sub plots contained three seeding rates (60, 80 and 100 kg ha⁻¹). Soil management, *i.e.* plowing, smoothing and leveling were carried out and then the experiment land was divided into 27 experimental units. The area of each experimental unit was 4 m² (2 m × 2 m) which contained 8 lines, 20 cm apart. Chemical fertilizers were added according to scientific recommendations, as all plots were fertilized by 35 Kg P ha⁻¹, which was added as triple superphosphate pre-planting and 50 kg N ha⁻¹ nitrogen, which was added as urea (46% N) in two equal doses, the first at the planting time, while the second at the flowering stage.

The seeds of grass pea (local cultivar), which were obtained from Seeds Technology Laboratory at the College of Agriculture - University of Karbala, were planted within the lines according to planting date and seeding rate treatments. Before planting, the seeds were tested for

germination and the germination percentage was about 92%. Crop management was carried out as needed, where the irrigation schedule performed every 8 days after planting and weeds were controlled by hand when necessary. The plants were harvested after the appearance of maturity signs, which were on 28/4, 7/5 and 16/5 according to each planting date, respectively. The plant height (cm), number of branches per meter square, number of pods per plant, number of seeds per pod, weight of 100 seeds (g) and seed yield (Mg ha⁻¹) characteristics were measured.

The data were statistically analyzed using the Genstat program v4.0 according to the arrangement and design used in the experiment. The research tested hypothesis that there was non-significant influence of planting dates and seeding rates and their interaction on the studied characteristics. The least significant difference (LSD) test was used to compare between averages at a 0.05 probability level (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Plant height (cm)

Table 3 findings show that there was a significant influence of planting dates (25/11, 5/12 and 15/12) on the plant height (Table 2), as the first date (25/11) gave the highest average, reaching 67.88 cm, compared with third date (15/12) which gave the lowest, reaching 54.31 cm. The superiority of the first date in the plant height can be attributed to the suitability of temperature and other climatic factors during the plant's growing season (Table 1), which was positively reflected on the plant's performance in terms of absorption, transport, carbon assimilation, cells division and elongation (Srinivas *et al.*, 2008).

Table 1: Physical and chemical soil properties.

Unit	Value	Trait
Sand	385	gm Kg Soil ⁻¹
Loam	244	
Clay	371	
Ec	3.72	ds m ⁻¹
pH	7.13	-
O.M	6.17	g Kg Soil ⁻¹
Ca	17.88	Meq L ⁻¹
K	1.05	
Mg	11.24	
Na	8.04	
Cl	21.94	
HCO ₃	5.77	
CO ₃	Nil	
SO ₄	9.79	
Available N	55.35	
Available P	12.27	
Available K	117.64	mg Kg Soil ⁻¹

Table (3) results clarify that there was a significant difference in the plant height by the influence of seeding rates (60, 80 and 100 kg ha⁻¹), where the seeding rate at a 100 kg ha⁻¹ achieved the maximum average, reaching 65.46 cm, compared with 60 kg ha⁻¹ seeding rate which achieved the minimum, reaching 57.44 cm. The increase of plant when increasing the plant population could be due to an increase the number of plants per unit area, which will increase the competition between plants for growth requirements, especially light. This prompts the plants to elongate to obtain sufficient light. Additionally, the increasing of shading between plants when seeding rates increase leads to an increase in the concentration of plant hormones responsible for stem elongation, such as auxins and gibberellins (Sadiq and Mohammed, 2022). This result are in agreement of Abdullah and Rafaat (2020) findings.

The interaction between planting dates and seeding rated hadn't significant influence on plant height (Table 3).

Number of branches (branch m⁻²)

The early planting date (25/11) was significantly superiority and produced the highest average number of branches, amounting to 522.3 branch m⁻², compared with late planting date (15/12) which produced 452.5 branch m⁻² (Table 3). The increase of the number of branches on the first date may be attributed to the rapid growth of the plant during its early stages of growth as a result of its growth being accompanied by suitable environmental conditions (Table 1), which may have stimulated the growth of dormant lateral

buds due to the increased transfer of photosynthesis products to them, thus increasing the number of lateral branches (Shahverdi *et al.*, 2023). Otherwise, low temperature occurrence at the early growth stages may be explain the decrease of grass pea plants growth in the third planting date (Ghosh *et al.*, 2018).

The high seeding rate (100 kg ha⁻¹) significantly excelled by providing the maximum average number of branches, reached 528.6 branch m⁻², compared with the low seeding rate (60 kg ha⁻¹) which gave 460.4 branch m⁻² (Table 3). It is noted from the results that the number of branches per meter square was proportionally increased with the increase of seeding rates, which can be attributed to the increase the number of plants per unit area (Rupinder and Harmeet, 2018).

The interaction between two factors had a significant influence on this characteristic and this may be due to different relative responses of this characteristic for the two studied factors, where the planting on 5/12 at a 100 kg ha⁻¹ gave the highest value, reaching 556.4 branch m⁻², while the planting on 15/12 at a 60 kg ha⁻¹ gave the lowest value, reaching 412.0 branch m⁻² (Table 3).

Number of pods (pods plant⁻¹)

Table (4) findings show that the early planting date (25/11) significantly excelled and recorded the maximum average number of pods, amounting to 10.43 pods plant⁻¹, with a non-significant difference with 5/12 planting date (10.11 pods plant⁻¹), compared with late planting date (15/12) which

Table 2: Climatic conditions of the winter season of 2023 in the study site.

Year	Month	Rain (mm)	Max. temp. (C ^R)	Min. temp. (C ^R)	Temp. avg. (C ^R)	Solar radiation (MJ m ⁻² day ⁻¹)	Total solar radiation
2023	November	0.0	24.21	11.87	18.04	12.28	386.3
	December	0.0	19.10	8.46	13.76	9.35	290.0
	January	0.7	17.43	4.87	11.15	10.13	314.0
	February	1.0	20.48	7.18	13.83	12.91	361.5
2024	March	0.0	26.06	10.11	18.08	17.99	557.7
	April	0.0	31.99	13.92	22.95	22.39	671.8
	May	0.0	38.29	19.45	28.87	25.72	797.2

Table 3: Influence of planting date and seeding rate on the plant height (cm) and number of branches (branch m⁻²).

Planting date	Plant height (cm)				Number of branches (branch m ⁻²)			
	Seeding rate (kg ha ⁻¹)			Average	Seeding rate (kg ha ⁻¹)			Average
	60	80	100		60	80	100	
25/11	63.41	68.20	72.03	67.88	488.5	542.0	536.3	522.3
5/12	58.42	63.21	66.83	62.82	480.8	510.7	556.4	516.0
15/12	50.47	54.95	57.52	54.31	412.0	452.3	493.2	452.5
LSD .05		NS		3.59*		22.1*		17.9*
Average	57.44	62.12	65.46		460.4	501.7	528.6	
LSD .05		3.02*				12.8*		
C.V (%)		4.8				2.5		

*Significant at P≤0.05; NS- Non-significant at P>0.05.

recorded 7.74 pods plant⁻¹. The increase could be due to planting at the suitable time and exposing the plants to appropriate climatic conditions during their life cycle and then completing the various stages of growth in suitable time periods, which helped the plant to produce branches and leaves, increase the efficiency of the photosynthesis process and transfer its products to the reproductive parts, which reduced the percentage of flowers drop and increased pod production (Piergiovanni *et al.*, 2010). Otherwise, the decreasing of pods number at the third date is mainly due to high temperatures during the period of pods formation (Table 2), which in turn leads to inhibition of the development of flower buds, abortion of flowers, or failure of fertilization and pod set (Ghosh *et al.*, 2018). These findings agreed with Rafaat *et al.* (2021) results.

The low seeding rate (60 kg ha⁻¹) was significantly superiority by giving the highest average number of pods, reaching 10.06 pods plant⁻¹, compared with the high seeding rate (100 kg ha⁻¹) which gave 8.70 pods plant⁻¹ (Table 4). The superiority may be due to the lack of competition between plants for growth factors as a result of the decrease the number of plants per unit area, which contributed to securing suitable conditions for growth and increasing the pollination and fertilization rates. This positively reflected on the increase the number of pod sites on the plant. Otherwise, the reduction of the pods number when planting at a high seeding rate may be due to increased competition between plants as well as plant organs for growth requirements (Al-Hilfy and Al-Muger, 2016).

Significant interaction between studied factors was noted as a result of different relative responses of pods number for studied factors, as the planting on 5/12 at a 60 kg ha⁻¹ achieved the maximum value, reaching 10.92 pods plant⁻¹, whereas the planting on 15/12 at a 100 kg ha⁻¹ achieved 6.93 pods plant⁻¹ (Table 4).

Weight of 100 seeds (g)

The results of Table (4) indicate that there was a non-significant influence of planting date, seeding rate and the interaction between them on the weight of 100 seeds.

Number of seeds (seeds pod⁻¹)

The results of Table (5) indicate that the early planting date (25/11) was significantly superiority by achieving the highest average number of seeds, amounting to 3.91 seeds pod⁻¹, compared with late planting date (15/12) which recorded 2.13 seeds pod⁻¹. The superiority of early planting in the seeds number per pod can be attributed to the suitable climatic conditions during ovules fertilization process (Table 2), as well as the increased transfer of dry matter to the fertilized ovules, thus increasing the number of seeds in the pod. Also, the significant influence of planting dates on the number of seeds per pod is mainly due to the influence of temperatures on the development of the seeds inside the pod, as any increase or decrease in temperature during the period of seed development leads to a reduction in the development period of this stage (the period of seed filling after the formation and elongation of the pods) and then increases the seeds abortion (Piergiovanni *et al.*, 2010). This result is consistent with Rafaat *et al.* (2021). Otherwise, high temperature occurrence at the flowering stage could be explain the reduce seeds number per grass pea pod growth in the third planting date (Ghosh *et al.*, 2018).

Table (5) findings reveal that the low seeding rate (60 kg ha⁻¹) significantly excelled and gave the maximum average number of seeds, reaching 3.37 seeds pod⁻¹, with a non-significant difference with 80 kg ha⁻¹ seeding rate (3.20 seeds pod⁻¹) compared with high seeding rate (100 kg ha⁻¹) which gave 2.82 seeds pod⁻¹. The superiority could be attributed to the fact that planting at a low seeding rate reduced the competition between plants on the growth factors, which led to an increase the efficiency of the photosynthesis process, an increase its metabolic products and regulation of their transfer to the reproductive parts, supplying the ovules with their requirements for necessary nutrients for their growth and preventing their abortion, which increased the number of seeds per pod (Jeraisy, 2011). These results indicate that the reduction of seeding rates was more efficient in fragmentation of

Table 4: Influence of planting date and seeding rate on the number of pods (pods plant⁻¹) and weight of 100 seeds (g).

Planting date	Number of pods (pods plant ⁻¹)				Weight of 100 seeds (g)			
	Seeding rate (kg ha ⁻¹)			Average	Seeding rate (kg ha ⁻¹)			Average
	60	80	100		60	80	100	
25/11	10.71	10.83	9.76	10.43	8.40	8.83	9.10	8.78
5/12	10.92	10.00	9.41	10.11	9.27	9.40	9.57	9.41
15/12	8.56	7.74	6.93	7.74	9.47	9.67	9.73	9.62
LSD .05		0.44*		0.37*		NS		NS
Average	10.06	9.52	8.70		9.04	9.30	9.47	
LSD .05		0.25*				NS		
C.V (%)		2.6				16.3		

*Significant at $P \leq 0.05$; NS- Non significant at $P > 0.05$.

Table 5: Influence of planting date and seeding rate on the number of seeds (seeds pod⁻¹) and seed yield (Mg ha⁻¹).

Planting date	Number of seeds (seeds pod ⁻¹)				Seed yield (Mg ha ⁻¹)			
	Seeding rate (kg ha ⁻¹)			Average	Seeding rate (kg ha ⁻¹)			Average
	60	80	100		60	80	100	
25/11	4.24	3.92	3.57	3.91	3.179	3.992	4.781	3.984
5/12	3.36	3.66	3.05	3.36	2.687	4.034	4.428	3.717
15/12	2.51	2.03	1.84	2.13	2.020	3.342	3.829	3.064
LSD .05		0.34*		0.25*		0.258*		0.206*
Average	3.37	3.20	2.82		2.629	3.790	4.346	
LSD .05		0.19*				0.149*		
C.V (%)		6.1				4.0		

*Significant at $P \leq 0.05$; NS- Non Significant at $P > 0.05$.

metabolites and efficiently distributing them among seeds, which led to an increase their number per pod.

The interaction between studied factors had a significant influence on this characteristic and this could be attributed to varied relative responses of this characteristic for two studied factors (Table 4), where the planting on 25/11 at a 60 kg ha⁻¹ achieved the highest value, amounting to 4.24 seeds pod⁻¹, with a non-significant difference with the plant on same date at 80 kg ha⁻¹ seeding rate (3.92 seeds pod⁻¹), while the planting on 15/12 at a 100 kg ha⁻¹ achieved 1.84 seeds pod⁻¹.

Seed yield (Mg ha⁻¹)

Table (5) findings clarify that the first planting date (25/11) was significantly distinguished by yielding the highest average seed yield, amounting to 3.984 Mg ha⁻¹, compared with the third planting dates (15/12) which yielded the lowest, amounting to 3.064 Mg ha⁻¹. The superiority of planting at an early date may be due to its superiority in the number of pods per plant (Table 4) and number of seeds per pod (Table 5). This result is consistent with Rafaat *et al.* (2021).

The high seeding rate (100 kg ha⁻¹) significantly excelled by producing the maximum average seed yield, reaching 4.346 Mg ha⁻¹, compared with the low seeding rate (60 kg ha⁻¹) which produced 2.629 Mg ha⁻¹ (Table 5). The superiority of planting at a high seeding rate in the seed yield could be attributed to the increase the number of plants per unit area, which compensated the decrease of yield components. This result is agreed with date Ghosh *et al.* (2018) and Abdullah and Rafaat (2020).

Significant interaction between studied factors was found as a result of different relative responses of seed number for studied factors, where the planting on 5/12 at a 100 kg ha⁻¹ yielded the highest value, reaching 4.781 Mg ha⁻¹, whereas the planting on 15/12 at a 60 kg ha⁻¹ yielded the lowest, reaching 2.020 Mg ha⁻¹ (Table 5).

The practical implications of grass pea cultivating are twofold, environmental and economic. The grass pea is characterized by a deep and strong root system, which makes it resistant to drought conditions. Also, it is efficient

at fixing atmospheric nitrogen, thus contributing to soil sustainability. Furthermore, the low production cost of this crop makes it an economic option for farmers in semi-arid regions. Moreover, the seed productivity and seed content of protein can contribute to achieving one of the sustainable development aims that involve eradicating hunger and achieving food security.

CONCLUSION

We conclude that the early planting date (25 November) led to improved plant growth and achieving a balance between sources and sinks, which was positively reflected on seed yield of grass pea. Also, the planting at a high seed rate (100 kg ha⁻¹) achieved the best results of seed yield, as increasing seed yield at high seeding rate can be directly attributes to large plant populations and strong relationship between seed yield and number of plant per unit area, which compensated the decrease of yield components. These results achieve the aims of sustainable agriculture in terms of increasing production and achieving food security.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

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