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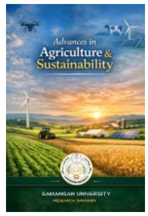

Effects of Planting Distance and Nitrogen on Garden Pea Yield (*Pisum sativum L.*)

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Keywords

Garden pea, nitrogen fertilizer, planting distance, treatment and yield.

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Abstract

A field experiment was conducted in 2025 at the Educational and Research Farm of Daikundi University to evaluate the effects of planting spacing and nitrogen fertilizer on the yield and yield components of garden pea (*Pisum sativum* L.). The experiment was arranged as a split-plot design based on a randomized complete block design with four replications. Four planting spacings (10, 15, 20, and 25 cm) were assigned to the main plots, while three nitrogen levels (0, 50, and 100 kg N ha^{-1} as urea) were allocated to the subplots. Analysis of variance showed that planting spacing significantly affected plant height, number of branches per plant, pods per plant, 100-seed weight, seed yield, and phenological traits ($P < 0.01$). Nitrogen fertilizer also had significant effects on these traits ($P < 0.05$ or $P < 0.01$). The interaction between planting spacing and nitrogen fertilizer was not significant for most traits but significantly affected 100-seed weight ($P < 0.05$). The highest seed yield among planting spacings was obtained at 20 cm (944.25 kg ha^{-1}), whereas the lowest yield was recorded at 10 cm (764.16 kg ha^{-1}). Application of 50 kg N ha^{-1} produced the highest seed yield (944.25 kg ha^{-1}), representing a 14.7% increase over the control. Therefore, a planting spacing of 20 cm combined with 50 kg N ha^{-1} is recommended to maximize garden pea productivity under the conditions of the research area.

1. Introduction

Garden pea is considered one of the major legumes in the world, containing 15–20 percent protein, and is used in many developing countries as one of the important sources of plant protein. Nowadays, in Afghanistan, one of the important issues in the agriculture sector is the proper spacing for garden pea cultivation in agricultural lands. In this regard, one of the solutions to address this problem is to study the response of garden pea plants to different planting distances. Inappropriate planting distances are the main factor for the inability of seeds to grow and develop under field conditions because unsuitable spacing slows down growth and ultimately delays plant establishment. Numerous reports indicate that seeds that can respond well to wider spacing during germination show better early growth and develop a stronger root system (Narula *et al*., 2000). Scientists stated that inappropriate spacing and incorrect use of nitrogen fertilizer caused a significant reduction in garden pea yield, and the effect of inappropriate spacing on grain protein content, plant physiology, plant morphology, yield, and garden pea grain quality was significant (Oweis *et al*., 2004).

In the research by Millan *et al* (2006), the effect of closer planting distances on yield and yield components of sorghum was examined, and it was shown that the effect of closer distance treatment on grain yield, number of plies per plant, and hundred-grain weight was significant at the one percent level, but the number of grains per ply did not respond to this treatment. In another study, sorghum yield and yield components were examined, and it was observed that inappropriate spacing reduced the length of the reproductive growth period in sorghum. In the ordinary varieties that were planted at appropriate intervals, they had the highest yield, with the greatest number of ears and grains per plant (Petr *et al.*, 2012). In another study on garden pea varieties under different planting distances, among the yield components, the highest correlation with yield was reported in relation to the traits of the number of ears per plant and 100-seed weight (Javadini *et al*., 2010).

In another study conducted by Moosavi *et al* (2016), in which garden pea was exposed to different planting spacings during the vegetative and reproductive stages. This study showed that garden pea yield during the vegetative stage was highly dependent on nitrogen fertilizer, and during the reproductive stage, it had relatively little effect on grain yield. It has been reported that garden pea grain yield along with harvest index has a positive correlation both under well-irrigated conditions and at appropriate planting distances, and during the reproductive stage, besides affecting yield, it also greatly reduced the harvest index (Bahavar *et al*., 2009). Since Afghanistan is located in an arid and semi-arid region, the organic matter content of its soils is low, resulting in low nitrogen levels. Most plants in these areas suffer from nitrogen deficiency, and therefore, supplying nitrogen through chemical fertilizers and organic materials is essential (Merzai Mohammad *et al*., 2024).

Proper use and improvement of nitrogen efficiency is a key strategy for advancing sustainable agricultural systems, which leads to achieving maximum yield with minimal input consumption and nitrogen loss. Studies show that more than 50 percent of the increase in food production compared to the past is due to the use of chemical fertilizers. Meanwhile, the share of nitrogen fertilizers compared to other fertilizers is higher, but unfortunately, their efficiency of use is low (Peksen *et al*., 2004).

Many studies have shown that nitrogen affects the quantity and quality of grain. Many have indicated that nitrogen can increase grain protein (Saman *et al*., 2010). The results of nitrogen uptake measurement showed that nitrogen uptake increased with plant growth and continued until pod filling, with the highest uptake observed from the pod formation stage to pod filling. With plant growth, the nitrogen concentration of aerial organs increased up to the flowering stage and the beginning of pod formation, but then began to decrease; however, nitrogen uptake, which depends on plant growth and the nitrogen concentration of aerial organs, continued until physiological maturity. The decrease in nitrogen concentration of aerial organs after flowering and the start of seed filling can be attributed to the transfer of nitrogen from stems and leaves to seeds, and the increase in nitrogen uptake after these stages is also due to continued plant growth, although no change in the increase of nitrogen uptake from the pod filling stage to physiological maturity was observed. It has been reported that about half of the nitrogen uptake of plants occurs by the flowering stage and the rest occurs over a 30-day period until seed filling (Soltani *et al*., 2006).

In a simultaneous study of the effects of different planting distances and nitrogen fertilizer application on mung bean, it was concluded that the extent of destructive effects of close distances among different factors depends mainly on the nitrogen nutrient element. They stated that plants in treatments with more available nitrogen had greater vegetative growth and also produced more shoots and leaves. As a result, when facing drought stress, compared to plants in other treatments that had less nitrogen available and experienced yield reduction, and according to them, increased nitrogen consumption increases the sensitivity of Garden pea plants (Sasani *et al*., 2004).

Although several research have evaluated the effects of planting distance and nitrogen fertilization on the yield and yield components of garden pea under different environmental conditions, limited information is available regarding their combined effects under the agroecological conditions of Afghanistan. Garden pea production in Afghanistan is constrained by low soil fertility, particularly nitrogen deficiency, inappropriate crop management practices, and the absence of locally developed recommendations for optimum plant spacing and nitrogen application rates. Most of the available recommendations are derived from studies conducted in other countries with different climatic conditions, soil characteristics, and production systems, which may not be directly applicable to Afghan farming conditions. Therefore, a clear knowledge gap exists regarding the identification of suitable planting distances and efficient nitrogen fertilizer rates for maximizing garden pea productivity in Afghanistan. Addressing this gap is essential for improving yield, enhancing nitrogen use efficiency, and providing practical recommendations to farmers. Consequently, this study was conducted to investigate the effects of different planting distances and nitrogen fertilizer application rates on the yield and yield components of garden pea under the climatic conditions of Daikundi Province, Afghanistan.

2. Material and Methods

The present study was conducted in May 2025 at the research farm of Daikundi University, located in Nili, the center of Daikundi Province, Afghanistan (33°35′25″ N latitude, 51°02′20″ E longitude, at an altitude of 2020 m above sea level). According to the regional classification, the area has a cold semi-arid climate with an average annual rainfall of approximately 250 mm. The soil of the experimental field was classified as sandy loam (S.L.). To determine the initial soil characteristics, five soil samples were collected in a zigzag pattern from the 0–30 cm soil depth across the experimental area and combined to form a composite sample. The composite soil sample had a pH of 8.3, electrical conductivity (EC) of 0.203 dS m^{-1}, and total nitrogen content of 0.0056%. The experiment was arranged in a split-plot design based on a randomized complete block design (RCBD) with four replications. Each replication consisted of 12 plots, and each plot included five rows measuring 3 m in length and 2.5 m in width. The row spacing was maintained at 50 cm. Plant spacing treatments of 10, 15, 20, and 25 cm resulted in plant densities of 20, 14, 10, and 8 plants m^{-2}, respectively. The main plot treatments consisted of four planting distances: S1 = 10 cm (control), S2 = 15 cm, S3 = 20 cm, and S4 = 25 cm. Nitrogen fertilizer was assigned to subplots at three levels: 0, 50, and 100 kg N ha^{-1}. The selected planting distances and nitrogen fertilizer levels were chosen based on local agronomic practices, recommendations for garden pea cultivation under semi-arid conditions, and findings from previous studies. The planting distances of 10, 15, 20, and 25 cm represented a range of plant population densities commonly adopted by farmers and were intended to evaluate the effects of inter-plant competition and resource utilization efficiency on crop growth and yield. The 10 cm spacing was considered the control treatment because it reflects the conventional practice used by many local growers. Similarly, nitrogen fertilizer rates of 0, 50, and 100 kg N ha^{-1} were selected to represent the absence of nitrogen application, a moderate rate, and a relatively high rate of nitrogen input, respectively. These levels were used to determine the response of garden pea to increasing nitrogen availability and to identify an optimum nitrogen rate for improving yield and yield components under the agro-climatic conditions of Daikundi Province.

Nitrogen fertilizer was applied in two equal splits, with half incorporated into the soil at planting and the remaining half top-dressed during the vegetative growth stage. No additional nutrient deficiencies were observed during the experimental period, and all plots received identical management practices except for the imposed treatments.

Irrigation was applied uniformly to all plots throughout the growing season to avoid moisture stress and eliminate the influence of differential water availability among treatments. The first irrigation was performed immediately after sowing to ensure adequate seed germination, while subsequent irrigations were provided according to crop water requirements and prevailing weather conditions.

For the measurement of morphological and agronomic traits, border plants were excluded to minimize edge effects. Sampling was conducted from an area of 0.25 × 0.50 m (0.125 m^2) within the second, third, and fourth rows of each plot at different growth stages. The measured traits included plant height, number of lateral branches per plant, number of pods per plant, number of seeds per pod, 100-seed weight, total dry matter, grain yield, and phenological characteristics.

Data were subjected to analysis of variance using SAS version 9.2 and SPSS software. Mean comparisons were performed using Duncan's Multiple Range Test at the 5% probability level, and figures were prepared using Microsoft Excel.

3. Results

Plant height

The results from the analysis of variance table indicated a significant effect of planting distance and nitrogen fertilizer on the trait of garden pea height at the one percent probability level (Table 1). Comparison of means indicated the effect of planting distance on reducing plant height, so that the highest plant height was 140.08 cm at a planting distance of 25 cm and the lowest was 65.08 cm in the control at the vegetative stage (Table 2). The increase in plant height in high densities can be attributed to the reduced light penetration in the canopy and intense competition among plants for receiving more light (Moniruzzaman et al., 2009). who observed that plant density significantly influenced plant height through changes in light interception and canopy structure. The maximum plant height of 140.08 cm was obtained with 100 percent nitrogen fertilizer, and the minimum of 73.33 cm was obtained in the control treatment. Of course, there was a statistically significant difference between this treatment and 50 percent nitrogen fertilizer (Table 3). Nitrogen deficiency, by reducing leaf size, leads to a decrease in the plant's photosynthetic capacity, and this can affect the reduction of aerial organ growth of the plant (Vos et al., 1998). This response can be explained by the role of nitrogen in chlorophyll formation, photosynthesis, and protein synthesis, all of which stimulate vegetative growth.

Table 1. Analysis of variance of garden pea agronomic traits under the effect of different garden pea planting interval and Nitrogen fertilizer treatments

*, ** and ns, significant at 5 and 1 percent probability levels and non-significant, respectively.

					Mean square				
S.O.V.	d.f.	Plant heigh	Branch No.	Pods per Plant	100 seed weight	Seed yield	Sowing to flowering	Sowing to pod	Sowing to maturity
Replication	3	45.566**	0.833*	35.685^{ns}	943.34**8	30065.5**8	3.533*	4.354**	0.909*
Row (a) spacing	3	1140.3**54	6.500*	1533.909*	5030.8**30	433991.**49	61.00**0	10.54**3	11.18**3
Error (a)	9	16.334	0.350	45.150	68.636	4113.39	1.435	0.353	0.557
Nitrogen ferti.(b)	2	315.55**0	38.89*5	155.895**	3193.3**03	5553369*	30.43**5	10.64*5	**9.550
R×Fert. S	6	6.583 ^{ns}	0.539 ^{ns}	4.034^{ns}	43.554*	639.10 ^{ns}	0.854^{ns}	0.451^{ns}	0.108^{ns}
Error (b)	24	3.041	0.131	10.888	15.658	1385.40	0.5000	0.305	0.104
%C.V.	-	1.459	6.810	3.500	1.093	3.633	1.279	3.991	1.318

Table2. Comparison of Average Phonological Stages, Yield, and Yield Components of Garden pea under Different Planting Spacings

Row spacing	Pl. height cm	Branch per plant	Pods per plant	100 seed wt (gr.)	seed yield (kg/ha^{-1})	Days to flowering	Days to podding	Days to maturity
10 cm	65.08^{d}	12.8^{c}	5.55^{b}	4.30^{d}	764.16^{ab}	48 ^{a}	30 ^{a}	45 ^{a}
15 cm	73.33^{c}	14.8 ^{b}	7.16 ^{b}	5.18 ^{c}	823.45^{b}	48 ^{a}	30 ^{a}	45 ^{a}
20 cm	99.75 ^{b}	15.3 ^{b}	8.66^{a}	6.71 ^{b}	944.25 ^{a}	48 ^{a}	30 ^{a}	45 ^{a}
25 cm	140.08 ^{a}	18.3 ^{a}	9.33^{a}	8.82 ^{a}	912.21^{ab}	48 ^{a}	30 ^{a}	45 ^{a}

Columns with similar alphabets are non-significant at 1% probability levels.

Table 3. Comparison of average phenological stages, yield, and yield components of garden pea at different nitrogen fertilizer levels

N fertilizer treatments	Pl. height cm	branch per plant	Pods per plant	100 seed wt(gr.)	Seed yield (Kg/ ha^{-1})	Days to flowering	Days to podding	Days to maturity
Check (no N applied)	73.33[c]	14.8[b]	7.16 [b]	5.18[c]	823.45[b]	48 [a]	30 [a]	45 [a]
50 kgN/ha^{-1}	99.75 [b]	15.3[b]	8.66[a]	6.71 [b]	94425[a]	48 [a]	30 [a]	45 [a]
100 Kg N/ha^{-1}	140.08[a]	18.3[a]	9.33[a]	8.82 [a]	912.21 [ab]	48 [a]	30 [a]	45 [a]

Columns with similar alphabets are non-significant at 1% probability levels.

Branch per plant

The results obtained from the analysis of variance table showed the significant effect of planting distance and nitrogen fertilizer on the trait of the number of secondary branches of garden pea at the 5 percent probability level (Table 1). The highest number of lateral branches, 18.3, was obtained at a planting distance of 25 cm, and the lowest, 12.8, at a planting distance of 10 cm during the flowering stage (Table 2). Given that at higher densities the spacing along the planting row decreases, due to the lack of sufficient space, the plants cannot produce a greater number of lateral branches. The reduction in the number of lateral branches in most cases can be attributed to the decreased light penetration in the lower parts of the plant canopy and the inactivity of the buds' forming branches. Some researchers' studies showed that increasing the seed rate in garden pea causes a significant decrease in the number of lateral branches. At lower densities, the production of lateral branches occurs due to the stimulation of buds that produce lateral branches in the angle between the leaves and the main stem. Although increasing density reduces the number of lateral branches in the plant, due to the increase in the number of branches per unit area, the yield will increase (Jafari *et al*., 2010). who found that increasing plant density significantly reduced branch production in Garden Pea. The highest number of lateral branches, 18.3 per 100 percent of applied nitrogen fertilizer, and the lowest amount, 14.8, was obtained in the control treatment. Of course, there was no statistically significant difference between this treatment and 50 percent nitrogen fertilizer (Table 3). Adequate nitrogen promotes vigorous vegetative growth and stimulates the development of secondary shoots, thereby increasing branching capacity.

Pods per plant

The results obtained from the analysis of variance table showed a significant effect of planting distance and nitrogen fertilizer on the trait of the number of leaves per garden pea plant at the levels of five percent and one percent, respectively (Table 1). The highest number of pods in Bethe was 9.33 at a planting distance of 25 cm, and the lowest was 5.55 at a planting distance of 10 cm during the grain sizing stage (Table 2). The reason for the increase in the number of branches can be explained as follows: the highest number of branches is observed in the plant when the density and arrangement of the planting are considered optimal for the plant. Normally, with the increase in plant density, the number of pods per plant decreases. This is because, due to increased competition for light and necessary nutrients, the number of nodes and fertile flowers is reduced, and the number of lateral branches decreases significantly, which consequently reduces the number of pods per plant. Considering the greater number of lateral branches, a higher number of pods in this treatment was justified. Typically, with an increase in the desired density, the number of flowers per plant decreases. This is because, due to increased competition for light and necessary nutrients, the number of nodes and fertile flowers is reduced, and the number of lateral branches decreases significantly. With the increase in the number of shoots in low densities, an increase in the number of shoots in the branches was achieved (Redden et al., 1987). Based on a study, with the increase of plant density from 30 to 50 planets per square meter, a significant decrease in the number of pods occurred (Jafari *et al*., 2010). The increase in pod number under wider spacing can be attributed to improved branching and greater availability of assimilates for reproductive development. Reduced competition allows plants to produce more fertile nodes and flowers, which subsequently develop into pods. The highest number of pods in Plot 9.33 was obtained at 100 percent of applied nitrogen fertilizer, and the lowest amount was 7.16 in the control treatment. Of course, there was a statistically significant difference between this treatment and 50% nitrogen fertilizer (Table 3). In a study on mustard, the increase in grain yield due to increased nitrogen fertilizer consumption was attributed to the increase in the number of pods per plant (Jaleel et al., 2008). which attributed yield increases under nitrogen fertilization to enhanced pod production.

Hundred seed weight

Analysis of variance indicated the significant interaction effect of planting distances at growth stages and nitrogen fertilizer on the hundred-seed weight of buckwheat at the five percent probability level (Table 1). Analysis of planting distances caused an increase in hundred-seed weight, so that the highest hundred-seed weight of 8.82 g was obtained at a planting distance of 25 cm and the lowest (4.30 g) at a planting distance of 10 cm at the grain-filling stage (Table 2). In the study conducted to determine the most appropriate plant density for new corn lines, the thousand-grain weight was not affected by plant density (Salehi *et al*., 2005). In this study, the thousand-seed weight of Garden pea increased with higher fertilizer application, which can be attributed to the increased transfer of photosynthetic substances to the Garden pea reproductive organs due to the increased nitrogen. Researchers stated that it seems nitrogen fertilizer increases grain weight by increasing protein percentage (Chaturvedi et al., 2005). effect of plant density on grain weight in maize, the present results indicate that seed filling in garden pea is sensitive to planting arrangement. The highest weight of one hundred seeds was 8.82 g at 100 percent nitrogen fertilizer application, and the lowest amount was 5.18 g in the control treatment. Of course, there was no statistically significant difference between this treatment and 50 percent of the consumed nitrogen fertilizer (Table 3). They stated in implementation that the effect of nitrogen fertilizer causes an increase in grain weight (Ayaz *et al*., 2004). This improvement may be associated with enhanced protein synthesis and greater translocation of photosynthates to seeds during grain filling.

Grain yield

The results obtained from the analysis of variance showed that the effect of planting spacing and nitrogen fertilizer on grain yield was significant at the one percent and five percent levels, respectively (Table 1). Appropriate planting distances led to an increase in grain yield, such that the highest grain yield of 944.25 Kg N ha^{-1} was obtained at a planting distance of 20 cm and the lowest of 764.16 Kg N ha^{-1}at a planting distance of 10 cm during the grain formation stage (Table 2).

Basically, farmers believe that yield can be increased by increasing density, but it should be noted that at densities higher than the optimal level, the reduction in plant weight is such that the yield increase resulting from the higher number of plants per unit area is negated (Rao *et al*., 1996). A study shows that although the relationship between plant density and grain yield varies in different regions and varieties, in general, with increasing plant density, grain yield increases to some extent and then remains constant. Then, with the increase in plant population density, even when moisture and nutrients are not limiting factors, grain yield rapidly decreases (Brothers *et al*., 1993). It was also reported that by reducing the crop row spacing from 69 to 23 centimetres and increasing the plant density from 25 to 38 plants per square meter, the grain yield of Garden Pea increased despite the presence of weeds (Malik *et al*., 1993). Although wider spacing increased yield components such as branches and pods per plant, the 20 cm spacing provided a more favorable balance between plant population and individual plant productivity, resulting in maximum yield per unit area. The highest grain yield of 912.21 Kg N ha^{-1} was obtained with 50 percent of applied nitrogen fertilizer, and the lowest amount of 823.45 Kg N ha^{-1} was obtained in the control treatment. Of course, there was no statistically significant difference between this treatment and 50 percent of the consumed nitrogen fertilizer (Table 3). The increase in yield can be attributed to improvements in plant height, branching, pod number, and seed weight, all of which contributed positively to final productivity.

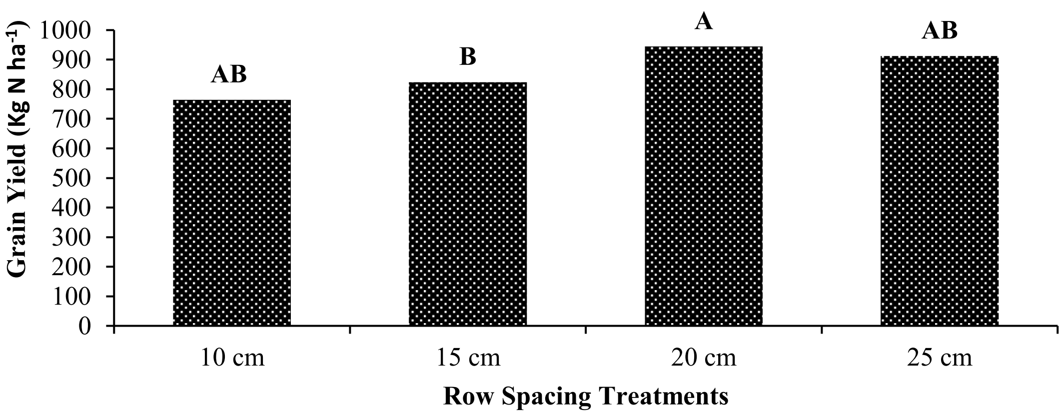

Figure 1. Comparison of the average effects of different planting distances on the yield and yield components of garden pea.

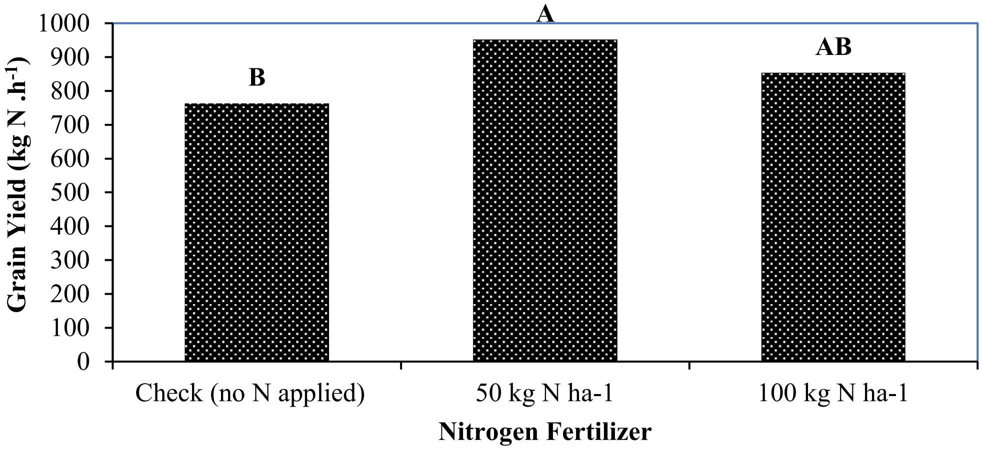

Figure 2. Comparison of the average effects of nitrogen fertilizer application on the yield and yield components of garden pea.

Phonological Characteristics

The effect of planting distances on the traits of days to flowering, podding, and full maturity was significant at the levels of one percent, five percent, and one percent, respectively (Table 1). The implementation of planting spacings did not lead to an increase in days to flowering, days to pod embryony, or days to full maturity, so that the growth stages reached 123 days. (Chart 4). According to the results of this study, it can be stated that in the reproductive stage, they are more sensitive to planting distances compared to the vegetative stage, one of the reasons for which is the decrease in the number of pods per plant and hundred-seed weight in treatments with shorter planting distances (Table 2). Variations in planting distance altered plant competition and resource availability, thereby influencing crop developmental rates. Wider spacing generally prolonged crop growth duration because plants maintained active vegetative growth for a longer period before entering reproductive stages. As expected, planting distances and nitrogen fertilizer increased the duration of these phenological traits (Table 3). In the study, they reported that the application of nitrogen fertilizer caused an increase in the duration of cultivation until flowering, pollination, and maturation (Mckenzie *et al.*, 2001). that observed that nitrogen fertilization extended the duration of reproductive growth stages in legumes.

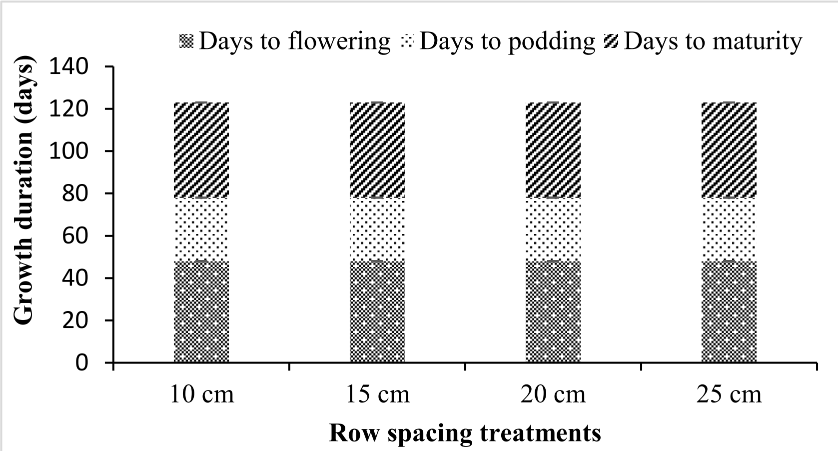

Figure 3. The stages and duration from Sowing to flowering, from Sowing to pod, and from pod Sowing to maturity are shown.

4. Trait correlation results

Trait correlation analysis (Table 4) revealed that grain yield was positively and significantly correlated with the number of lateral branches (r = 0.399*) and the number of pods per plant (r = 0.567*) at the 5% probability level. Grain yield also showed positive and highly significant correlations with plant height (r = 0.387**), days to flowering (r = 0.561**), days to pod opening (r = 0.598**), and days to full maturity (r = 0.568**) at the 1% probability level. In contrast, grain yield exhibited a weak and non-significant negative correlation with 100-seed weight (r = -0.112ns). The positive association between grain yield and the number of lateral branches and pods per plant suggests that these traits are important contributors to yield formation in garden pea. Plants with a greater number of branches can produce more reproductive sites, leading to increased pod production and ultimately higher grain yield. Likewise, the strong positive correlation between grain yield and pod number indicates that pod production is a major yield-determining component under the tested planting distances and nitrogen fertilizer levels. The positive correlations of grain yield with plant height and phenological traits (days to flowering, pod opening, and full maturity) may indicate that plants with longer growth durations had more time to accumulate biomass and photosynthates, which were subsequently allocated to reproductive organs. Increased vegetative growth likely enhanced light interception and photosynthetic activity, resulting in greater assimilate production and improved grain filling. These findings suggest that both vegetative vigor and an extended reproductive period contribute positively to yield improvement. The non-significant correlation between grain yield and 100-seed weight indicates that yield variation was mainly associated with the number of yield-producing structures rather than seed size. This result suggests that planting distance and nitrogen fertilizer primarily influenced yield through their effects on branch development and pod formation rather than on individual seed weight.

Table 4. Simple correlation coefficients among garden pea traits under different planting distances and nitrogen fertilizer levels

Characteristics	1	2	3	4	5	6	7	8
1-Pl. Height	1							
2- Branch no..	0.246^{*}	1						
3-pods per plant	0.763^{**}	0.431^{**}	1					
4-100 seed wt	0.659^{**}	0.681^{**}	0.548^{**}	1				
5-seed yield	0.387^{**}	0.399^{*}	0.567^{*}	0.112^{ns}	1			
6-Days to flower	0.543^{*}	0.593^{**}	0.541^{**}	-0.026^{ns}	0.561^{**}	1		
7-Days to podding	0.567^{*}	0.416^{**}	0.567^{**}	-0.001^{ns}	0.598^{**}	0.391^{**}	1	
8-Days to maturity	0.584^{**}	0.467^{**}	0.459^{**}	0.056^{ns}	0.568^{**}	0.349^{**}	-0.122^{ns}	1

*, ** and ns, significant at 5 and 1 percent probability levels and non-significance, respectively.

5. Conclusion

The results of this study demonstrated that both planting distance and nitrogen fertilizer application significantly affected the growth, yield, and yield components of garden pea. Among the tested treatments, a planting distance of 25 cm combined with nitrogen application produced the highest values for plant height, pod number, seed number per pod, 100-seed weight, and overall seed yield. In contrast, the control treatment resulted in the lowest performance for most measured traits. These findings indicate that optimizing plant spacing and nitrogen fertilization can substantially improve garden pea productivity under the agro-climatic conditions of Daikundi Province, Afghanistan. Therefore, the use of 25 cm plant spacing together with appropriate nitrogen fertilization is recommended for maximizing garden pea yield in similar environments in the centre of Daykundi province, Nili.

6. Statement and declaration

6.1 Acknowledgements

The authors haven't gotten any funding from institutions or organizations for this research; nonetheless, we have paid for some of the items needed for the experiment from our own pockets.

6.2 Authors' contributions

All the authors have contributed to the conceptualization of research work and designing of experiments, execution of field/lab experiments and data collection, analysis of data and interpretation and preparation of the manuscript.

6.3. Compliance with ethical standards

Conflict of interest: The research is original and the findings is neither published nor under consideration elsewhere. All the authors that have contributed for preparation of this manuscript do not have any conflict of interest.

6.4 Ethical issues: None.

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