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| RESEARCH ARTICLE

Effect of Different Seeding Rates on Growth and Yield of Common Bean

Gul Agha Sadiq[1], Fazlrabi Azizi[2], Khalilullah Khaleeq[3] ✉ Zabihullah Farkhari[4] and Ahmad Munir Amini[5]
[1,2]*Department of Horticulture, Faculty of Agriculture, Kunduz University, Afghanistan*
[3,5]*Department of Agronomy, Faculty of Agriculture, Kunduz University, Afghanistan*
[4]*Department of Environmental Science, Faculty of Agriculture, Kunduz University, Afghanistan*
Corresponding Author: Khalilullah Khaleeq, **E-mail**: khalil.khaleeq@gmail.com

| ABSTRACT
Legumes are one of the most important sources of protein in the diet of many people in developing countries. The protein content of legumes is about twice that of grains, and plant based production of legumes has numerous advantages over animal protein supply in terms of cost and consumer health; the best plant based protein belongs to the common bean, which contains all essential amino acids for the human body. The experiment laid out in a randomized complete block design with three replications, a field experiment was conducted at the agriculture faculty of Kunduz University farm during the cropping season of 2023, the study aimed to investigate the effect of different seeding rates on the growth and yield of common bean *viz*. 125 kg/ha, 150 kg/ha, 175 kg/ha, 200 kg/ha and 225 kg/ha. The result showed that the best seeding rate was 200 kg/ha, which resulted in significantly higher plant height (39.87cm), leaf area (335.88cm^2), branches/plant (9.89), dry Matter (6.43 gr/plant), pods/plant (13.27), seeds/pod (5.26), 100 seed weight (30.80gr), grain yield (2210.99 kg/ha), Stover yield (4500.00 kg/ha), gross return (265319 AFN/ha), net return (229233 AFN/ha) and B: Cost Ratio (6.33) followed by seeding of 175 kg/ha, the minimum growth and yield were in seeding rate of 125 kg/ha. It can be concluded that selecting the appropriate seeding rate is crucial for optimizing the growth and yield of common bean.

| KEYWORDS

Common bean, growth, seeding rate, yield

| ARTICLE INFORMATION

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1. Introduction

Common bean (*Phaseolus vulgaris* L.) is an essential protein source principally for low-income farmers. The evolution of crop practices has allowed for an expressive gain in the productivity of common beans. There is still much subsistence farming characterized by low technology inputs (*Souza et al*., 2013). The common bean is one of the most popular legumes consumed worldwide. The crop is grown for immediate human consumption and has a greater commercial value than all other legume crops combined (*T. Porch et al., 2013*). Common bean is cultivated in almost all continents of the world for utilization of 50% of the grain legume consumed as a source of protein around the world (*Khaleeq, K.,* 2023). The crop is the best among pulses and is referred to as "the poor man's meat" because it makes up for any potential protein deficiencies in low-income households (*D. Legese et al*., 2006). Grain legumes are important to break crops in cereal based crop rotations. Including them in crop rotation can interrupt disease and pest cycles, improve soil fertility through nitrogen (N) fixation and carbon sequestration and reduce greenhouse gas emissions and use of fossil energy (*Robson et al.,* 2002). These system-internal outputs are often underestimated, while the market output of grain legumes per unit area is relatively low and volatile. Consequently, grain legume cultivation in Europe declined from 5.8 to 1.8 Mha between 1961 and 2013, whereas production still increased in that period from 3.3 to 4.2 Mt (*Zander et al.,* 2016). This results in a deficit of vegetal proteins and dependency on imports like soybean, of which around two-thirds used in the European feed industry are imported (*Henseler et al.,* 2013).

High yields are realized with optimum plant population and planting method. However, due to a lack of holistic recommendations on the plant population of faba bean cultivars, plant populations on farmers' fields appear lower or higher than the optimum. As a result, a very low yield was obtained. Plant density is an important agent that affects yield and yield components of legumes. If the plant population is too high, plants compete with each other for resources and low yield is realized. On the other hand, if the population is too low, more growing space is wasted, and it lowers yield. In line with these facts, Kakiuchi and Kobata (2004) found that lower plant density increased the pod number per plant, whereas higher plant density decreased the parameter. Similarly, several authors (Abdel-Aziz et al., 1999) reported that plant height increased with increasing population density up to 33.3 plant/m2 or 44.4plant/m2 (*El-Douby et al.,* 1996) also reported that plant density had shining influences on plant height, biological and seed yield (kg/ha) where the parameters increased by increasing plant densities.

It is desired because it is quick maturing and can be cropped under different cropping and smallholder farmer systems. Common bean improves soil fertility through nitrogen fixation, and it is an alternative source of protein and income for smallholder farmers (*Ferris S and E Kaganzi.,* 2008). There is generally inter and intra-specific variation in the amount of N2 fixed by legumes due to several reasons, including nodulation efficiencies, genotype and maturity period, etc. The ability of legumes to fix N2 allows farmers to grow them with minimal inputs of N fertilizer *(Nazir et al.,* 2022).

In several types of beans, high plant density in bean has been associated with pest outbreaks, diseases and shedding of leaves. Under high plant densities, the majority of bean plants become too thin, less vigorous and increase in height. Resulting in lodging due to high competition between plants (*Bakry BA et al*., 2011). Low light intensity during high plant population causes less radiation interception, which consequently results in reduced photosynthetic efficiency and reduced number and quality of bean pods (*Worku W et al.,* 2004).

2. Materials and Methods

To determine the effect of different seeding rates of growth and yield of common beans, a field experiment was conducted at the research farm of Kunduz University. The experiment was laid out in randomized complete block design (RCBD) with three replications. The experiment was comprised of the following treatments: Seeding rates (125 kg/ha, 150 kg/ha, 175 kg/ha, 200 kg/ha and 225 kg/ha); the average annual rainfall is 254 mm. Soil (0–15 cm depth) of the experimental site was sandy clay loam in texture (sand 73.4%, silt 11.8% and clay 12.6%) with slightly alkaline, having pH of 7.43, Cation exchange capacity of 78.4 meq/100 g and electrical conductivity (ECe) of 3.32 ds/m. The available N, P and K contents were 118, 8.4 and 142 kg/ha, respectively. The gross plot size was $3\times4=12m^2$; the net plot size was $10m^2$; the crop was sown during cropping season on March 2023 with the help of a single row hand drill in 30 cm apart rows, Phosphorus at the rate of 60 kg p_2o_5/ha and 30 N/ha was applied to all plots at the time of sowing. Half nitrogen was broadcasted at the time of sowing, and the remaining half was applied with first irrigation, which was given 30 days after sowing. All cultural practices were the same for all treatments. The observations recorded were plant height at 60 DAYS, Leaf area (cm^2), Branches/plant, Dry Matter at 60 DAYS, Pods/plant, Seeds/pod, 100 seed weight, Grain yield (kg/ha), Stover Yield (kg/ha), Gross return (AFN/ha), Net return (AFN/ha) and B: Cost Ratio. Data collected were analyzed using one-way ANOVA with the Web Agri Stat Package 2.0 (WASP). The Least Significant Difference (LSD) test at a 5% probability level was applied to compare the treatment means.

3. Result and Discussion

3.1 Effect of seeding rates on plant height, Branches/plant and Dry Matter

Growth parameters responded significantly to different seeding rates of common beans (table 1). Plant height, Leaf area (cm^2), Branches/plant and Dry Matter (gr/plant) increased up to a seeding rate of 200 kg/ha, the highest plant height (39.87 cm), Leaf area ($335.88cm^2$), Branches/plant (9.89) and Dry Matter (6.43 gr/plant) was recorded in treatment 200 kg/ha, followed by treatments 175 kg/ha (36.04 cm, 302.18 cm^2, 9.55, 4.77 gr/plant respectively) the minimum growth parameters was recorded in seeding rate of 175 kg/ha in all growth parameters. However, it is important to note that the growth parameters began to decline at a seeding rate of 225 kg/ha, indicating that there may be a threshold beyond which further increases in seeding rate may not be beneficial. Further research is needed to determine the optimal seeding rate for common beans under different environmental conditions and management practices. Overall, these findings have important implications for farmers and agronomists seeking to optimize common bean production. By carefully selecting the appropriate seeding rate, it may be possible to maximize yield and improve the overall health and vigor of common bean crops. The result is similar to (*Kissi Wakweya et al*. 2016) also reported the highest plant height (167.6 cm) and biomass yield (105, 27.3 kg/ha) was observed at the highest seed rate of 225 kg/ha. While the lowest value (157 cm) and (9635.4 kg/ha) was recorded at 125 kg/ha seed rate. Similarly, the highest number of seeds pod^{-1} (2.7) were observed at 125, 175 and 200 kg/ha seed rates and the lowest value (2.6) at 150 and 225 kg/ha. Several faba bean investigators reported the dense planting resulted in decreases for seeds pod^{-1}, seeds $plant^{-1}$ and pods $plant^{-1}$

Table (1): Effect of seeding rates on plant height, Branches/plant and Dry Matter

Seeding rates	plant height at 60 DAYS	Leaf area (cm^2)	Branches/plant	Dry Matter (gr/plant)
125 kg/ha	32.63^{b}	240.10^{c}	5.72^{c}	3.56^{b}
150 kg/ha	33.15^{b}	276.18^{bc}	8.28^{ab}	4.11^{b}
175 kg/ha	36.04^{ab}	302.18^{ab}	9.55^{ab}	4.77^{b}
200 kg/ha	39.87^{a}	335.88^{a}	9.89^{a}	6.43^{a}
225 kg/ha	35.70^{b}	264.18^{bc}	8.00^{b}	4.16^{b}
SE m±	4.449	869.512	0.923	0.734
CD (P=0.05)	3.971	55.520	1.809	1.613

3.2 Effect of seeding rates on yield components and yield of common bean

Different levels of seeding rates significantly influenced the yield components and yield of common bean, the highest pods/plant (13.27), seeds/pod (5.26), 100 seed weight (30.80), grain yield (2210.99 kg/ha) and Stover yield (4500.00 kg/ha) was recorded in seeding rate of 200 kg/ha, followed by a seeding rate of 175 kg/ha, the lowest yield components and yield pods/plant (7.76), seeds/pod (3.55), 100 seed weight (24.71), grain yield (1794.44 kg/ha) and Stover yield (3566.66 kg/ha was recorded in seeding rate of 125 kg/ha, similarly, (*dahmardeh et al.,* 2010) reported the highest number of seeds pod^{-1} (2.7) were observed at 125, 175 and 200 kg/ha seed rates and the lowest value (2.6) at 150 and 225 kg/ha. Several faba bean investigators reported the dense planting resulted in decreases for seeds pod^{-1}, seeds $plant^{-1}$ and pods $plant^{-1}$ (*Khaleeq et al.,* 2023) reported The seed rate of common bean is significantly affected by different seed rates, the highest yield attributes and yield was on pods/plant (13.27), seeds/pod (6.37), 100 seed weight (30.80g), seed yield/plant (8.84g) and grain yield (2.21 t/ha) was in treatment 200 kg ha^{-1} the lowest yield attributes and yield was in seed rate(125 kg ha-1) these are pods/plant (7.48), seeds/pod (4.243), 100 seed weight (23.94g), seed yield/plant(7.35g) and grain yield (1.88t/ha). (*Kissi Wakweya et al*., 2016) reported the result also showed that harvest index and 1000 seed weight decreased as plant density increased from the lowest to the highest for both traits. This might be due to the fact that as plant density per unit area increased, there was more plant to plant competition, which resulted in low nutrient partitioning into seeds as compared to straw; as a result, there was low seed yield with low seed weights. This low seed weight was the main cause for the low thousand seed weight and harvest index. This result was similar to the findings of (*Hassan and Hafiz*, 1998 and *Mokhtar,* 2001), who reported dense Planting resulted in a decrease in those traits. Similarly, even though seed yield (kg/ha) was insignificant, it showed an increasing trend from 125 to 175 kg/ha and then declined. This might be due to severe plant to plant competition beyond certain levels of plant populations.

Table (2): Effect of seeding rates on yield components and yield of common bean

Seeding rates	Pods/plant	Seeds/pod	100 seed weight (gr)	Grain yield (kg/ha)	Stover Yield (kg/ha)
125 kg/ha	7.76^{c}	3.55^{c}	24.71^{c}	1794.44^{c}	3566.66^{c}
150 kg/ha	9.063^{bc}	4.59^{b}	28.74^{ab}	1931.66^{bc}	3623.33^{c}
175 kg/ha	10.17^{b}	4.92^{ab}	27.33^{b}	2009.80^{b}	3926.66^{b}
200 kg/ha	13.27^{a}	5.26^{a}	30.80^{a}	2210.99^{a}	4500.00^{a}
225 kg/ha	10^{b}	4.63^{b}	27.33^{b}	2033.99^{b}	4083.33^{b}
SE m±	0.844	0.101	1.248	7219.944	12803.33
CD (P=0.05)	1.730	0.599	2.103	159.985	213.047

3.3 Effect of seeding rates on gross return, net return and B: Cost Ratio

The economic impact of seeding rates has been depicted in Table 3, resulting maximum gross return, net return and net B: cost ratio (265319 AFN/ha, 229233 AFN/ha and 6.33 respectively) were in treatment 200 kg/ha compared to other treatments followed by treatment 175 kg/ha, the minimum gross return, net return and net B: cost ratio were in treatment 125 kg/ha (215333.3AFN, 187497.3 AFN, 5.41 respectively).

Table (3): Effect of seeding rates on gross return, net return and B: Cost Ratio

Seeding rates	Gross return (AFN/ha)	Net return (AFN/ha)	B: Cost Ratio
125 kg/ha	215333.3^{c}	187497.3^{c}	5.41^{c}
150 kg/ha	231799.1^{bc}	201213.1^{bc}	5.80^{b}
175 kg/ha	241176.7^{b}	207840.7^{abc}	6.16^{a}
200 kg/ha	265319^{a}	229233^{a}	6.33^{a}
225 kg/ha	237163.3^{b}	222133^{ab}	5.71^{b}
SE m±	106119900	129096757	0.105
CD (P=0.05)	19395.996	21392.983	0.610

4. Conclusion

The objective of this study was to determine the most effective seeding rate for common beans. The results showed that the best yield was achieved at a seeding rate of 200 kg/ha. This finding is significant as it can help farmers maximize their crop yield and profitability. The interpretation and discussion of these results suggest that the seeding rate plays a crucial role in the growth and yield of common beans. The study's findings provide valuable insights into the optimal conditions for growing this crop, which can inform future agricultural practices. However, it is important to acknowledge the limitations of this study, such as the potential influence of environmental factors on the results. Future research could explore the impact of different environmental conditions on the effectiveness of seeding rates for common beans. Overall, this study provides important insights into the optimal seeding rate for common beans. These findings can inform future agricultural practices and contribute to improving crop yield and profitability.

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