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Effect of sowing date and spacing on growth and yield of mung bean (*Vigna radiata* L.)

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Abstract
A field experiment was conducted during *Kharif* 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experiment plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.62%), available N (182 kg/ha), available P (32.2 kg/ha), available K (240.7 kg/ha). The experiment was laid out in Randomize Block Design with nine treatments each replicated. The treatment combinations are mentioned as T_1: 2nd fortnight of June + Spacing 20 cm × 10 cm, T_2: 2nd fortnight of June + Spacing 30 cm × 10 cm, T_3: 2nd fortnight of June + Spacing 40 cm × 10 cm, T_4: 1st fortnight of July + Spacing 20 cm × 10 cm, T_5: 1st fortnight of July + Spacing 30 cm × 10 cm, T_6: 1st fortnight of July + Spacing 40 cm × 10 cm, T_7: 2nd fortnight of July + Spacing 20 cm × 10 cm, T_8: 2nd fortnight of July + Spacing 30 cm × 10 cm, T_9: 2nd fortnight of July + Spacing 40 cm × 10 cm. The results showed that sowing on 1st fortnight of July at 30 cm×10 cm (Treatment 5) recorded highest maximum plant height (64.58), dry weight (10.56), number of pods per plant (14.68), number of seeds per pod (8.64), test weight (44.53 g), seed yield (1.88 t/ha). The before said treatment also recorded maximum gross return (Rs. 1, 35, 476.41/ha), net return (Rs. 98,140.41/ha) and B: C ratio (2.63).

Keywords: Mung bean, sowing time, spacing, growth, yield

1. Introduction
Greengram (*Vigna radiata* L.,) is one of the important pulse crops grown in India. Green gram is also known as mung, mungo, golden gram, Chickasaw pea and Orengo pea. It contains about 25% protein, 1.3% fat, 3.5% minerals, and 4.1% fiber and 56.7% carbohydrates and also rich source of calcium and iron. The origin of cultivated green gram is India and Central Asia. Greengram is a short duration, drought tolerant pulse crop. It seed contain 24.7% protein as well as sufficient quantity of calcium, phosphorous and important vitamins. Due to its supply of cheaper protein source it is designated as “poor man’s meat”. Green gram is considered as substitute of animal protein and forms the balance diet when used with cereals. It checks the soil erosion. It also forms good silage and green manure crop. Greengram is also used as green manuring crop. Being leguminous crop, it has the capacity to fix the 42 kg N ha^{-1} from atomospheric nitrogen (Pandey *et al*., 2019) [10].

It is estimated that Indian population will be around 1460 million by 2030 and demand for pulses would further grow in the years to come. India is the largest producer of mungbean which accounts for 65 percent of the world’s area and shares 54 percent of the world’s production. The important mungbean growing states are Rajasthan, Maharashtra, Madhya Pradesh, Tamil Nadu, Andhra Pradesh Karnataka, Odisha, Bihar and annual production of mungbean is about 1.8 million tones (Soren *et al*., 2012) [11].

In view of overall discussion, it is clear that yield is increased by sowing crop at proper time and using the high yielding cultivars (Ali and Gupta, 2012) [2]. Keeping in mind the significance of sowing dates and importance of yield potential of mungbean cultivars a research study was completed to estimate the effect of different planting dates on growth and yield of mung bean cultivars. Among the various agronomic practices, sowing time is the most important factor influencing its yield, which differs from region to region and variety to variety. But lack of awareness among farmers about optimum sowing date is one of the reasons of its low productivity.

In early sowing of mung bean, a second can be grown on the same field in early September for higher income with increasing soil fertility. Any delay in sowing time not only reduces the yield but also create problems for harvesting of same. The foremost information on time of sowing therefore needs to be specified. Sowing date is also one of the major non-monetary input affecting growth, yield and its contributing characters. It is considered as important factor which is having the vast potential to explore the maximum yield (Palsaniya *et al*., 2016) [7].

Row spacing affects plant growth and yield due to increased competition with increased plant population. Moreover, the optimum plant population differs with the availability of soil moisture, relative humidity and nutrients. Higher plant population reduced plant growth and yield components but increased yield per unit area. Spacing plays an important role in contributing to the high yield because thick plant population will not get proper light for photosynthesis and high infestation of diseases. On the other hand, very low plant population will also reduce the yield. Due to this reason normal population is necessary for high yield. Advantage of optimum spacing under irrigated conditions is due to reduced competition for light because when the moisture is lacking, light is no longer limiting factor and the advantage of uniform spacing is lost (Ihsanullah *et al*., 2002) [4]. Spacing by maintaining plant population to an optimum level, play an important role in growth and development by affecting plant density and interns moisture, nutrients and space availability.

2. Materials and Methods

2.1 Study Area Description

The experiment was conducted during the *Kharif* season 2023, at the Crop Research Farm (CRF), Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) which is located at 25° 39' 42"N latitude, 81° 67' 56"E longitude, and 98 m altitude above the mean sea level (MSL). The soil is sandy loam in texture and have neutral in soil reaction (pH 7.8), low in organic carbon (0.62%), available N (182 kg/ha), available P (32.2 kg/ha), available K (240.7 kg/ha).

2.2 Treatments and Design

The experiment was laid out in Randomize Block Design with nine treatments each replicated. The treatment combinations are mentioned as T_1: 2nd fortnight of June + Spacing 20 cm × 10 cm, T_2: 2nd fortnight of June + Spacing 30 cm × 10 cm, T_3: 2nd fortnight of June + Spacing 40 cm × 10 cm, T_4: 1st fortnight of July + Spacing 20 cm × 10 cm, T_5: 1st fortnight of July + Spacing 30 cm × 10 cm, T_6: 1st fortnight of July + Spacing 40 cm × 10 cm, T_7: 2nd fortnight of July + Spacing 20 cm × 10 cm, T_8: 2nd fortnight of July + Spacing 30 cm × 10 cm, T_9: 2nd fortnight of July + Spacing 40 cm × 10 cm. Plot was replicated three times to determine the effect of Sowing date and Spacing on Growth and Yield of Mung bean.

2.3 Experimental Procedure

The nutrient sources were Urea, SSP and MOP to fulfil the requirement of nitrogen, phosphorous and potassium. The recommended dose of 20 kg/ha nitrogen, 40 kg/ha and phosphorus 20 kg/ha potassium were applied according to the treatment details. Nitrogen, phosphorus, and potash were applied as basal at the time of sowing. Sowing time and Spacing maintained as per the treatment combination. Several plant growth parameters were recorded at harvest and several yield parameters were recorded after harvest. In growth parameters plant height (cm), number of nodules/plants and plant dry weight (g) were recorded and yield parameters like number of pods/plant, number of seeds/pod, test weight (g) and seed yield (t/ha) were recorded.

2.4 Data Analysis

All collected data were statistically analyzed using analysis of variance (ANOVA) at 0.05% probability level (Gomez, K. A. and Gomez, A. A. 1984) [12].

3. Result and Discussion

3.1 Plant Height (cm)

The tallest plant height was observed in Sowing on 1st fortnight of July at 30 cm×10 cm spacing recorded highest maximum plant height 64.58 (Table 1) and the shortest plant height was recorded in 2nd fortnight of July at 40 cm x 10 cm spacing 61.37 (table 1) in 60 DAS. The tallest plant height recorded was probably due to a comparatively longer growing period along with optimum environmental conditions this result is that the shortest plant height was obtained from late sowing. The notable impact of sowing date on plant height could potentially be attributed to variations in the growth periods. Early planting provides a favorable environment for the crop from germination to maturity, which eventually results in a higher plant height than late planting. The results were in accordance with Kumar and Kumawat (2014) [5]. Increased plant density decreased the number of pods per plant and as plant density decreased the number of pods per plant increased. In general, the total number of pods per plant was low in plots with the highest plant densities and high in plots containing lowest plant densities reported by Abdullah *et al.,* (2007) [1].

3.2 Nodules per plant

A significant and higher number of nodules/plants was observed in sowing on 1st fortnight of July at a spacing of 40 cm x 10 cm spacing with a record of 10.14 in 60 DAS (table 1) with symbiotic nitrogen fixation and helped in retaining cell wall and membrane integrity of nodules. Crop sown on 1st fortnight of July produced maximum number of nodules and it was significantly comparable to other treatments. The early sown crop (2nd fortnight of June) and late sown crop (2nd fortnight of July) showed significantly minimum number of nodules. Crops can utilize the factors of favourable environment which ultimately influences plant to have more growth and development in mung bean crop. Similar findings were reported by Miah *et al*., (2009) [6].

3.3 Plant dry weight (g)

Significant and maximum plant dry weight was 10.56 in 60 DAS (table 1) recorded in treatment 5 sowing on 1st fortnight of July at 30 cm x 10 cm spacing. Better photosynthetic activity due to greater exposure to light and increased the availability of nutrients to the plants which resulted in higher plant dry weight. Late sown crop have lesser vegetative and reproductive time period and normal sown crop remained in the field for longer time period and assembled more photosynthates that's why early sown crop gave more dry matter. Similar results were also noticed by Farz *et al*., (2006) [3].

3.4 Pods per plant

The significant and maximum number of pods/plants was observed in sowing on 1st fortnight of July at a spacing of 30 cm x 10 cm spacing with a record of 14.68 (Table 2). This resulted from early seeding, when photosynthates were better divided between pod formation and growth, and favorable

environmental circumstances. Rainfall occurrences coincided with the pod development stage at later sowing dates, leading to subpar pod formation. Similar findings were reported by Rabbani *et al*. (2013) [8].

3.5 Seeds per pod

The significant and maximum number of pods/plants was observed in sowing on 1st fortnight of July at a spacing of 30 cm x 10 cm spacing with a record of 8.64 (table 2). It might be due to the sufficient availability of nutrients and their absorption by the plants, with better photosynthetic activity, resulting in a higher number of seeds per pod. Delay in sowing hampered the number of seed per pod. The normal sowing (1st fortnight of July) had relatively more seeds per pod than late sowing (2nd fortnight of July). The early sown crop (2nd fortnight of June) has less seeds per pod due to high temperature and minimum rainfall. Similar findings were reported by Miah *et al*., (2009) [6].

3.6 Test weight

Higher test weight was observed in sowing on 1st fortnight of July at a spacing of 30 cm x 10 cm spacing with a record of 44.53 (Table 2). The effect of spacing on mung bean test weight is reported by numbers of researchers. Higher test weight of Green gram was recorded with spacing 30 cm x 10 cm. This might due to better growth of crop, efficient dry matter partitioning and better translocation to the sink, leading to the formation of large sized grains. Similar findings were reported by Rao *et al*. (2013) [9].

3.7 Seed yield

The higher and more significant seed yield was obtained in 1st fortnight of July at 30 cm x 10 cm spacing with a record of 1.88 (Table 2). The lowest grain yield was obtained from 2nd fortnight of July at 40 cm x 10 cm spacing with a record of 1.08 (Table 2). When plants are planted early, they have more time to grow and flourish. The reduction in seed production observed in the late July sowing is ascribed to a shorter growing period for the late-planted crop, as the crop's maturity time fell with the sowing delay. The crop sown on 1st fortnight of July resulted significantly in highest yield due to more pod per plants, the longest pod length and also for suitable temperature which is enhance the vegetative growth of the crop. Similar findings were reported by Miah *et al*., 2009 [6].

Table 1: Effect of sowing date and Spacing on Growth parameters of Mung bean

Sl. No.	Treatment	Plant height (cm)	Number of nodules/plant	Plant dry weight (g)
1.	2nd fortnight of June + 20 cm x 10 cm spacing	61.57	9.40	10.06
2.	2nd fortnight of June + 30 cm x 10 cm spacing	63.89	9.58	10.21
3.	2nd fortnight of June + 40 cm x 10 cm spacing	63.06	9.42	10.28
4.	1st fortnight of July + 20 cm x 10 cm spacing	62.65	9.53	9.94
5.	1st fortnight of July + 30 cm x 10 cm spacing	64.58	10.12	10.56
6.	1st fortnight of July + 40 cm x 10 cm spacing	62.72	10.14	10.36
7.	2nd fortnight of July + 20 cm x 10 cm spacing	60.92	8.79	9.95
8.	2nd fortnight of July + 30 cm x 10 cm spacing	61.65	9.02	9.97
9.	2nd fortnight of July + 40 cm x 10 cm spacing	61.37	8.87	9.79
F test		S	S	S
SEm (±)		0.51	0.22	0.14
CD (P=0.05)		1.52	0.67	0.43

Table 2: Effect of sowing date and Spacing on Yield attributes of Mung bean

Sl. No.	Treatment	Pods/plant	Seeds/plant	Test weight (g)	Seed yield (t/ha)
1.	2nd fortnight of June + 20 cm x 10 cm spacing	12.37	7.06	41.65	1.82
2.	2nd fortnight of June + 30 cm x 10 cm spacing	13.86	8.04	42.68	1.58
3.	2nd fortnight of June + 40 cm x 10 cm spacing	13.14	7.80	42.97	1.10
4.	1st fortnight of July + 20 cm x 10 cm spacing	12.43	7.37	39.86	1.83
5.	1st fortnight of July + 30 cm x 10 cm spacing	14.68	8.64	44.53	1.88
6.	1st fortnight of July + 40 cm x 10 cm spacing	13.79	8.06	43.41	1.21
7.	2nd fortnight of July + 20 cm x 10 cm spacing	12.29	7.22	40.86	1.81
8.	2nd fortnight of July + 30 cm x 10 cm spacing	12.66	7.49	41.69	1.32
9.	2nd fortnight of July + 40 cm x 10 cm spacing	13.15	7.62	40.67	1.08
F test		S	S	S	S
SEm (±)		0.26	0.12	0.38	0.06
CD (P=0.05)		0.78	0.36	1.14	0.18

4. Conclusion

Based on the results of the investigation it concluded that fortnight of July + 30 cm x 10 cm spacing is optimum and suitable to produce maximum seed yield of Mung bean because of plant population and less weed compared to the other treatment combination.

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