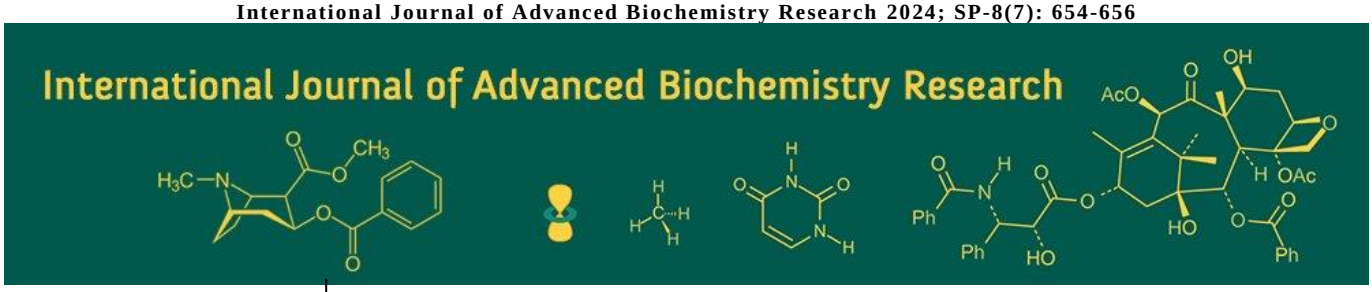

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Effect of sowing date and spacing on yield and economics of mung bean (*Vigna radiata* L.)

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Abstract
The study was carried out at the Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P), India during *Kharif* 2023. The soil of the experiment area had a sandy loam texture, The soil reaction is almost neutral (pH 7.8), the organic carbon content is low (0.62%), the available N is 182 kg/ha, the available P is 32.2 kg/ha, and the available K is 240.7 kg/ha. The experiment consisted of 9 treatments and 3 replications. The treatments combinations were 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 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), and seed yield (1.88 t/ha) were recorded for seeding on July 1st fortnight at 30 cm × 10 cm (Treatment 5). Maximum gross return (Rs. 1,35,476.41/ha), net return (Rs. 98,140.41/ha), and B:C ratio (2.63) were also recorded for the previously mentioned treatment.

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

Introduction
Greengram or mungbean (*Vigna radiata* L.) is one of the important pulse crop in India. It is becoming an important crop, as it is the best alternative to meet the food needs of the large population of developing countries due to its nutritional superiority and nitrogen fixing characters (Raza *et al.*, 2012) [6].

Greengram is originated from India and Central Asia. In India, Greengram is grown over an area about 4.26 Mha with an average production of 2.01 mt Average grain yield of 472 kg/ ha (Annual report 2017-2018) greengram seeds contain 25% protein, 1-15% oil, 3.5-4.5% ash and 56.7% carbohydrates. High lysine content makes its protein an excellent complement to rice in terms of balanced human nutrition. During 2017- 2018 the total coverage under mungbean in uttarpradesh 0.72 Lha with a production 0.40 Lt. and the productivity 555.56 (kg/ha). 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) [8].

Among the various agronomic practices, sowing time is the most important factor influencing the yield of mung bean (Malik M.A *et al.* 2006) [12]. Optimum sowing time of mung bean may vary from one variety to another and also from one region to another due to variation of agro- ecological conditions (Sarkar *et al.*, 2004) [7]. Late sowing which result in flowering during the high temperature to low moisture periods will reduce yield. Early sowing date in humid and sub-humid areas of may lead to high disease pressures and maximum yield loss may be observed (Itefa, 2016) [1].

Spacing is one of the most important cultural practices to determine the grain yield. Stand density affects architecture, alters growth and development pattern and influence carbohydrate production and partition. Ideally spaced equidistantly from each other competes minimally for nutrients and other growth factors.

Narrow rows make more efficient use of available light and also shade the surface soil completely during the early part of the season while the soil is still moist. This results in lower moisture evaporation from the soil surface. With the utilization of higher densities, it soon became clear that distribution within the row could be a limiting factor in wide rows, preventing the full expression of the crop yield potential.

Materials and Methods

A field experiment was conducted during *Kharif* season 2023 at Crop Research Farm, Department of Agronomy, 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). Urea, SSP and MOP were the source of N, P, K nutrients to fill the requirements. The recommended dose of 20kg of N/ha, 40kg of P/ha were applied. The treatment consisted 3 levels of sowing date and 3 levels of spacing along with recommended doses of N:P:K (20:40:20). 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. Seeds are sown in line manually at depth of 4-5 cm in furrows with seed rate of 15kg/ha. In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters like pods/plant, seeds/pod, test weight (g)) and seed yield (t/ha) were recorded statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design.

Result and Discussion

Yield and Yield attributes

Number of pods / 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 1). 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) [4].

Number of seeds / 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 1). 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) [3].

Test Weight (g)

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. 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) [5].

Seed Yield (t/ha): 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. The lowest grain yield was obtained from 2nd fortnight of July at 40 cm x 10 cm spacing with a record of 0.94. 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 [3].

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

Economics

(a) Gross returns (INR/ha)

Data in table 2 revealed that Maximum gross return (135476.41 INR/ha) was found in treatment 5 (1st fortnight of July + 30 cm x 10 cm spacing) and minimum gross return (74444.37 INR/ha) was found to be in treatment 9 (2nd fortnight of July + 40 cm x 10 cm spacing).

(b) Net returns (INR/ha)

Data in table 2 revealed that higher net return (98190.41 INR/ha) was found in treatment 5 (1st fortnight of July + 30 cm x 10 cm spacing) and minimum net return (37758.37 INR/ha) was found to be in treatment 9 (2nd fortnight of July + 40 cm x 10 cm spacing).

(c) Benefit Cost ratio (B:C)

Data in table 2 revealed that the maximum benefit cost ratio (2.63) was recorded in treatment 5 (1st fortnight of July + 30 cm x 10 cm spacing) which was superior to rest of all treatment combinations.

Table 2: Effect of Sowing date and Spacing on Economics of Mung bean

Sl. No.	Treatment	Gross return (INR/ha)	Net return (INR/ha)	Benefit Cost ratio (B:C)
1.	2nd fortnight of June + 20 cm x 10 cm spacing	133049.92	95163.92	2.51
2.	2nd fortnight of June + 30 cm x 10 cm spacing	114706.51	77420.51	2.08
3.	2nd fortnight of June + 40 cm x 10 cm spacing	79979.07	43293.07	1.18
4.	1st fortnight of July + 20 cm x 10 cm spacing	133412.59	95526.59	2.52
5.	1st fortnight of July + 30 cm x 10 cm spacing	135476.41	98190.41	2.63
6.	1st fortnight of July + 40 cm x 10 cm spacing	87324.96	50638.96	1.38
7.	2nd fortnight of July + 20 cm x 10 cm spacing	132697.42	94811.42	2.50
8.	2nd fortnight of July + 30 cm x 10 cm spacing	96712.11	59426.11	1.59
9.	2nd fortnight of July + 40 cm x 10 cm spacing	74444.37	37758.37	1.03

Conclusion

On the basis of one season of experiment it concluded that with treatment 5 that fortnight of July + 30 cm x 10 cm spacing recorded maximum seed yield (1.88 t/ha), gross return (135476.41 INR/ha), net return (98190.41 INR/ha) and benefit: cost ratio (2.63) as compared to other treatments.

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