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Research paper

Effect of date of sowing and level of phosphorus on growth and yield of summer mungbean (*Vigna radiata* L.) in Red and Lateritic soils of West Bengal

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ABSTRACT

A field experiment was conducted to study the effect of two sowing dates (16th March and 26th March) and five phosphorus levels (0, 20, 40, 60 and 80 kg P_2O_5/ha) in mungbean during pre-*kharif* (summer) season of 2022 at Instructional Farm of Seacom Skills University, Kendradangal, Birbhum, West Bengal, India. The research work revealed that growth parameters were significantly higher under 26th March sowing over 16th March. Among the P levels, higher dose of P improved growth parameters. In case of yield attributes maximum number of pods/plant (9.6), pod length (6.9 cm) and seeds/pod (10.3) were recorded in 26th March sown crop of mungbean. Maximum seed yield (705 kg/ha) and stover yield (1609 kg/ha) also recorded in 26th March sowing. Different P dose showed significant variations for yield traits and maximum pods/plant (11.45), pod length (7.96 cm) and seeds/pod (11.23) recorded with 80 kg P_2O_5 / ha. Highest seed yield (812 kg/ha) and stover yield (1710 kg/ha) were obtained with 80 kg P_2O_5 /ha. The gross returns, net returns and benefit: cost ratio was maximum when the crop sown on 26th March with 80 kg P_2O_5/ha. Hence, mungbean sown on 26th March 2022 along with 80 kg P_2O_5/ha application could be more effective in augmenting growth, yield and economics in the red and lateritic soils of West Bengal.

***Key words*:** Mungbean, Phosphorus, Sowing time, Summer season, Yield

INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek] is predominantly a rainy season crop, but it can be grown as profitable crop during summer season under irrigated (Kundu *et al*., 2021). Mungbean has wider adaptability, better palatability, higher market price and easy digestibility (Kumar *et al*., 2022). In West Bengal, summer mungbean are typically sown from the last week of February to the first week of April following the harvest of rapeseed & mustard, lentil, potato, and other crops. The one of the major option to increase the production of pulses is to grow short duration pulses during summer season when maximum crop fields remain fallow (Chongre *et al*., 2020). The optimum time of sowing ensures the complete harmony between the vegetative and reproductive phases on one hand, and the climatic rhythm on the other, and thus helps in realizing the potential yield. Planting time is the single most crucial element for maximizing mungbean production. Sowing time affects plant vegetative and reproductive periods, harvest time, yield and its quality. Phosphorus (P) is an essential nutrient for plant growth and development, and its dose can have a significant effect on the growth and yield of mungbean. Due to its significant involvement in root multiplication and subsequent atmospheric nitrogen (N) fixation, P plays major role in pulse crops (Kumar and Debbarma, 2023). However, its availability is restricted because of fixation. As a result, a large proportion of applied P may become chemically bound, whereas only a small fraction of soil P remains in the soil solution available for plant uptake (Johan *et al*., 2021). Keeping these in view, a comprehensive study was done on the effect of sowing date and level of P on growth and yield of summer mungbean on red and lateritic soils of West Bengal.

MATERIALS AND METHODS

A field experiment was implemented on mungbean crop during pre-*kharif* season (summer) of 2022 on a medium land of Red and Lateritic soils (Order: Inceptisol), silt loamy soil at Instructional Farm (23°42′ N latitude, 87°38′ E longitude and at an elevation of 9.75 m above mean sea level) of Seacom Skills University, Kendradangal, Birbhum, West Bengal, India. During cropping period of mungbean, average temperature ranged from 20.7°C to 38.6°C and relative humidity varies from 30 to 82.9%. The rainfall during the experimental period (March to May) was 256.5 mm. The experiment was laid down in factorial randomized block design with 2 factors viz., date of sowing (2 times) and P dose (5 levels) replicated thrice with 10 treatment combinations: i.e., two dates of sowing are 16th March and 26th March, and five P-levels are 0, 20, 40, 60 and 80 kg P_2O_5/ha. Nitrogen and potassium were applied at recommended dose. The seeds of mungbean var. 'Samrat' (PDM 139) were sown at 30 cm (row to row) × 10 cm (plant to plant) spacing. Soaked and *Rhizobium* culture treated seeds were sown at 30 kg/ha seed rate in the field. Pre-sowing irrigation was applied for proper germination and plant stand. When the crop required it, necessary field operations like weeding, and insect-disease control were carried out as per recommendation for the region.

Two picking followed by whole-plant harvesting were done during first week of June to third week of June. The harvested pods were sun-dried for 2-3 days before being manually threshed by beating the pods with sticks to separate the seeds. After that, the separated seeds were once again sun-dried to reduce the moisture content to 12% (moisture is determined by Smart Sensor AR991 Food grain Moisture Meter). The growth parameters like plant height, number of branch/plant, number of leaves/plant, dry matter production, crop growth rate and root length ultimately all yield attributes and seed yield of mungbean were recorded as per standard methods (Chongre *et al*., 2020).

Recorded data on all measured attributes of mungbean was subjected to analysis of variance (ANOVA) according to the techniques define for factorial randomized complete block design as described by Gomez and Gomez (1984). Significant difference of sources of variation was tested at the probability level of 0.05. The standard error of the mean (SEm±) and the CD value were indicated in the tables to compare the difference between the mean values.

RESULTS AND DISCUSSION

Growth parameters

Sowing on 26th March resulted in maximum plant height (53.61 cm), highest number of branches per plant (9.62), maximum leaves per plant (21.10), more dry matter production (255.2 g/m^2), highest crop growth rate (6.29 g/m^2/day) and maximum root length (14.29 cm) compared to 16th March sowing (Table 1). This might be due to favourable temperature for growth with delay sowing of mungbean plants during summer at Kendradangal, Birbhum. The results are in agreement with the findings of Kumar *et al*. (2020) where they reported better performance under March sowing than other date of sowing. In case of P-level, maximum plant height (59.3 cm), highest number of branches per plant (11.5), maximum leaves per plant (22.1), more dry matter production (315.2 g/m^2), highest crop growth rate (8.13 g/m^2/day) and maximum root length (16.5 cm) recorded with 80 kg P_2O_5/ha. This might be due to increase in photosynthetic activity, efficient translocation and utilization of photosynthesis causing rapid cell elongation and cell division and also improved nitrate reductase activity, alleviates ROS accumulation at entire period of crop under high P application (Kumari *et al*., 2022). It is a well-known fact that, P plays a vital role in improving nutritional status of plant through increased photosynthetic activity and N_2 fixation. Phosphorus is an important element in all biological systems, participating in most metabolic pathways and as a structural component of nucleic acids, coenzymes, phosphoproteins and phospholipids that ultimately increase the dry matter accumulation (Kumawat *et al*., 2022). In addition to its involvement in metabolic processes and energy conversions, P has a significant impact on root growth, which is the site of biological nitrogen (N) fixation (Teja *et al*., 2022). In case of interaction effect, second date of sowing (26th March 2022) along with higher doses of P at 80 kg P_2O_5/ha shows the better result in terms of all growth parameters.

Yield attributes and yield

Sowing date significantly influenced the pods/plant and 1000-seed weight (Table 2). Significantly highest pods/plant (9.60) was recorded in case of 26th March sowing whereas, 1000-seed weight was highest (27.40 g) under 16th March sowing. Non-significant response of sowing dates was recorded in case of pod length, seed/pod, seed yield, stover yield and harvest index. However,

Table 1. Effect of date of sowing and level of phosphorus on growth parameters of summer mungbean

Treatment	Plant height at harvest (cm)	Number of branches/plant at harvest	Number of leaves/plant at harvest	Dry matter at harvest (g/m^2)	Crop growth rate (45-60 DAS) g/m^2/day	Root length (cm)
Sowing date						
16th March	45.55	9.12	18.36	246.2	6.23	14.28
26th March	53.61	9.62	21.10	255.2	6.29	14.29
CD (p=0.05)	0.97	0.18	0.63	4.91	NS	NS
Level of P (kg P_2O_5/ha)						
0	42.53	7.59	17.75	179.7	5.78	11.14
20	46.95	8.48	18.27	209.4	3.73	13.43
40	49.19	9.32	19.70	256.2	5.64	14.42
60	49.90	10.01	20.27	293.1	8.04	15.93
80	59.33	11.45	22.14	315.2	8.13	16.51
CD (p=0.05)	1.54	0.28	0.58	7.76	0.20	0.43
Sowing date × Level of P						
16th March × P_0	42.13	7.33	15.66	178.9	5.76	11.92
16th March × P_{20}	44.20	8.40	16.63	208.5	3.69	13.08
16th March × P_{40}	45.78	9.00	17.56	253.7	5.53	14.32
16th March × P_{60}	46.97	9.54	19.62	285.9	7.64	16.01
16th March × P_{80}	49.67	11.33	22.33	304.3	8.48	16.06
26th March × P_0	42.93	7.86	19.84	180.6	5.80	10.36
26th March × P_{20}	49.71	8.56	19.91	210.2	3.77	13.77
26th March × P_{40}	54.60	9.64	21.86	258.8	5.75	14.51
26th March × P_{60}	58.82	10.49	31.92	300.3	8.43	15.85
26th March × P_{80}	71.00	11.57	21.95	326.1	7.79	16.97
CD (p=0.05)	2.18	NS	0.83	NS	0.29	0.61

NS: non-significant

all these parameters were significantly influenced due to P-levels. Significantly highest values of these parameters were recorded under 80 kg P_2O_5/ha. Seed yield was increased by 12.6% with the application of 80 kg P_2O_5/ha over 40 kg P_2O_5/ha. The interaction effect was non-significant for seed yield, however, significant interaction was recorded case of pods/plant, pod length and stover yield with the highest values under 26th March sowing + 80 kg P_2O_5/ha. Phosphorus plays a vital role in energy storage and transfer. It may be a constituent of nucleic acids (DNA and RNA) and majority of enzymes which are of great importance within the transformation of energy in carbohydrate metabolism and respiration of plants ultimately increase the crop yield (Abraham *et al.*, 2021).

Economics

The cost of cultivation varied according to treatment combinations (Table 3). The highest gross return, net return and benefit cost ratio recorded in second date of sowing along with higher dose of P. In terms of expenditure incurred for cultivation, the highest cost of cultivation was recorded in the plot where application of higher dose of P with recommended dose of nitrogen and potassium applied. Highest gross return was recorded in late sowing with higher dose of P (₹ 63.2 × 10^3 /ha) followed by first date of sowing along with higher dose of P (₹ 62.8 × 10^3 /ha) and lowest gross return was recorded in second date of sowing along with zero P dose. Benefit cost ratio followed similar trend with highest value under 26 March sowing along with 80 kg P_2O_5/ha (2.54).

Table 2. Effect of date of sowing and level of phosphorus on yield attributes and yield of summer mungbean

Treatment	Pods/plant	Pod length (cm)	Seeds/pod	1000 Seed weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
Sowing date							
16th March	9.12	6.87	10.24	27.40	703	1584	30.68
26th March	9.60	6.94	10.27	25.55	705	1609	30.40
CD (p=0.05)	0.18	NS	NS	0.48	NS	NS	NS
Level of P (kg P_2O_5/ha)							
0	7.59	6.57	9.19	25.23	573	1358	29.68
20	8.48	6.67	9.67	26.03	668	1560	30.03
40	9.32	6.73	10.25	26.63	721	1658	30.33
60	10.01	7.02	10.95	27.07	725	1698	30.49
80	11.39	7.54	11.23	27.41	812	1710	32.19
CD (p=0.05)	0.28	0.20	0.30	0.76	21	46	0.88
Sowing date × Level of P							
16th March × 0 kg P_2O_5/ha	3.33	6.75	9.16	25.97	578	1343	30.11
16th March × 20 kg P_2O_5/ha	8.40	6.56	9.66	27.09	663	1548	30.04
16th March × 40 kg P_2O_5/ha	9.00	6.87	10.26	27.67	719	1650	30.35
16th March × 60 kg P_2O_5/ha	9.54	7.06	10.91	28.10	743	1684	30.64
16th March × 80 kg P_2O_5/ha	11.33	7.13	11.23	28.18	809	1697	32.28
26th March × 0 kg P_2O_5/ha	7.86	6.40	9.22	24.50	568	1374	29.24
26th March × 20 kg P_2O_5/ha	8.56	6.78	9.68	24.96	673	1571	30.01
26th March × 40 kg P_2O_5/ha	9.64	6.60	10.25	25.59	724	1665	30.31
26th March × 60 kg P_2O_5/ha	10.49	6.97	10.99	26.05	744	1711	30.33
26th March × 80 kg P_2O_5/ha	11.45	7.96	11.23	26.63	814	1724	32.11
CD (p=0.05)	0.39	0.29	NS	NS	NS	0.61	NS

NS: non-significant

Table 3. Effect of date of sowing and level of phosphorus on economics of *summer* mungbean

Treatments	Total cost of cultivation (× 10³ ₹/ha)	Gross return (× 10³ ₹/ ha)	Net return (× 10³ ₹/ ha)	Benefit-cost (B:C) ratio
16th March × 0 kg P_2O_5/ha	20.5	44.9	24.4	2.18
16th March × 20 kg P_2O_5/ha	22.0	51.5	29.4	2.29
16th March × 40 kg P_2O_5/ha	23.6	55.8	32.2	2.33
16th March × 60 kg P_2O_5/ha	25.2	57.7	32.5	2.35
16th March × 80 kg P_2O_5/ha	26.7	62.8	36.1	2.36
26th March × 0 kg P_2O_5/ha	20.1	44.0	23.9	2.19
26th March × 20 kg P_2O_5/ha	22.1	56.2	34.1	2.20
26th March × 40 kg P_2O_5/ha	23.6	57.7	34.1	2.44
26th March × 60 kg P_2O_5/ha	25.2	58.9	32.2	2.51
26th March × 80 kg P_2O_5/ha	26.7	63.2	38.0	2.54

CONCLUSION

Based on results of present study, it may be concluded that sowing of summer mungbean should be done on 26th March to realize the higher yield in West Bengal. Also, crop should be applied with 80 kg P_2O_5/ha along with recommended dose of N & K in Red and Lateritic soils of West Bengal.

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