Response of butter beans (*Phaseolus lunatus* L.) for different combinations of nitrogen and phosphorus on growth, yield and quality characters

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Response of butter beans (*Phaseolus lunatus* L.) for different combinations of nitrogen and phosphorus on growth, yield and quality charactersT Janani¹✉, T Saraswathi², D Muthumanickam³ & C Thangamani⁴¹ Department of Vegetable Science, HC & RI, TNAU, Periyakulam-625604² Horticultural Research Station, Kodaikanal-624103³ Agricultural Research Station, Bhavanisagar-638451⁴ Horticultural Research Station, Kodaikanal-624103✉ Corresponding author: T Janani, Email: jananijana1994@gmail.com**Article Info***Article history*

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Key Words: Butter beans, nitrogen, phosphorus, yield.**Abstract**

A field experiment was conducted during June-October (2017) at Horticultural Research Station, Kodaikanal to study the response of butter beans for different combinations of nitrogen and phosphorus on growth, yield and quality characters. A randomized block design was followed with 17 combinations of N (30, 40, 50 and 60 kg/ha), P (37.5, 50, 62.5 and 75 kg/ha) and additional combination of 70: 75:50 kg N P₂O₅ K₂O/ha. K 50 kg/ha was kept constant. The experimental results revealed that all the fertilizer treatments significantly increased the plant height, number of branches per plant, days to 50 % flowering, number of pods per cluster, 100 seed weight, pod weight, pod yield per hectare, protein content and crude fibre content of butter beans. Maximum plant height (220.33 cm), number of branches per plant (4.79), minimum days to 50 % flowering (50) and 100 seed weight were recorded in the combination of 50 kg N, 37.5 kg P₂O₅ and 50 kg K₂O per hectare. Number of pods per cluster (6.78), pod weight (14.00 g) and pod yield per hectare (5.85 t) were maximum in the combination of 60 kg N, 75 kg P₂O₅ and 50 kg K₂O per hectare.

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Introduction

Butter bean is an important species grown for its edible bold seeds among 12 primary grain leguminous crops. It is also known as Burma bean, Civet bean, Guffin bean, Haba bean, Hibbert bean, Madagascar bean, Paigya, Pallar bean, Sieve bean and

Sugar bean. It has a rich starch with sweet taste with smooth, flat shaped, meaty texture and a creamy distinctive flavour. It has been cultivated in several regions including Brazil, Peru, Mexico, USA and tropical Africa and has been introduced into Europe, Africa and Asia. In South Asia and that too particularly in

India, butter-beans are grown in Maharashtra, Pune, Karnataka (Chikmangalur) and in Tamil Nadu (Kodaikanal and Nilgiris). According to USDA national nutritional database, the raw seeds have energy of 338 K cal, carbohydrates 63.38 g, protein 21.46 g, total fat 0.69 g and dietary fat 19 g per 100 gram. It also contains the phytochemicals, coumestrol and saponin compounds that may impart anticancer properties. Besides, it fixes atmospheric nitrogen through symbiosis with soil nitrogen fixing bacteria which is commonly known as *Rhizobium* (Lopez-Lopez et al. 2013). Nitrogen fixing nodules supplies about 20-50 per cent total nitrogen to the plant roots and the rest has to come from another sources of nitrogen. For chlorophyll synthesis and carbon dioxide assimilation occurs in organic and inorganic forms (Jones 2003) for which nitrogen is essential (Jasso- Chaverria et al. 2005). Phosphorus is the most immobile and major mineral nutrient required by plants, inaccessible and unavailable nutrient present in soil (Narang et al. 2000). It is the most important for production of seed and formation of root system, which is essential for uptake of nutrients from the soil (Das et al. 2008). The present investigation was, therefore, carried out to find the optimum dose of nitrogen and phosphorus for butter beans.

Materials and Methods

The field experiment was conducted at Horticultural Research Station, Kodaikanal in the field block number nine-A (102° N, 77.5° E) during 2017 (June - October). The 17 treatment combinations consisting of four levels of nitrogen (30, 40, 50 and 60 kg/ha) and four levels of phosphorus (37.5, 50.0, 62.5

and 75.0 kg/ha) along with 70: 75:50 kg N P₂O₅ K₂O/ha. Potassium 50 kg/ha was the constant dose for all combinations. This experiment was furnished in randomized block design with three replications. Nitrogen was done using urea and applied in two splits as per recommendation i.e. half at sowing and rest at earthing up (at 30 days after sowing). Basal application of P and K was done using single super phosphate and muriate of potash respectively, as per treatments at the time of sowing. The soil of the experiment was peat and lateritic. Five plants were selected randomly from each treatment of all replications and were tagged for recording various observations and the data collected were analyzed statistically by using AGRES Software version 3.01. Mean, standard error difference, coefficient of variation and critical difference were obtained from above analysis. The experimental conclusions were drawn only on significant differences between the treatment means at 0.05% level of significance. Seed material used was KKL 1 butter beans variety released during 1991 from Horticultural Research Station, Kodaikanal. It suits for an altitude of 1200-2100 m above MSL in hilly regions of Tamil Nadu. The nitrogen content in seed was estimated and multiplied by 6.25 to obtain the protein content in seed. Carbohydrate was estimated by anthrone method and crude fibre was estimated by Goering and Vansoest method.

Results and discussion

Significant differences were observed in growth, yield and quality characters during crop growth period by adopting different combinations of nitrogen and phosphorus.

Plant height (220.33 cm), number of branches (4.79) and reduced days to 50 % flowering (50) were attained maximum in the combination of 50:37.5:50 N, P₂O₅ and K₂O kg ha⁻¹ (Table 1). Due to better utilization of applied fertilizer, especially nitrogen in two splits enhanced the carbohydrate synthesis and encouraged the height of the plants. It is also in line with the findings of Baloch et al. (2013) who opined that the proper availability of essential nutrients to the plants by timely application during their growth phase increases the height of plants. Phosphorus required for cell division in shoot and root tips in large quantities. Phosphorus helps in the improvement of growth parameters and biochemical reactions including translocation of photosynthates by nitrogen fixation (Williams et al. 2014). Increased level of nitrogen and phosphorus might have

accelerated the synthesis of organic compounds, metabolic activity and carbohydrates, which are responsible for increase in the number of branches per plant as reported by (Srinivas & Prabhakar 1982). The higher dose of fertilizers could be attributed to the effective functioning of plant system which would have been increased the production of bioactive flower forming substances. On further, the increase in nitrogen and phosphorus fertilizers level might have reduced the days taken for flowering up to a certain limit. Similar results were quoted by Naeem et al. (2002). The timely application of increased dose of fertilizer causes accelerated photosynthesis and rapid translocation of photosynthates towards the initiation of flower buds might be the reason for early flowering (Prabhu et al. 2003).

Table 1. Effect of different levels of nitrogen and phosphorus on growth and yield characters

Treatments	Plant height (cm)	Number of branches	Days to 50 % flowering	Number of pods per cluster	Pod weight (g)	Number of seeds per pod
T ₁ - 30kg N:37.5kg P ₂ O ₅ :50kg K ₂ O/ha	184.20	3.93	54	4.23	9.20	5.13
T ₂ - 40kg N:37.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	202.33	4.13	57	5.78	11.05	5.23
T ₃ -50kg N:37.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	220.33	4.79	50	5.99	13.09	6.06
T ₄ -60kg N:37.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	199.00	4.58	55	4.69	12.62	5.00
T ₅ -30 kg N:50 kg P ₂ O ₅ :50 kg K ₂ O/ha	164.20	3.86	52	4.79	9.74	5.10
T ₆ -40 kg N:50 kg P ₂ O ₅ :50 kg K ₂ O/ha	212.53	3.76	57	5.65	11.56	5.33
T ₇ -50 kg N:50 kg P ₂ O ₅ :50 kg K ₂ O/ha	207.73	3.67	55	4.85	12.32	5.00
T ₈ -60 kg N:50 kg P ₂ O ₅ :50 kg K ₂ O/ha	154.06	3.53	51	4.05	12.97	4.46

T ₉ -30kg N:62.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	170.73	3.88	58	5.02	10.06	4.80
T ₁₀ -40kg N:62.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	189.13	3.86	53	5.86	11.78	4.43
T ₁₁ -50kg N:62.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	213.33	4.20	57	6.21	13.15	4.70
T ₁₂ -60kg N:62.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	213.66	3.93	54	4.12	13.01	5.23
T ₁₃ -30 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	180.26	3.86	59	5.27	10.59	5.06
T ₁₄ -40 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	182.40	4.06	53	5.19	12.19	4.76
T ₁₅ -50 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	187.86	3.95	56	6.45	13.50	4.86
T ₁₆ -60 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	208.00	4.16	52	6.78	14.00	5.06
T ₁₇ -70 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	167.53	3.80	61	5.50	11.04	4.66
Grand mean	188.74	4.00	54.94	5.31	11.90	4.96
SEd	9.31	0.17	1.70	0.31	0.51	0.34
CD 0.05%	18.96	0.34	3.46	0.63	1.04	0.69

Yield characters showed the significant influence of nitrogen and phosphorus combinations. Pod weight (14.00 g), number of pods per cluster (6.78) (Table 1) and pod yield (5.85 t ha⁻¹) (Table 2) were attained maximum in the combination of 60:75:50 N, P₂O₅ and K₂O kg ha⁻¹. Application of nitrogen up to certain level increases shoot and leaf growth, which would have helped in the synthesis of greater amount of carbohydrates and more efficient in protein synthesis to the developing pods and that might have resulted in increased number of cells as well as elongation of individual cells. Similar findings were also quoted by Reddy et

al. (1990). The application of nitrogen to plants especially at reproductive stage results in producing more number of pods per cluster and also increases the pod yield (Mishra 2003; Sharma et al. 2018). Srinivasa & Naik (1988) reported that nitrogen and phosphorus fertilizer increases the pod yield. Phosphorus helps in better root growth, resulted in better absorption of nutrients that ultimately improve the synthesizing greater amount of food materials and translocation of photosynthates into pods led to increase in pod weight. Similar findings were reported by Nikbakht et al. (2008).

Table 2. Effect of different levels of nitrogen and phosphorus on yield and quality characters

Treatments	100 seed weight (g)	Pod yield (t/ha)	Crude fibre (%)	Protein (%)	Carbohydrate (%)
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T ₁ - 30kg N:37.5kg P ₂ O ₅ :50kg K ₂ O/ha	88.50	2.98	5.94	23.69	42.05
T ₂ - 40kg N:37.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	71.66	4.09	7.18	25.63	40.61
T ₃ -50kg N:37.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	93.05	5.57	5.98	33.88	41.02
T ₄ -60kg N:37.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	82.33	5.39	7.99	28.19	40.65
T ₅ -30 kg N:50 kg P ₂ O ₅ :50 kg K ₂ O/ha	84.33	3.34	6.10	25.06	40.36
T ₆ -40 kg N:50 kg P ₂ O ₅ :50 kg K ₂ O/ha	84.66	4.48	6.93	26.19	40.11
T ₇ -50 kg N:50 kg P ₂ O ₅ :50 kg K ₂ O/ha	77.66	5.31	5.88	28.69	41.23
T ₈ -60 kg N:50 kg P ₂ O ₅ :50 kg K ₂ O/ha	79.20	4.69	4.93	27.63	40.74
T ₉ -30kg N:62.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	65.29	4.57	7.23	26.31	40.14
T ₁₀ -40kg N:62.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	72.81	4.60	4.97	26.81	41.48
T ₁₁ -50kg N:62.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	83.21	5.68	5.90	34.94	41.22
T ₁₂ -60kg N:62.5 kg P ₂ O ₅ :50 kg K ₂ O/ha	91.66	5.45	5.17	28.50	40.41
T ₁₃ -30 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	88.25	4.86	5.97	27.25	40.69
T ₁₄ -40 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	84.34	4.99	5.10	28.00	40.52
T ₁₅ -50 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	83.21	5.75	5.60	35.31	40.30
T ₁₆ -60 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	79.89	5.85	5.88	36.19	40.47
T ₁₇ -70 kg N:75 kg P ₂ O ₅ :50 kg K ₂ O/ha	76.24	4.87	5.24	26.63	40.10
Grand mean	82.21	4.91	5.99	28.75	40.69
SEd	4.28	0.29	0.19	0.60	0.53
CD 0.05%	8.72	0.59	0.40	1.2	NS

Phosphorus plays vital role in many plant processes such as energy metabolism, nitrogen fixation, synthesis of nucleic acids and membranes, photosynthesis, respiration and enzyme regulation. Phosphorus nutrients are more essential for better growth and yield

development of leguminous crops and the result revealed that application of higher dose of fertilizer levels could attribute better supply of nutrients to the growth of the plant and development which consequently increases the yield (Marschner 1995; Nkaa et al. 2014;

Nagar et al. 2017; Sachin et al. 2019). Number of seeds per pod (6.06) and 100 seed weight (93.05 g) was recorded maximum in the combination of 50:37.5:50 N, P₂O₅ and K₂O kg ha⁻¹ (Table 2). Phosphorus plays key role in improving the seed filling, quality, presence of active leaves in reproductive stage and high photosynthetic efficiency helps in influence of weight of the seeds.

The quality parameters viz., protein, carbohydrate and crude fibre content decide the nutritive value and quality of the bean. The highest protein content (36.19%) and crude fibre content (7.99 %) was obtained in the combination of 60:75:50 N, P₂O₅ and K₂O kg ha⁻¹ (Table 2). Carbohydrate content was found to be non significant among the treatment combinations. Due to different environmental conditions includes rainfall, light intensity, length of growing season, day duration, temperature might attribute variation in protein content (Bampidis & Christodolou 2011). Nitrogen and phosphorus fertilizer increases the activity of nitrate reductase enzyme which in turn increases the protein content. These results are in conformity with the findings of Pandya & Bhatt (2007). Musa et al. 2011 reported that crude fibre content and also reduction in carbohydrate content was influenced by the nitrogen and phosphorus application.

Conclusion

The result revealed that the combination of increased level of nitrogen (60 kg N ha⁻¹), phosphorus (75 kg P₂O₅ ha⁻¹) and along with potassium (50 kg K₂O ha⁻¹) exerted the positive effects on butter beans in terms of yield and quality characters.

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