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Effect of biofertilizers and NPK levels on yield and nutrient uptake by cluster bean (*Cyamopsis tetragonoloba* L. Taub.) in lateritic soils of Konkan

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Abstract
A field experiment was conducted to study the effect of biofertilizers i.e., *rhizobium* and PSB and different levels of NPK on yield and nutrient uptake by cluster bean (*Cyamopsis tetragonoloba* L. Taub.) in lateritic soils of Konkan in Randomized Block Design comprising ten treatments combinations and three replications at College of Agriculture, Dapoli, Dist. Ratnagiri during *rabi* season of 2021. Significant improvement in yield and nutrient uptake by cluster bean was recorded with the sole and combine application of nutrients through chemical fertilizers and biofertilizers. The results indicated that the application of 40:60:60 N:P_2O_5:K_2O kg ha^{-1} with seed inoculation of rhizobium and PSB recorded the highest green pod yield and stover yield of cluster bean as well as nutrient uptake by plant.

Keywords: NPK levels, yield, nutrient uptake, *Cyamopsis tetragonoloba* L., lateritic soils

Introduction
Cluster bean (*Cyamopsis tetragonoloba* L. Taub.) commonly known as guar, is a multipurpose legume and occupies a large area under arid and semiarid region of the country. India contributes 82% of the total guar production in the world. It is grown on an area of 23.30 lakh hectare with a productivity of 428 kg per hectare of pods.

For better production and quality of crops, the supply of nutrients in adequate amount is essential due to responsive behaviour of the crop. Adequate plant nutrient supply holds the key for improving the production and sustaining soil fertility. In the view of maintaining the soil health and quality of produce, combine application of chemical fertilizers along with biofertilizers plays a vital role. Biofertilizers, mainly *rhizobium* and PSB which are commonly used have enormous potential to increase the nutrient use efficiency. Biofertilizers do not directly supply nutrients to crop plant, but have capacity to fix atmospheric nitrogen and convert insoluble phosphate into soluble form. Biofertilizers are low cost, effective and renewable source of plant nutrients to supplement chemical fertilizers.

The area under cluster bean cultivation in Konkan region is increasing day by day. The lateritic soils are deficient in available phosphorus, low to medium in available nitrogen and low to medium in available potassium. Low concentration of solid phosphorus and high phosphorus fixing capacity of soil are some important reasons for low phosphorus availability in lateritic soils of Konkan (Dongale 1989) [2]. Therefore, the present investigation was designed to find out the effect of biofertilizers and different levels of NPK on yield, quality, nutrient uptake and its influence on soil properties in lateritic soils of Konkan.

Material and Methods
A field experiment was carried out during the *rabi* season, 2021 at Department of Agronomy, College of Agriculture, Dapoli. The soil of experimental plot was sandy loam having bulk density 1.44 Mg m-3, Particle density 2.35 Mg m-3, pH 5.2, Organic Carbon 10.10 g kg^{-1}, Available N 225.79 kg ha^{-1}, Available P_2O_5 7.10 kg ha^{-1}, Available K_2O 276.78 kg ha^{-1}. The experiment was laid out in Randomized Blok design with ten treatments and three replications. FYM @ 10 t ha^{-1} was added to all treatments except treatment T1 *i.e.*, absolute control. Cluster bean variety Pusa Navbahar was sown with the distance of 45×15 cm.

Biofertilizers *i.e.*, *rhizobium* and PSB were applied as a seed treatment 200 g/10 kg seed just before sowing and dried in shed. Other package of practices was followed as per the recommendations for the crop in the zone.

The pods of cluster bean were harvested in seven pickings at full grown stage, tender characteristics size and colour and converted in q ha^{-1}. For nutrient uptake, plant and pod samples collected at harvest were digested with acids and N, P and K content in plant and pods were estimated by following micro-kjeldhal method (Jackson, 1973) [3], vanado-molybdo phosphoric yellow colour method (Chopra and Kanwar 1978) [1] and flame photometer method (Jackson, 1973) [3]. N, P and K uptake was computed by multiplying the seed yield /stover yield in kg ha^{-1} with respective per cent nutrient content and product was divided by 100. The uptake of nutrients by seed and stover were expressed as nutrient uptake by crop in kg ha^{-1}.

Results and Discussion

Green Pod Yield and Stover Yield

It is evident from the data that seed and stover yields were significantly influenced due to application of different doses of NPK with and without biofertilizers over the control (Table 1). Application of 40:60:60 NPK kg ha^{-1} + biofertilizers recorded the significantly highest green pod yield *i.e.,* 76.53 q ha^{-1} and stover yield (8.79 q ha^{-1}) where, it was at par with T3 (40:40:40 NPK kg ha^{-1}), T4 (20:40:40 NPK kg ha^{-1} + BF), T5 (40:40:60 NPK kg ha^{-1}), T6 (40:40:60 NPK kg ha^{-1}+ BF) and T9 (40:60:60 NPK kg ha^{-1}+ BF) in case of seed yield and proved significantly superior in stover yield. Adequate supply of nitrogen in the early life stage of plant promotes the rapid overall improvement and growth of the plant. At later stage in reproductive phase when the current photosynthesis is not able to furnish the increased assimilate demand of the plant sinks, the storage compounds probably remobilize and move to active sinks (pods and seeds), which ultimately increased number of pods and seeds per pod (Manohar *et al.*, 2018) [4]. Efficacy of the inorganic fertilizer was pronounced when they are combined with biofertilizers. *Rhizobium* inoculation increased the root volume through better root development, nodulation, more nutrient availability resulting in vigorous plant growth and dry matter production which in turn resulted in better flowering, pod formation and ultimately pod yield. Since, PSB may help in reducing phosphorus fixation by its chelating effect and also solubilized the fixed phosphorus leading to more uptakes of nutrients and reflected in better yield attributes.

Table 1: Effect of different levels of NPK with and without biofertilizers on yield of cluster bean

Tr. No.	Treatment	Green pod yield (q ha^{-1})	Stover yield (kg ha^{-1})
T1	Absolute control	29.35	597.27
T2	Biofertilizers only	31.82	676.80
T3	40:40:40 NPK kg ha^{-1}	69.48	858.67
T4	40:40:40 NPK kg ha^{-1} + BF	73.07	863.00
T5	40:40:60 NPK kg ha^{-1}	69.02	861.67
T6	40:40:60 NPK kg ha^{-1} + BF	72.04	861.83
T7	40:60:40 NPK kg ha^{-1}	62.21	853.50
T8	40:60:40 NPK kg ha^{-1} + BF	67.62	865.67
T9	40:60:60 NPK kg ha^{-1}	71.25	862.33
T10	40:60:60 NPK kg ha^{-1} + BF	76.53	879.33
S.E.(m) ±		2.56	4.11
C.D. (P = 0.05)		7.61	12.20

Nutrient uptake

The uptake being closely related to total yield and contents of nutrients reflects consumption of nutrients by the crop from the soil at a particular yield level. Data pertain to the uptake of nitrogen, phosphorus, and potassium in stover of cluster bean plant at flowering stage and at harvest were affected by the application of different levels of NPK with and without biofertilizers (Table 2). As influenced by the application of different levels of NPK with and without biofertilizers, nitrogen uptake varied from 10.11 to 30.10 kg ha^{-1}, phosphorus uptake from 1.35 to 4.93 kg ha^{-1} and potassium uptake from 4.19 to 14.93 kg ha^{-1} by cluster bean (Table 2). Evaluation of the data indicated that the application of the graded dose of NPK with and without biofertilizers significantly increased NPK uptake by plant and pod of cluster bean over the absolute control. Significantly highest total N uptake (30.10 kg ha^{-1}), total P uptake (4.93 kg ha^{-1}) and total K uptake (14.93 kg ha^{-1}) were recorded with treatment T10 (40:60:60 NPK kg ha^{-1} + BF), which was at par with treatment T6 in N uptake, T9 in P uptake and T9, T5 and T6 in K uptake.

Table 2: Effect of different NPK levels with and without biofertilizers on uptake of NPK by cluster bean

Tr. No.	Treatment	Macro-nutrients Uptake (kg ha^{-1})		
		N	P	K
T1	Absolute control	10.11	1.35	4.19
T2	Biofertilizers only	11.36	1.57	5.37
T3	40:40:40 NPK kg ha^{-1}	24.48	3.48	11.87
T4	40:40:40 NPK kg ha^{-1} + BF	26.48	3.80	13.03
T5	40:40:60 NPK kg ha^{-1}	24.16	3.55	13.53
T6	40:40:60 NPK kg ha^{-1} + BF	27.98	3.71	13.90
T7	40:60:40 NPK kg ha^{-1}	22.33	3.76	11.52
T8	40:60:40 NPK kg ha^{-1} + BF	25.48	4.12	12.64
T9	40:60:60 NPK kg ha^{-1}	26.36	4.36	14.00
T10	40:60:60 NPK kg ha^{-1} + BF	30.10	4.93	14.93
S.E.(m) ±		0.89	0.24	0.55
C.D. (P = 0.05)		2.64	0.72	1.62

The significant increase in NPK uptake due to direct addition of nutrient through fertilizer to the available pool of the soil as well as organic matter decomposition release nutrients to soil solution, which becomes available to the plants, resulting in higher uptake. A higher P uptake under co-inoculation of biofertilizers and K application might be attributed to enhanced nitrogenise and nitrate-reductase enzyme activities in soil leading to more biological N fixes by *rhizobium* and increased availability of P in soil due to greater solubilisation (Patil *et al.* 2011) [5].

Conclusion

Considering the green pod yield, straw yield and uptake by plant, the application of 40:60:60 $N:P_2O_5:K_2O$ kg ha^{-1} with seed inoculation of rhizobium and PSB can be useful to enhance cluster bean production in lateritic soils of Konkan.

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