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Effect of Nitrogen and Phosphorus on Growth and Yield of Clusterbean (*Cyamopsis tetragonoloba* (L.) Taubert) in Sandy Loam Soils of Andhra Pradesh

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ABSTRACT

A field experiment was conducted during *kharif* 2013 at Agricultural College, Bapatla to study the effect of nitrogen and phosphorus on growth and yield of clusterbean. The experiment was laid out in Randomized block design with factorial concept, replicated thrice with four nitrogen levels *viz.,* N_1- *Rhizobium* inoculation alone, N_2- 20 kg N ha^{-1}, N_3-20 kg N ha^{-1} + *Rhizobium*, and N_4-40 kg N ha^{-1} and three phosphorus levels *viz.,* P_1 – 30 kg P_2O_5 ha^{-1}, P_2 – 60 kg P_2O_5 ha^{-1}, P_3 – 30 kg P_2O_5 ha^{-1} + PSB. The results showed that nitrogen level of N_3-20 kg N ha^{-1} + *Rhizobium* and phosphorus level P_3 – 30 kg P_2O_5 ha^{-1} + PSB significantly influenced growth characters, yield attributes, yield and economics of clusterbean.

Key words : Clusterbean, Growth, Nitrogen, Phosphorus.

Clusterbean popularly known as guar is extremely drought hardy, deep-rooted, and summer annual legume capable of symbiotic nitrogen fixation occupying a prominent position in global agriculture. Clusterbean of late, has acquired the status of industrial crop because of high galactomannan content which has many industrial uses and thus a main foreign exchange earner. Guar now accounts for around 18 percent of India's total agricultural exports. Guar gum is the main by-product of guar, as it is being used in several industries particularly mining, petroleum and shale gas extractions, in addition to textiles, paper, pharmaceuticals and food industry, where it has been widely used since ancient times.

Like other crops, clusterbean needs nitrogen for better growth and production. However, the major part of nitrogen is met by *Rhizobium* present in the root nodules and only starter dose of nitrogen is required to meet the requirement of young plants. Seed inoculation with an efficient *Rhizobium* strain increases the nodulation resulting in increased yields of clusterbean pods. An application of phosphorus influences symbiotic nitrogen fixation as well as the yield and quality of leguminous crop. Therefore, proper management of phosphatic fertilizer in legumes is of prime importance. Phosphorus solubilizing bacteria (PSB) have the capacity of solubilizing the insoluble phosphate in the soil and make it available to the crop plant, which increases overall plant growth resulting in increased crop productivity.

The greatest limitation of increasing productivity of clusterbean is inadequate supply of nutrients since the soils are poor in native fertility (Singh and Khan. 2003).The judicious use of fertilizers plays a vital role in any crop production and clusterbean has no exception for that matter. The short supply and recent price hike in inorganic fertilizer encouraged the use of biofertilizers in combination with chemical fertilizers which improve the soil fertility as well as productivity. Therefore, proper nutrient management is of prime importance in crop production (Kumhar *et al.* 2012).

Therefore, considering the growing export demand and its industrial use there is a need to find out an optimum nutrient requirement for clusterbean to enhance its productivity and quality as it is spreading fast in non-traditional areas, particularly in Andhra Pradesh. Keeping this in view, the present investigation was planned.

MATERIAL AND METHODS

The experiment was conducted on sandy loam soils of Agricultural College, Farm, Bapatla

of the Acharya N. G. Ranga Agricultural University, during *kharif* 2013 in a Randomized block design with factorial concept, replicated thrice. The experiment comprises four nitrogen levels *viz.,* N_1- *Rhizobium* inoculation alone, N_2 - 20 kg N ha^{-1}, N_3 -20 kg N ha^{-1} + *Rhizobium*, and N_4 -40 kg N ha^{-1} and three phosphorus levels *viz.,* P_1 – 30 kg P_2O_5 ha^{-1}, P_2 – 60 kg P_2O_5 ha^{-1}, P_3 – 30 kg P_2O_5 ha^{-1} + PSB. The initial fertility status of the soil is 544 (medium), 21 (low), and 615 (high) kg ha^{-1} of N, P_2O_5, K_2O respectively and pH 6.62, E.C 1.13 dsm^{-1}. The nitrogen and phosphorus levels were applied as per the treatments. The data recorded on various parameters of crop was subjected to statistical scruitiny by adopting appropriate methods of "Analysis of variance" (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

Growth parameters

Among the nitrogen levels, the highest number of branches $plant^{-1}$ was recorded with 20 kg N ha^{-1} + *Rhizobium* inoculation. Among the phosphorus levels, 30 kg P_2O_5 ha^{-1} + PSB recorded more number of branches $plant^{-1}$ which was on a par with 60 kg P_2O_5 ha^{-1}. Among the interaction between N and P levels, combination of nitrogen @ 40 kg ha^{-1} with phosphorus @ 60 kg ha^{-1} recorded significantly the highest number of branches $plant^{-1}$. Combined inoculation of chemical fertilizers along with *Rhizobium* and PSB recorded more number of branches $plant^{-1}$ which was in accordance with the findings of Sammauria *et al.* (2009).

The highest drymatter production was observed with 20 kg N ha^{-1} + *Rhizobium* which was on a par with 40 kg N ha^{-1} and while among phosphorus levels the highest drymatter production was recorded with 30 kg P_2O_5 ha^{-1} + PSB which was on a par with 60 kg P_2O_5 ha^{-1}. Interaction of 20 kg N ha^{-1} + *Rhizobium* and 30 kg P_2O_5 ha^{-1}+ PSB resulted in the highest drymatter production. The enhanced dry matter production with combined use of nitrogen and phosphorus might be due to extensive root proliferation leading to better uptake and translocation of other essential nutrients for growth and development of the crop. Significant increase in number of nodules was observed due to successive increase in phosphorus application upto

Table 1. Effect of nitrogen and phosphorus levels on growth characters of clusterbean at harvest.

Treatments	Plant height (cm)	Branches $plant^{-1}$	Nodules $plant^{-1}$	Drymatter production (kg ha^{-1})
Nitrogen levels				
N_1 : *Rhizobium* inoculation alone	95.8	13.6	4.6	3517
N_2 : 20 kg N ha^{-1}	93.7	13.2	4.3	3600
N_3 : 20 kg N ha^{-1} +*Rhizobium*	96.3	14.9	5.4	4248
N_4 : 40 kg N ha^{-1}	98.6	14.4	5.0	4202
SEm±	2.14	0.53	0.28	101.9
CD (p=0.05)	NS	1.56	NS	299
Phosphorus levels				
P_1 : 30 kg P_2O_5 ha^{-1}	94.4	12.3	4.6	3527
P_2 : 60 kg P_2O_5 ha^{-1}	96.1	14.5	4.6	3963
P_3 : 30 kg P_2O_5 ha^{-1} + PSB	97.8	15.4	5.4	4185
SEm±	1.85	0.46	0.24	88.2
CD (p=0.05)	NS	1.35	0.7	259
Interaction NxP				
SEm±	3.71	0.92	0.48	176.4
CD (p=0.05)	NS	2.70	NS	518

Table 2. Effect of nitrogen and phosphorus levels on yield attributes, yield of clusterbean.

Treatments	Number of clusters plant^{-1}	Number of pods cluster^{-1}	No of seeds pod^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Nitrogen levels						
N_1 : *Rhizobium* inoculation alone	17.5	3.8	5.5	26.8	971	2566
N_2 : 20 kg N ha^{-1}	16.6	3.6	5.4	26.9	875	2744
N_3 : 20 kg N ha^{-1} +*Rhizobium*	19.5	4.0	5.6	27.0	1190	3125
N_4 : 40 kg N ha^{-1}	19.0	4.0	5.5	27.3	1097	3078
SEm±	0.39	0.09	0.10	0.64	50.75	93.60
CD (p=0.05)	1.14	0.26	NS	NS	148.8	274.5
Phosphorus levels						
P_1 : 30 kg P_2O_5 ha^{-1}	16.6	3.6	5.3	26.8	847	2669
P_2 : 60 kg P_2O_5 ha^{-1}	18.4	3.7	5.4	26.7	994	2989
P_3 : 30 kg P_2O_5 ha^{-1} + PSB	19.4	4.2	5.7	27.6	1259	2946
SEm±	0.34	0.08	0.09	0.55	43.95	81.06
CD (p=0.05)	0.98	0.22	0.25	NS	128.8	237.7
Interaction NxP						
SEm±	0.67	0.15	0.17	1.11	87.90	162.13
CD (p=0.05)	1.97	0.44	NS	NS	257.7	475.5

30 kg P_2O_5 ha^{-1} + PSB inoculation. The increase in the nodulation at higher doses of phosphorus might be due to rapid root growth and multiplication of bacteria and increase in their activity in rhizosphere.

Yield attributes and yield

Yield attributes *viz.,* number of clusters plant^{-1}, number of pods cluster^{-1} and stover yield were recorded highest with 20 kg N ha^{-1} along with *Rhizobium* inoculation which was on a par with 40 kg N ha^{-1} among the nitrogen levels and 30 kg P_2O_5 ha^{-1} + PSB recorded the highest number of clusters plant^{-1} and number of pods cluster^{-1}, number of seeds pod^{-1} and stover yield among phosphorus levels. The interaction effect of 20 kg N ha^{-1} + *Rhizobium* inoculation and 30 kg P_2O_5 ha^{-1} + PSB inoculation resulted in highest yield attributes *viz.,* number of clusters plant^{-1}, number of pods cluster^{-1} and stover yield while, the number of seeds pod^{-1} and test weight were not influenced by their interaction.

The highest seed yield was produced with 20 kg N ha^{-1}+ *Rhizobium* inoculation. Drymatter production during the crop growth period and translocation of drymatter to the pods are the major determinants of the seed yield of clusterbean. Application of 20 kg N ha^{-1} as starter dose supplied the crop with sufficient nitrogen in early phase of growth followed by nodule bacteria in later part of the crop. Cumulative effect of these two might have contributed towards higher seed yield. Singh and Singh (1989), and Singh *et al.* (1992) reported similar findings with lentil crop. Among the phosphorus levels the higher seed yield was recorded with 30 kg P_2O_5 ha^{-1} + PSB inoculation which was on a par with 60 kg P_2O_5 ha^{-1}. PSB play an important role in releasing and making phosphorus available to crop plants resulting in the increased crop yield. Whereas, phosphorus plays a vital role in energy transformation and metabolic processes of plants, photosynthesis, flowering, fruiting and seed formation. (Reager *et al.*2000).

The interaction effect influenced the seed yield significantly. Application of 20 kg N ha^{-1}+ *Rhizobium* inoculation along with 30 kg P_2O_5 ha^{-1} + PSB resulted in highest seed yield. This might be due to higher availability of nutrients that stimulated

Table 3. Economics of different treatments imposed on clusterbean as influenced by different nitrogen and phosphorus levels.

Treatments	Total cost of cultivation (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	BCR
$N_1 P_1$	13216	23490	1.8
$N_1 P_2$	14682	19929	1.4
$N_1 P_3$	13235	41640	3.1
$N_2 P_1$	13444	19051	1.4
$N_2 P_2$	14910	22026	1.5
$N_2 P_3$	13463	31529	2.3
$N_3 P_1$	13463	30514	2.3
$N_3 P_2$	14929	29998	2.0
$N_3 P_3$	13482	52134	3.9
$N_4 P_1$	13685	20912	1.5
$N_4 P_2$	15151	41339	2.7
$N_4 P_3$	13704	38175	2.8

the crop growth parameters, besides favourably influencing the yield attributes, which ultimately reflected in higher seed yield.

Economics

The highest net returns and benefit cost ratio were recorded with 20 kg N ha^{-1} + *Rhizobium* inoculation along with 30 kg P_2O_5 ha^{-1} + PSB. This might be due to low cost of cultivation as *Rhizobium* and PSB involves less cost for fertilization.

It can be concluded that application of 20 kg N ha^{-1} + *Rhizobium* inoculation along with 30 kg P_2O_5 ha^{-1} + PSB was more beneficial in realizing higher culster bean seed yield as well as monetary returns than remaining combination of nitrogen with different phosphorus levels.

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