

Effect of integrated nutrient management on growth, yield and nutrient uptake of clusterbean (*Cyamopsis tetragonoloba*) under irrigated conditions

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ABSTRACT

A field experiment was conducted during *kharif* season of 2014 to study the effect of integrated nutrient management on growth, yield and nutrient uptake of clusterbean (*Cyamopsis tetragonoloba*). Significant improvement in growth, yield and nutrient uptake was recorded with sole and integrated application of nutrients through chemical fertilizers and biofertilizers. The results showed that application of 50, 75 and 100 % of recommended dose of fertilizer (20 kg N, 40 kg P₂O₅/ha) was 21.2, 45.7 and 50.8 % over the control respectively. Association between *Rhizobium* and phosphate solubilising bacteria was synergistic and inoculation of both fertilizers significantly improved the seed yield. Inoculation of *Rhizobium*, phosphate solubilising bacteria and *Rhizobium* + phosphate solubilising bacteria recorded 21.1, 14.1 and 24.7 % higher seed yield than the control respectively. However, the combination of both inoculants further failed to significantly increase the seed and straw yield of clusterbean further.

Key words: Biofertilizer, Chemical fertilizer, Clusterbean, Nutrient uptake, Seed yield.

INTRODUCTION

Clusterbean (*Cyamopsis tetragonoloba*), commonly known as guar, is a multipurpose legume and occupies a large area under arid and semi arid region of the country. In south-western region of Punjab, this crop attains a status of commercial crop due to its high productivity and low input requirement. For its better production and quality, the supply of nutrients in adequate amount is essential due to responsive behavior of the crop. So, the present investigation was carried out to study the effect of integrated nutrient management on productivity of clusterbean sown under irrigated conditions.

MATERIALS AND METHODS

A field experiment was conducted at Farm of P.G. Department of Agriculture, Khalsa College Amritsar during early *kharif* season of 2014. The soil of the experimental site was sandy loam with pH 7.6, organic carbon 0.25%, available N 158 kg ha⁻¹, available P₂O₅ 25 kg ha⁻¹, and K₂O 329.7 kg ha⁻¹. The experiment was laid out in randomized block design with 4 replications and 10 nutrient management treatments viz T₁ - control, T₂ - 50% of recommended dose of fertilizer, T₃ - 75% of recommended dose of fertilizer, T₄ - 100% of recommended dose of fertilizer, T₅ - *Rhizobium*, T₆ - phosphate solubilising bacteria, T₇ - *Rhizobium* + phosphate solubilising bacteria, T₈ - 50% of recommended dose of fertilizer + *Rhizobium*, T₉ - 50% of recommended dose of fertilizer + phosphate solubilising bacteria, T₁₀ - 50% of recommended dose of fertilizer + *Rhizobium* + phosphate

solubilising bacteria. HG - 365 clusterbean was sown 18 kg seed/ha to a depth of 4-5 cm in the third week of July. The net plot size was 5.0 × 3.2 m. The recommended dose of fertilizer was 20 kg of N + 40 kg of P₂O₅/ha was applied as basal dose through urea and single superphosphate as treatments. Biofertilizer were applied as treatment @ 5g/kg of seed just before sowing. Other cultural practices were applied uniformly as per recommendation for crop in the area. One life saving irrigation of 5 cm applied during long dry spells in a season. Five random plants were selected from each plot excluding the border row for taking observation on growth and yield attributes. The representative dry sample of shoots and seeds were analyzed for ascertaining nutrient (N, P, K) content. The N, P and K content were analyzed by Micro-Kjeldahl, Vanadomolybdophosphoric yellow colour and Flame-Photometry methods respectively (Jackson 1973). Data was statistically analyzed by the procedure described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth character: Nutrient management had significant influence on growth characters of clusterbean, viz plant height, dry matter accumulation and leaf area (Table 1). Significant variation in plant height due to nutrient management was recorded at 60 days after sowing and harvesting stages. Maximum plant height at these stages was registered with application of 100% recommended dose of fertilizer (T₄) which was significantly superior to all other nutrient management treatments except application of 75%

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TABLE 1: Growth and yield characters of clusterbean (*Cyamopsis tetragonoloba*) as influenced by integrated nutrient management.

Treatment	Plant height (cm)			Dry matter accumulation (G/plant)				Branch/Plant		Leaf area index/plant		Pods/Plant	Pod length (cm)	Seeds/pod	1000-seeds Weight (g)
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest	Harvest	30 DAS	60 DAS	30 DAS	60 DAS				
T ₁	15.6	50.0	78.3	1.3	4.7	6.4	6.4	4.2	9.4	0.8	1.4	25.7	4.5	4.4	26.8
T ₂	16.2	66.5	88.7	1.4	6.0	7.9	7.9	4.3	11.4	1.0	1.9	28.3	5.7	5.5	27.8
T ₃	15.9	72.9	94.7	1.6	6.5	9.9	9.9	4.4	12.8	1.1	2.1	30.9	6.5	6.3	28.1
T ₄	16.4	76.3	103.3	1.7	7.2	12.7	12.7	4.4	13.4	1.2	2.2	32.5	6.8	6.4	29.4
T ₅	15.6	60.2	89.5	1.4	5.7	7.2	7.2	4.6	10.9	0.7	1.6	27.1	5.8	5.3	27.6
T ₆	15.3	57.4	58.0	1.3	5.6	7.1	7.1	4.0	10.6	0.7	1.7	27.5	5.8	5.2	27.6
T ₇	15.8	63.6	92.3	1.4	6.0	7.7	7.7	4.1	11.2	0.8	1.7	28.3	6.4	5.5	27.9
T ₈	16.5	67.9	95.0	1.6	6.5	9.1	9.1	4.4	12.6	1.1	2.1	29.9	6.4	5.9	28.2
T ₉	16.0	63.9	92.7	1.6	6.3	8.2	8.2	4.0	12.4	1.1	2.2	29.3	6.5	6.0	28.2
T ₁₀	17.5	72.8	99.7	1.7	7.1	11.3	11.3	4.4	13.8	1.1	2.3	32.3	7.1	6.5	29.8
CD (P=0.05)	NS	8.5	7.9	0.2	0.8	1.4	1.4	NS	1.8	0.2	0.3	2.7	0.9	0.8	NS

recommended dose of fertilizer and inoculation of both biofertilizers integrated with 50% recommended dose of fertilizer (T₁₀). Nutrient management had significant influence on drymatter accumulation at all the stages. Progressive improvement in drymatter accumulation was recorded with application of successive level of chemical fertilizers and difference in dry matter accumulation between 75 and 50% of recommended dose of fertilizer (T₃, T₂) and 100 and 75 % of recommended dose of fertilizer (T₄, T₃) was significant at harvesting stage only. Inoculation of biofertilizer alone failed to cause significant improvement in drymatter accumulation over control. At harvesting highest drymatter accumulation over observed with application of 100% recommended dose of fertilizer (T₄) which being at par with integrated application of chemical fertilizer @ 50% recommended dose of fertilizer with inoculation of both biofertilizers (T₁₀). Significant variations in number of branches/plant were recorded under different nutrient management treatments. Maximum number of branches was recorded under T₁₀ followed by T₄, T₃ and T₈. Application of chemical fertilizer @ 75 and 100% of recommended dose of fertilizer (T₃ and T₄) registered significantly higher leaf area over control at stages, i.e 30 and 60 days after sowing. At 60 days after sowing highest leaf area index (2.3) was recorded with application of 50% recommended dose of fertilizer + *Rhizobium* + phosphate solublising bacteria (T₁₀) which was at par with application of chemical fertilizer @ 50 and 75 % of recommended dose of fertilizer (T₃, T₄) and integration of 50% recommended dose of fertilizer with single inoculation of *Rhizobium* (T₈) and phosphate solublising bacteria (T₉). The increased availability of nutrients with application of chemical fertilizers and biological nitrogen fixation by *Rhizobium* increased solubilization of native and applied phosphorus by phosphate solublising bacteria. This might have favored the plant growth characters under aforesaid treatments. Singh and Singh (1989) also reported improvement in growth attributes of clusterbean with application of nutrients.

Yield attributes: Different nutrient supply strategies exhibited a variable response in influencing the yield attributes (Table 1). Application of chemical fertilizer @ 75 and 100% of recommended dose of fertilizer (T₃, T₄) and integration of biofertilizer with 50 % recommended dose of fertilizer (T₈, T₉ and T₁₀) resulted in significantly higher number of pods/plant than control. Highest number of pods/plant were recorded with application of 100% recommended dose of fertilizer (T₄) which was at par with 75% recommended dose of fertilizer (T₃) and integration use of 50% recommended dose of fertilizer with *Rhizobium* (T₈) and *Rhizobium* + phosphate solublising bacteria (T₁₀). Integrated use of inoculation of both biofertilizers with 50% of recommended dose of fertilizer (T₁₀) recorded longest

pod followed by 100% recommended dose of fertilizer (T_4). Except single inoculation of phosphate solubilising bacteria (T_6) all other nutrient management treatments brought significant improvement in number of seeds/pod over the control. Highest number of seeds/pod were registered with application of 100% recommended dose of fertilizer (T_4), which was at par with 50% recommended dose of fertilizer with inoculation of *Rhizobium* (T_8) and *Rhizobium* + phosphate solubilising bacteria (T_{10}), 75% recommended dose of fertilizer (T_3), 50% recommended dose of fertilizer + phosphate solubilising bacteria (T_9) and 50% recommended dose of fertilizer + *Rhizobium* (T_8). The variation in 1000-seed weight under various treatments was non-significant. Better growth associated with increased availability of plant nutrients might have resulted in better development of yield attributes under aforesaid treatments. These results were in accordance with the results of those reported by Uday-Burman *et al.* (2007) in clusterbean (*Cyamopsis tetragonoloba*).

Productivity: Nutrient management had significantly influence on seed, stover and biomass productivity (Table 2). Application of chemical fertilizer registered significant improvement in seed yield and magnitude of increase with application of recommended dose of fertilizer by 50% (T_2), 75% (T_3) and 100% (T_4) was 21.1, 45.6 and 50.9% over the control, respectively. Singh (2002) and Saxena *et al.* (2003) reported that application of 20 kg N + 40 kg P_2O_5 / ha recorded 36.2 and 41.6% higher seed yield of clusterbean over control respectively. The difference in seed yield realized with T_3 and T_{10} was non-significant. Further 100% recommended dose of fertilizer brought significant improvement in seed yield over respective dose of chemical fertilizer and sole inoculation of biofertilizer. Higher seed yield was registered with application of 100% recommended dose of fertilizer (T_4) followed by 75% recommended dose of fertilizer (T_3), 50% recommended dose of fertilizer + *Rhizobium* + phosphate solubilising bacteria (T_{10}) and 50% recommended dose of fertilizer +

Rhizobium (T_8). The increased growth coupled with better expression of yield attributes might have attributed for enhancing the seed yield under foresaid treatments. Application of chemical fertilizer (T_2 , T_3 and T_4) resulted in 25.8, 38.8 and 45.2% higher stover yield than control respectively. Sole inoculation of biofertilizer have positive effect on Stover yield and magnitude of improvement was highest with combined inoculation of *Rhizobium* + phosphate solubilising bacteria (T_7) followed by single inoculation of *Rhizobium* (T_5) and phosphate solubilising bacteria (T_6). Integration of biofertilizer with 50% recommended dose of fertilizer (T_8 , T_9 and T_{10}) resulted in further improvement in Stover yield as compared to sole inoculation of biofertilizer (T_5 , T_6 and T_7). Highest stover yield was realized with inoculation of both biofertilizer with 50% recommended dose of fertilizer (T_{10}), which remained at par with 75% and 100% of recommended dose of fertilizer (T_3 , T_4). Application of chemical fertilizers brought significant improvement in biomass yield, respectively than control. Palsania *et al.* (2002) also reported significant improvement in productivity of clusterbean (*Cyamopsis tetragonoloba*) with application of 30 kg N + 0 kg P_2O_5 /ha.

Nitrogen uptake: Distinct variation in nutrient uptake was noticed under different nutrient management treatments (Table 3). Nutrient management had significant influence on nitrogen uptake by clusterbean (*Cyamopsis tetragonoloba*). Application of chemical fertilizer @ 50, 75 and 100% of recommended dose of fertilizer (T_2 , T_3 and T_4) resulted in 42.3, 76.7 and 84.9% higher N uptake over the control respectively. Integrated use of chemical fertilizer @ 50% of recommended dose of fertilizer with *Rhizobium* (T_8), phosphate solubilising bacteria (T_9) and *Rhizobium* + phosphate solubilising bacteria (T_{10}) recorded higher total nitrogen uptake over respective sole application of chemical fertilizer and biofertilizers.

Phosphorus uptake: Application of chemical and biofertilizers registered significantly higher total phosphorus

TABLE 2: Effect of integrated nutrient management on productivity and economics of clusterbean (*Cyamopsis tetragonoloba*).

Treatment	Seed yield (tonnes/ha)	Stover Yield (tonnes/ha)	Total biomass yield (tonnes/ha)	Harvest index (%)	Total cost (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit Cost ratio
T1	0.57	1.93	2.51	23.2	4950.8	9350.0	4399.2	0.9
T2	0.69	2.43	3.12	22.1	5395.0	11410.0	6015.0	1.1
T3	0.83	2.68	3.51	23.6	5616.0	13480.0	7864.0	1.4
T4	0.86	2.81	3.65	23.6	5838.0	13990.0	8152.0	1.4
T5	0.69	2.28	2.97	23.1	4960.0	11260.0	6300.0	1.3
T6	0.65	2.23	2.88	22.6	4965.0	10690.0	5725.0	1.2
T7	0.71	2.44	3.15	22.5	4975.0	11680.0	6705.0	1.4
T8	0.81	2.52	3.33	24.2	5291.0	13060.0	7769.0	1.5
T9	0.76	2.46	3.22	23.5	5296.0	12350.0	7054.0	1.3
T10	0.82	2.86	3.67	22.3	5306.0	13520.0	8214.0	1.6
CD (P=0.05)	0.11	0.29	0.34	NS				

TABLE 3: Content and uptake of nutrient by clusterbean (*Cyamopsis tetragonoloba*) as influenced by integrated nutrient management.

Treatment	N content (%)		P content (%)		K content (%)		N uptake (kg/ha)			P Uptake (kg/ha)			K uptake (kg/ha)		
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total
T1	3.3	0.9	0.31	0.17	0.78	1.25	18.8	17.0	35.8	1.8	3.2	5.0	4.5	24.1	28.6
T2	3.8	1.0	0.32	0.16	0.76	1.28	26.8	24.3	51.1	2.2	4.0	6.2	5.3	31.1	36.4
T3	4.3	1.0	0.33	0.16	0.75	1.33	35.2	28.1	63.3	2.7	4.4	7.1	6.2	35.7	41.9
T4	4.3	1.0	0.33	0.19	0.89	1.28	37.3	28.8	66.1	2.9	5.3	8.1	7.7	35.7	43.4
T5	3.9	0.8	0.32	0.16	0.79	1.31	27.0	19.3	46.3	2.2	3.7	6.0	5.4	29.9	35.3
T6	3.9	0.9	0.32	0.17	0.83	1.30	25.2	19.7	44.9	2.1	3.7	5.8	5.4	28.7	34.1
T7	3.9	0.9	0.32	0.17	0.72	1.27	27.7	22.9	50.7	2.2	4.1	6.3	5.1	31.1	36.2
T8	4.1	1.0	0.33	0.18	0.77	1.31	33.2	25.1	58.3	2.7	4.5	7.2	6.2	33.1	39.3
T9	3.9	1.0	0.33	0.18	0.86	1.33	29.4	24.5	54.0	2.5	4.5	6.9	6.5	32.7	39.2
T10	4.4	1.0	0.33	0.17	0.86	1.36	35.8	27.3	63.0	2.7	4.9	7.6	7.1	38.7	45.8
CD (P=0.05)	NS	NS	NS	NS	0.08	NS	5.2	5.4	8.4	0.3	0.5	0.7	1.2	4.9	5.3

uptake over control. Highest total phosphorus uptake was recorded with application of chemical fertilizer @ 100% of recommended dose of fertilizer (T₄) which was significantly higher over all other treatments except integrated use of chemical fertilizer @ 50% of recommended dose of fertilizer with *Rhizobium* + phosphate solubilising bacteria (T₉). Application of chemical fertilizer (T₂, T₃ and T₄) resulted in 24.3, 42.7 and 62.1% higher total phosphorus uptake over the control respectively. Inoculation of phosphate solubilising bacteria (T₆) and integrated use of phosphate solubilising bacteria with chemical fertilizer @ 50% of recommended dose of fertilizer (T₉) recorded 16.2 and 38.1% higher total phosphorus uptake over control, respectively.

Potassium uptake: Distinct variation in potassium uptake was noticed under different nutrient management treatments. Application of chemical fertilizers @ 50, 75 and 100% of recommended dose of fertilizer (T₂, T₃ and T₄) recorded 27.1, 46.3 and 51.5% higher total potassium uptake over the control respectively. Highest uptake of potassium was recorded with application of chemical fertilizer @ 50% of recommended dose of fertilizer + *Rhizobium* + phosphate solubilising bacteria (T₁₀) which was at par with application of chemical fertilizer @ 75 and 100% of recommended dose of fertilizer (T₃, T₄). The steady supply of nutrients with the use of chemical fertilizer and biofertilizers might have attributed to higher nutrient uptake under aforesaid treatments. The results corroborate the findings of Singh and Singh (1990).

ECONOMICS

Total cost of cultivation was highest under 100% recommended dose of fertilizer (T₄). However highest gross return (Rs 13,990/ha) was recorded with application of 100% recommended dose of fertilizer (T₄) followed by T₁₀ and T₃ (Table 2). The maximum net return was realized with integrated use of 50% recommended dose of fertilizer with inoculation of both biofertilizers (T₁₀). Integration of biofertilizer with chemical fertilizer (T₈, T₁₀) was more remunerative with higher benefit: cost ratio (1.5 and 1.6) than sole application of chemical (1.2 to 1.4) and biofertilizers (1.3 to 1.4).

It can be concluded that application of nutrient (N and P) or bio- Fertilizer (*Rhizobium*, PSB) had favorable influence on growth, yield and nutrient uptake of clusterbean. Integrated use of chemical fertilizer @ 50% recommended dose of fertilizer + *Rhizobium* + phosphate solubilising bacteria in clusterbean fetched maximum benefit: cost ratio and yield comparable to application of 100% of recommended dose of fertilizer under irrigated condition.

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