Original Research Article

"Effect of potassium and zinc on growth, yield and economics of Cluster bean (*Cyamopsistetragonoloba* L.)"

ABSTRACT

The field experiment was conduct in CRF in department of agronomy during *kharif* season of 2022 on clusterbean crop. The treatment consisted of three level of K (15, 20 and 25 kg/ha) Zn (10, 15 and 20 kg/ha) and control. The experiment was layout in Randomized Block Design (RBD) with 10 treatment and replicated thrice. Application of K (25 kg/ha) and Zn (20 kg/ha) produces higher plant height (139.20cm), maximum number branches per plant (5.86), nodules/plant (49.45) and higher dry weight (21.53g), maximum number of pods/plant (73.13), maximum number of grains/pod (9.13), higher seed yield (1363.56kg/ha), straw yield (3208.91kg/ha).

However, the maximum gross return (77405.66INR/ha), maximum net return (54121.66INR/ha) and maximum benefit cost ratio (2.32) was obtained with same treatment- 9 (K 25kg/ha + $ZnSO_4$ 20kg/ha).

Keywords: N, P, K, Zn doses, Growth, Yield, Quality, Cluster beans and economics.

Introduction

Clusterbean (*Cyamopsistetragonoloba L. Taub.)* popularly known as guar, is a deep rooted legume crop grown for feed, fodder and green manure. It belongs to the family *Leguminaceae*and is known to improve soil fertility. It is generally 100-140 cm tall and bears 4 to 8 branches (branch type). India leads among the major guar producing countries of the world, contributing around 75 to 80% to the world's total production(1.5 m tonnes) **(Annonymous, 2021)**. It is an important cash crop of Rajasthan, Haryana, Punjab, U.P. Utter Pradesh largest producer of clusterbean having area 3140.2 m ha,with production of 1.5 mt and productivity of 484kg/ha which is maximum in the country **(Annonymous, 2022)**.The arangment on clusterbeanis 8.10 g moisture, 10.8 g carbohydrate, 23% protein, 1.4 g fat, 1.4 g minerals, 0.09 mg thiamine,

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0.03 mg riboflavin, 47 I.U. vitamin C, 316 I.U, vitamin A (per 100 g of edible portion). The potential yield of most of the varieties ranges from 12-15 q/ha but the average yield productivity of the country are less than potential average. This may be ascribed to many reasons but soil type and imbalanced fertilization is the major factor. The Potassium fertilizer is the third most important essential nutrient after nitrogen and phosphorus. The potassium activates more than 60 enzymes and enzymatic catalyzes the system involved in photosynthesis, metabolism and translocation of carbohydrates and proteins, membrane permeability, stomatal regulation and water utilization. Other benefits ascribed to K include the resistance of plants against pests, disease and stress caused by drought, frost, salinity, sodicity in assuring improved crop quality characteristics **(Kherawat*et al* 2013)**. zinc is said to activate several enzymes, play a role in auxin synthesis and increase meristematic activities. Most of the work done on the nutrition of this crop has been related with major elements whereas the significance of micronutrients is still ignored .In the plant system, zinc is important for a number of enzymatic and physiological processes. Additionally, many enzymatic reactions are activated by zinc, which is a key nutrient in the construction of several enzymes like alcohol dehydrogenase, carbonic anhydrase, and superoxide dismutase. Zinc is also necessary for the synthesis of enzymes in plants **(Pedler*et al* 2000)**. The work undertaken on these aspects in clusterbean is very meagre. Therefore, keeping this in view a study was conducted on effect of potassium and zinc on growth and yields of clusterbean.

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2. MATERIALS AND METHODS

This experiment was laid out during *Kharif*season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The crop research farm is situated at 25.570N latitude, 87.190 E longitude and at an altitude of 98 m above mean sea level. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 8.0), low in organic carbon (0.40 %), available N (225 kg/ha), available P (38.2 kg/ha) and available K (240.7 kg/ha). The experiment was laid out in randomized block design and comprised of levels potassium and zinc with ten treatments and each were replicated thrice *viz.* T_1 - 15kg/ha potassium + 10kg/ha zinc, T_2 -15 kg/ha potassium + 15 kg/ha zinc, T_3 -15kg/ha potassium + 20kg/ha zinc, T_4 - 20kg/ha potassium + 10kg/ha zinc, T_5 -20kg/ha potassium + 15kg/ha zinc, T_6 - 20kg/ha

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potassium + 20kg/ha zinc, T_7 - 25kg/ha potassium + 10kg/ha zinc, T_8 - 25kg/ha potassium + 15kg/ha zinc, T_9 -25kg/ha potassium + 20kg/ha zinc, T10 - Control (RDF 20:40:20).The observations were recorded on different growth parameters viz. Plant height,number of branch, number of nodules, dry weight, number of pod/plant, number of seeds/pod, seed yield, stover yield . Maximum net returns, gross returns, and benefit cost ratio.

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RESULT AND DISSCUSSION:

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Growth parameters

Plant height (cm)

At 80 DAS, significantly and higher plant height (139.20cm) was recorded in treatment 9 [Potassium (25kg/ha) + Zinc (20kg/ha)]. However, the treatment 8 [Potassium (25kg/ha) + Zinc (15kg/ha)], treatment 7 [Potassium (25kg/ha) + Zinc (10kg/ha)], treatment 6 [Potassium (20kg/ha) + Zinc (20kg/ha)] were found to be statistically at par with treatment 9 [Potassium (25kg/ha) + Zinc (20kg/ha)].

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The significant and higher plant height was with application of potassium (25 kg/ha) might be due to with increased levels of K function in most of the physiological and metabolic processes resulting in increased growth and development, resulting in higher plants hieght. Similar result was also reported by **Singh *et* al. (2016).**

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Number of branches/plant

At 80 DAS, significant and maximum number of branches/plant (5.86) was recorded with treatment 9 [Potassium (25kg/ha) + Zinc (20kg/ha)]. However, the treatment 8 [Potassium (25kg/ha) + Zinc (15kg/ha)], treatment 7[Potassium (25kg/ha) + Zinc (10kg/ha)], treatment 6[Potassium (20kg/ha) + Zinc (20kg/ha)] were found to be statistically at par with treatment 9 [Potassium (25kg/ha) + Zinc (20kg/ha)].The significant and maximum number of branches/plant was observed with the application of zinc(20kg/ha) might be due Zn function in the production of indole acetic acid, a growth hormone and tryptophan, a precursor of auxin. The similar result was also reported by **Sharma et al. (2004), Kuniya et al.(2018).**

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Number of nodules/plant

At 80 DAS, significant and maximum number of nodules/plant (49.45) was recorded with treatment 9[Potassium (25kg/ha) + Zinc (20kg/ha)]. However, the treatment 8[Potassium (25kg/ha) + Zinc (15kg/ha)] was found to be statistically at par with treatment 9[Potassium (25kg/ha) +Zinc (20kg/ha)].The significant and maximum

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number of nodule/plant was observed with the application of Potassium (25kg/ha) might be due increased levels of Potassium activates more than 60 enzyme systems, including the nitrogenous enzyme which is essential for N_2 -fixation. Potassium is also essential to generate carbohydrates by photosynthesis which provide the energy needed by bacteria in nodules to fix atmospheric N_2 and contributes to good root growth providing a proper "home" for the nodules in which N is fixed resulting maximum number of nodule/plant. The similar result was also reported by **Patil*et al*. (2019).** Further increase in number of nodule/plant observed with the application of zinc(20kg/ha) might be due to Zn function in N fixation through nodule formation and Zn play a major role in leg haemoglobin synthesis .The similar result was also reported by **Kuniya*at* el. (2018).**

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Plant dry weight

At 80 DAS, significant and maximum plant dry weight (21.50g) was recorded in treatment 9 [Potassium (25kg/ha) +Zinc (20kg/ha)]. However, the treatment 8 [Potassium (25kg/ha) +Zinc (15kg/ha)], treatment 7 [Potassium (25kg/ha) +Zinc (15kg/ha)], treatment 6 [Potassium (20kg/ha) +Zinc (20kg/ha)], were statistically at par with treatment 9 [Potassium (25kg/ha) +Zinc (20kg/ha)].The significant and higher plant dry weight (g) was observed with the application of Potassium (25kg/ha) might be due increase levels of K function of protein yield is the resultant of dry matter yield and protein content because it balance photosynthesis and respiration due to potassium application because of an increase in dry matter yield. Similar results were reported by**Tomar*et* al. (2001).** Further increase in dry weight observed with the application of zinc (20kg/ha) might be due to Zinc application created a balanced nutritional environment which enhanced metabolic activities and photosynthetic rate, resulting in improvement and ultimately accumulation of plant dry matter. Similar types of results were reported by **Meena*et* al. (2006).**

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Number of pods/ plant

At harvest, Treatment 9[Potassium (25kg/ha)+Zinc (20kg/ha)] was recorded significant and maximum number of pods/ plant (73.13) which was superior over all other treatments.However,the treatment 8[Potassium (25kg/ha) + Zinc (15kg/ha)] and treatment 7[Potassium (25kg/ha) + Zinc (10kg/ha)] was found to be statistically at par with the treatment 9[Potassium (25kg/ha) + Zinc (20kg/ha)].

The significant and maximum number of pods/plant was observed with the application of zinc (20kg/ha) might be due increase levels of Zn application to crops on nutrient metabolism, biological activity and growth parameters and hence which

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applied zinc results in taller and higher enzyme activity in pods/ plant.Similar results were reported by **Yashona*et* al.(2018).**

Number of seeds/pod:

At harvest, Treatment 9[Potassium (25kg/ha) + Zinc (20kg/ha)] was recorded significant and maximum number of seeds/pod (9.13) which was superior over all other treatments.However, the treatment 8 [Potassium (25kg/ha) + Zinc (15kg/ha) (8.53)] was found to be statistically at par with the treatment 9 [Potassium (25kg/ha) + Zinc (20kg/ha)].The significant and maximum number of seed/pod was observed with the application of K (25kg/ha) might be due increases level of K application increased the transportation of photosynthates; protein synthesis from source to sink might be the main reason for increase in number of seeds.Similar results were reported by **Hussain*et* al.(2011).** Further increase in dry weight observed with the application of zinc (20kg/ha) might be due increase levels of Zn application of appropritefertilisersincreased assimilate production and photosynthesis efficiency of the seed filling.Similar types of results were reported by **Ali *et* al.(2004) and Yashona(2018).**

Seed Yield (kg/ha):

At harvest, Treatment 9 [Potassium (25kg/ha) + Zinc (20kg/ha)] was recorded significantly maximum Seed yield (1363.56kg/ha) which was superior over all other treatments.However, the treatment 8 [Potassium (25kg/ha) + Zinc (15kg/ha)], treatment 7 [Potassium (25kg/ha) + Zinc (10kg/ha)] were found to be statistically at par with the treatment 9 [Potassium (25kg/ha) + Zinc (20kg/ha)].

The significant and maximum seed yield was observed with the application of Potassium (25kg/ha) might be due increase levels of K application to may be attributed strong exchange mechanism in soil, greater cell division and elongation, efficient nodulation and CO_2 assimilation. The higher photosynthetic surface for longer duration in crops receiving K might have resulted in enhanced photosynthetic activity and thus more metabolites are directed for the development of crop increase in seeds yield.Similar results were reported by **Borse*et* al. (2002); Begadkar*et* al.(2020).** Further increase in dry weight observed with the application of zinc (20kg/ha) might be due to Zinc application role in biosynthesis of indole acetic acid which is responsible for initiation of primodialfor reproductive parts and partitioning of photosynthesis toward them which result in better grain yield..Similar results were reported by **Ram *et al*.(2013) and Sunil *et* al.(2017).**

Straw yield (kg/ha):

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At harvest, Treatment 9 [Potassium (25 kg/ha) + Zinc (20kg/ha)] was recorded significantly maximum Stover yield (3208.91kg/ha) which was superior over all other treatments.However,the treatment-8 [Potassium (25kg/ha) + Zinc (15kg/ha)] was found to be stastically at par with treatment-9[Potassium (25kg/ha) + Zinc (20kg/ha)] .The significant and maximum straw yield was observed with the application of Potassium (25kg/ha) might be due increase levels of K application to may be either direct or indirect, under different environments, in major plant processes such as photosynthesis, respiration, protein synthesis, enzyme activation, water uptake, osmoregulation straw yield of plant.Similarresults were reported by**Nellore *et* al.(2021).** Further increase in dry weight observed with the application of zinc (20kg/ha) might be due to Zinc application role decreases pH of soil and increases root absorption of minerals and improves biosynthisisof plant growth regulator IAA, carbohydrate and N metabolism which lead of straw yield. .Similar results were reported by **Ali *et* al. (2004) and Yashona*et* al (2018).**

Economice

The result showed that maximum gross return (INR 77405.66/ha), net return (INR 54121.66/ha) and B:C ratio (2.32) were also recorded in treatment 9(Potassium25kg/ha + Zinc 20kg/ha).Higher gross returns, net returns, benefit cost ratio was recorded with application of zinc (20kg/ha) might be due to maximum recovery from application of zinc with less expenditure and higher seed yield and strow yield obtained from these trestment. These results are in conformity with those observed by **Sunil *et al.*(2017).**

CONCLUSION:

Based on the above findings. It can be concluded that in Cluster bean with the application of Potassium25 kg/ha along with the application of Zinc 20 kg/ha (Treatment 9) was observed highest seed yield and benefit cost ratio.

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Table 1 Effect of Potassium and Zinc on growth of Cluster bean.

S.No.	Treatment combinations	At 80 DAS			
		Plant height (cm)	Number of branches/plant	Number of nodules/plant	Dry weight (g/plant)
1.	Potassium (15kg/ha) + Zinc (10kg/ha)	118.26	4.40	39.63	17.76
2.	Potassium (15kg/ha) + Zinc (15kg/ha)	124.06	4.80	40.13	18.26
3.	Potassium (15kg/ha) + Zinc (20kg/ha)	124.10	4.83	40.66	18.30
4.	Potassium (20kg/ha) + Zinc (10kg/ha)	127.33	4.90	41.33	18.60
5.	Potassium (20kg/ha) + Zinc (15kg/ha)	127.20	4.93	42.20	18.40
6.	Potassium (20kg/ha) + Zinc (20kg/ha)	128.80	5.03	43.08	19.60
7.	Potassium (25kg/ha) + Zinc (10kg/ha)	131.40	5.33	43.13	19.61
8.	Potassium (25kg/ha) + Zinc (15kg/ha)	136.73	5.53	46.33	21.00
9.	Potassium (25kg/ha) + Zinc (20kg/ha)	139.20	5.86	49.45	21.53
10.	Control (N:P:K 20:40:20 kg/ha)	109.53	3.80	39.46	17.43
	F test	S	S	S	S
	SEm(±)	3.90	0.29	1.65	0.90
	CD (p=0.05)	11.60	0.86	4.90	2.67

Table:2 Effect of Potassium and Zinc on yield and yield attributesof Cluster bean.

S.No.	Treatment combination	Number of pods per Plants	Number of seed per pod	Test weight (g)	Seed Yield (kg/ha)	Stover Yield (kg/ha)	Harvest Index (%)
1.	Potassium (15kg/ha) + Zinc (10kg/ha)	53.80	7.53	26.13	1093.96	2662.02	29.12
2.	Potassium (15kg/ha) + Zinc (15kg/ha)	56.60	7.60	26.70	1127.85	2670.36	28.96
3.	Potassium (15kg/ha) + Zinc (20kg/ha)	58.20	7.66	26.96	1150.56	2766.89	27.79
4.	Potassium (20kg/ha) + Zinc (10kg/ha)	59.20	7.73	26.93	1164.42	2840.29	29.07
5.	Potassium (20kg/ha) + Zinc (15kg/ha)	61.73	7.86	27.33	1170.02	2910.09	28.66
6.	Potassium (20kg/ha) + Zinc (20kg/ha)	62.93	7.93	27.46	1196.44	2937.19	31.07
7.	Potassium (25kg/ha) + Zinc (10kg/ha)	69.20	8.20	27.50	1261.89	2988.80	29.48
8.	Potassium (25kg/ha) + Zinc (15kg/ha)	72.00	8.53	28.83	1266.69	3005.02	29.64
9.	Potassium (25kg/ha) + Zinc (20kg/ha)	73.13	9.13	29.53	1363.56	3208.91	29.84
10.	Control (N:P:K 20:40:20 kg/ha)	49.66	7.40	25.86	1036.69	2576.74	28.70
	F test	S	S	NS	S	S	NS
	SEm(±)	2.62	0.25	0.90	34.95	82.28	0.98
	CD (p=0.05)	7.77	0.75	-	103.83	244.42	-

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Table 3 Effect of Potassium and Zinc of economics on Cluster bean.

S.No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C
1.	Potassium (15kg/ha) + Zinc (10kg/ha)	22080.00	62538.33	40458.33	1.83
2.	Potassium (15kg/ha) + Zinc (15kg/ha)	22580.00	64105.05	41525.05	1.84
3.	Potassium (15kg/ha) + Zinc (20kg/ha)	23080.00	65609.66	42529.66	1.84
4.	Potassium (20kg/ha) + Zinc (10kg/ha)	22176.00	66600.66	44424.66	2.00
5.	Potassium (20kg/ha) + Zinc (15kg/ha)	22676.00	67201.66	44525.66	1.96
6.	Potassium (20kg/ha) + Zinc (20kg/ha)	23176.00	68525.78	45349.78	1.95
7.	Potassium (25kg/ha) + Zinc (10kg/ha)	22284.00	717729.23	49445.23	2.21
8.	Potassium (25kg/ha) + Zinc (15kg/ha)	22784.00	72026.33	49242.33	2.16
9.	Potassium (25kg/ha) + Zinc (20kg/ha)	23284.00	77405.66	54118.66	2.32
10.	Control (N:P:K 20:40:20 kg/ha)	21176.00	59534.93	38385.93	1.81