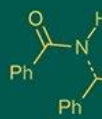


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(8): 702-706
www.biochemjournal.com
Received: 08-05-2026
Accepted: 17-06-2026

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Effect of Zinc and Panchgavya on growth and yield of Clusterbean (*Cyamopsis tetragonoloba*)

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i8Si.9516>

Abstract

The present investigation entitled “Effect of Zinc and Panchgavya on Growth and Yield of Clusterbean (*Cyamopsis tetragonoloba* L.)” was carried out at the Crop Research Farm, Department of Agronomy, under Prayagraj agro-climatic conditions to assess the impact of zinc and Panchgavya, individually and in combination, on growth, yield attributes, and economics of clusterbean. The experiment comprised ten treatments with varying levels of zinc (10, 20, and 30 kg/ha) and foliar sprays of Panchgavya (2%, 4%, and 6%) along with a recommended NPK control, laid out in a randomized block design with three replications. Results revealed that the combined application of Zn @ 30 kg/ha + Panchgavya @ 6% (T9) recorded significantly higher values for plant height (92.38 cm), number of branches per plant (8.35), crop growth rate (0.79 g/m²/day), relative growth rate (0.71 g/g/day), number of pods per plant (34.19), seeds per pod (8.21), test weight (29.87 g), seed yield (923 kg/ha), and stover yield (2496 kg/ha), along with maximum harvest index (28.22%). The study concludes that integrated use of zinc and Panchgavya, particularly Zn @ 30 kg/ha with 6% Panchgavya foliar spray, is highly effective in enhancing productivity and profitability of clusterbean under semi-arid conditions, while also promoting eco-friendly and sustainable nutrient management practices.

Keywords: Zinc, Panchgavya, Clusterbean, Growth, Yield

Introduction

Cluster bean (*Cyamopsis tetragonoloba* (L.) Taub), commonly known as guar, is a hardy, drought-tolerant legume mainly grown in Rajasthan during the kharif season under rainfed conditions. Its deep roots help efficiently use soil moisture, allowing it to survive in arid, semi-arid, and even moderately saline soils. Guar is economically important due to its seed gum content (28-40%), widely used in industries. The crop is versatile—used as a vegetable, fodder, green manure, and for seed production. It also improves soil fertility by fixing atmospheric nitrogen (37-196 kg/ha/year) and serves as nutritious cattle feed.

Clusterbean (*Cyamopsis tetragonoloba* L.) is an important legume crop cultivated mainly in arid and semi-arid regions of India, where it plays a significant role in crop diversification, soil enrichment, and income generation. However, its productivity remains suboptimal due to several agronomic challenges. Key issues include poor nutrient management, low organic matter content in soil, inadequate use of micronutrients, and a general lack of integrated and sustainable agronomical practices (Bhatt *et al.*, 2017) [4]. These limitations are further exacerbated by climatic stresses such as erratic rainfall and high temperatures, which are common in clusterbean-growing areas.

In the global scenario, clusterbean (*Cyamopsis tetragonoloba*) is primarily cultivated for its seed gum content, which is extensively used in the food, textile, and oil industries. The global area under clusterbean cultivation is estimated at approximately 4.5 million hectares, with a total production of 2.8 million tonnes and an average productivity of 622 kg/ha (FAOSTAT, 2024) [7]. India is the leading producer, contributing nearly 80% of the world's clusterbean production. In India, clusterbean is cultivated over an area of 30.5 lakh hectares, producing about 15.6 lakh tonnes with an average productivity of 511 kg/ha. Rajasthan alone accounts for over 80% of the national area, with about 25.3 lakh hectares under cultivation, producing 12.2 lakh tonnes at a productivity of 482 kg/ha. Other contributing states include Haryana, Gujarat, and Madhya Pradesh (Government of India, 2024; Ministry of Agriculture & Farmers Welfare, 2024).

Zinc is an essential micronutrient involved in several enzymatic activities and metabolic functions in plants, particularly in protein synthesis, auxin production, and chlorophyll formation. In clusterbean, zinc application has been reported to improve germination rate, root development, leaf chlorophyll content, and enzyme activity, ultimately enhancing vegetative growth and reproductive success. Zinc deficiency is a common constraint in arid and semi-arid soils where clusterbean is primarily cultivated, leading to stunted growth, reduced nodulation, and low yields (Rathi *et al.*, 2021)^[15]. Application of zinc sulphate at appropriate doses (typically 25-50 kg/ha of ZnSO₄) has shown to significantly improve seed yield, dry matter production, and gum content in guar seeds.

Panchgavya, a traditional organic formulation prepared from five cow-derived products—cow dung, cow urine, milk, curd, and ghee—has been recognized for its bio enhancing properties. When applied as a foliar spray or soil drench, Panchgavya enriches the microbial population in the rhizosphere, stimulates plant growth hormones such as auxins and cytokinins, and improves plant resistance to diseases. In clusterbean, Panchgavya enhances seed germination, promotes vigorous growth, improves nodulation by *Rhizobium*, and contributes to better pod formation and seed filling (Meena *et al.*, 2019)^[12]. The synergistic effect of Panchgavya with balanced fertilization, including micronutrients like zinc, results in improved nutrient use efficiency and enhanced physiological functions.

The combined application of zinc and Panchgavya has shown promising results in increasing chlorophyll content, leaf area index, nodulation, biological yield, and seed yield of clusterbean, especially under organic or integrated nutrient management systems. This integrated approach not only boosts productivity but also improves soil health and sustainability of the cropping system.

From an agronomic perspective, one of the primary concerns is nutrient imbalance, particularly micronutrient deficiencies such as zinc. Zinc is essential for several physiological processes including enzyme activation, auxin synthesis, and membrane integrity. Its deficiency is common in Indian soils, especially those that are alkaline, sandy, or low in organic matter—conditions typical of clusterbean fields. Inadequate zinc availability leads to poor root development, delayed flowering, reduced chlorophyll synthesis, and ultimately, lower yield and quality (Sethi *et al.*, 2025)^[18].

Therefore, integrating zinc fertilization with the application of Panchgavya represents a promising agronomic intervention to overcome the nutrient and soil health challenges in clusterbean cultivation. This study aims to evaluate the combined effect of zinc and Panchgavya on the growth and yield of clusterbean, with the objective of identifying a sustainable and productive cultivation strategy. Role of Panchgavya in Sustainable Agriculture

Panchgavya, an organic concoction made from five cow-derived products (milk, curd, ghee, urine, and dung), is gaining prominence in sustainable agriculture. Its application has been associated with enhanced plant growth, yield, and soil health. Research indicates that foliar sprays of Panchgavya, especially when combined with neem leaf extracts, can significantly boost dry matter accumulation, nutrient uptake, and yield in clusterbean. Dual applications at branching and flowering stages have shown yield

increases of up to 34% compared to controls (Kumawat *et al.*, 2011)^[9].

Synergistic Effects of Zinc and Panchgavya

While both zinc and Panchgavya individually contribute to improved clusterbean growth and yield, their combined application may offer synergistic benefits. In pearl millet, for example, the integration of 20 kg/ha zinc sulfate with 5% Panchgavya foliar spray resulted in significant enhancements in plant height, grain yield, and economic returns. Such findings suggest potential similar benefits in clusterbean cultivation, warranting further investigation. (Banti and Debbarma, 2023)^[10].

This study examines the effects of zinc and Panchgavya, alone and in combination, on the growth, yield, and nutrient content of clusterbean. It aims to identify effective nutrient management strategies to improve productivity in a sustainable and cost-efficient manner, while contributing to better agricultural practices and food security.

Materials and Methods

The experiment was carried out at Crop Research Farm of the Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during Kharif season of 2023. The soil of the experimental field was sandy loam in texture, with soil pH 8.0, low level of organic carbon (0.62%), available N (225 Kg/ha), P (38.2 Kg/ha) and K (240.7 Kg/ha). The treatment consists of two types of fertilizers viz., Zinc and Panchgavya and combined application of both biofertilizers along with three levels of gibberellic acid. The experiment was laid out in RBD with 10 treatments each replicated thrice. The treatment combinations are T₁ - Zn 10 kg/ha + Panchgavya 2%, T₂ - Zn 20 kg/ha + Panchgavya 2%, T₃ - Zn 30 kg/ha + Panchgavya 2%, T₄ - Zn 10 kg/ha + Panchgavya 4%, T₅ - Zn 20 kg/ha + Panchgavya 4%, T₆ - Zn 30 kg/ha + Panchgavya 4%, T₇ - Zn 10 kg/ha + Panchgavya 6%, T₈ - Zn 20 kg/ha + Panchgavya 6%, T₉ - Zn 30 kg/ha + Panchgavya 6% and T₁₀ - Control (RDF) - N:P:K - 20:40:20 kg/ha. Data recorded on different aspects of crop, viz., plant height (cm), number of nodules/plant, plant dry weight (g), pods/plant, seeds/pod, test weight (g), seed yield (kg/ha), stover yield (kg/ha) and harvest index were statistically analysed by analysis of variance method as described by Gomez and Gomez (1976)^[8].

Results and Discussion

Plant height (cm)

At 80 DAS, Significant and higher plant height (92.38 cm) was recorded at treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)]. However, treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] was found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)].

Significant and higher plant height was observed with application of Zinc (30 kg/ha) may be due to zinc is an important component of various enzymes that are responsible for driving many metabolic reactions in crops. Similar results were also reported by Saji and Dawson (2023)^[16]. Further, significant and higher plant height was recorded with application of Panchgavya 6% may be due to the application of nutrients through foliar spray of panchgavya which enhanced the growth rate of plant since it contains the favorable macro and micro nutrients, growth

hormones and biofertilizers in liquid formulation. Moreover, the presence of growth enzymes in panchgavya might have favoured rapid cell division and elongation. Similar results were found by Savaliya *et al.*, (2023)^[17] in cowpea crop.

Number of branches/plant

At 80 DAS, Significant and highest Number of branches / plant (11.59) was recorded at treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)]. However, treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] was found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)].

Significant and maximum Number of branches / plant was observed with application of Zinc (30 kg/ha) because Zinc is as essential element as it is required for structural and catalytic components of protein and enzymes in normal growth and development of plants. Similar results were also reported by Meena and Jat (2016)^[12]. Further, significant and maximum Number of branches / plant was recorded, this could have occurred as a result of the increased amount of nutrient uptake which might have promoted roots enabling them to absorb more nutrients with application of Panchgavya 6% leading to improved growth of cluster bean plants. Similar results were found by Ammaladinne *et al.*, (2019)^[1].

Number of nodules / plant

At 80DAS, Significant and highest Number of nodules / plant (110.59) was recorded at treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)]. However, treatment 7 [Zn (10 kg/ha) + Panchgavya (6%)] and treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] were found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)].

Significant and maximum Number of nodules / plant was observed with application of Zinc (30 kg/ha) because Zinc function in N fixation through nodule formation and play a major role in leg haemoglobin synthesis. Similar results were also reported by Kharb and Debbarma (2023)^[10]. Further, significant and maximum number of nodules/plant was recorded with application of Panchgavya 6% might be due to the plant system and boosted the production of growth regulators in the cell system, which in turn promoted the growth and development of cluster bean plants. Similar results were found by Bhawariya and Gayathri (2024)^[5].

Plant dry weight (g)

At 80 DAS, Significant and highest plant dry weight (49.59) was recorded at treatment 9 [Zn 30 kg/ha + Panchgavya 6%]. However, treatment 7 [Zn (10 kg/ha) + Panchgavya (6%)] and treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] were found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)].

Significant and maximum plant dry weight was observed with application of Zinc (30 kg/ha) might be due to Zinc application creating a balanced nutritional environment which enhanced metabolic activities and photosynthetic rate, resulting in improvement and ultimately accumulation of plant dry matter. Similar results were also reported by Naveena *et al.*, (2021)^[13]. Further, significant and higher plant height was recorded with application of Panchgavya 6% might be due to the better availability of nutrients. The IAA and GA present in panchagavya when applied as foliar spray could have created stimuli in the plant system and increased the production of growth regulators in cell system and the action of growth regulators in plant system

ultimately stimulated the necessary growth and development. Similar results were found by Ayunenla *et al.*, (2019).

Crop growth rate (g/m²/day)

Effect of treatments on Crop growth rate (g/m²/day) at 60-80 DAS was significantly influenced due to different treatments.

At 60-80 DAS, significantly higher Crop growth rate (0.79 g/m²/day) was recorded at treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)]. However, treatment 7 [Zn (10 kg/ha) + Panchgavya (6%)] and treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] were found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)].

Significant and higher Crop growth rate was with application of Zinc (30 kg/ha) might be due to the improved nutrient availability of Zn available at the site of photosynthesis, may be the cause of these increased plant development characteristics. Similar results were also reported by Priyanka *et al.*, (2024)^[14]. Further, significant and higher Crop growth rate was with application of Panchgavya (6%) can enhance plant growth parameters like plant height, dry matter accumulation, and yield attributes. This positive impact is attributed to the presence of macro and micronutrients, vitamins, and growth hormones in Panchgavya, which improve leaf area, photosynthetic activity, and overall plant metabolism. Similar results were found by Choudhary *et al.*, (2023)^[15] in moth bean crop.

Post Harvest Observation

Number of pods / plant

Significantly the highest Number of seeds / pod of 8.21 was recorded at treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)]. However, treatment 7 [Zn (10 kg/ha) + Panchgavya (6%)] and treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] were found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)] (Table 2). Significant and maximum Number of pods / plant was observed with application of Zinc (30 kg/ha) might be due increase levels of Zn application to crops on nutrient metabolism, biological activity and growth parameters and hence which applied zinc results in larger and higher enzyme activity in pods/ plant. Similar results were also reported by Meena and Jat (2016)^[12]. Further, significant and maximum Number of pods / plant was recorded with application of Panchgavya 6% might be due to the high nutritional content, plant growth stimulators and other microbial activities leading to improved growth of cluster bean plants. Similar results were found by Bhawariya and Gayathri (2024)^[5].

Number of seeds / pod

Significantly the highest Number of seeds / pod of 8.21 was recorded at treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)]. However, treatment 7 [Zn (10 kg/ha) + Panchgavya (6%)] and treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] were found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)] (Table 2). Significant and maximum Number of seeds / pod was observed with application of Zinc (30 kg/ha) might be due increase levels of Zn application of appropriate fertilizers increased assimilate production and photosynthesis efficiency of the seed filling. Similar results were also reported by Saji and Dawson (2023)^[16]. Further, significant and maximum Number of seeds / pod was recorded with application of

Panchgavya might be due to the availability of nutrients at the site of photosynthesis leading to improved growth of cluster bean plants. Similar results were found by Savaliya *et al.*, (2023)^[17] in cowpea crop.

Test weight (g)

Significantly the highest Test weight (g) of 29.87 g was recorded at treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)]. However, treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] were found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)] (Table 2). Significant and maximum test weight was observed with application of Zn (30 kg/ha) which might be an essential element required for the structural components of proteins in order for plants to grow and develop appropriately, the application of zinc produced the significant and greatest test weight. Anuradha *et al.*, (2017)^[2] also observed similar findings. Panchgavya application, particularly when combined with other fertilizers, can lead to a significant increase in seed yield, which directly affects test weight. Similar results were found by Banti and Debbarma (2023)^[10].

Seed yield (kg/ha)

Significantly the highest Seed yield (kg/ha) of 923 kg/ha was recorded at treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)]. However, treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] was found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)] (Table 2). Significant and highest Seed yield was observed with application of Zinc might be due to Zinc application role in the biosynthesis of Indole acetic acid which is responsible for the initiation of primordial for reproductive parts and

partitioning of photosynthesis toward them which results in the better grain yield. Similar results were also reported by Meena and Jat (2016)^[12]. Further, significant and maximum Seed yield was recorded with application of Panchgavya might be due to the increased amount of nutrient uptake which might have promoted roots enabling them to absorb more nutrients, thereby enhancing the yield and yield attributes of cluster bean. Similar results were found by Chaudhari *et al.*, (2018)^[6].

Stover yield (kg/ha)

Significantly the highest Stover yield (kg/ha) of 2496 kg/ha was recorded at with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)]. However, treatment 8 [Zn (20 kg/ha) + Panchgavya (6%)] was found to be statistically at par with treatment 9 [Zn (30 kg/ha) + Panchgavya (6%)] (Table 2). Significant and higher Stover yield was observed with application of Zinc might be due to Zinc application role decreases the pH of the soil and increasing root absorption of minerals and improving biosynthesis of plant growth regulator IAA, carbohydrate and N metabolism which leads to higher straw yield. Similar results were also reported by Yashona. Further, significant and maximum Stover yield was recorded with application of Panchgavya. Panchgavya can enhance plant growth by improving the availability of nutrients in the soil, leading to increased plant size, number of branches, and number of pods / plant. Similar results were found by Naveena *et al.*, (2021)^[13].

Harvest Index (%)

Significantly the highest Harvest Index (%) of 28.22% was recorded at treatment 10 [Control (20:40:25) NPK kg/ha]. Though, there was no significant difference found among the treatments.

Table 1: Effect of Zinc and Panchgavya on growth attributes of Clusterbean

S. no	Treatment combination	Plant height (cm)	Number of nodules/plant	Branches/plant	Dry weight (g)	CGR (g/m ² /day)
1.	Zn 10 kg/ha + Panchgavya 2%	73.55	98.50	8.50	43.50	0.45
2.	Zn 20 kg/ha + Panchgavya 2%	75.36	99.75	8.75	43.75	0.49
3.	Zn 30 kg/ha + Panchgavya 2%	76.89	101.02	9.02	44.02	0.52
4.	Zn 10 kg/ha + Panchgavya 4%	80.60	102.24	9.24	44.24	0.55
5.	Zn 20 kg/ha + Panchgavya 4%	83.03	103.72	9.72	45.72	0.59
6.	Zn 30 kg/ha + Panchgavya 4%	83.81	104.27	10.27	46.27	0.61
7.	Zn 10 kg/ha + Panchgavya 6%	85.69	105.89	10.89	47.89	0.67
8.	Zn 20 kg/ha + Panchgavya 6%	91.85	108.12	11.43	48.12	0.72
9.	Zn 30 kg/ha + Panchgavya 6%	92.38	110.59	11.59	49.59	0.79
10.	N.P.K - 20:40:25 (Control)	79.20	97.15	8.15	42.12	0.43
	F - Test	S	S	S	S	S
	S.Em (±)	0.33	3.10	0.10	0.76	0.035
	CD (p= 0.05)	0.68	6.20	0.20	2.35	0.123

Table 2: Effect of Zinc and Panchgavya on yield attributes and yield of Clusterbean

S. no	Treatment combination	Number of Pods/plant	Number of Seeds/pod	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
1.	Zn 10 kg/ha + Panchgavya 2%	23.05	6.35	22.15	634.00	1652.00
2.	Zn 20 kg/ha + Panchgavya 2%	25.95	6.77	23.05	655.00	1765.00
3.	Zn 30 kg/ha + Panchgavya 2%	26.56	6.93	23.52	682.00	1881.00
4.	Zn 10 kg/ha + Panchgavya 4%	27.04	7.05	24.98	715.00	1930.00
5.	Zn 20 kg/ha + Panchgavya 4%	27.27	7.38	25.52	777.00	2020.00
6.	Zn 30 kg/ha + Panchgavya 4%	28.23	7.51	26.64	792.00	2187.00
7.	Zn 10 kg/ha + Panchgavya 6%	30.51	7.88	27.65	811.00	2202.00
8.	Zn 20 kg/ha + Panchgavya 6%	32.85	8.07	29.11	908.00	2479.00
9.	Zn 30 kg/ha + Panchgavya 6%	34.19	8.21	29.87	923.00	2496.00
10.	N.P.K - 20:40:25 (Control)	22.23	5.89	21.24	628.00	1550.00
	F - Test	S	S	S	S	S
	S.Em (±)	0.70	0.29	0.40	8.16	11.71
	CD (p= 0.05)	1.42	0.60	0.81	16.69	23.94

Conclusion

From the results, it is concluded that in clusterbean the application of Zinc (30 kg/ha) along with panchgavya (6%) (Treatment 9) was observed higher growth and yield.

Acknowledgement

The authors are thankful to Department of Agronomy, Naini Agricultural Institute, Prayagraj, Sam Higginbottom University of Agriculture Technology and sciences, (U.P) India for providing necessary facilities to undertake the studies.

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