



Impact of Varieties and Foliar Spray of Micronutrient on Growth Parameters of Cluster Bean under Teak Based Agroforestry System

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i183329

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/103162>

Original Research Article

Received: 02/05/2023
Accepted: 12/07/2023
Published: 21/07/2023

ABSTRACT

Management of agroforestry system in different region has been widely focused on reducing soil erosion and water losses, environmental balance restoration, improve land use and uplifting economic benefits. This study was conducted to evaluating the impact of varieties and foliar application of micronutrient on growth parameters of cluster bean under teak based agroforestry system as well as open condition. The experiment was laid out in Randomized Block Design with Factorial concept consisting of 3 factors viz., varieties, foliar spray of micronutrient iron and foliar spray of micronutrient zinc at 2 levels each in 4 replications. Among two tested varieties, variety Pusa Navbahar performed well in terms of growth as compare to local variety in both growing conditions. Furthermore, foliar spray of 0.5% FeSO₄ and foliar spray of 0.5% ZnSO₄ also recorded

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maximum growth parameters as compare to their control condition under both growing conditions. All interaction effect were found non-significant for most of growth parameters except plant height under both growing conditions (teak-based agroforestry system and open condition). Further, t-test analysis shows that growth parameters were higher for open condition.

Keywords: Cluster bean; teak-based agroforestry system; variety; micronutrient; growth parameters.

1. INTRODUCTION

Today, Indian agriculture faces diverse challenges and constraint due to growing demographic pressure, increasing food, feed and fodder needs, natural resource degradation and climate change [1] therefore a management system needs to be devised that is capable of producing food from marginal agricultural land and is also capable of maintaining and improving quality of producing environment [2]. Agroforestry is the only option because it has a tremendous potential to simultaneously offer both economically and ecologically viable option to farmers and rural people community for large-scale diversification in agriculture to get supplement fuel, fodder, fruits and fibers on one hand and stabilizing the ecosystems (increase the tree cover, production of timber and other wood products thus reduces the pressure on the forests) on the other hand [3].

Agroforestry is a collective name for land use systems and technologies where woody perennials (trees, shrubs, palm, bamboos, etc.) are deliberately used on the same piece of land management units as agricultural crops and/or animals in some form of spatial arrangement or temporal sequences and there are both ecological and economical interactions between the different components [4].

Tectona grandis Linn. (Family - Lamiaceae) is one of the most well-known woods in the world, renowned for its dimensional stability, extreme durability, and hardness, as well as its resistance to decay even when unprotected by paints and preservatives. This tree is commonly called as teak and locally known as sagon, sagwan etc. It is one of the most important heartwoods of the world over.

Vegetables are one of the essential nutrient suppliers of our daily diet. Increasing the production of vegetables is our prior need which can be easily attained through their cultivation under different light levels permitted by the upper story crop like trees.

Cluster bean *Cyamopsis tetragonoloba* (L.) is a robust annual herb having long tap root and well-developed laterals. Guar is mainly grown in the semi-arid areas of North and North-West part of India (mainly in Rajasthan) and South-East Pakistan [5]. Cluster bean can be used for a variety of purposes, including vegetable, cattle feed/fodder, and green manure. It is a good source of nutrition, and its tender green pods are also inexpensive. Further, cluster bean meal and seed are used as high protein cattle feed [6]. Cluster bean is primarily grown during the rainy (kharif) season, but it can also be grown under irrigation during the summer. Sowing can be made from the second week of July to the first week of August, and during the summer from the last week of February to the first week of March.

Legume crops require not only adequate macronutrient but also micro nutrient. Therefore, an optimum supply of micronutrient under balanced condition is very important for achieving good growth and higher productivity. Use of micronutrients helps in good seedling growth and enhances crop productivity in many cases [7]. Application of foliar nutrients immediately provides necessary nutrients to the plants [8]. Sprayed nutrients may provide efficiency from 10-20 times than soil application [9].

Research report on foliar nutrition effect on cluster bean is still scarce. The current investigation aimed to evaluate the effect of verities and foliar application of micronutrient (Fe and Zn) on cluster bean growth under teak based agroforestry system and open condition.

2. MATERIALS AND METHODS

2.1 Description of Study Site

The experiment was conducted at college farm of Navsari Agricultural University, Navsari, Gujarat, which, lies between 20°55'25"N latitude and 72°54'29"E longitude with an average elevation of 10 m above mean sea level. According to agroclimatic conditions, Navsari falls in

agroecological situation III of South Gujarat, which is typically characterized by humid and warm monsoon with heavy rainfall (around 1500 mm), moderately cold winter and fairly hot and humid summer.

2.2 Experimental and Treatment Details

Cluster bean crop was grown under teak plantation as well as open condition in summer season for two consecutive years (2021 and 2022). The recommended package of practices was followed for growing the crop. The sowing of crop was done in February month for both the years. Recommended dose of fertilizers (RDF-20:40:00) and FYM (10 t/ha) was applied to crop. The experiment was laid out in Randomized Block Design with Factorial concept consisting of 3 factors viz., varieties, foliar spray of micronutrient iron and foliar spray of micronutrient zinc at 2 levels each in 4 replications. Two different varieties of cluster bean viz. Pusa Navbahar (V_1), Local Variety (V_2), Iron application viz. No foliar spray of iron (F_0), foliar spray of iron [0.5 % $FeSO_4$ (F_1)] at 30 and 45 days after sowing (DAS) and zinc application viz., No foliar spray of zinc (Z_0), foliar spray of zinc [0.5 % $ZnSO_4$ (Z_1)] at 30 and 45 DAS were tested for various growth parameters of cluster bean. All the treatments given to cluster bean crop in teak based agroforestry system were also applied in open condition.

2.3 Statistical Analysis

The data regarding the growth parameters recorded for each treatment during experiment were subjected to statistical analysis of variance technique as described by Panse and Sukhatme [10]. The experiment was laid out in Randomized Block Design (RBD) with factorial concept. The significance of treatment differences was tested by 'F' test as 5% level of significance. The Critical Difference (CD) were calculated when the difference among treatments were found significant for making the comparison among treatment means. The Standard Error of mean [SEm (\pm)] was also worked out for each parameter. The Co-efficient of Variance [CV (%)] was calculated. T-test using equal variance was used to see the statistical significance between both growing conditions (teak based agroforestry system and open condition) for growth parameters of cluster bean.

3. RESULTS

3.1 Plant Height (cm)

Data related to plant height as affected by varieties and foliar spray of micronutrients are given in Table 1.

3.1.1 Effect of varieties

Data recorded on plant height of cluster bean crop was shown significant effect of varieties. In pooled analysis, Pusa Navbahar variety recorded highest plant height (126.90 and 119.33 cm) as compare to local variety (113.83 and 102.01 cm), respectively in open condition and teak based agroforestry system. Similar trend of response was also noted in both the years of study in both growing conditions.

3.1.2 Effect of foliar spray of Iron

Plant height was recorded significantly maximum (126.13 and 114.70 cm) by foliar spray of 0.5 % $FeSO_4$ and minimum (114.59 and 106.64 cm) with no spray of iron, respectively in open condition and teak based agroforestry system in pooled analysis. For both the years the trend was similar.

3.1.3 Effect of foliar spray of Zinc

Foliar spray of zinc 0.5% $ZnSO_4$ recorded significantly maximum plant height (124.94 and 117.73 cm), respectively in open condition and teak based agroforestry system in pooled analysis. Both the years follow same trend in both growing conditions.

3.1.4 Interaction effect

The interaction effect of varieties and foliar spray of zinc ($V \times Z$) was found significant for plant height of cluster bean in year 2021 and pooled analysis under teak based agroforestry system. Among different treatment combinations of varieties and zinc foliar spray, Pusa Navbahar variety with foliar spray of 0.5% $ZnSO_4$ (V_1Z_1) recorded maximum plant height (127.81 and 128.82 cm, respectively) for year 2021 and pooled analysis (Table 1a). In case of open condition, treatment combination of foliar spray of iron and zinc ($F \times Z$) interaction was found significant for plant height in pooled analysis. Foliar spray of 0.5% $FeSO_4$ with foliar spray of 0.5% $ZnSO_4$ (F_1Z_1) recorded maximum plant height (128.44 cm) in pooled analysis in open condition (Table 1b). Rest all interactions were

found non-significant for plant height of cluster bean under teak based agroforestry system and open condition.

3.2 Number of Branches per Plant

Data pertaining to number of branches per plant as affected by varieties and foliar spray of micronutrient are given in Table 2.

3.2.1 Effect of varieties

In pooled analysis, variety Pusa Navbahar recorded significantly maximum number of branches per plant (10.20 and 8.83) over local variety (8.56 and 7.22), respectively in open condition and teak based agroforestry system. Year 2021 and 2022 follow the similar trend of result.

3.2.2 Effect of foliar spray of Iron

Foliar spray of 0.5 % FeSO₄ resulted in highest number of branches per plant (10.00 and 8.65) as compare to local variety (8.76 and 7.40), respectively in open growing condition and teak based agroforestry system in pooled analysis. Further result showed that both the years also follow same trend.

3.2.3 Effect of foliar spray of Zinc

Foliar spray of 0.5 % ZnSO₄ recorded maximum number of branches per plant (10.10 and 8.79) in comparison to no spray of zinc (8.66 and 7.27), respectively in open condition and teak based agroforestry system in pooled analysis. During both the years of experiment, similar trend was observed.

3.2.4 Interaction effect

Interaction effect of different combinations of varieties (V), foliar spray of zinc (Z) and iron (F) found to be non-significant for number of branches per plant for both the years and pooled analysis under teak based agroforestry system and in open condition.

3.3 Number of Leaves per Plant

Table 3 showed the information regarding variation in number of leaves per plant as influenced by varieties and foliar spray of micronutrient.

3.3.1 Effect of varieties

Varieties differed significantly for number of leaves per plant. Variety, Pusa Navbahar recorded maximum number of leaves per plant (50.67 and 38.76) over local variety (42.63 and 31.64), respectively in open condition and teak based agroforestry system in pooled analysis. Further result showed that both the years of study follow same trend.

3.3.2 Effect of foliar spray of Iron

Higher number of leaves per plant (48.95 and 37.14), respectively in open condition and teak based agroforestry system was found with foliar application of 0.5 % FeSO₄ over no application of iron in pooled analysis. The trend was observed similar during year 2021 and 2022.

3.3.3 Effect of foliar spray of zinc

Number of leaves per plant was recorded maximum by foliar spray of 0.5 % ZnSO₄ (49.61 and 37.49) as compare to no spray of zinc (43.70 and 32.91), respectively in open condition and teak based agroforestry system in pooled analysis. In individual year also, the trend was same.

3.3.4 Interaction effect

For both growing conditions, interaction effect of varieties (V), foliar spray of zinc (Z) and iron (F) and their other combinations were found to be non-significant for both years and pooled analysis in both growing conditions.

3.4 Stem Diameter (mm)

The data with regard to effect of varieties and foliar spray of iron and zinc on stem diameter of cluster bean crop is presented in Table 4.

3.4.1 Effect of varieties

The variety Pusa Navbahar recorded highest stem diameter (13.64 and 11.91 mm), respectively in open condition and teak based agroforestry in pooled analysis. Further, in open condition and teak based agroforestry system, the lowest stem diameter (12.60 and 10.85 mm, respectively) was recorded by local variety in pooled analysis.

Table 1. Effect of varieties, foliar spray of micronutrient on plant height (cm) of cluster bean under teak based agroforestry system and in open condition

Treatments	Teak based Agroforestry System			Open Condition								
	2021	2022	Pooled	2021	2022	Pooled						
Variety (V)												
V ₁ (Pusa Navbahar)	117.70	120.95	119.33	123.29	130.52	126.90						
V ₂ (Local Variety)	99.91	104.12	102.01	111.34	116.31	113.83						
Foliar Spray of Micronutrient Iron (F)												
F ₀ (No Iron)	104.69	108.60	106.64	111.83	117.35	114.59						
F ₁ (0.5% FeSO ₄)	112.93	116.47	114.70	122.79	129.48	126.13						
Foliar Spray of Micronutrient Zinc (Z)												
Z ₀ (No Zinc)	101.45	105.78	103.61	113.24	118.33	115.78						
Z ₁ (0.5% ZnSO ₄)	116.16	119.29	117.73	121.38	128.50	124.94						
#S.Em.±	1.86	2.05	1.38	2.25	1.97	1.49						
#C.D. at 5%	5.47	6.03	3.95	6.62	5.79	4.27						
C.V. (%)	6.84	7.28	7.08	7.68	6.38	7.04						
	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%
Year (Y)					1.38	NS					1.49	4.27
Y x V					1.95	NS					2.11	NS
Y x F					1.95	NS					2.11	NS
Y x Z					1.95	NS					2.11	NS
V x F	2.63	NS	2.89	NS	1.95	NS	3.18	NS	2.78	NS	2.11	NS
Y x V x F					2.77	NS					2.99	NS
V x Z	2.63	7.74	2.89	NS	1.95	5.59	3.18	NS	2.78	NS	2.11	NS
Y x V x Z					2.77	NS					2.99	NS
F x Z	2.63	NS	2.89	NS	1.95	NS	3.18	NS	2.78	NS	2.11	6.04
Y x F x Z					2.77	NS					2.99	NS
V x F x Z	3.72	NS	4.10	NS	2.77	NS	4.50	NS	3.94	NS	2.99	NS
Y x V x F x Z					3.91	NS					4.23	NS

CD and SEm values are same for the individual effect of Variety, Foliar application of Iron and Zinc

Table 1a. Interaction effect of variety (V) and foliar spray of micronutrient zinc (Z) on plant height (cm) at harvest of cluster bean under teak based agroforestry system

Treatment (V x Z)	Plant height (cm)			
	Year 2021		Pooled	
	Z ₀	Z ₁	Z ₀	Z ₁
V ₁	107.60	127.81	109.84	128.82
V ₂	95.30	104.52	97.39	106.64
S.Em.±	2.63		1.95	
C.D. at 5 %	7.74		5.59	

Table 1b. Interaction effect of foliar spray of micronutrient iron (F) and zinc (Z) on plant height (cm) at harvest of cluster bean in open condition

Treatment (F x Z)	Plant height (cm)		
	Pooled		Z ₁
	Z ₀		
F ₀	107.74		121.44
F ₁	123.83		128.44
S.Em.±	2.12		
C.D. at 5 %	6.04		

3.4.2 Effect of foliar spray of iron

The result showed that in open condition and teak based agroforestry system, foliar 0.5% FeSO₄ spray resulted in highest stem diameter (13.52 and 11.76 mm, respectively) in pooled analysis. During study, both the years also follow same trend.

3.4.3 Effect of foliar spray of zinc

Pooled analysis data revealed that highest stem diameter was attained by 0.5% ZnSO₄ foliar spray (13.55 and 11.85 mm), respectively in open conditions and teak based agroforestry system. Furthermore, similar trend followed by both the years.

3.4.4 Interaction effect

Interaction effect of different treatment combinations were found non-significant for stem diameter in consecutive year and pooled analysis under teak based agroforestry system and in open condition.

3.5 T-Test analysis for Growth Parameters between Both Growing Conditions

The result of t-test showed that plant height and number of branches were not significantly affected by both growing conditions. However, number of leaves per plant and stem diameter were significantly affected. All the growth parameters were registered maximum under open condition as compare to teak-based agroforestry system (Table 5).

4. DISCUSSION

It is possible that genetic growth differences between varieties account for sizable variations in plant height, number of branches per plant, number of leaves, and stem diameter. The findings were supported by Kalyani [11], Anupama et al. [12], Thakur et al. [13], Naik et al. [14], Rajamanickam [15] and Nanthakumar et al. [16].

The application of micronutrients may result in an increase in plant growth characteristics such as plant height, number of leaves and branches per plant due to their involvement in chlorophyll formation, which may have aided in cell division, meristematic activity in apical tissue, cell expansion and cell wall formation. Foliar micronutrient feeding increased photosynthetic and other metabolic activities, photo-assimilate deposition, carbohydrate translocation, physiological and other metabolite improvement, and an increase in various plant metabolites responsible for cell division and elongation. Singh et al. [17] reported that foliar application of iron and zinc increased growth parameters in mung bean. Growth attributes of mung were significantly improved by foliar application of iron sulphate [18]. The result of study is consistent with that earlier report by Mondal et al. [19], Heidarian et al. [20], Raliya and Tarafdar [21], Khatab et al. [22], Divyashree [23], Marzouk et al. [24], Vasava et al. [25] and Fatima et al. [26].

Table 2. Effect of varieties, foliar spray of micronutrient on number of branches per plant of cluster bean under teak based agroforestry system and in open condition

Treatments	Teak based Agroforestry System			Open Condition								
	2021	2022	Pooled	2021	2022	Pooled						
Variety (V)												
V ₁ (Pusa Navbahar)	8.48	9.18	8.83	10.02	10.38	10.20						
V ₂ (Local Variety)	6.72	7.72	7.22	8.35	8.76	8.56						
Foliar Spray of Micronutrient Iron (F)												
F ₀ (No Iron)	6.98	7.82	7.40	8.57	8.95	8.76						
F ₁ (0.5% FeSO ₄)	8.22	9.07	8.65	9.80	10.20	10.00						
Foliar Spray of Micronutrient Zinc (Z)												
Z ₀ (No Zinc)	6.91	7.62	7.27	8.47	8.85	8.66						
Z ₁ (0.5% ZnSO ₄)	8.30	9.28	8.79	9.90	10.29	10.10						
#S.Em.±	0.20	0.16	0.13	0.17	0.17	0.12						
#C.D. at 5%	0.59	0.48	0.37	0.52	0.50	0.35						
C.V. (%)	10.60	7.72	9.14	7.74	7.15	7.44						
	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%
Year (Y)				0.13	0.37						0.12	0.35
Y x V				0.18	NS						0.17	NS
Y x F				0.18	NS						0.17	NS
Y x Z				0.18	NS						0.17	NS
V x F	0.28	NS	0.23	NS	0.18	NS	0.25	NS	0.24	NS	0.17	NS
Y x V x F				0.25	NS						0.24	NS
V x Z	0.28	NS	0.23	NS	0.18	NS	0.25	NS	0.24	NS	0.17	NS
Y x V x Z				0.25	NS						0.24	NS
F x Z	0.28	NS	0.23	NS	0.18	NS	0.25	NS	0.24	NS	0.17	NS
Y x F x Z				0.25	NS						0.24	NS
V x F x Z	0.40	NS	0.32	NS	0.25	NS	0.35	NS	0.34	NS	0.24	NS
Y x V x F x Z				0.36	NS						0.34	NS

CD and SEm values are same for the individual effect of Variety, Foliar application of Iron and Zinc

Table 3. Effect of varieties, foliar application of micronutrient on number of leaves per plant of cluster bean under teak based agroforestry system and in open condition

Treatments	Teak based Agroforestry System			Open Condition								
	2021	2022	Pooled	2021	2022	Pooled						
Variety (V)												
V ₁ (Pusa Navbahar)	36.73	40.79	38.76	47.80	53.55	50.67						
V ₂ (Local Variety)	30.42	32.87	31.64	38.95	46.31	42.63						
Foliar Spray of Micronutrient Iron (F)												
F ₀ (No Iron)	31.79	34.72	33.25	41.49	47.22	44.36						
F ₁ (0.5% FeSO ₄)	35.36	38.93	37.14	45.25	52.64	48.95						
Foliar Spray of Micronutrient Zinc (Z)												
Z ₀ (No Zinc)	31.28	34.54	32.91	40.59	46.80	43.70						
Z ₁ (0.5% ZnSO ₄)	35.87	39.11	37.49	46.16	53.06	49.61						
#S.Em.±	0.69	0.65	0.47	0.95	0.91	0.66						
#C.D. at 5%	2.05	1.92	1.36	2.82	2.67	1.88						
C.V. (%)	8.30	7.10	7.68	8.84	7.29	8.02						
	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%
Year (Y)				0.47	1.36						0.66	1.82
Y x V				0.67	NS						0.93	NS
Y x F				0.67	NS						0.93	NS
Y x Z				0.67	NS						0.93	NS
V x F	0.98	NS	0.92	NS	0.67	NS	1.35	NS	1.28	NS	0.93	NS
Y x V x F				0.95	NS						1.32	NS
V x Z	0.98	NS	0.92	NS	0.59	NS	1.35	NS	1.28	NS	0.93	NS
Y x V x Z				0.95	NS						1.32	NS
F x Z	0.98	NS	0.92	NS	0.59	NS	1.35	NS	1.28	NS	0.93	NS
Y x F x Z				0.95	NS						1.32	NS
V x F x Z	1.39	NS	1.30	NS	0.95	NS	1.91	NS	1.82	NS	1.32	NS
Y x V x F x Z				1.35	NS						1.87	NS

CD and SEm values are same for the individual effect of Variety, Foliar application of Iron and Zinc

Table 4. Effect of varieties, foliar spray of micronutrient on stem diameter (mm) of cluster bean under teak based agroforestry system and in open condition

Treatments	Teak based Agroforestry System			Open Condition								
	2021	2022	Pooled	2021	2022	Pooled						
Variety (V)												
V ₁ (Pusa Navbahar)	11.67	12.16	11.91	13.42	13.86	13.64						
V ₂ (Local Variety)	10.68	11.02	10.85	12.49	12.71	12.60						
Foliar Spray of Micronutrient Iron (F)												
F ₀ (No Iron)	10.81	11.20	11.01	12.60	12.85	12.73						
F ₁ (0.5% FeSO ₄)	11.54	11.98	11.76	13.31	13.72	13.52						
Foliar Spray of Micronutrient Zinc (Z)												
Z ₀ (No Zinc)	10.72	11.11	10.92	12.55	12.83	12.69						
Z ₁ (0.5% ZnSO ₄)	11.63	12.07	11.85	13.36	13.74	13.55						
#S.Em.±	0.24	0.22	0.16	0.23	0.23	0.16						
#C.D. at 5%	0.71	0.64	0.46	0.69	0.68	0.47						
C.V. (%)	8.72	7.62	8.17	7.32	7.05	7.19						
	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%	S.Em.±	C.D. at 5%
Year (Y)				0.16	NS					0.16	NS	
Y x V				0.23	NS					0.23	NS	
Y x F				0.23	NS					0.23	NS	
Y x Z				0.23	NS					0.23	NS	
V x F	0.34	NS	0.31	NS	0.23	NS	0.33	NS	0.33	NS	0.23	NS
Y x V x F				0.32	NS					0.33	NS	
V x Z	0.34	NS	0.31	NS	0.23	NS	0.33	NS	0.33	NS	0.23	NS
Y x V x Z				0.32	NS					0.33	NS	
F x Z	0.34	NS	0.31	NS	0.23	NS	0.33	NS	0.33	NS	0.23	NS
Y x F x Z				0.32	NS					0.33	NS	
V x F x Z	0.48	NS	0.44	NS	0.32	NS	0.47	NS	0.46	NS	0.33	NS
Y x V x F x Z				0.46	NS					0.47	NS	

CD and SEm values are same for the individual effect of Variety, Foliar application of Iron and Zinc

Table 5. Effect of growing conditions on growth parameters of cluster bean

Growing conditions	Plant height (cm)	No. of branches per plant	No. of leaves per plant	Stem diameter (mm)
Teak based agroforestry system	110.67	8.03	35.20	11.38
Open condition	120.36	9.38	46.65	13.12
t Stat	-1.62	-1.97	-4.17	-4.04
P (T<=t) two tail	0.13	0.07	0.00	0.00

Reduced plant growth under teak based agroforestry system could be attributed to light intensity. Because in open condition better availability of light which ultimately increased plant height, number of branches per plant, number of leaves per plant and stem diameter of cluster bean. Lesser amount of light allowed by teak might have negative effect on growth of cluster bean. Oladele et al. [27] reported reduced growth of ginger under mature teak plantation. Kumar et al. [28] observed higher plant height of *Ocimum* spp. in sole cropping as compare to teak plantation. Reduced growth of cluster bean was attained under ailanthus-based agroforestry system over sole cropping Rajalingam et al. [29]. Cotton growth was lower under teak based agroforestry system as compare to control condition (No teak tree) Hulke et al. [30].

5. CONCLUSION

Based on findings of experiment, it is concluded that among tested varieties of cluster bean, Pusa Navbahar variety significantly improved growth parameters in both growing conditions. Similarly, foliar spray of 0.5% FeSO₄ and 0.5% ZnSO₄ also enhanced the growth of cluster bean in comparison to no spray. Furthermore, study demonstrated that teak based agroforestry system reduced the growth parameters of cluster bean as compare to open condition.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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