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Studies on Vegetative Attributes Affected by Bio fertilizers on Different Cultivars of Pear (*Pyrus communis* L.) under the Climatic Condition of Western Uttar Pradesh

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ABSTRACT: An experiment was conducted during 2021 to 2023 at Horticultural Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, U.P., to investigate the impact of biofertilizers on the vegetative characteristics of five pear varieties: Babugosha, Punjab Beauty, Punjab Gold, Punjab Nectar, and Gola. These varieties were subjected to varying doses of bio fertilizers, including different combinations of *Azotobacter, Trichoderma,* PSB, and Vermicompost. Eight distinct treatments were formulated by combining these biofertilizer components. Plants are associated with rhizospheric microbes, which have the ability to promote crop growth and stress tolerance, enhance plant nutrition, and improve vegetation propagation. Thus, the formulation and application of biofertilizers containing these beneficial microbes is a promising approach to improve horticultural crops. Out of the 8 treatments applied, the findings of the study revealed that among the different biofertilizer applications, Treatment 8 (T8), consisting of N-100% + P-100% + *Azotobacter* (100g) + PSB (100g) + *Trichoderma* (50g) + vermicompost at 3kg, exhibited favourable interactions with variety 5 (V5), known as the Gola variety. This treatment resulted in the highest plant height (6.42 and 6.50 cm), maximum number of lateral branches (25.69 and 26.03) per plant, greatest stem girth (31.59 and 31.98 mm), and largest canopy spread (3.66 and 3.69 m) over both years of the experiment. These combination of N-100% + P-100% + *Azotobacter* (100g) + PSB (100g) + *Trichoderma* (50g) + vermicompost at 3kg proved to be the most effective in promoting the vegetative growth of the trees, specifically enhancing parameters such as plant height, number of lateral branches, plant canopy size, and stem girth in the case of the Gola variety.

Keywords: Bio fertilizer, Plant Canopy, Cultivar of pear, INM, vermicompost.

INTRODUCTION

Pears are considered one of the oldest fruit crops grown across the world. Pear belongs to the genus *Pyrus*, the subfamily Maloideae (Pomoideae) in the family Rosaceae. There are 22 widely recognized primary species, which are distributed across Europe, temperate Asia and mountainous regions of northern Africa (Bell *et al*., 1996). Most cultivated pears are functional diploids, possessing a chromosome number 2n = 34. However, a few polyploid (triploids and tetraploids) cultivars of *P. communis* and *P. bretschneideri* exist (Zielinski and Thompson 1967). Pear is widely cultivated across the sub-tropical and temperate regions of India. This genus is considered to originate in the mountainous area of western and southwestern China (Lombard and Westwood, 1987) during the Tertiary periods (65-55 million years ago) and to spread into the east and west. Two sub-centres (Central Asia, and Eastern China) of diversity for the genus have been identified (Vavilov, 1951).

Pear occupies an area of 43.86 thousand hectares with an annual production of 0.309 million metric tonnes. The major pear producing states are Punjab, Jammu and Kashmir, Uttarakhand, Himachal Pradesh. Punjab ranks first in production with an annual production of 101.57 thousand metric tonnes from an area of 4.34 thousand hectares. The leading state with highest area under cultivation of pear is Jammu and Kashmir (14.16 thousand hectares) followed by Uttarakhand, Himachal Pradesh, Punjab etc. The average national productivity of pear is estimated to be 7.05 MT/ha whereas Punjab has the highest productivity (23.40 MT/ha) followed by Jammu and Kashmir (Anonymous, 2021).

The name pear, from the Anglo Saxon pere or peru hu, is derived from Latin pirum. As per National Nutrient Database released by United States Department of

Agriculture (USDA) in 2018, 100 g of guava fruit contains 15.23 g carbohydrates, 3.1 g total dietary fibre, 9.75 g sugar and 0.36 g protein. Beside this, it is also abundant in vitamin C (4.3 mg), potassium (116 mg), phosphorus (12 mg), calcium (9 mg), magnesium (7 mg) and iron (0.18 mg) (Anonymous, 2018).

Pear production and quality, however, fall short of expectations. Widespread usage of chemical fertilizers speeds up production. Over the past forty years, the indiscriminate use of chemical fertilizers, pesticides, weedicides, etc. has had a negative impact on soil fertility, water quality, produce quality, and has caused the emergence of new pest and disease strains. We now have the option of using biological inputs like biofertilizers due to the continually rising cost of commercial fertilizers and the loss in soil health caused by an overreliance on chemical inputs.

An integrated nutrient management system (INMS) can play an important role in stabilizing both soil health and long-term crop production, which can be achieved despite the combined use of all possible sources of nutrients. The combination of chemical fertilizers and organic fertilizers and biofertilizers can maintain soil health and soil fertility (Gurjar *et al.,* 2022). Integrated Nutrient management (INM) comprises organic, inorganic and microorganisms are highly beneficial for sustainable food and fruit production as it ameliorates soil environment, maintains adequate level of nutrients and provide favorable conditions for higher yield with divine quality. Among various factors which affect the productivity and cost of production, in view of the other fact, it becomes too imperative to make fruit production a more cost-effective enterprise. Bio-fertilizer is considered an important component of INM.

Bio fertilizers are an important part of sustainable agriculture practices, as they enhance crop growth and increase yield by 20-30% in plants. Biofertilizers are input containing microorganisms capable of mobilizing and solubilization of nutritive elements through biological processes. They are less expensive, ecofriendly and sustainable and do not require non-renewable source of energy during their production (Rathod *et al*., 2022). Application of Bio-fertilizers are one of the most successful current tool of agriculture. Although most of our agricultural activities are driven by the monsoon, farmers can benefit from utilizing a suitable biofertilizer by improving soil fertility and producing a larger yield (Singh and Sadawarti 2020). Bio fertilizers are live organisms that help to improve soil fertility and plant growth. These microorganisms aid in the nitrogen fixation process, which generates plant growth factors. Bio fertilizers are the most importance for plant production and soil as they play an important role in increasing vegetative growth, yield and fruit quality on pear (Fayed, 2005).

MATERIAL AND METHOD

Experimental Site. The investigation was conducted at the Horticulture Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram, Meerut, U.P. during the year 2021-22 and 2022-23. The location of the experimental field is at 20°04' North Latitude and 77°42' East Longitude, at a height of 237.75 meters above mean sea level. The Experimental material consists of 120 trees, and all of them were subjected to uniform cultural practices, avoiding pruning during the course of experimentation. The experiment was performed on a 7 – 8-year-old pear orchard spaced at 3 × 3 m, laid out in a Factorial Randomized Block Design (FRBD), and required parameters were recorded.

The number of varieties was five, each replicated 3 times. Five cultivars of Pear were studied namely Punjab Gold, Punjab Nectar and Punjab Beauty collected from PAU, Ludhiana, Punjab, Baggugosa and Gola collected from GBPUA&T, Pant Nagar Uttarakhand.

Climatic conditions. The climate of the Meerut region is sub-tropical and semi-arid, with scorching summer and cool winters. During the summer, the region's average maximum temperature is 40-45^{0}C, while the average lowest temperature is 4-6.8 ^{0}C. From December to February, the region is prone to frost. The monsoon season typically begin in the last week of June and ends until late September. This region's overall rainfall, as well as its distribution, is quite unequal. Between July and September, 85-95% of the season's total rainfall falls. During the month of December to January and the spring, the region has a few cyclonic rain storms. Average annual rainfall in the region is about 872.7 mm and annual relative humidity varies from 68-84%. Mean monthly weather parameters prevailing during the course of the investigation were obtained from the metrological observatory of Department of Agriculture metrological observatory of Department of Agriculture, SVPUA&T and Meerut (Uttar Pradesh).

Plant Height (m). The tree height was measured from ground level to the top of the highest branch of plant with the help of measuring pole ignoring the off shoots and average was calculated. The tree height was expressed in meters.

Number of lateral branches/plants. The number of lateral branches/plants was recorded by counting the number of lateral branches in each of the experimental tree and it was expressed in numbers.

Canopy spread (m). The canopy spread was calculated by measuring the length of canopy both in the both East-West and North-South direction with the help of bamboo stick or measuring tape and average was worked out in meters.

Stem Girth (mm). Stem Girth was recorded from five randomly selected plants by the digital Vernier callipers and average was calculated to find diameter of stem.

Statistical Analysis. The experimental data recorded in respect of different observations in the present investigation will be analysed statistically with the help of significance of differences among treatments by the '- test' and conclusion were drawn at 5% probability level, when 'F' value from analysis, pertaining two various sources of variation in the analysis of variance.

Treatment Details
Details of the treatments
Factor A: Varieties of pear (five)

Sr. No.	Variety	Notation
1.	Babugosha	V_1
2.	Punjab beauty	V_2
3.	Punjab Gold	V_3
4.	Punjab Nectar	V_4
5.	Gola	V_5

Factor B: Biofertilizers

S. No.	Fertilizers and Biofertilizer	Notation
1.	Control	T_1
2.	NPK as recommended (150:75:240 gm/tree)	T_2
3.	Control + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost@ 3kg	T_3
4.	N 75% + P 75% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg	T_4
5.	N 50% + P 50% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg	T_5
6.	N 75% + P 50% + *Azotobacte*r (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg	T_6
7.	N 50% + P 75% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg	T_7
8.	N 100% + P 100% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg	T_8

RESULT AND DISCUSSION

Plant height. A perusal of Table 1 indicated that the plant height was significant with respect to different variety and biofertilizers during 2021-22 and 2022-23. It is evident from the data that maximum plant height (5.98 and 6.06cm) was recorded with Gola variety (V_5 treatment) followed by V_2 (Punjab beauty) and V_3 (Punjab gold) treatment, while the minimum plant height (5.23 and 5.34cm) was recorded with Babugosha and Punjab nectar variety. Among various biofertilizer application, T_8 (N-100%+P-100%+*Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3kg) take maximum plant height (6.42 and 6.50cm) at par with T_2 (NPK as recommended (150:75:240 gm/tree) and T_4 (N 75% + P 75% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg) treatment during both the years of experiments, whereas control (T_1) treatment takes minimum plant height (4.62 and 4.74cm) during both the year of experiments. A close perusal of the observation presented in Table 1, pertaining to plant height showed non-significant effect for different variety and biofertilizers. Among all treatment combination, V_5T_8 (Gola variety with N-100%+P-100%+*Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3kg) treatment combination showed the maximum plant height (6.54 and 6.62cm) at par with V_2T_8 (Punjab beauty with N 100% + P 100% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg) and V_5T_2 (Gola with NPK as recommended (150:75:240 gm/tree) treatment combinations. While, V_4T_1 (Punjab Nectar with control) treatment combination take minimum plant height (4.28 and 4.34cm) during both the year of experiments.

On an average the pooled data presented in Table 1, indicated that the plant height was showed significant results with respect to different variety and biofertilizers application during experiment trail. It is evident from the data that maximum plant height (6.02cm) was recorded with Gola variety (V_5) followed by Punjab beauty (V_2), while the minimum plant height (5.30cm) was recorded with Punjab Nectar variety. Among various biofertilizer application, T_8 (N-100%+P-100%+ *Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3kg) take maximum plant height (6.46cm) followed by application of (NPK as recommended *i.e.*, 150:75:240g/tree (T_2), whereas control (T_1) treatment takes minimum plant height (4.68cm) under control (T_1) treatment during experiment trail. A close perusal of the observation presented in Table 1, pertaining to plant height showed non-significant interaction effect among different variety and biofertilizers during experiment trail. Among all treatment combination, V_5T_8 (Gola variety with N-100% + P-100% + *Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g)

+ vermicompost @ 3kg) treatment combination showed the maximum plant height (6.58cm) followed by Punjab beauty with N-100%+P-100%+ *Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3kg (V_2T_8), treatment combination. While, V_4T_1 (Punjab Nectar with control) treatment combination take minimum plant height (4.31cm) during experiment trail. The results were in conformity with the finding of Rani *et al*. (2021) in guava, Kamatyanatti *et al*. (2019) in plum and Singh and Varu (2013) in papaya. The increase in plant height can be attributed to valuable effect of microbes present in the rhizosphere leading to higher mobilization of solute to the roots and thus the improvement in tree growth behaviour. Nitrogen fixing biofertilizers mainly Azotobacter produce growth promoting hormone like IAA which is absorbed by the roots which could be one of the reasons for increase in vegetative growth (Marathe and Bharambe 2007).

Table 1: Effect of Bio-fertilizers on plant height (m) of different cultivars of pear.

2021-2022												
Treatments	**Bio-fertilizers**										**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	0.26	0.09
V_1	4.28	5.65	4.31	5.61	5.24	5.33	5.09	6.31	**5.23**	T=	0.33	0.12
V_2	4.89	6.28	4.92	5.81	5.45	5.89	6.10	6.51	**5.73**	V×T=	NS	0.26
V_3	4.34	6.16	4.60	5.70	4.87	5.30	5.26	6.39	**5.33**			
V_4	4.28	6.11	4.54	5.64	4.81	5.24	5.20	6.33	**5.27**			
V_5	5.31	6.47	5.33	6.37	5.72	6.24	5.86	6.54	**5.98**			
Mean	**4.62**	**6.13**	**4.74**	**5.82**	**5.22**	**5.60**	**5.50**	**6.42**				
2022-2023											**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	0.25	0.09
V_1	4.34	5.61	4.87	5.26	5.31	5.70	6.17	6.40	5.46	T=	0.32	0.11
V_2	5.29	6.51	5.21	5.89	5.35	5.79	5.74	6.59	5.80	V×T=	NS	0.25
V_3	4.40	6.34	4.66	5.77	4.93	5.37	5.33	6.48	5.41			
V_4	4.34	6.19	4.60	5.71	4.88	5.31	5.27	6.42	5.34			
V_5	5.32	6.56	5.41	6.45	5.80	6.32	5.98	6.62	6.06			
Mean	**4.74**	**6.24**	**4.95**	**5.82**	**5.25**	**5.70**	**5.70**	**6.50**				
Pooled											**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	0.25	0.09
V_1	4.31	5.63	4.59	5.43	5.27	5.51	5.63	6.35	**5.34**	T=	0.32	0.12
V_2	5.09	6.39	5.07	5.85	5.40	5.84	5.92	6.55	**5.76**	V×T=	NS	0.26
V_3	4.37	6.25	4.63	5.73	4.90	5.34	5.29	6.43	**5.37**			
V_4	4.31	6.15	4.57	5.67	4.84	5.28	5.23	6.38	**5.30**			
V_5	5.32	6.52	5.37	6.41	5.76	6.28	5.92	6.58	**6.02**			
Mean	**4.68**	**6.19**	**4.85**	**5.82**	**5.24**	**5.65**	**5.60**	**6.46**				

Number of lateral branches per plant. The data presented in Table 2 indicated that the different variety and biofertilizers were significantly affect the number of lateral branches per plant during both the years of experimentation 2021-22 and 2022-23. It is evident from the data that the maximum number of lateral branches (25.82 and 25.92) per plant was recorded under V_5 (Gola variety) followed by V_2 and V_3 (Punjab gold) treatment, whereas, minimum number of lateral branches (22.82 and 22.91) per plant was recorded under V_1 (Baggugosha) treatment. Among different biofertilizers, treatment T_8 (N-100%+P-100%+ *Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + Vermicompost @ 3kg) gave maximum number of lateral branches (27.56 and 27.67) per plant followed by treatment T_2 (NPK as recommended (150:75:240 gm/tree) and T_4 (N 75% + P 75% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg), while minimum number of lateral branches (20.56 and 20.64) per plant was recorded with control (T_1) treatment during both the years of experiments. Interaction effect among different variety and biofertilizers were also found non-significant with respect to number of lateral branches per plant (Table 2). The maximum number of lateral branches (28.08 and 28.19) per plant was obtained with V_5T_8 (Gola variety with N-100%+ P-100%+ *Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg), which was at par with V_2T_8 (Punjab beauty with N-100%+ P-100%+ *Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) and V_5T_2 (Gola with NPK as recommended (150:75:240 gm/tree) treatment combination, whereas, Punjab Nectar variety with control (V_1T_1) treatment combination was recorded the minimum number of lateral branches (19.41 and 19.49) per plant during both the year of experiments.

On an average the pooled data presented in Table 2 indicated that the different variety and biofertilizers were significantly effect on number of lateral branches per plant during experiment trail. It is evident from the data that the maximum number of lateral branches (25.87) per plant was recorded under V_5 (Gola variety) followed by V_2 (Punjab beauty) and V_3 (Punjab gold) treatment, whereas, minimum number of lateral branches (22.86) per plant was recorded under V_1 (Baggugosha) treatment. Among different biofertilizers, treatment T_8 (N-100%+P-100%+*Azotobacter*(100g) +

PSB (100g) + Trichoderma (50g) + Vermicompost @ 3kg) gave maximum number of lateral branches (27.62) per plant followed by treatment T_2 (NPK as recommended (150:75:240 gm/tree) and T_4 (N 75% + P 75% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg), while minimum number of lateral branches (20.60) per plant was recorded with control (T_1) treatment during experiment trail. Interaction effect among different variety and biofertilizers were also found non-significant with respect to number of lateral branches per plant (Table 2).

Table 2: Effect of Bio-fertilizers on Number of Lateral Branch/plants of different cultivars of pear.

2021-2022												
Treatments	**Bio-fertilizers**										**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	1.12	0.40
V_1	19.41	20.22	20.67	22.30	22.50	24.17	26.15	27.12	**22.82**	T=	1.41	0.50
V_2	21.52	27.84	21.26	27.12	23.41	25.26	24.06	27.95	**24.80**	V×T=	3.16	1.12
V_3	18.64	27.88	19.77	24.47	20.92	22.78	22.58	27.46	**23.06**			
V_4	20.39	26.51	19.52	24.22	20.67	22.53	22.33	27.21	**22.92**			
V_5	22.83	28.81	22.92	27.36	24.58	26.80	25.16	28.08	**25.82**			
Mean	**20.56**	**26.25**	**20.83**	**25.09**	**22.42**	**24.31**	**24.06**	**27.56**				
2022-2023											**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	1.04	0.37
V_1	19.49	20.33	20.75	22.39	22.59	24.26	26.25	27.23	**22.91**	T=	1.31	0.47
V_2	21.61	27.95	21.34	27.23	23.50	25.36	24.16	28.06	**24.90**	V×T=	2.94	1.04
V_3	18.71	27.99	19.85	24.57	21.01	22.87	22.67	27.57	**23.16**			
V_4	20.47	26.61	19.60	24.32	20.76	22.62	22.42	27.32	**23.01**			
V_5	22.92	28.93	23.01	27.47	24.68	26.91	25.26	28.19	**25.92**			
Mean	**20.64**	**26.36**	**20.91**	**25.19**	**22.51**	**24.41**	**24.15**	**27.67**				
Pooled											**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	1.07	0.38
V_1	19.45	20.27	20.71	22.34	22.54	24.22	26.20	27.18	**22.86**	T=	1.35	0.48
V_2	21.57	27.90	21.30	27.17	23.46	25.31	24.11	28.00	**24.85**	V×T=	3.03	1.08
V_3	18.68	27.93	19.81	24.52	20.97	22.82	22.62	27.52	**23.11**			
V_4	20.43	26.56	19.56	24.27	20.72	22.57	22.37	27.27	**22.97**			
V_5	22.87	28.87	22.96	27.41	24.63	26.86	25.21	28.13	**25.87**			
Mean	**20.60**	**26.31**	**20.87**	**25.14**	**22.46**	**24.36**	**24.10**	**27.62**				

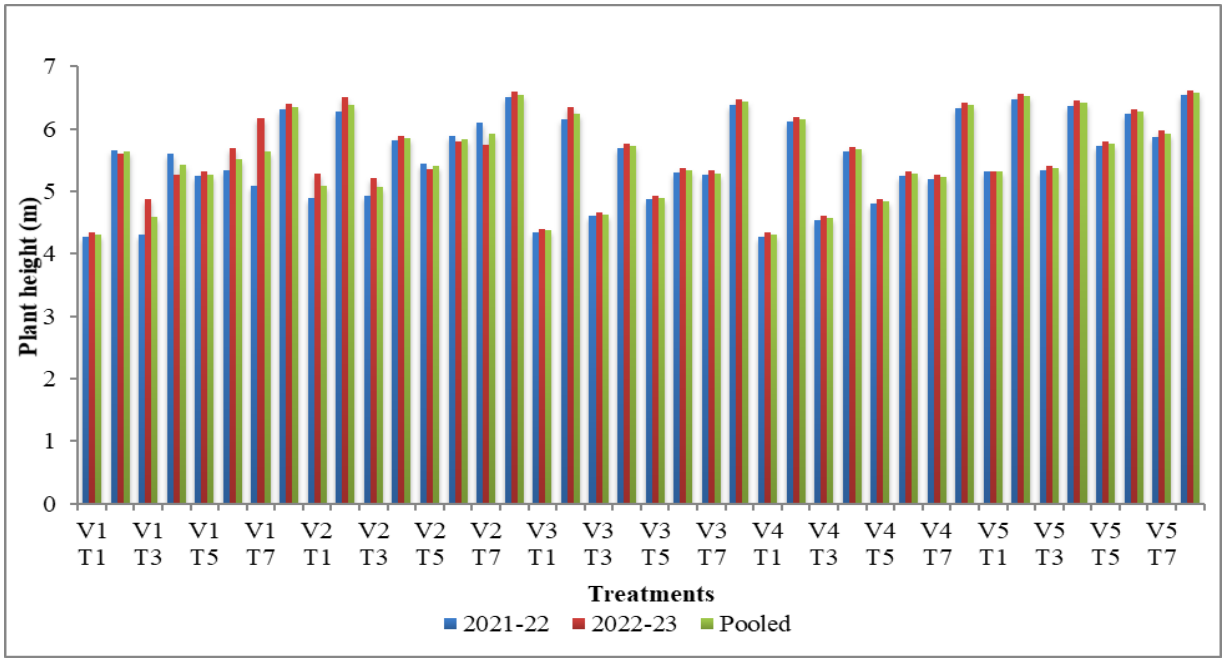

Fig. 1. Effect of Bio-fertilizers on plant height (m) of different cultivars of pear.

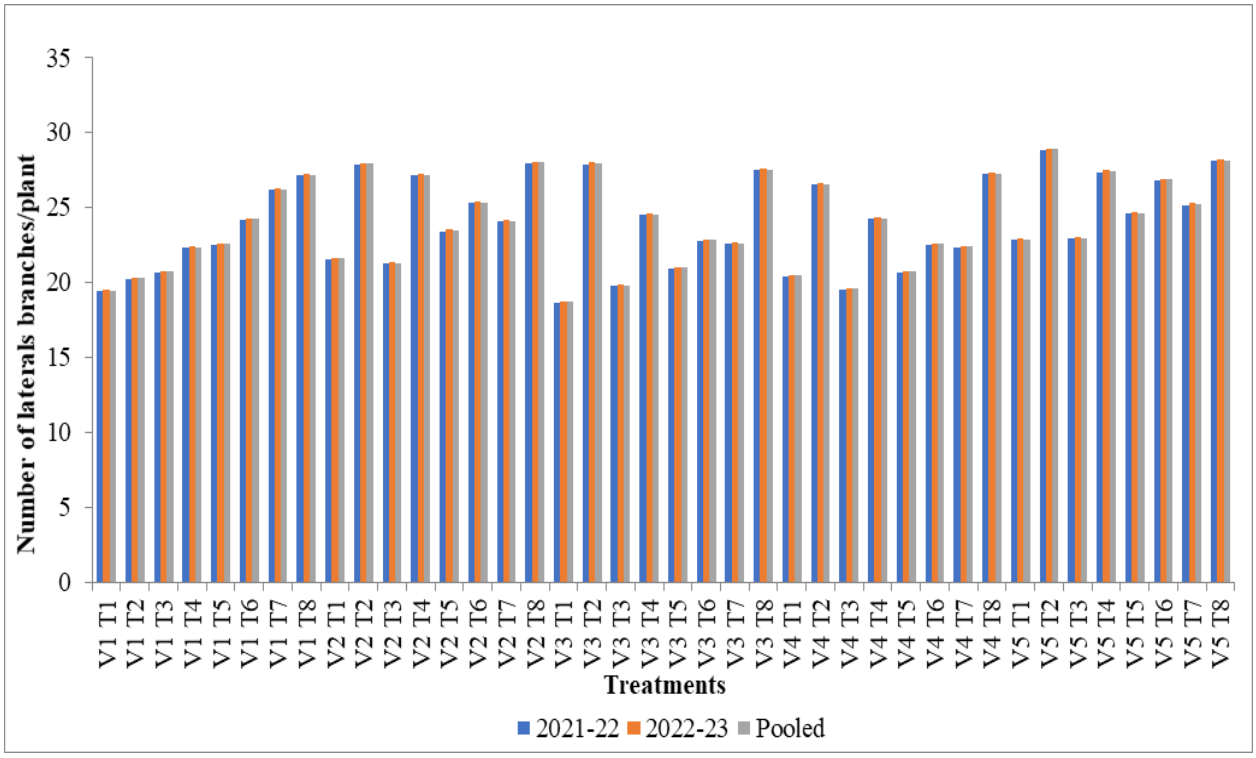

Fig. 2. Effect of Bio-fertilizers on number of laterals branches/plant of different cultivars of pear.

The maximum number of lateral branches (28.13) per plant was obtained with V_5T_8 (Gola variety with N-100%+ P-100%+*Azotobacter*(100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg), which was at par with V_2T_8 (Punjab beauty with Gola variety with N-100%+ P-100%+*Azotobacter*(100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) and V_5T_2 (Gola with NPK as recommended (150:75:240 gm/tree) treatment combination, whereas, Punjab gold variety with control (V_3T_1) treatment combination was recorded the minimum number of lateral branches *i.e.* 18.68 per plant during experiment trail**.**

Biofertilizers contain beneficial microorganisms, such as plant growth-promoting bacteria and mycorrhizal fungi, that have the ability to produce phytohormones like auxins, cytokinins, and gibberellins. These phytohormones play a critical role in promoting cell division, elongation, and differentiation, which can lead to the formation of lateral branches.

Canopy spread. Data in the Table 3 indicated that effect of different variety and biofertilizers was found significant, regarding canopy spread (m) during both the year of experiments 2021-22 and 2022-23. Among different variety, V_5 (Gola variety) recorded maximum canopy spread 3.24 and 3.28m followed by V_2 (Punjab beauty) and V_3 (Punjab gold) treatment, while, Baggugosha (V_1) obtained minimum canopy spread *i.e* 2.86 and 2.90m during both the years of experiments. Among various biofertilizer, were observed the maximum canopy spread (3.46 and 3.50m) under T_8 (N-100%+P-100%+*Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) treatment followed by T_2 (NPK as recommended (150:75:240 gm/tree) and T_4 (N 75% + P 75% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg) treatment, while the minimum canopy spread (2.58 and 2.61m) was recorded from control (T_1) treatment during both the years of experiments. The interaction effect among different variety and biofertilizers were significant on canopy spread (Table 3) during both the years of experiments 2021-22 and 2022-23. Treatment combination V_5T_8 (Gola variety with N-100%+P-100%+*Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) treatment combination was found to give maximum canopy spread (3.52 and 3.57m) at par with V_2T_8 (Punjab beauty with Gola variety with N-100%+ P-100%+*Azotobacter*(100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) and V_5T_2 (Gola with NPK as recommended (150:75:240 gm/tree) treatment combinations over its control, whereas, the minimum canopy spread (2.34 and 2.37m) was observed under V_3T_1 (Punjab gold with control) treatment combination during both the years of experiments.

On an average pooled data of Table 3 indicated that effect of different variety and biofertilizers was found significant, regarding canopy spread (m) during experiment trail. Among different variety, V_5 (Gola variety) recorded maximum canopy spread (3.26m) followed by V_2 (Punjab beauty) and V_3 (Punjab gold) treatment, while, Baggugosha (V_1) obtained minimum canopy spread (2.88m) during experiment trail. Among various biofertilizer, were observed the maximum canopy spread (3.48m) under T_8 (N-100%+P-100%+*Azotobacter*(100g) + *PSB* (100g) + Trichoderma

(50g) + vermicompost @ 3.0kg) treatment followed by T_2 (NPK as recommended (150:75:240 gm/tree) and T_4 (N 75% + P 75% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg) treatment, while the minimum canopy spread (2.60m) was recorded from control (T_1) treatment during experiment trail. The interaction effect among different variety and biofertilizers were significant on canopy spread (Table 3) during experiment trail. Treatment combination V_5T_8 (Gola variety with N-100%+P-100%+*Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) treatment combination was found to give maximum canopy spread (3.55m) at par with V_2T_8 (Punjab beauty with Gola variety with N-100%+ P-100%+*Azotobacter*(100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) and V_5T_2 (Gola with NPK as recommended (150:75:240 gm/tree) treatment combinations over its control, whereas, the minimum canopy spread (2.35m) was observed under V_3T_1 (Punjab gold with control) and V_1T_1 (Baggugosha with control) treatment combination during experiment trail.

. The results were in conformity with the findings of Rani *et al*. (2021) in guava and Sau *et al.* (2017) in mango. Biofertilizers contain beneficial microorganisms that interact with plants in ways that enhance nutrient uptake, hormone production, stress tolerance, and overall physiological processes. These interactions can lead to a more vigorous and extended canopy.

Stem girth. The results present in Table 4 indicate that stem girth was found significant with respect to different variety and biofertilizers during both the years of experiments 2021-22 and 2022-23. Gola variety (V_5) gave maximum stem girth (31.71 and 31.81mm) was recorded to obtained first position followed by V_2 (Punjab beauty) and V_3 (Punjab gold) treatment. However, the minimum stem girth (28.04 and 28.13 mm) was recorded with Baggugosha variety (V_1). Among different biofertilizers, T_8 (N-100%+P-100%+*Azotobacter*(100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg gave maximum stem girth (33.89 and 33.99mm) followed by T_2 (NPK as recommended (150:75:240 gm/tree) and T_4 (N 75% + P 75% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg) treatment, while, minimum stem girth (24.75 and 24.82mm) was recorded with control (T_1) treatment during both the years of experiments. Interaction effect among different variety and biofertilizers have significant on stem girth (Table 4) during both the years of experiments 2021-22 and 2022-23.

Table 3: Effect of Bio-fertilizers on plant canopy spread (m) of different cultivars of pear.

2021-2022												
Treatments	**Bio-fertilizers**										**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	0.14	0.05
V_1	2.44	2.54	2.59	2.80	2.82	3.03	3.28	3.40	**2.86**	T=	0.18	0.06
V_2	2.70	3.49	2.67	3.40	2.94	3.17	3.02	3.51	**3.11**	V×T=	0.40	0.14
V_3	2.34	3.50	2.48	3.07	2.63	2.86	2.83	3.45	**2.89**			
V_4	2.56	3.33	2.45	3.04	2.59	2.83	2.80	3.41	**2.88**			
V_5	2.86	3.61	2.88	3.43	3.08	3.36	3.16	3.52	**3.24**			
Mean	**2.58**	**3.29**	**2.61**	**3.15**	**2.81**	**3.05**	**3.02**	**3.46**				
2022-2023											**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	0.13	0.05
V_1	2.47	2.57	2.63	2.83	2.86	3.07	3.32	3.45	**2.90**	T=	0.17	0.06
V_2	2.74	3.54	2.70	3.45	2.98	3.21	3.06	3.55	**3.15**	V×T=	0.37	0.13
V_3	2.37	3.54	2.51	3.11	2.66	2.90	2.87	3.49	**2.93**			
V_4	2.59	3.37	2.48	3.08	2.63	2.86	2.84	3.46	**2.91**			
V_5	2.90	3.66	2.91	3.48	3.12	3.41	3.20	3.57	**3.28**			
Mean	**2.61**	**3.34**	**2.65**	**3.19**	**2.85**	**3.09**	**3.06**	**3.50**				
Pooled											**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	0.13	0.05
V_1	2.45	2.55	2.61	2.82	2.84	3.05	3.30	3.43	**2.88**	T=	0.17	0.06
V_2	2.72	3.52	2.68	3.43	2.96	3.19	3.04	3.53	**3.13**	V×T=	0.38	0.14
V_3	2.35	3.52	2.50	3.09	2.64	2.88	2.85	3.47	**2.91**			
V_4	2.57	3.35	2.47	3.06	2.61	2.85	2.82	3.44	**2.90**			
V_5	2.88	3.64	2.89	3.45	3.10	3.39	3.18	3.55	**3.26**			
Mean	**2.60**	**3.32**	**2.63**	**3.17**	**2.83**	**3.07**	**3.04**	**3.48**				

The maximum stem girth (34.52mm and 34.62mm) was recorded under V_5T_8 (Gola variety with N-100% + P-100% + *Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) treatment combination at par with V_2T_8 (Punjab beauty with Gola variety with N-100%+ P-100%+*Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) and V_5T_2 (Gola with NPK as recommended (150:75:240 gm/tree) treatment combinations. The minimum stem girth (22.61 and 22.68mm) was produced under V_4T_1 (Punjab Nectar with control) treatment combinations during both the years of experiments.

On an average pooled data of Table 4 indicates that stem girth was found significant with respect to different variety and biofertilizers during experiment trail. Gola variety (V_5) gave maximum stem girth (31.76mm) was recorded to obtained first position followed by V_2 (Punjab beauty) and V_3 (Punjab gold) treatment. However, the minimum stem girth (28.08mm) was recorded with Baggugosha variety (V_1). Among different biofertilizers, T_8 (N-100%+P-100%+ *Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg gave maximum stem girth (33.94mm) followed by T_2 (NPK as recommended (150:75:240 gm/tree) and T_4 (N 75% + P 75% + *Azotobacter* (100gm) + PSB (100gm) + Trichoderma (50gm) + Vermicompost @ 3 kg) treatment, while, minimum stem girth (24.78 mm) was recorded with control (T_1) treatment during experiment trail. Interaction effect among different variety and biofertilizers have significant on stem girth (Table 4) during experiment trail. The maximum stem girth (34.57 mm) was recorded under V_5T_8 (Gola variety with N-100% + P-100% + *Azotobacter* (100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) treatment combination at par with V_2T_8 (Punjab beauty with Gola variety with N-100%+ P-100%+*Azotobacter*(100g) + *PSB* (100g) + Trichoderma (50g) + vermicompost @ 3.0kg) and V_5T_2 (Gola with NPK as recommended (150:75:240 gm/tree) treatment combinations. The minimum stem girth (22.64mm) was produced under V_4T_1 (Punjab Nectar with control) treatment combinations during experiment trail.

The results were in conformity with the finding of Rani *et al*. (2021) in guava and Singh and Varu (2013) in papaya. Biofertilizers influence auxin signalling pathways leading to cell expansion and elongation, resulting in thicker stems.

Table 4: Effect of Bio-fertilizers on stem girth (mm) of different cultivars of pear.

2021-2022												
Treatments	**Bio-fertilizers**										**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	1.04	0.37
V_1	22.63	26.01	25.41	27.42	27.66	29.71	32.15	33.35	**28.04**	T=	1.32	0.47
V_2	27.51	35.15	27.91	33.08	29.32	31.52	29.36	34.36	**31.03**	V×T=	2.95	1.05
V_3	22.92	34.67	24.31	30.09	25.73	28.01	27.76	33.76	**28.40**			
V_4	22.61	34.25	24.00	29.78	25.42	27.70	27.45	33.46	**28.08**			
V_5	28.06	35.19	28.18	33.63	30.22	32.95	30.94	34.52	**31.71**			
Mean	**24.75**	**33.05**	**25.96**	**30.80**	**27.67**	**29.98**	**29.53**	**33.89**				
2022-2023											**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	1.27	0.45
V_1	22.70	26.09	25.48	27.50	27.74	29.80	32.25	33.45	**28.13**	T=	1.60	0.57
V_2	27.59	35.26	27.99	33.18	29.41	31.61	29.44	34.46	**31.12**	V×T=	3.58	1.27
V_3	22.98	34.77	24.38	30.18	25.80	28.09	27.84	33.87	**28.49**			
V_4	22.68	34.35	24.07	29.87	25.50	27.78	27.54	33.56	**28.17**			
V_5	28.15	35.30	28.26	33.73	30.31	33.05	31.03	34.62	**31.81**			
Mean	**24.82**	**33.15**	**26.04**	**30.89**	**27.75**	**30.07**	**29.62**	**33.99**				
Pooled											**CD**	**SE(m)**
Varieties	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**Mean**	V=	1.15	0.41
V_1	22.67	26.05	25.45	27.46	27.70	29.76	32.20	33.40	**28.08**	T=	1.46	0.52
V_2	27.55	35.20	27.95	33.13	29.37	31.57	29.40	34.41	**31.07**	V×T=	3.26	1.17
V_3	22.95	34.72	24.35	30.13	25.77	28.05	27.80	33.82	**28.45**			
V_4	22.64	34.30	24.04	29.82	25.46	27.74	27.49	33.51	**28.12**			
V_5	28.11	35.25	28.22	33.68	30.27	33.00	30.98	34.57	**31.76**			
Mean	**24.78**	**33.10**	**26.00**	**30.85**	**27.71**	**30.02**	**29.58**	**33.94**				

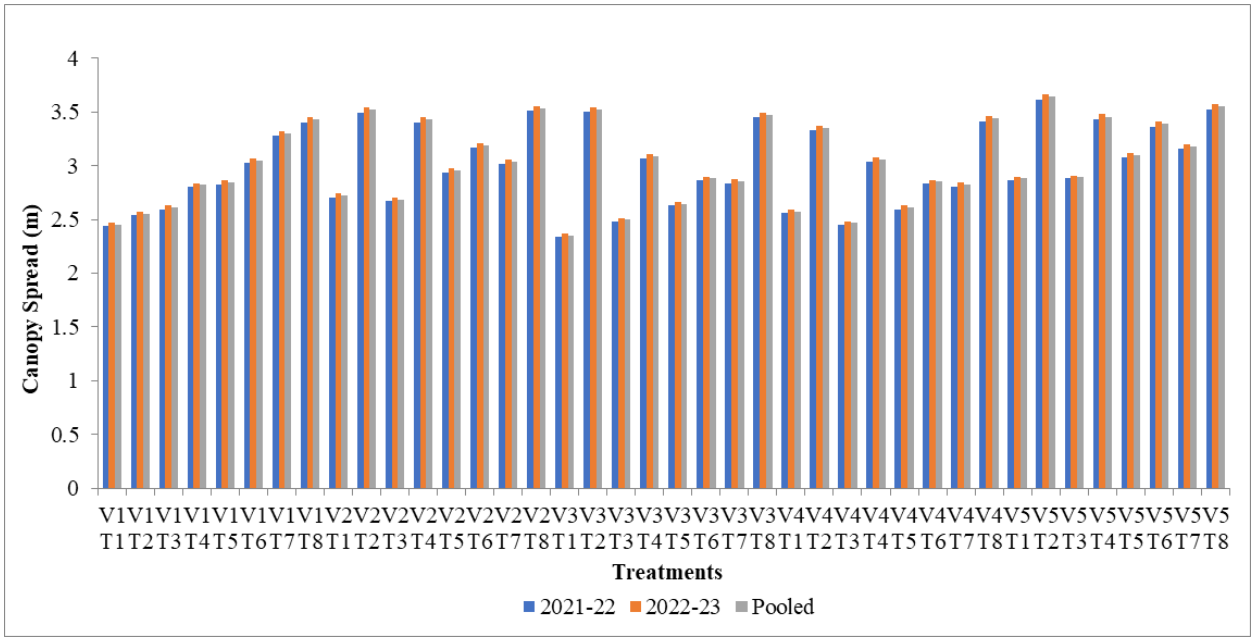

Fig. 3. Effect of Bio-fertilizers on canopy sprayed (m) of different cultivars of pear.

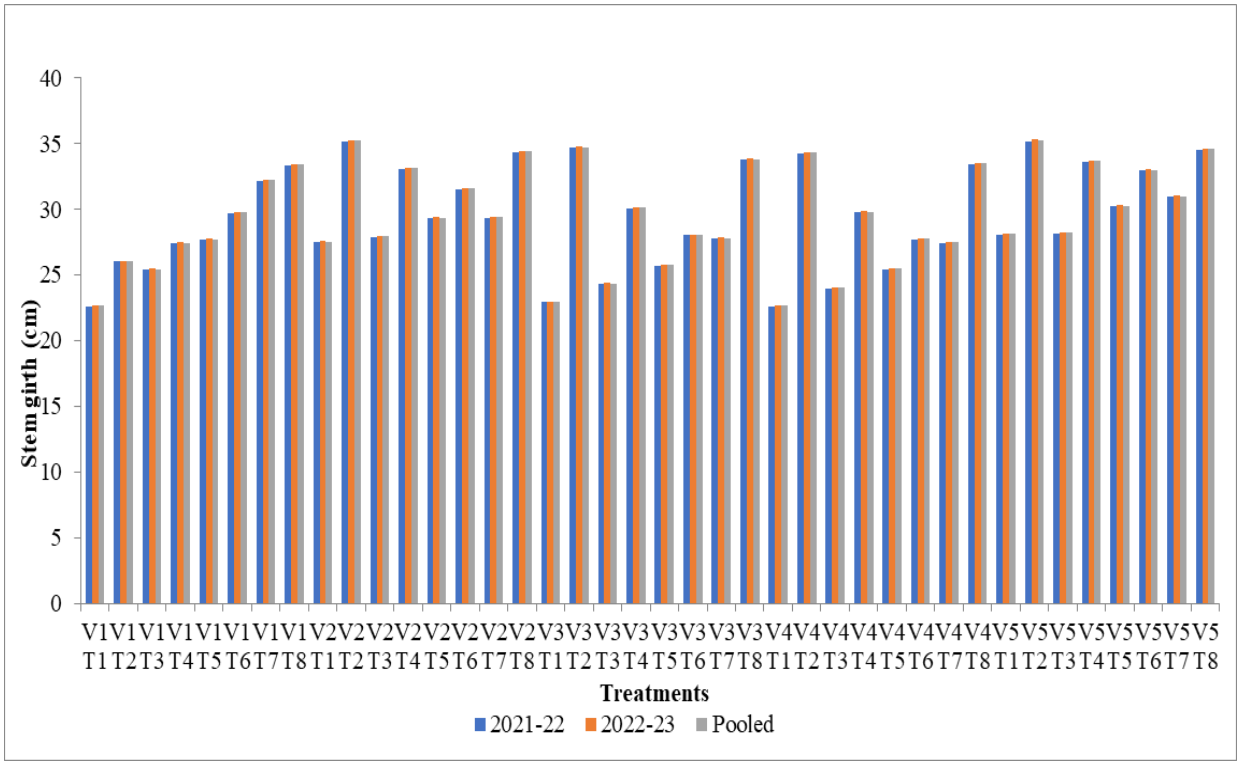

Fig. 4. Effect of Bio-fertilizers on stem girth (cm) of different cultivars of pear.

CONCLUSION

In conclusion, the combination of T8 treatment (N-100%+P-100%+Azotobacter 100g + PSB 100g + Trichoderma 50g + vermicompost at 3kg) demonstrates remarkable performance across various aspects of vegetative growth. Specifically, the V5 Gola variety exhibits a strong compatibility with the integrated use of this biofertilizer composition comprising N-100%+P-100%+Azotobacter 100g + PSB 100g + Trichoderma 50g + vermicompost at 3kg, particularly within the context of the western Uttar Pradesh region. It is noteworthy that the Gola variety, in conjunction with the aforementioned biofertilizer blend, showcases exceptional potential. Therefore, the application of N-100%+P-100%+Azotobacter 100g + PSB 100g + Trichoderma 50g + vermicompost at 3kg is recommended for optimal outcomes in the cultivation of the Gola variety, emphasizing its superior

performance when utilized in tandem with this biofertilizer combination.

FUTURE SCOPE

The prospects of biofertilizers in horticultural crop production is promising, as these natural and sustainable alternatives to chemical fertilizers offer numerous advantages for improving yields, quality, and environmental sustainability. By minimizing the use of synthetic chemical fertilizers, biofertilizers can help mitigate the negative environmental effects associated with nutrient runoff, water pollution, and soil degradation. This aligns with the principles of sustainable agriculture and conservation. the future of biofertilizers in horticultural crop production holds tremendous potential for sustainable and environmentally responsible agriculture. As research advances and the importance of sustainable farming practices becomes more recognized, biofertilizers are likely to play a pivotal role in enhancing horticultural crop yields, quality, and overall system resilience.

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Conflict of Interest. None.

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