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Evaluation of Best Performing Microbial Culture in Relation to Growth, Yield and Quality of Sponge Gourd (*Luffa cylindrica* L.)

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Authors' contributions

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

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ABSTRACT

The present investigation the effect of different microbial culture on growth, yield and quality of Sponge Gourd (*Luffa cylindrica* L.) was undertaken at Vegetable Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) during 2022. The experiment was laid out in a Randomized Block Design with 10 tratment *viz.*, T_0 (Control), T_1 (PSB - Photosynthetic Bacteria Rhodosudomonas palustris) - 20 ml/sq.m), T_2 (PSB - Photosynthetic Bacteria Rhodosudomonas palustris) - 30 ml/sq.m), T_3 (PSB - Photosynthetic Bacteria Rhodosudomonas palustris) - 40 ml/sq.m), T_4 (Vermiwash-20 ml/sq.m), T_5 (Vermiwash-30 ml/sq.m), T_6 (Vermiwash-40 ml/sq.m), T_7 (Azotobacter-8 ml/sq.m), T_8 (Azotobacter - 10 ml/sq.m) and T_9 (Azotobacter- 15ml/sq.m) with three replications. Results

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revealed that treatment T_9 (Azotobacter- 15ml/sq.m) recorded significantly highest vine length, highest number of primary branches per plant is treatment T_4 (Vermiwash-20 ml/sq.m) and number of node per plant is treatment T_4 (Vermiwash-20 ml/sq.m). Earliness parameter such as days of first flowering is minimum days is T_9 (Azotobacter- 15ml/sq.m) and node number at first male flower appears was recorded in treatment T_9 (Azotobacter- 15ml/sq.m). Node number at first female flower appears was recorded in treatment T_9 (Azotobacter- 15ml/sq.m). Days to first fruit setting after anthesis recorded in treatment Azotobacter-10ml/sq.m (T_8). Yield parameter like number of fruit per plant were recorded under T_6 (Vermiwash-40 ml/sq. m). Average weight for 10 fruits (g) was recorded highest in treatment T_9 (Azotobacter-15 ml/sq.m).Fruit length was recorded highest in treatment (Vermiwash – 40 ml/sq.m T_6). Fruit girth was recorded highest in treatment T_9 (Azotobacter-15 ml/sq.m). Fruit yield per plot (kg) was recorded highest in treatment T_6 (Vermiwash – 40 ml/sq.m) and fruit yield /ha (q) was highest in was found in Vermiwash – 40 ml/sq.m (T_6).

Keywords: Photosynthetic bacteria; Vermiwash; Azotobacter; sponge gourd; monoecious; cucurbits.

1. INTRODUCTION

In India, number of major and minor cucurbits is cultivated, which share about 5.6% of the total vegetable production [1]. Through, authentic statistical records of area, production and productivity of Sponge gourd are not available, but in the year 2012 India ranked the second place in the production of Sponge gourd (FAO, 2010). The Sponge Gourd (*Luffa cylindrica* Linn; 2n = 26) is one of the important tropical and subtropical cucurbitaceous crop grown extensively throughout India. It has a smooth surface and is one of the popular vegetable. It is a good source of vitamin A and C and has laxative properties. Fully ripen Sponge Gourds have high amount of fibers which are used as a cleansing agents (bathing and utensils) and making shoe soles, tablemates. The sponge of the mature fruit helps the skin in increasing the blood circulation and as a relief for rheumatic and arthritis sufferers. Also the fruits are used to cure jaundice, diabetes, to purify blood and to cure skin diseases.

Luffa commonly called sponge gourd, loofah, vegetable sponge, bath sponge or dishcloth gourd, is a member of the family Cucurbitaceae. Tropical countries of Asia and Africa are believed to be the primary centers of origin. Of the four species of *Luffa*, that occur in Asia [2]. Species of *Luffa* are diploid and are cross-pollinated. The genus is closely related to and hassimilar cultural requirements as cucumber. The young fruit, when small, (around 6 inches) is delicious and is used in soup or stew as a vegetable, which is good for diabetes [3]. Oil extracted from seeds has industrial use. Older fruits have been reported to develop purgative chemicals [4].

Luffa is a fast-growing, long-season, warm-climate vine that can climb to a height of about 5m. It tolerates a wide range of climatic and soil conditions, although excessive rainfall during flowering and fruiting period can cause damage and reduce yield [3]. It is a warm-season plant that prefers average monthly temperatures in the range of 18 to 24°C, with daytime highs of 30 to 35°C. The plants are sensitive to frost. Sponge gourd prefers pH of around 6 to 6.8 and requires high level of K and P. It also grows well in green house and will grow on many soil types but well drained sandy loams are preferred [5].

Hence, it is to explore the potential of sponge gourd to develop as natural fiber and contribute to the industry as well as to the export market. Sponge gourd is monoecious, flowers open in the early morning and remain open for a day. The flowers are big and bright yellow, highly attractive and are a rich source of pollen for the foraging insects, chiefly bees [6].

To study the effect of *azotobactor*, PSB and vermiwash on the growth, yield and quality of sponge gourd.

Azotobacters are free living nitrogen fixing bacteria which belongs to azotobacteriaceae family and mostly found in alkaline and neutral soils. It does not require any host and fixes the atmospheric nitrogen especially in non-leguminous plants without any symbiotic relationship (Sengupta, 2002).

Photosynthetic bacteria can be used in a variety of agriculture applications. Currently, some of the most popular usages include rice fields, Allie vegetables, greenhouse cultivation, floriculture, fruit trees, and stock raising. Effective microorganisms are also being used to eliminate

industrial waste because it can reduce the level of poisonous substances such as ammonia, hydrogen sulfides, and a variety of organic acids. PSB-Photosynthetic Bacteria (*Rhodosudomonas palustris*). Several photosynthetic bacteria have been isolated at 700 ppm of CO_2 concentration whereas these photosynthetic bacteria were absent in ambient condition. Naturally adapted microorganisms may prove to be more suitable for climate change studies [7].

Vermiwash is a liquid coelomic fluid earthworm body collected without harming is vermiwash. The application of vermiwash is in plant growth enhancement and peat management. Vermiwash contains several enzyme, plant growth hormones and vitamins along with micro and macro nutrients that stimulate the growth and yield of crops and even develop resistance in crop receiving this spray. Such preparation would certainly have the soluble plant nutrients a part from some organic acids and mucus of earthworms and microbes [8,1].

2. MATERIALS AND METHODS

The experiment was conducted in the Vegetable Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) during 2022-23. The experiment was conducted on Sponge Gourd (*Luffa cylindrica* L.) with ten treatment including control and three replication in Randomized block design. The total number of plant included in the experiment were 120 and were space at 1.5m x 3m.

Statistical analysis was done by using method of analysis of variance (ANOVA) for randomized block design (RBD) by Fischer and Yates [9]. Whenever 'F' test was found significant for comparing the means of two treatments, critical difference (C. D. at 5%) was worked.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

The number of primary branches per plant ranged from 8.16 to 20.91. The maximum number of primary branches per plant was recorded under treatment T_4 – Vermiwash-20ml/sq.m (20.91) followed by T_3 – PSB (Photosynthetic Bacteria *Rhodosudomonas palustris*) - 40 ml/sq.m (16.83) respectively. The treatment T_1 and T_5, were statistically at par, but they differed significantly as compared to treatment T_0 (control) which recorded minimum number of primary branches per plant (8.16). Similar results were found by Vimala and Natarajan [10] biofertilizer viz., Rhizobium @ 6 kg /h and phosphobacteria 35ml/ sq. meter showed the highest values for primary branches, of per plant.

The No. of node per plant Vermiwash – 20 ml/sq.m (T_4) recorded the maximum number of node per plant (46.00) and was on par with those receiving PSB-40 ml/sq.m and PSB (Photosynthetic Bacteria Rhodosudomonas palustris)-20ml/sq.m (T_3 and T_1) was significantly superior to the rest of the treatments. The minimum number of node per plant (39.08) were recorded control (T_0) was significantly inferior to the remaining treatments. Similar results were found by Das et al., [11] reported that the application of Azotobactor 5 kg/ha + PSB 5 kg/ha and recorded maximum No. of node per plant (41.00) in gourd.

The vine length ranged from 490.00 cm to 619.75 cm. The maximum vine length was recorded under treatment T_9- Azotobacter-15 ml/ sq.m (619.75 cm) followed by T_5 - Vermiwash-30 ml/ sq.m (600.00 cm), T_6 – Vermiwash - 40 ml/sq.m (590.25 cm), respectively. The treatment T_5 and T_6, were statistically at par, but they differed significantly as compared to treatment T_0 (control) which recorded minimum vine length (490.00) cm. Similar results were found by Abdel-sattar and Mohamed [12].

3.2 Flowering Parameter

Days to first flowering was maximum in control (T_0) followed by the treatment (Photosynthetic Bacteria *Rhodosudomonas palustris*) – 20 ml/ sq.m (T_1) which recorded 35.16 days and 33.50 days respectively. Azotobacrer-15ml/sq.m (T_9) recorded the minimum days to appearance of first flowering 27.25 days followed by Azotobacrer-10 ml/sq.m (T_8) 28.25 days. Similar findings were reported by Bonnie et al., (2000) in Azotobacter treated tomato plants with minimum day to flowering and Karuppiah et al., (2005) in ridge gourd.

The Node number at which first male flower appears Azotobacter-15ml/sq.m (T_9) recorded the minimum number of node number at which first male flower appears (4.25) and was on par with those receiving Vermiwash-40 ml/sq.m and Azotobacter - 8ml/sq.m (T_6 = 4.5 and T_7 = 4.91)

was significantly superior to the rest of the treatments. The maximum number of node number at which first male flower appears (10.83) were recorded control (T_0) was significantly inferior to the remaining treatments. Similar result found that the Thriveni et al. [13] biofertilizers (Azotobacter + Azospirillum + PSB) minimum node number in bitter gourd. The Node number at which first female flower appears Azotobacter-15ml/sq.m (T_9) recorded the minimum number of node number at which first female flower appears (5.00) and was on par with those receiving Vermiwash-40 ml/sq.m, Azotobacter - 8ml/sq.m and Azotobacter – 10 ml/sq.m (T_6 = 5.41, T_7 = 5.66 and T_8= 5.66) was significantly superior to the rest of the treatments. The maximum number of node number at which first female flower appears (14.25) were recorded control (T_0) was significantly inferior to the remaining treatments. Similar result Patel et al., [14] recorded that an application of vermicompost and Azotobacter, PSB each 5 kg ha^{-1} to the bottle gourd crop found to minimum No. of node at first female flower.

The day to first fruit setting Azotobacter-10ml/sq.m (T_8) recorded the minimum number of day to first fruit setting (2.91) and was on par with those receiving PSB (Photosynthetic Bacteria Rhodosudomonas palustris) – 20ml/sq.m (T_1=3.00), PSB (Photosynthetic Bacteria Rhodosudomonas palustris) – 30ml/sq.m (T_2=3.00), PSB (Photosynthetic Bacteria Rhodosudomonas palustris) – 40ml/sq.m (T_3=3.00), Vermiwash-30 ml/sq.m(T_4=3.00), Vermiwash-40 ml/sq.m(T_6=3.00), Azotobacter - 15ml/sq.m (T_9=3.00) was significantly superior to the rest of the treatments. The maximum number of day to first fruit setting (4.00) were recorded control (T_0) was significantly inferior to the remaining treatments. Similar result found that the Sreenivas et al. [15] recorded significantly days to first fruit setting with the application of Vermicompost in ridge gourd.

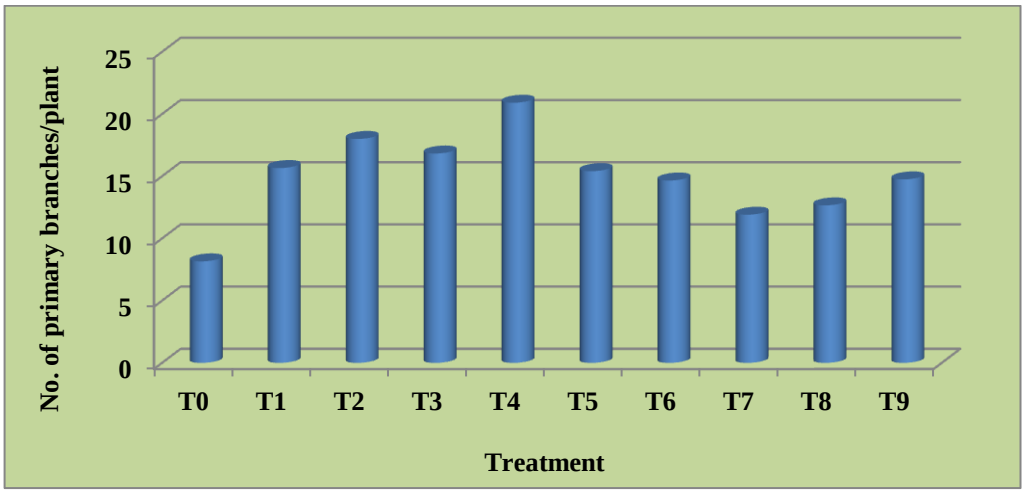

Fig. 1. Effects of microbial culture on No. of primary branches/plant

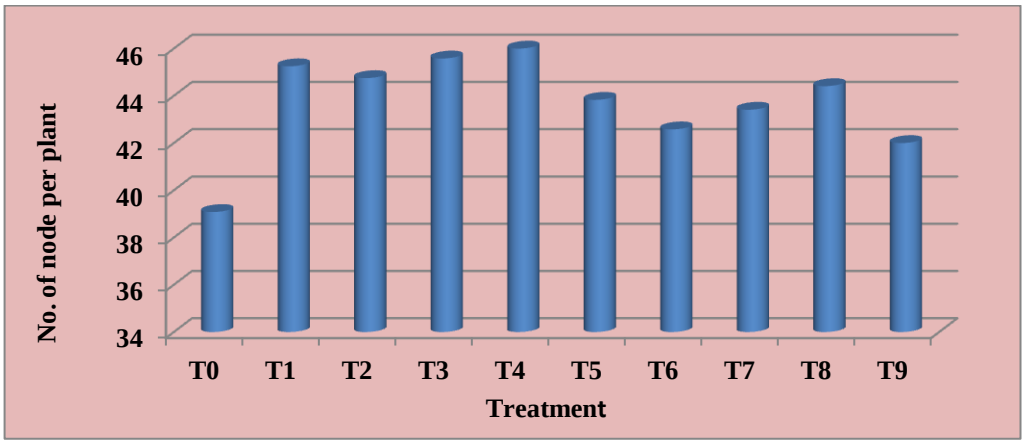

Fig. 2. Effects of microbial culture on No. of node /plant

Table 1. Evaluation of best performing microbial culture in relation to growth of sponge gourd

Treatments	No. of primary branches/plant	No. of node per plant	Vine length (cm)at harvest
Control (T_0)	8.16	39.08	490.00
PSB- 20 ml/sq.m (T_1)	15.66	45.25	550.75
PSB- 30 ml/sq.m (T_2)	18	44.75	580.25
PSB- 40 ml/sq.m (T_3)	16.83	45.58	530.75
Vermiwash- 20 ml/sq.m (T_4)	20.91	46.00	570.25
Vermiwash-30 ml/sq.m (T_5)	15.41	43.83	600.00
Vermiwash-40 ml/sq.m (T_6)	14.66	42.58	590.25
Azotobacter-8 ml/sq.m (T_7)	11.91	43.41	588.00
Azotobacter-10 ml/sq.m (T_8)	12.66	44.41	590.00
Azotobacter-15 ml/sq.m (T_9)	14.75	42.00	619.75
F-test	S	S	S
SE(d)	2.46	1.41	2.30
C.V.	20.25	3.95	0.49
CD at 5% level	5.21	2.98	4.88

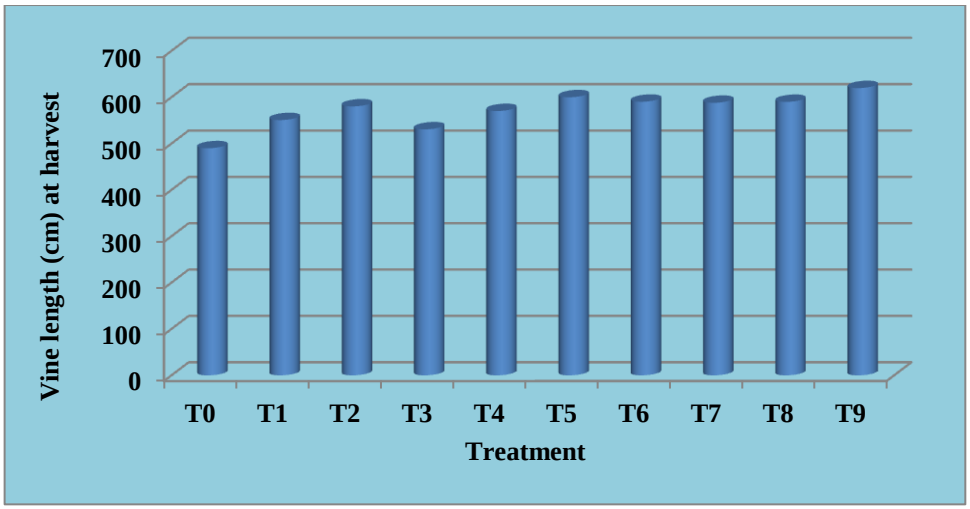

Fig. 3. Effects of microbial culture on Vine length (cm) at harvest

Table 2. Evaluation of best performing microbial culture in relation to flowering of sponge gourd

Treatments	Days of first flowering	Node number at first male flower appears	Node number at first female flower appears	Days to first fruit setting after anthesis
Control (T_0)	35.16	10.83	14.25	4.00
PSB- 20 ml/sq.m (T_1)	33.50	8.08	12	3.00
PSB- 30 ml/sq.m (T_2)	32.75	5.58	11.66	3.00
PSB- 40 ml/sq.m (T_3)	30.87	7.08	13.16	3.00
Vermiwash-20 ml/sq.m (T_4)	31.00	5.75	7.66	3.08
Vermiwash-30 ml/sq.m (T_5)	31.25	5.00	6.66	3.00
Vermiwash-40 ml/sq.m (T_6)	29.62	4.50	5.41	3.00
Azotobacter-8 ml/sq.m (T_7)	28.50	4.91	5.66	3.16
Azotobacter-10 ml/sq.m (T_8)	28.25	5.00	5.66	2.91
Azotobacter-15 ml/sq.m (T_9)	27.25	4.25	5	3.00
F-test	S	S	S	S
SE(d)	0.69	1.26	1.01	0.22
C.V.	2.77	25.41	14.24	8.93
CD at 5% level	1.47	2.68	2.14	0.48

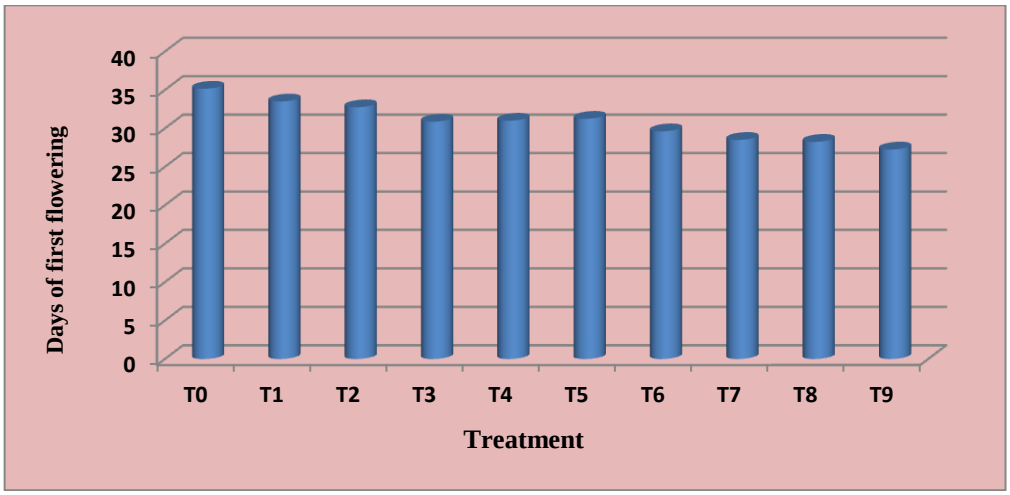

Fig. 4. Effects of microbial culture on days of first flowering

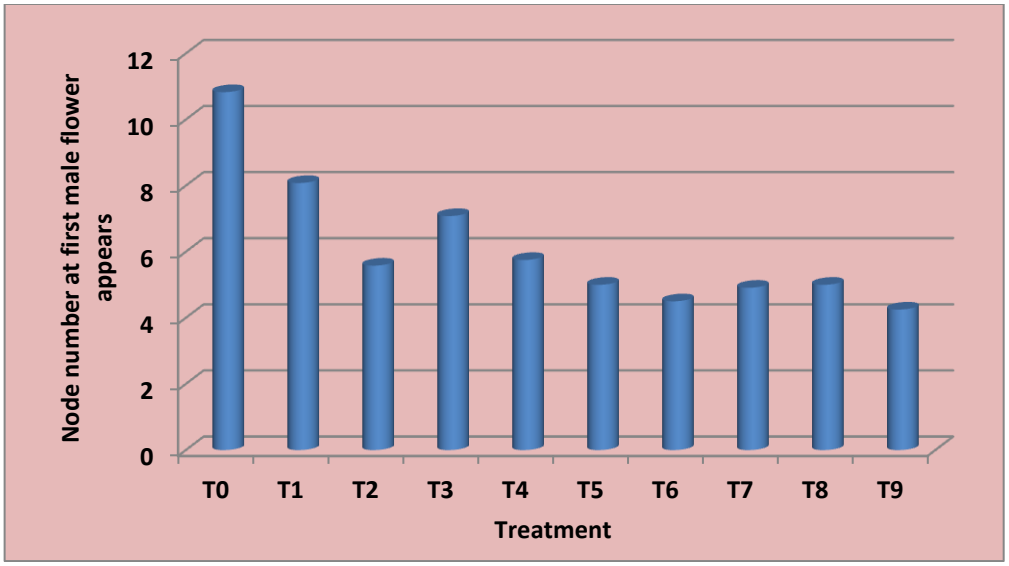

Fig. 5. Effects of microbial culture on Node No. at first male flower appears

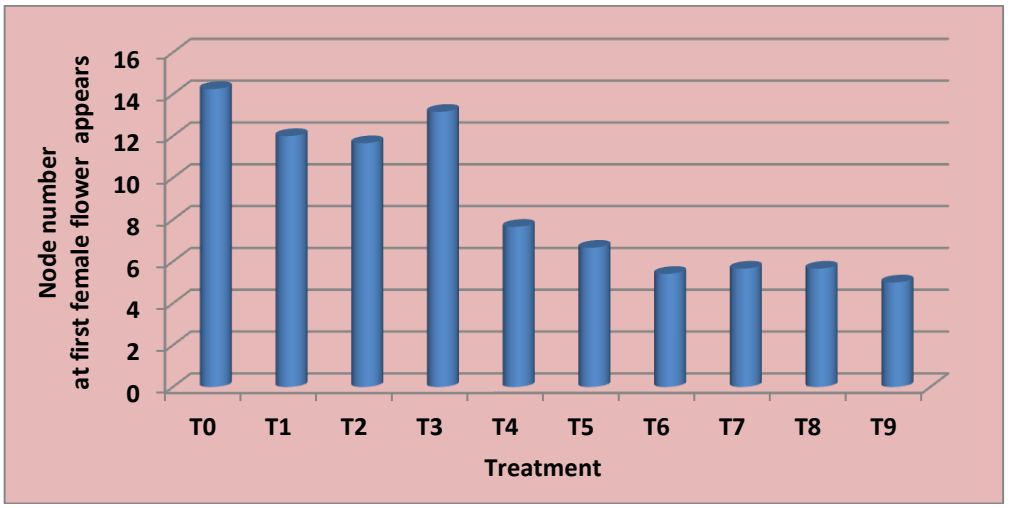

Fig. 6. Effects of microbial culture on Node No. at first female flower appears

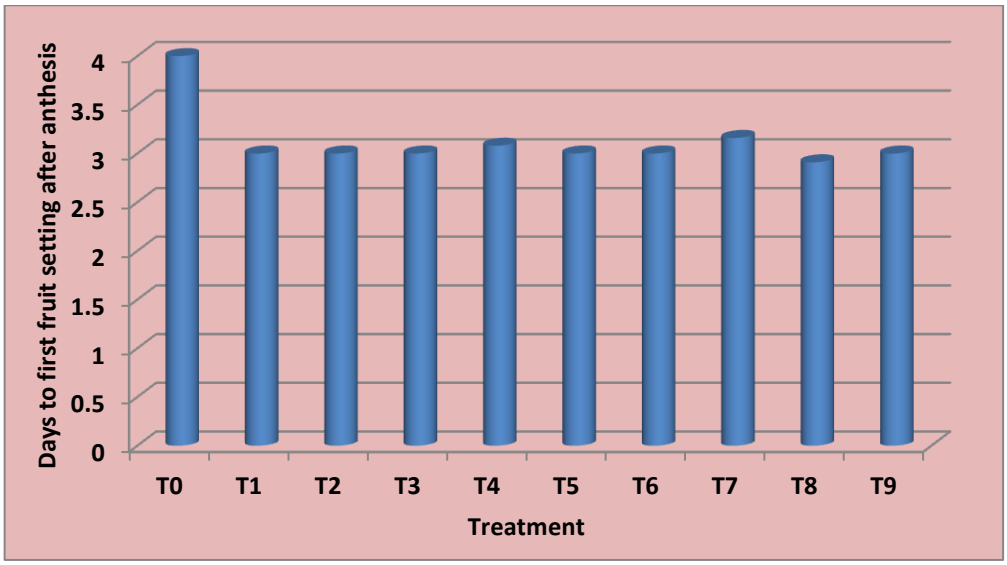

Fig. 7. Effects of microbial culture on days to first setting after anthesis

3.3 Yield Parameter

The maximum number of fruit per plant (45.48) during were recorded under T_6 (Vermiwash-40 ml/sq. m) which was found statistically at par with its concentration *i.e.* Vermiwash-30 ml/sq. m (T_5) and PSB (Photosynthetic Bacteria Rhodosudomonas palustris) – 40 ml/sq. m (T_3). Similar result found that the Nayak et al. [16] reported that the application of biofertilizers (Azotobactor + Azospirillum + PSB), lime and organic manure (Vermicompost) in maximum number of fruit per plant (45.48). The maximum average weight for 10 fruits (1653.53 g) during were recorded under T_9 (Azotobacter-15 ml/sq.m) which was found statistically at par with its concentration *i.e.* Vermiwash-40ml/sq.m (T_6) and PSB (Photosynthetic Bacteria Rhodosudomonas palustris -40 ml/sq.m (T_3). Similar result found that the Lucas-Garcia et al. [17] reported that gourd plants supplied with Azotobacter recorded increased of fruits weight 1600.33 g.

The maximum fruit length (27.33 cm) was found in Vermiwash – 40 ml/sq.m (T_6) followed by Azotobacter- 15ml/sq.m 26.66 cm (T_9) and Vermiwash– 30ml/sq.m 26.00 cm (T_5), Azotobacter- 15 ml/sq.m 26.00 cm the minimum fruit length (20 cm) was observed in control plants (T_0). Reddy et al. [18] reported similar Nayak et al. [16] reported that the application combination with biofertilizers (Azotobacter + Azospirillum + PSB), lime and organic manure (Vermicompost) in sponge gourd to increase the length length of fruit (22.50 cm).

Table 3. Evaluation of best performing microbial culture in relation to yield of sponge gourd

Treatments	Number of fruits per plant	Av. Weight for 10 fruit (g)	Fruit length (cm)
Control (T_0)	33.75	1626.66	20
PSB- 20 ml/sq.m (T_1)	41.25	1590.00	22
PSB- 30 ml/sq.m (T_2)	42.50	1546.66	23
PSB- 40 ml/sq.m (T_3)	43.66	1506.66	24
Vermiwash-20 ml/sq.m (T_4)	42.66	1640.00	25
Vermiwash-30 ml/sq.m (T_5)	44.33	1643.33	26
Vermiwash-40 ml/sq.m (T_6)	45.48	1546.66	27.33
Azotobacter-8 ml/sq.m (T_7)	37.25	1513.33	25.00
Azotobacter-10 ml/sq.m (T_8)	39.50	1563.33	26.00
Azotobacter-15 ml/sq.m (T_9)	41.33	1653.33	26.66
F-test	S	S	S
SE(d)	0.84	22.35	1.93
C.V.	2.50	1.73	9.67
CD at 5% level	1.78	47.33	4.09

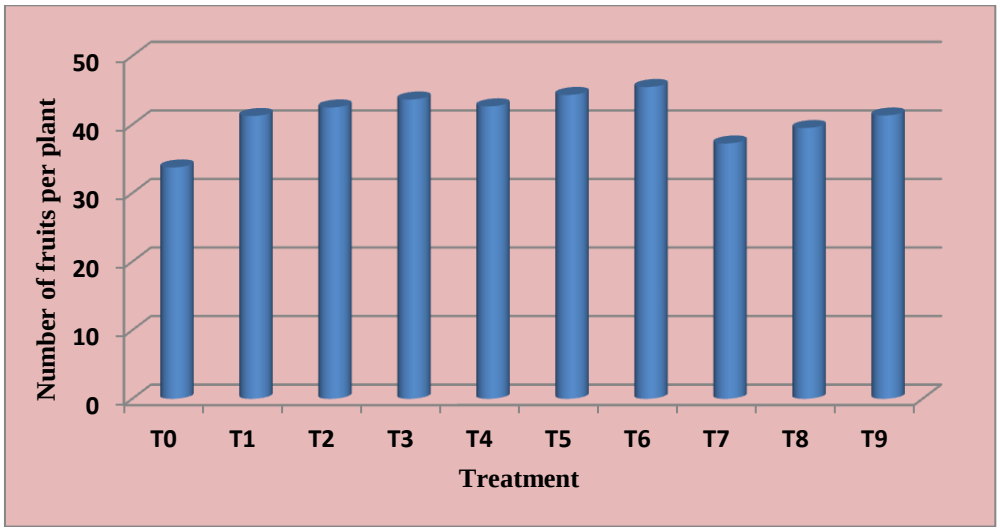

Fig. 8. Effects of microbial culture on No. of fruit/plant

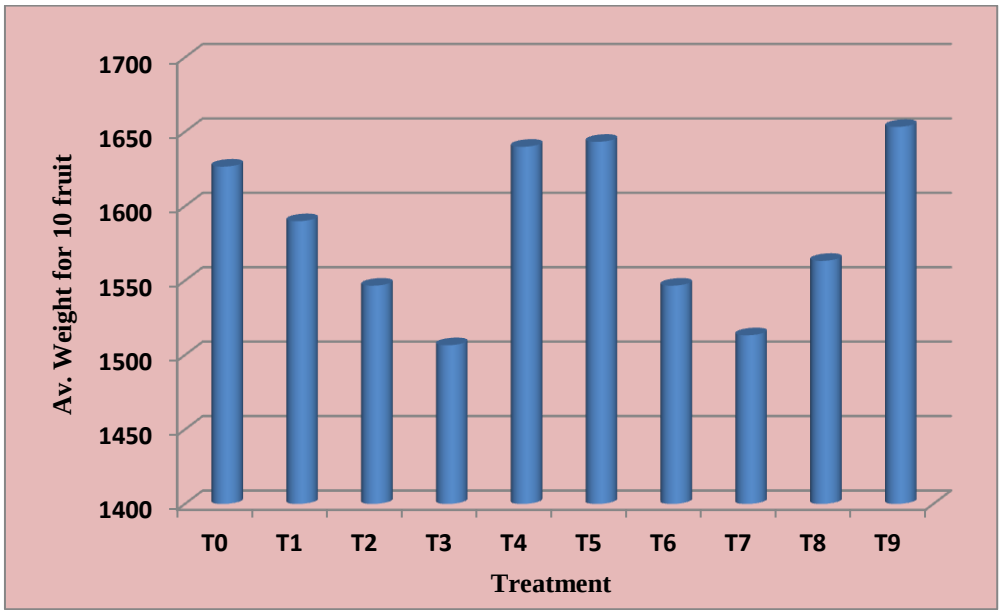

Fig. 9. Effects of microbial culture on Av. Weight for 10 fruit

The maximum fruit girth (32.00 mm) during were recorded under T_9 (Azotobacter- 15 ml/sq.m) which was found statistically at par with its concentration *i.e.* PSB (Photosynthetic Bacteria Rhodosudomonas palustris -40ml/sq.m (T_3), Vermiwash-40 ml/sq.m (T_6) and Azotobacter -10 ml/sq.m (T_8). Nayak et al. [16] reported that the application combination with biofertilizers (Azotobacter + Azospirillum + PSB), lime and organic manure (Vermicompost) in sponge gourd to increase the length length of fruit (31.50 mm). Maximum average fruit yield per plot (25.80 kg) was found in Vermiwash - 40ml/sq. m (T_6) followed by PSB (Photosynthetic Bacteria Rhodosudomonas palustris – 40 ml/sq. m 25.18 kg (T_3) and Vermiwash – 30 ml/sq.m 10.77 kg (T_5) the minimum average fruit yield per plot (19.33 kg) was observed in control plants (T_0). Reddy et al. [18] reported similar results in muskmelon, Yogesh et al., (2009) in cucumber. Maximum fruit yield/ ha (q) (164.50) was found in Vermiwash – 40 ml/sq.m (T_6) followed by Vermiwash – 30 ml/sq. m 155.47 q (T_5) and Azotobacter – 15ml/sq.m 149.07 q (T_9) the minimum fruit yield/ ha (124.07 q) was observed in control plants (T_0). Similar result found that the Yobo et al. [19,20], who recorded significantly higher fruit yield in gourd.

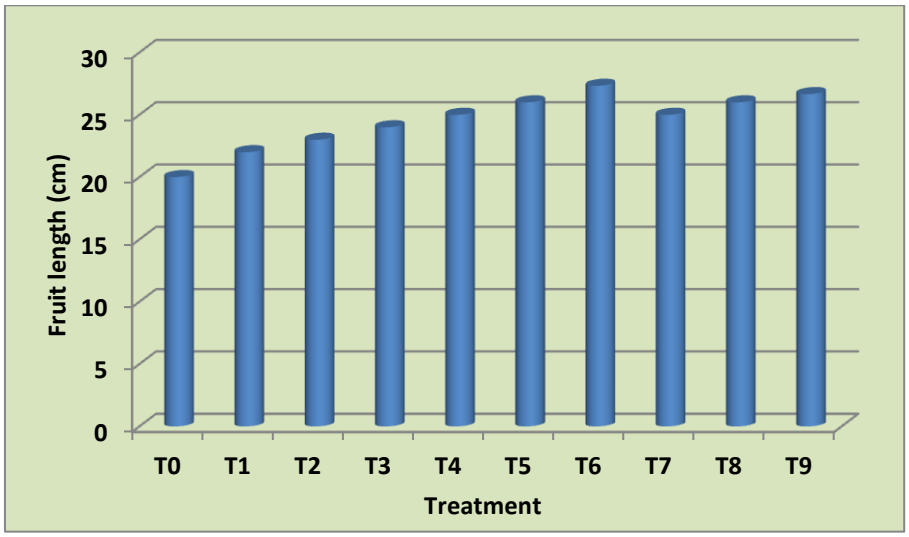

Fig. 10. Effects of microbial culture on fruit length (cm)

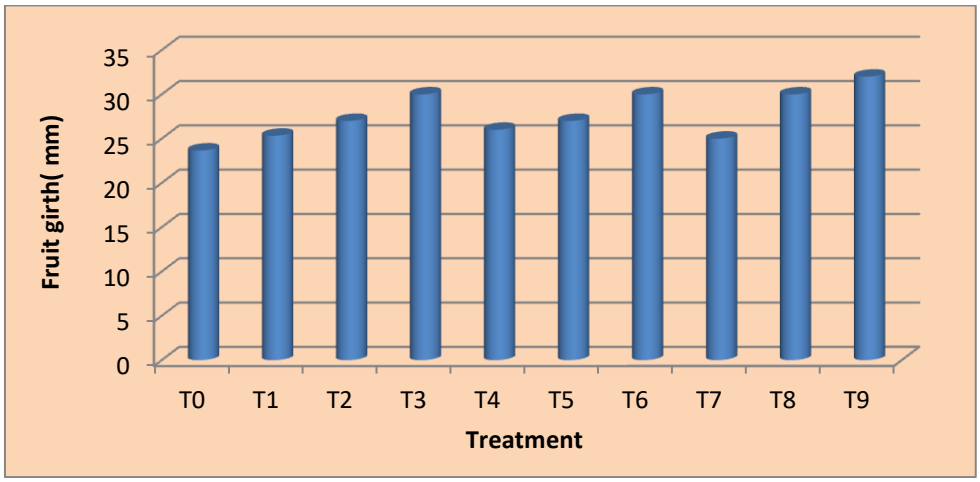

Fig. 11. Effects of microbial culture on fruit girth (mm)

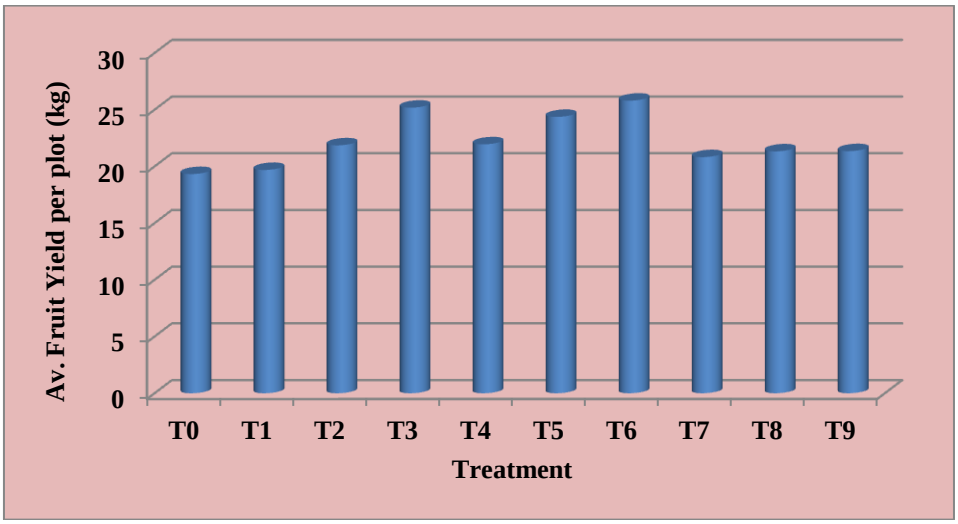

Fig. 12. Effects of microbial culture on Av. Fruit yield per plot (kg)

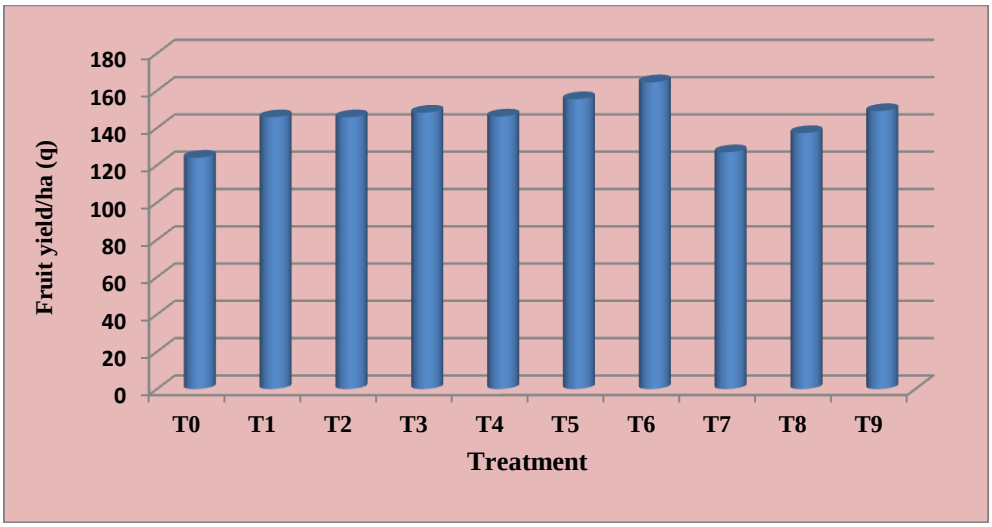

Fig. 13. Effects of microbial culture on fruit yield/ha (q)

Table 4. Evaluation of best performing microbial culture in relation to yield of sponge gourd

Treatments	Fruit girth (mm)	Av. Fruit Yield per plot (kg)	Fruit yield/ha (q)
Control (T_0)	23.66	19.33	124.07
PSB- 20 ml/sq.m (T_1)	25.33	19.69	145.75
PSB- 30 ml/sq.m (T_2)	27.00	21.86	145.75
PSB- 40 ml/sq.m (T_3)	30.00	25.18	148.24
Vermiwash-20 ml/sq.m (T_4)	26.00	21.95	146.19
Vermiwash-30 ml/sq.m (T_5)	27.00	24.37	155.47
Vermiwash-40 ml/sq.m (T_6)	30.00	25.80	164.50
Azotobacter-8 ml/sq.m (T_7)	25.00	20.82	127.00
Azotobacter-10 ml/sq.m (T_8)	30.00	21.33	137.28
Azotobacter-15 ml/sq.m (T_9)	32.00	21.35	149.07
F-test	S	S	S
SE(d)	2.48	0.95	5.07
C.V.	11.02	5.25	5.05
CD at 5% level	3.05	2.01	10.74

4. CONCLUSION

From The results of the present investigation concluded that the different microbial culture of Sponge Gourd (*Luffa cylindrica* L.) could be sources without affecting growth performance and yield. Results revealed that plant growth characteristics treatment T_9 (Azotobacter-15 ml/sq.m) (619.75) recorded significantly highest vine length. Yield parameter like Fruit yield/ha(q.) was recorded highest in treatment T_6 (Vermiwash-40ml/plant) (164.50q/ha). Quality parameter like total soluble solid (tss)(0brix) was recorded highest in treatment T3 (photosynthetic bacteria-40ml/plant) (21.50).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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