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Effect of Biofertilizers on growth and yield attributes of Guava (*Psidium guajava* L) cv. L-49

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Abstract
Research was conducted on 4 years old guava trees var. L-49 during Nov-Dec at College of Horticulture and Forestry, Pasighat, Arunachal Pradesh. The result showed that Plant height (17.90%) and Plant girth (16.66%), Canopy spread (N-S) (21.90%), Canopy spread (E-W) (22.59%) was highest with the application of ½ RDF + Azotobacter 100 g + Azospirillum 100 g + VAM 100 g followed by ¼ RDF + Azotobacter 100 g + Azospirillum 100 g + PSB 100 g + VAM 100 g. Application of ½ RDF + Azotobacter 100 g + Azospirillum 100 g + VAM100 g showed maximum Fruit set (59.43%), Number of fruiting branches (26.40), Number of fruits per branch (8.60), No. of fruits per tree (234.28) and Fruit yield (57.53 kg/ha). Fruit retention (59.76%) was maximum with the application of ¼ RDF+ Azotobacter 100 g + Azospirillum 100 g + PSB 100 g + VAM 100 g.

Keywords: Biofertilizers, growth, guava, yield

1. Introduction
Guava (*Psidium guajava*) also known as "apple of the tropics", successfully grown under tropical and subtropical areas worldwide. Guava belongs to family Myrtaceae and chromosome number is 2n=22. Guava is considered as 4th most important fruit crop of India withtheproductionof40.83milliontones (NHB, 2015). Guava is considered to be one of the increasing storability of fresh fruits (Mandal *et al*., 2012) [12]. Apart from origin to Tropical America, the cultivation of guava is expanded from Mexico to Peru and become a commercial fruit crop of India. In India major guava producing states are Uttar Pradesh, Bihar, Madhya Pradesh, and Maharashtra among these states' guava production is maximum in Allahabad in Uttar Pradesh, the state produces good quality fruit in India as well as in the world (Mitra and Bose, 1990) [3]. Guava is a small tree with shallow root and it produces branches that is near to the ground. The bark of guava tree is very smooth and colour is green to reddish brown. The flowers are bisexual or hermaphrodite and white in colour. The flowers are appeared as a cluster born on mature branches. Guava is cross pollinated crop. The size of fruits depends on cultivar, shape is spherical to pyriform, flesh color is white, yellow, pink, salmon, or red, skin color is green to bright yellow and aroma is weak to pungent. Guava is highly nutritionally valuable, can be used for fresh consumption and for processing purpose. Guava is rich in pectin so it used for making jam, jelly and other processed products. After barbedose cherry and aonla guava ranks third in vitamin-C (260 mg/100 g), thiamine (0.03-0.07 mg), riboflavin (0.02-0.04 mg), phosphorus (22.5-40 mg/100 g), calcium (10.0-30.0 mg/100 g), iron (20-35 mg/100 g) and also pectin (0.5-1.8% in 100 g pulp) (Sukla *et al.*, 2009). Guava fruits are available almost round the year. Guava bears fruits 3 times in a year (Shikhamay *et al*. 1986). There are three distinct flowering season Ambe-bahar (February), Hastha-bahar (October), Mrig- bahar (June).
Biofertilizers contains living microorganisms, which when applied to the soilor plant colonize the rhizosphere or the interior of the plant and promotes growth by increasing the supply of availability of primary nutrients to the host plant. It has capability to deploy the nutritive element from unsustainable from to sustainable form by biological process (Dey *et al*., 2005) [4]. Some biofertilizer like Azotobacter, Azospirillum, VAM and PSB has important role in nutrient management for soil as well as for plant.

In non-leguminous crops Azotobacter and Azospirillum fixed atmospheric nitrogen (Kerni and Gupta., 1986). Azotobacter and Azospirillum promote plant development and yield of several crops in different climatic regions. Azotobacter and Azospirillum helps in root development and enhance the rate of water and mineral uptake by roots. On the other hand, Phosphate solubilizing bacteria (PSB) are beneficial bacteria, it has capability of solubilizing inorganic phosphorus from insoluble compounds. VAM is one of the most important elements of soil. VAM helps in uptake of Zn, Cu, Fe, Mn, etc. VAM fungal hyphae plays an important role in soil by creating skeletal structure of macroaggregates through physical enlargement of soil particles. Using of Nitrogen, Phosphorus, Potassium along with biofertilizers has important role. Nitrogen is vital to chlorophyll which allows plants to carry out photosynthesis. Phosphorus also plays an important role for healthy plant growth. It helps in encouraging root growth, promotes blooming and potassium is associated with quality, such as size, shape, colour, even taste and others. Use of biofertilizers along with inorganic fertilizers effects plant growth, yield and quality (Ram and Rajput. 2000) [17]

The cultivation of guava in Arunachal Pradesh is not generally practicable like other fruit crops such as citrus, apple, banana, kiwi and walnut. The climate of Arunachal is humid sub-tropical in nature which favours the good quality fruit production of guava. The average rainfall of this state is above 3000mm. Guava response well to the application of inorganic fertilizers and organic fertilizer as it helps in growth and good quality fruit production (Hayes, 1970). But chemical fertilizer can cause tremendous effect on soil health. Bio-fertilizers have been sought to be one of the answers to restore the soil health apart from solving nutrition problem of plants. Bio-fertilizers are basically carrier-based microorganism used for maintaining soil health.

2. Materials and Methods

Four-year-old guava trees were selected for the experiment. Two trees were selected for each treatment. The experiment was carried out in Randomized Block Design with 3 replications. The spacing was 6x6m.

The biofertilizers were applied in the month of November to December. Nitrogen was applied in the form of urea. Nitrogen was applied in two equal split doses, first dose at before flowering at second dose at fruit development stage. Phosphorus and Potassium was applied at full dose. Biofertilizers were applied 15 days after application of chemical fertilizers along with FYM. Biofertilizers were applied around the tree trunk by making a ring which was 1m away from tree trunk and light irrigation was given after application.

1. T_1- Control
2. T_2- ½ RDF + Azotobacter (100 gm)
3. T_3- ½ RDF + PSB (100 gm)
4. T_4- ½ RDF + Azospirillum (100 gm)
5. T_5- ½ RDF + VAM (100 gm)
6. T_6- ½ RDF + Azotobacter (100 gm) + PSB (100 gm)
7. T_7- ½ RDF + Azotobacter (100 gm) + Azospirillum (100 gm)
8. T_8 - ½ RDF + Azotobacter (100 gm) + Azospirillum (100 gm) + VAM (100 gm)
9. T_9- ¼ RDF + Azotobacter (100 gm) + Azospirillum (100 gm) + PSB (100 gm) + VAM 100 g
10. T_{10}- Full dose of RDF (N 1140 g, P 1000 g, K 400 g)

3. Results and Discussions

3.1 Effect of Biofertilizers on growth attributes of guava.

Among different treatments, the highest plant growth, plant girth, tree canopy (north-south) was found with the application of ½ RDF + Azotobacter 100 gm + Azospirillum 100 gm + VAM 100 gm as compare to other treatments and canopy (E-W) maximum came with ¼ RDF + Azotobacter 100 g + Azospirillum 100 g + PSB 100 g + VAM. This inspection is proportionate with the research of Ratna *et al.*, (2019), this investigation found that application of Azospirillum 100 gm + 50% RDF + VAM 30 gm + Vermicompost 10 kg/tree was Found most effective in increasing plant height, Crown height, plant girth. Narendra *et al*., (2019) [23] reported that, application of Vermicompost 7.5 kg + Phosphorus solubilizing bacteria (PSB) 50 gm per plant was effective for increasing plant height, plant girth. Ramawatar *et al.,* (2020) [17] a reported that, application of 75% RDF+10 kg Vermicompost + 50 gm Azotobacter + 50 gm PSB + 5 kg mustard oil cake per plant was most effective for plant growth characteristics (tree height, plant girth, canopy spread). Vikas *et al*., (2016) [27] also reported that, tree height, girth, canopy spread was maximum with the application of 75% RDF + Cow dung slurry @ 10 lit/tree + Azospirillum 100 gm /tree + PSB 100 gm /tree. Increasing of growth due to improving soil conditions because of application of FYM and bio-fertilizers along with N: P: K that release different micro and macro nutrients that is necessary for plants at their proper stage (A.A Singh *et al*., 2014) [14].

3.2. Effect of Biofertilizers on yield attributes of guava

Among all the different treatments, number of fruiting branches (8.60), number of fruiting branches (26.40), number of fruits per branch (8.60), no. of fruits per tree (234.28) and fruit yield per plant (57.53), fruit set (59.43) was found with the application of ½ RDF + Azotobacter 100 gm + Azospirillum 100 gm + VAM 100 gm. No. of days taken for flowering (28.73) and fruit retention (59.76%) was maximum with the application of ¼ RDF + Azotobacter 100 g + Azospirillum 100 g + PSB 100 g + VAM 100 g. This inspection is collaborated with the research of Meena *et al.,* (2013) [37]. It reported that, number of fruits per tree, yield/plant yield/hac was highest with the application of ½ RDF + 25 kg FYM + 250 g Azospirillum + 250 gm Azotobacter 250 gm significantly increased number of fruits per plant, yield/plant, yield/hac. Kumar *et al*., (2017) stated that, maximum number of fruits, fruit yield per tree was found with the application of Azotobacter 20 gm +PSB @ 20 gm + Vermicompost @ 10 kg + 50% recommended NPK. Sourabh *et al.,* (2018) [21] also reported that, vermicompost and FYM along with biofertilizers at three RDF (50%, 75%, and 100%), Azotobacter + PSB inoculation along with 100% RDF+ Vermicompost showed maximum flowers per branch, fruit set, number of fruits, yield/tree. The growth of fruiting branches, maximum number of fruits, maximum number of fruiting branches were significantly increased because of improving soil nutrient availability because of biofertilizers application. It also increased uptake of nutrients by the plants for their better vegetative growth. (Singh *et al*., 2018) [37]. This improvement due to application of biofertilizers along with NPK that is related to auxin synthesis. This more flowering and fruiting due to occurrence of photosynthates at critical stage (Kumar *et al.,* 2015).

Table 1: Effect of Biofertilizers on growth attributes of guava.

Treatments	Plant height (m)				Plant girth (cm)			
	Initial	Final	Increase	Increase %	Initial	Final	Increase	Increase %
T1	2.07	2.33	0.26	12.56	28.70	31.10	2.40	8.36
T2	2.35	2.70	0.35	14.89	27.75	30.24	2.49	8.97
T3	2.46	2.78	0.32	13.00	28.90	31.84	2.94	10.17
T4	2.20	2.53	0.33	15.00	29.12	32.11	2.99	10.10
T5	2.22	2.58	0.36	16.21	29.14	32.10	2.96	10.15
T6	2.56	2.97	0.41	16.40	28.77	31.71	2.94	10.21
T7	2. 46	2. 84	0.38	15.44	24.55	27.12	2.57	10.46
T8	2.29	2.70	0.41	17.90	28.11	32.08	3.98	14.15
T9	2. 34	2.73	0.39	16.66	30.04	34.02	3.97	13.21
T10	2.26	2.61	0.35	15.48	28.87	31.78	3.12	10.80
S Ed ±	0.021	0.026	-	0.58	SEd± 1.12	SEd ± 3.72	-	0.28
CD at 5%	0.064	0.057	-	1.23	2.38	5.91	-	0.58

Table 2: Effect of Biofertilizers on yield attributes of guava.

Treatments	No. of days taken	No. of fruiting branches	No. of fruits per branch	Fruit Set (%)	Fruit retention (%)	No. of fruits per tree	Fruit yield per plant (kg)
T1	39.80	17.83	6.66	42.02	46.30	76.93	26.70
T2	37.67	18.00	7.33	54.06	52.13	97.95	36.33
T3	38.00	19.80	7.02	54.60	54.40	109.03	43.43
T4	37.00	18.16	6.01	56.20	54.10	121.96	37.40
T5	36.10	20.77	7.50	55.13	55.19	112.23	49.20
T6	35.46	21.93	7.66	56.53	57.10	161.43	53.73
T7	35.33	25.56	8.05	56.80	57.70	196.08	50.40
T8	32.00	26.40	8.60	59.43	56.58	234.28	57.53
T9	28.73	25.10	8.10	58.43	59.76	220.61	55.46
T10	32.34	23.01	7.30	56.66	57.11	170.75	51.10
S Ed ±	0.78	1.66	0.43	4.36	6.47	41.84	1.88
CD at 5%	1.64	3.56	0.91	9.16	11.61	87.91	3.96

4. Conclusions

The treatment T8 (1/2 RDF + Azotobacter 100 g + Azospirillum 100 g + VAM 100 g) was found significantly increased vegetative growth parameters including plant height (0.41m), plant girth (3.98cm), canopy spread (N-S) (0.53 m) E-W (0.54 m) followed by T9 (1/4 RDF + Azotobacter 100 g + Azospirillum 100 g + PSB 100 g + VAM 100 g). Yield and yield attributing parameters such as no. of fruiting branches (26.40), No. of fruits per branch (8.60), Fruit set (59.43%) and yield (57.53 kg/plant) were recorded with T8 (1/2 RDF + Azotobacter 100 g + Azospirillum 100 g + VAM 100 g). Days to first flowering (28.73 days), fruit retention (59.76%) was maximum with T9 (1/4 RDF + Azotobacter 100 g + Azospirillum 100 g + PSB 100 g + VAM 100 g). So, it can be concluded that, treatment, T8 i.e., ½ RDF + Azotobacter 100 g + Azospirillum 100 g + VAM 100 g was the most effective treatment for improving growth, quality, yield and shelf life of guava cv. L-49 followed by ¼ RDF+ Azotobacter 100 g + Azospirillum 100 g + PSB 100 g + VAM 100 g under Pasighat, Arunachal Pradesh.

Declaration: Authors have declared that no competing interests exist.

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