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BIOFERTILIZER MEDIATED GROWTH PROMOTION IN JACKFRUIT (*ARTOCARPUS HETEROPHYLLUS* L.) CV. CHANDRA: A STUDY ON KSB AND *PSEUDOMONAS* APPLICATION

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ABSTRACT

An experimental trial investigation on the "Effect of Bio-fertilizers on growth and development of Jackfruit (*Artocarpus heterophyllus* L.) cv. Chandra" was undertaken at Instructional farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar from 2021-22. The experimental trail incorporated of 9 treatments carried out in Randomized Block Design (RBD) with 3 replications. The most significant improvements in plant growth attributes like height of the plant (56.98%), rootstock girth (8.09%) and scion girth (7.90%), number of leaves/plant (66.66%), petiole length (8.70%), length of internode (16.80%), number of nodes/plant (36.36%), leaf length (16.33%), leaf width (12.34%) and leaf area (29.88%) were noted in treatment T_8 (KSB, *Pseudomonas*) (75g each) within different treatments of biofertilizers. This treatment located superior in enhancing the soil attributes consisting organic carbon %, available nitrogen, phosphorus and potassium content of soil were located dramatically higher from rest of the treatments. Similarly, this treatment had a pronounced moderating response on pH and electrical conductivity of soil.
***Keyword* :** Jackfruit, Biofertilizers, Poor man's food, Moraceae.

Introduction

The Jackfruit tree (*Artocarpus heterophyllus* Lam.) is categorized under Moraceae family. Jackfruit is originated from India, thriving extensively in the Western Ghats, a reason of rich biodiversity hotspot. Except India, it is usually cultivated in backyard gardens across tropical and subtropical nations especially, Brazil, Thailand, Myanmar, Indonesia, Bangladesh, Malaysia Philippines and Sri Lanka. Jackfruit is a moderately-sized fruit plant generally grows to a manageable height of 28-80 feet, which allowing effortless harvesting of fruits. The fruit of jackfruit bearers on auxiliary branches and primary branches of the trees, known as cauliflorous fruiting habit. The word *Artocarpus* is originated from the Greek words *artos* (bread) and *carpos* (fruit) as revealed by (Bailey, 1949). "Jackfruit is an essential source of protein, starch, calcium, and thiamine, (Burkill, 1997). It holds a wide range of essential vitamins and minerals such as Vitamin-A, Vitamin-C, thiamine, riboflavin, calcium, potassium, iron, sodium, zinc and niacin. It is regionally known as *kathal* and because of its trendiness and multiple traits, it has achieved the status of national fruit of Bangladesh.

It is now universally accepted that there are so many bio-active compounds in vegetables and fruits for which protective mechanisms have been suggested. It has been shown experimentally that consumption of vegetables and fruits are favorable against certain diseases (Galaverna *et al*., 2008). Traditional use of jackfruit to cure a good number of diseases is well documented by numerous ethno-botanical studies. It is a multifaceted species provides a wide range of valuable resources like food, fuel, timber, livestock feed, clinical and industrial materials. The tree has a profound effect on the ecological conservation. It has been verified highly efficient in improving soil fertility and preventing soil degradation." It is rarely identified as a commercial fruit crop, despite it is extensively cultivated in Southern and Eastern parts of India because of variable fruit quality as well as lengthy cultivation periods.

The plant's development and production traits are notably influenced by fertilizer application approaches. In present trail biofertilizer was evaluated for their efficacy on jackfruit plants. Biofertilizers are suggested as a substance containing beneficial microbes that integrates the atmospheric nutrient uptake, fostering soil productivity, plant health and productivity, while promoting eco-friendly and economically sustainable approaches. (Youssef and Eissa, 2014). The majorly utilized biofertilizers being, bacterial species of utilizing the phosphorous and potash into a available form to the plants, which are called phosphorous solubilizing bacteria (PSB) and potash solubilizing bacteria (KSB). Phosphorus solubilizing bacteria (PSB) excretes some organic acids like acetic acid, lactic acid, succinic acid, gluconic acid and fumaric acid, etc. By solubilizing tricalcium phosphate and rock phosphate, organic acids increase the availability of nutrients for plants. (Ramasamy *et al.,* 2011). Potassium solubilizing bacteria (KSB) can solubilize potassium minerals, making them available for plants uptake.

However, the performance of the biofertilizers has assured to enhance plant growth and development in different trees, yet their usages remain limited among farmers due to several challenges. Research work manifesting the use of biofertilizers in fruit crop is very scanty. Their use in crops like jackfruit has hardly been tested.

Material and Methods

A research trial was supervised at Department of Fruit Science, College of Horticulture and Forestry, Jhalarapatan, Jhalawar on its Instructional Farm in the newly planted block of Jackfruit cv. Chandra. The research trial was arranged in RBD with comprising 9 treatments combination in which, *Pseudomonas* and Potassium Solubilizing Bacteria (KSB) two types of biofertilizers were used. Biofertilizer was applied at the rate of 50 and 75g each. The treatments were executed in the soil in the periphery of plants, during last week of August 2021 after recording base (initial) growth and development attributes of plants as well as soil attributes. The detail of treatment is as under: T_0-Control, T_1-KSB @ 50g, T_2-KSB @ 75g, T_3-*Pseudomonas* @ 50g, T_4-*Pseudomonas* @ 75g, T_5-KSB @ 50g + *Pseudomonas* @ 50g, T_6- KSB @ 50g + *Pseudomonas* @ 75g, T_7-KSB @ 75g + *Pseudomonas* @ 50g, T_8-KSB @ 75g + *Pseudomonas* @ 75g.

Plant height of jackfruit was assessed from base of the stem to the highest point with a measuring scale. The initial girth of rootstock and scion was measured separately with help of vernier caliper before treatment application, thereafter, the periodical observation of rootstock and scion girth was measured for every two months interval. The number of leaves/plant and the number of nodes under different treatments of jackfruit was counted manually at every two months interval. Length between the two nodes was measured with measuring scale from beginning of experiment untill end of the experiment.

Petiole length, leaf length and leaf width were recorded with help of measuring scale. Each time increase in average value was calculated based on initial value. The data collected during the research were statistically analysed by RBD (Randomized Block Design) as proposed by Panse *et al.* (1995). Wherever required, the data showing variation between 0 to 30 per cent square root transformation was followed (Gomez and Gomez, 1984). Wherever, the variation in data not felled in either 0 to 30 or 30 to 70 per cent, no transformation of data was undertaken.

The pH of Soil was measured by using 1:2 soil and water suspensions by glass electrode pH meter. Soil water suspension of 1:2 was prepared by taking 20g of soil and 40 ml distilled water in 100ml beaker (Jackson, 1973). Electrical conductivity of soil water suspensions (1:2.5) was measured using EC meter (Model Elico CL 180) as elaborated by Jackson (1973). These EC2.5 values were converted later to saturation paste value (EC). The soil organic carbon was determined using the method proposed by Walkley and Black (1934) chromic acid wet oxidation method. The nitrogen content was calculated by using alkaline potassium permanganate method as proposed by Subbiah and Asija (1956). Available phosphorus was calculated with extraction by 0.5 M $NaHCO_3$ solution adjusted at pH 8.5 as proposed by Olsen *et al.* (1954). And available potassium was obtained by extracting the soil by shaking with 1 N neutral ammonium acetate solution by flame photometer as proposed by Metson (1956).

Results

Effect on shoot parameters

Table 1 presents the values of rootstock and scion girth of jackfruit fruit tree as influence by various biofertilizers. With reference the maximum per cent increment in rootstock girth (8.09%) and scion girth (7.90%) was noticed in T_8 (KSB, *Pseudomonas*) (75g each) at the time of final observation, which was statistically dominant from rest of the treatments.

Effect on leaf parameters

Table 2 enumerated the data on leaf attributes of jackfruit tree, consisting of leaf number, petiole length, leaf length, width, and area. Revealed that different biofertilizers sources varied significantly in respect to their effect on no. of leaves per plant, petiole length, leaf length, width and area. The data showed maximum per cent increase in no. of leaves/plant (66.66%), length of petiole (8.70%), length of leaf (16.33%), width of leaf (12.34%) and leaf area (29.88%) at the end of experiment in March in treatment T_8 (KSB, *Pseudomonas*) (75g each), which was statistically superior from rest of the treatments. Whereas lowest per cent increment in no. of leaves/plant (25.00%), length of petiole (4.39%), length of leaf (4.42 %), width of leaf (4.88%) and area of leaf (10.03%) were recorded in T_0 (Control).

Effect on soil parameters

Table 3 indicated the minimum pH of soil (7.38) and Soil electrical conductivity was found (0.35 dS m^{-1}) was there in treatment T8 (KSB, *Pseudomonas*) (75g each) (7.38). The data with respect to effect of biofertilizers on available N (kg/ha), available P (kg/ha), available potassium (kg/ha) and soil organic carbon percentage are presented in Table 4. The maximum available N (319.33 kg/ha), available P (27.66 kg/ha), available K (290.33 kg/ha) and organic carbon percentage (0.52%) was recorded in T8 (KSB, *Pseudomonas*) (75g each).

Table 1: Effect of biofertilizers on height of plant (cm), rootstock girth (mm), scion girth (mm), number of nodes/plants, length of internode (cm) of Jackfruit cv. Chandra

Treatments	Height of plant	Rootstock girth	Scion girth	Number of nodes/plants	Length of internode
T_0 (Control)	20.85(19.37)	2.85(2.93)	2.54(2.49)	9.33(12.06)	2.06(6.66)
T_1	20.83(30.75)	2.70(4.96)	2.48(4.32)	9.33(16.66)	2.07(11.73)
T_2	24.21(28.58)	2.86(4.53)	2.50(4.50)	10.66(18.54)	2.09(9.09)
T_3	22.70(31.97)	2.94(4.34)	2.39(5.49)	10.66(18.51)	1.94(13.00)
T_4	21.48(30.33)	2.59(5.57)	2.45(5.74)	9.33(21.73)	2.12(11.57)
T_5	23.73(33.70)	2.79(5.02)	2.47(6.38)	10.00(20.00)	2.13(9.67)
T_6	22.83(47.31)	2.81(6.58)	2.42(7.29)	10.66(28.00)	1.94(15.30)
T_7	24.30(41.70)	3.10(6.13)	2.64(6.81)	11.00(22.22)	1.91(14.58)
T_8	24.15(56.98)	2.82(8.09)	2.39(7.90)	10.00(36.36)	2.15(16.80)
SEm (±)	2.01	0.20	0.11	0.39	0.80
CD (5%)	6.05	0.61	0.33	1.17	2.40

Table 2: Effect of biofertilizers on of Jackfruit number of leaves/plants, petiole length (mm) leaf length (cm) leaf width (cm) and leaf area cv. Chandra

Treatments	Number of leaves/plants	Petiole length	Leaf length	Leaf width	Leaf area
T_0 (Control)	6.66 (25.00)	3.30 (4.39)	3.25 (4.42)	2.43 (4.88)	7.51 (10.03)
T_1	6.66 (33.33)	3.42 (5.08)	3.16 (7.08)	2.49 (7.24)	7.98 (17.55)
T_2	7.00 (40.00)	3.44 (5.26)	3.37 (7.69)	2.47 (8.17)	8.81 (20.26)
T_3	7.66 (35.29)	3.48 (5.54)	3.22 (10.21)	2.16 (10.31)	6.93 (21.53)
T_4	6.66 (42.85)	3.30 (6.62)	3.39 (10.70)	2.38 (9.35)	7.94 (24.61)
T_5	8.00 (41.17)	3.46 (6.27)	3.28 (13.25)	2.37 (9.29)	8.23 (26.67)
T_6	7.66 (43.75)	3.51 (7.34)	3.45 (14.55)	2.46 (11.96)	8.02 (29.32)
T_7	8.33 (47.05)	3.48 (6.43)	3.28 (14.11)	2.36 (11.58)	8.11 (25.84)
T_8	6.66 (66.66)	3.50 (8.70)	3.42 (16.33)	2.49 (12.34)	8.46 (29.88)
SEm (±)	0.29	0.10	0.10	0.54	0.22
CD (5%)	0.88	0.29	0.31	1.63	0.66

Note: 1. Data in parentheses indicate per cent increment of parameters.
2. CD has been calculated based on percentage value

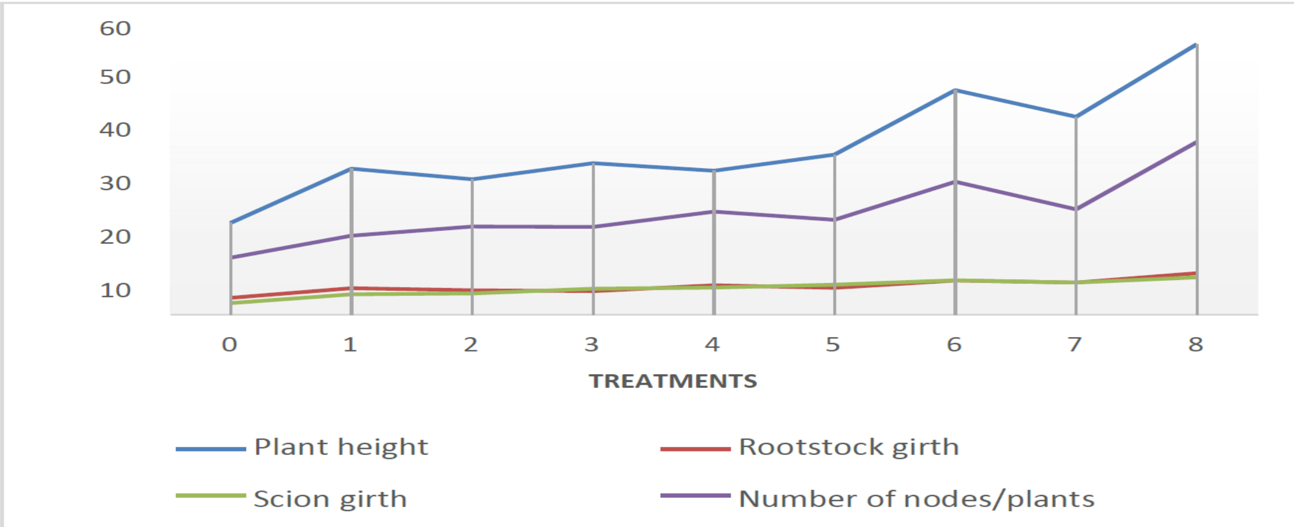

Fig. 1 : Effect of biofertilizers on Shoot parameters (Plant height, Rootstock girth, scion girth and number of nodes/plant) of Jackfruit cv. Chandra

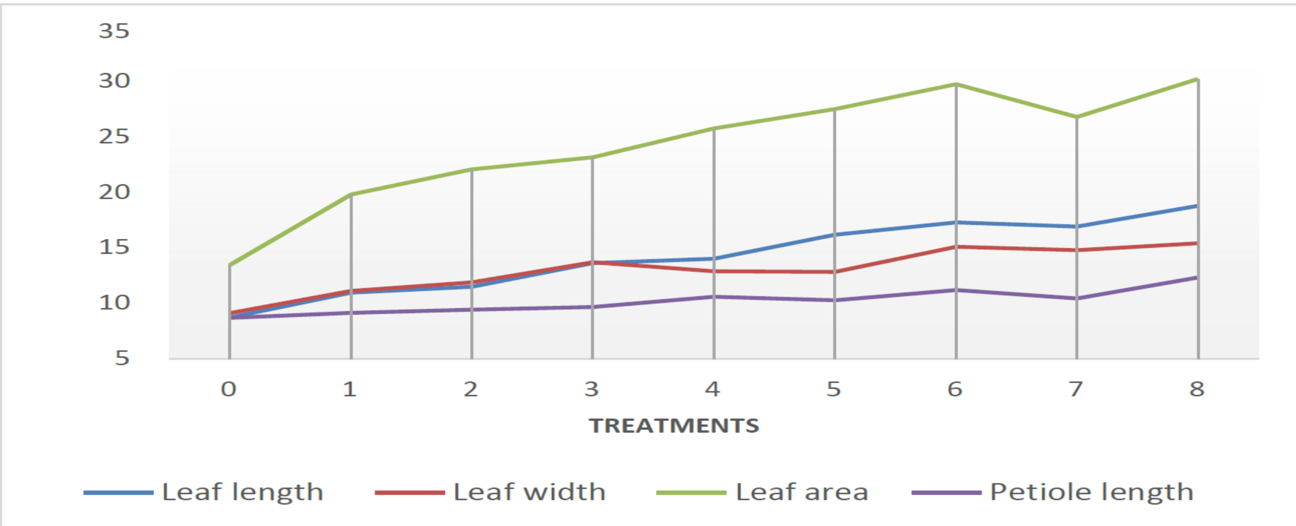

Fig. 2 : Effect of biofertilizers on Leaf parameters (Leaf length, Leaf width, Leaf area and Petiole length) of Jackfruit cv. Chandra

Table 3: Effect of biofertilizers on pH, EC, N, P_2O_5, K_2O and OC of Jackfruit cv. Chandra

Treatments	**Soil attributes**					
	pH	EC (dS m^{-1})	N (kg/ha)	P (kg/ha)	K (kg/ha)	**OC(%)**
Initial value	7.45	0.40	312.00	21.14	278.30	**0.41**
T_0	7.45	0.40	312.00	21.14	278.30	**0.41**
T_1	7.44	0.39	313.33	22.33	279.00	**0.43**
T_2	7.44	0.38	314.00	24.33	279.66	**0.44**
T_3	7.43	0.38	314.66	25.00	282.00	**0.45**
T_4	7.43	0.37	315.00	25.33	284.16	**0.46**
T_5	7.42	0.37	316.00	25.33	286.90	**0.48**
T_6	7.41	0.36	317.33	26.00	288.00	**0.50**
T_7	7.40	0.36	318.66	26.33	289.00	**0.51**
T_8	7.38	0.35	319.33	27.66	290.33	**0.52**
SEm (±)	0.004	0.005	0.55	0.60	0.46	**0.008**
CD (5%)	**0.01**	**0.01**	**1.66**	**1.30**	**1.40**	**0.02**

Discussion

Data as respect the impact of biofertilizers in shoot parameter like rootstock and scion girth are presented in Table 1. The higher shoot attributes under this treatment can be associated to its increased effectiveness in optimizing the rhizosphere micro-environment, ensuring adequate essential nutrients for optimal plant growth and development. The beneficial result of this treatment on soil attributes can be linked to improved physico-chemical properties of soil (pH, EC moderation, organic carbon and N, P, and K status), and increased the production of growth promoting substances like (auxins, gibberellins, and cytokinin's) in the root zone plants.

Numerous researches have been done by several investigators and they observed that application of plant growth promoting rhizobacters (PGPR) based biofertilizers boosts overall growth of fruit tree. as Dutta and Kundu (2012) in mango; Nileema and Annasaheb, (2017) in banana; Goswami *et al*. (2012) in guava cv. Pant Parbhat; Dutta *et al.* (2009) in guava; Kumar *et al.* (2014) in Aonla; Esitken *et al.* (2010) in strawberry; Godara (1993) in peach.

Data in respect to the effect of biofertilizers on leaf attributes such as no. of leaves, petiole length, leaf length, leaf width and leaf area are presented in Table 2 in respect to different leaf parameters all traits were recorded significantly superior in T_8 treatment (KSB @ 75 g + *Pseudomonas* 75 g).

Improvement in the leaf parameters in treatment T_8 (KSB, *Pseudomonas*) (75g each) may be due to probably better ability of phosphorous solubilizing bacteria (PSB) to production of plant growth regulating compounds such as Indole Acetic Acid and gibberellic acid. PSB strains are capable to produce a wide range of acids like organic and inorganic and CO_2 which perhaps led to moderating acidity of soil and subsequently might converted the insoluble forms of phosphorus into soluble form (Mosse, 1981). Such impact may also be accounted for better result under leaf parameters in treatment T_8(KSB, *Pseudomonas*) (75g each).

In present study, all recorded parameters (Table 3) for soil nutrient status were found significantly influenced by applied biofertilizers of diverse plant growth promoting rhizobacteria. Better enhancement in physico-chemical traits of soil in treatment T8 (KSB 75 g + *Pseudomonas* 75 g) might be associated with increased in organic matter of the soil as cited by Gogoi *et al.* (2004). The relatively better pH of soil in this treatment may be attributed due to higher production of several organic and inorganic acids produced by microbes, which have tendency to maintain neutral soil pH. (Bagyaraj and Manjunath 1980).

In this research, soil EC (electrical conductivity) decreased significantly with increasing biofertilizers doses in application. Neelkant *et al.* (2021) noted that by application of *Azospirillum,* PSB, KSB there was significant decrease in soil electrical conductivity in jackfruit orchard which corroborates the present research.

The increase in available nitrogen and phosphorus content as observed in the experiment in the treatment T8 (KSB @ 75 g + *Pseudomonas* 75 g) may be due to better effectivity of this treatment over other treatments in augmenting nitrogen fixation and phosphate solubilization. Some bacteria have the ability to solubilize inorganic phosphorus due to chelation, exchange reaction, phosphate production and excretion of organic acids that have moderating effect on soil pH and in rendering the insoluble phosphate into soluble form. Generally, the solubility of calcium phosphates and magnesium also increases with decreasing pH.

The increase in potassium content under biofertilizers better than other treatments in T8 (KSB, *Pseudomonas*) (75g each) may be due to comparatively better dissolution rate of silicates and minerals which releases K, production of enzymes like chitinase and cellulases that causes breakdown of minerals leading to increased rate of K availability. These findings are in agreement with the work of Esitken *et al.* (2010), Manjunath *et al*. (1983), Hussain *et al*. (2017) and Singh *et al.* (2021) in custard apple.

Conclusion

From the present study, it was concluded that application of T_8 (KSB @ 75g + *Pseudomonas* 75g) in jackfruit (*Artocarpus heterophyllus* L.) cv. Chandra is useful in improving growth and development of plant parameters. Treatment T_8 (KSB @ 75g + *Pseudomonas* 75g) was found statistically higher from rest of the treatments with respect to the plant growth and development parameters like plant height, rootstock girth, scion girth, length of internode, number of leaves per plant, petiole length, leaf length, leaf width and leaf area respectively. Whereas soil parameters like pH and electrical conductivity had better moderation along with significant increase in organic carbon, available nitrogen, phosphorus and potassium under T8 (KSB @ 75g + *Pseudomonas* 75g).

Hitherto, purporting to the study conducted for a limited period of eight months, the commercial application of findings requires further affirmative study under varying soil and climatic conditions to draw meaningful conclusion.

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