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RESEARCH PAPER

Economics Analysis of Production of Litchi Air Layered Plants by using Plant Growth-Promoting Rhizobacteria (PGPRs)

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ABSTRACT

The experiment was carried out on litchi trees in Fruit Nursery, Department of Horticulture, Marallia (Miran sahib), Jammu. Mature litchi trees of cv. Dehradun (above 25 years old) planted in scientific manner with square system at 10 m distance of uniform size and vigor was selected as mother tree for air layering. The experiment consists of 10 treatments with three replications of each treatment. The PGPRs used in the layering were *Pseudomonas fluorescens, Bacillus* sp., Consortia *(Bacillus* sp. + *Pseudomonas fluorescens).* The highest B:C ratio (1:1.87) was recorded in treatment containing consortia (*Bacillus*sp. + *Pseudomonas fluorescens*) @10^8 cfu ml^{-1} whereas, the lowest B:C ratio (1:1.46) was recorded in control.

HIGHLIGHTS

- The difference in gross returns between the treatment combinations is due to survival per cent of air layers among the different treatments.
- With the highest cost-benefit ratio of :1.87 recorded in treatment containing consortia (*Bacillus* sp. + *Pseudomonas fluorescens*) @10^8 cfu ml^{-1}., the PGPRs were determined to be highly economically viable for implementation in commercial production.

Keywords: Bagging, litchi, PGPRs, benefit-cost ratio

Litchi (*Litchi chinensis* Sonn.), a subtropical evergreen fruit crop that belongs to the family Sapindaceae, which has 125 genera and about 1000 species. Litchi is a fruit native to China that has been cultivated in India since the 18th century. In India, litchi is cultivated on area of 96,000 hectares yielding 7,30,000 metric tonnes (Anonymous, 2020). Bihar, West Bengal, Uttarakhand, Jharkhand, Assam, Tripura, Orissa, and Punjab are the primary litchi-growing states. Litchi is cultivated on 938 hectares in Jammu, with a total yield of 1964 metric tonnes (Anonymous, 2019).

Air layering is the most practical, accessible, economical, quick, and simple method of propagation since it does not need any specific procedures as are necessary in grafting and budding. Air layer plants are smaller and more uniform in size, with a drooping growth habit and profuse bearing. Therefore, nurserymen use air layering as a commercial method for propagation of litchi. Litchi are propagated primarily through air layering, and the quality of root development in air layers is influenced by a variety of variables. Among these variables, the use of bioinoculants

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is significant since it enhances the percentage of success by facilitating root development in litchi plants. Formation of callus, root initiation, root growth, and survival percentage of air layers are all aided by bioinoculants.

Bacteria that have colonised the rhizosphere and stimulate plant development through various processes are known as plant growth-promoting rhizobacteria (PGPRs) (Dey *et al*. 2004, Herman *et al*. 2008). Plant growth-promoting rhizobacteria (PGPRs) are beneficial to plant growth because they aid in the uptake of resources (such as phosphorus, nitrogen, and essential minerals) and regulate plant hormone levels. As bio-control agents, they also decrease the inhibitory effects of various pathogens on plant growth and development. Recent research has found that bacteria from various genera (*Pseudomonas*, *Bacillus, Burkholderia, Agrobacterium* and others) induce rooting of stem cuttings in sour cherries (Esitken *et al*. 2003), rosehips (Ercisli *et al*. 2004), and kiwifruit (Ercisli *et al*.2003), Erturk *et al.* 2010), etc. As a result, it's expected that using plant growth promoting rhizobacteria (PGPRs) will aid in proper rooting of litchi air layers. Hence the current study was under taken to work out the economics of production of litchi air layered plants by using PGPRs.

MATERIALS AND METHODS

The experiment was conducted on litchi trees in Fruit Nursery, Department of Horticulture, Marallia (Miran sahib), Jammu. Mature litchi trees of cv. Dehradun (above 25 years old) planted in scientific manner with square system at 10 m distance of uniform size and vigor was selected as mother tree for air layering. All the trees were maintained under uniform scientific culture practices before and during the course of research. Following was the treatments detail: T_1-*Bacillus*sp.@10^6 cfu ml^{-1}, T_2- *Bacillus*sp. @10^8 cfu ml^{-1}, T_3- *Bacillus* sp.@10^{10} cfu ml^{-1}, T_4- *Pseudomonas fluorescens* @10^6 cfu ml^{-1}, T_5- *Pseudomonas fluorescens* @ 10^8 cfu ml^{-1}, T_6- *Pseudomonas fluorescens* @ 10^{10} cfu ml^{-1}, T_7- Consortia (*Bacillus*sp.+ *Pseudomonas fluorescens*) @10^6 cfu ml^{-1}, T_8- Consortia (*Bacillus*sp.+ *Pseudomonas fluorescens*) @10^8 cfu ml^{-1}, T_9- Consortia (*Bacillus*sp.+ *Pseudomonas fluorescens*) @10^{10} cfu ml^{-1}, T_{10}- (Control).

Economic Analysis

To identify the most profitable treatment, an economic analysis of the various treatments was done in terms of net returns and the benefit:cost (B:C) ratio.

Gross income

Gross returns were obtained by multiplying the number of layers survived and price per plant (with polybag).

Net returns

After deducting the cost of cultivation from the gross income, net returns were calculated.

$$\text{Net returns} = \text{Gross income} - \text{Cost of cultivation}$$

Cost Benefit Ratio

$$\text{C:B ratio} = \frac{\text{Gross return}}{\text{Total cost of cultivation}}$$

RESULTS AND DISCUSSION

Table 1 presented the effect of Plant Growth Promoting Rhizobacteria (PGPRs) on the cost of production for air-layered litchi plants of the Dehradun variety. This table consisted of ten treatments (T_1 to T_{10}) and various cost items associated with the cultivation of these plants. Labour charges, which represented the cost of the workforce involved in the plant cultivation, remained consistent at ₹ 580 for all treatments. The cost of Farm Yard Manure (FYM), an organic fertilizer, was also uniform at ₹ 210 across all treatments. Similarly, the cost of sand, which was likely used as a growth medium, stands at ₹ 160 for all treatments.

However, the primary focus of this table was to analyze the impact of PGPRs on production costs. In treatments T_1 to T_9, PGPRs were utilized which incurred a cost of ₹ 572. PGPRs are known for their ability to promote plant growth, and in this context, they contributed to the overall expenses. Treatment T_{10}, on the other hand, did not use PGPRs, resulting in a notably lower total cost of ₹ 1,885 compared to the ₹ 2,457 total cost in the other treatments. Additionally, there were other cost items that were

Table 1: Effect of Plant Growth Promoting Rhizobacteria (PGPRs) on cost of production of air layered litchi plants cv. Dehradun

Sl. No.	Items	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
1	Labour charges (₹)	580	580	580	580	580	580	580	580	580	580
2	Cost of FYM (₹)	210	210	210	210	210	210	210	210	210	210
3	Cost of Sand (₹)	160	160	160	160	160	160	160	160	160	160
4	Cost of PGPRs (₹)	572	572	572	572	572	572	572	572	572	0
5	Cost of layering (₹)	180	180	180	180	180	180	180	180	180	180
6	Cost of sphagnum moss (₹)	65	65	65	65	65	65	65	65	65	65
7	Irrigation charges (₹)	590	590	590	590	590	590	590	590	590	590
8	Depreciation on assets (₹)	100	100	100	100	100	100	100	100	100	100
	Total	₹ 2457	₹ 2457	₹ 2457	₹ 2457	₹ 2457	₹ 2457	₹ 2457	₹ 2457	₹ 2457	₹ 1885

Table 2: Effect of Plant Growth Promoting Rhizobacteria (PGPRs) on return structure of air layered litchi plants cv. Dehradun

Sl. No.	Items	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
1	Number of air layered litchi plants	60	60	60	60	60	60	60	60	60	60
2	Survival %age	68.33	70.00	66.67	73.33	76.67	71.67	80	83.33	78.33	50.00
3	Number of layers survived	41	42	40	44	46	43	48	50	47	30
4	Price per plant (with polybag) (₹)	92	92	92	92	92	92	92	92	92	92
5	Total value of plants (₹)	3772	3864	3680	4048	4232	3956	4416	4600	4324	2760
6	Gross income (₹)	3772	3864	3680	4048	4232	3956	4416	4600	4324	2760
7	Total cost of cultivation (₹)	2457	2457	2457	2457	2457	2457	2457	2457	2457	1885
8	Net return (₹)	1315	1407	1223	1591	1775	1499	1959	2143	1867	875
9	C:B ratio	1:1.54	1:1.57	1:1.50	1:1.65	1:1.72	1:1.61	1:1.80	1:1.87	1:1.76	1:1.46

consistent across all treatments. The cost of layering, a propagation technique, remains the same at ₹ 180, and the cost of sphagnum moss, likely used for enhancing root development, was fixed at ₹ 65. Irrigation charges, an essential expense for plant growth, were identical at ₹ 590 in all treatments. Furthermore, depreciation on assets, representing the reduction in the value of equipment or resources over time, was consistent at ₹ 100 for each treatment. The demonstrated that the use of PGPRs in treatments T_1 to T_9 incurred an additional cost of ₹ 572, contributing to a higher total cost of ₹ 2,457. Conversely, treatment T_{10}, which omitted PGPRs, resulted in a reduced total cost of ₹ 1,885. While other cost factors like labour, materials, and irrigation charges remained constant, the use of PGPRs played a significant role in the cost variations observed in the different treatments, highlighting their impact on the overall cost of production for air-layered litchi plants.

Data furnished in Table 2 and Fig. 1 showed that net returns were found to be highest in T_8 consortia (*Bacillus* sp. + *Pseudomonas fluorescens*) @10^8 cfu ml^{-1} (₹ 2143) whereas, the lowest net returns were found in control (₹ 875). The difference in gross returns between the treatment combinations is due to survival per cent of air layers among the different treatments which was 83.33 % in T_8 consortia (*Bacillus* sp. + *Pseudomonas fluorescens*) @10^8 cfu ml^{-1} as rhizobacteria strains had a significant impact on the growth and development of plants through biological N_2 fixation, enhanced inorganic phosphate solubilization of organic phosphorus compounds, secretion of iron-chelating compounds known as siderophores, and an effect on the absorption, uptake and translocation of micronutrients (Cakmakci *et al*. 2006 and Aslantas *et al*. 2007) hence, better survival percentage and 50.00 % in control. The highest B:C ratio (1:1.87) was recorded in treatment T_8 containing consortia (*Bacillus* sp. + *Pseudomonas fluorescens*) @10^8 cfu ml^{-1} whereas, the lowest B:C ratio (1:1.46) was recorded in control as the survival per cent of air layers among the different treatments was maximum in T_8 consortia (*Bacillus* sp. + *Pseudomonas fluorescens*) @10^8 cfu ml^{-1}.

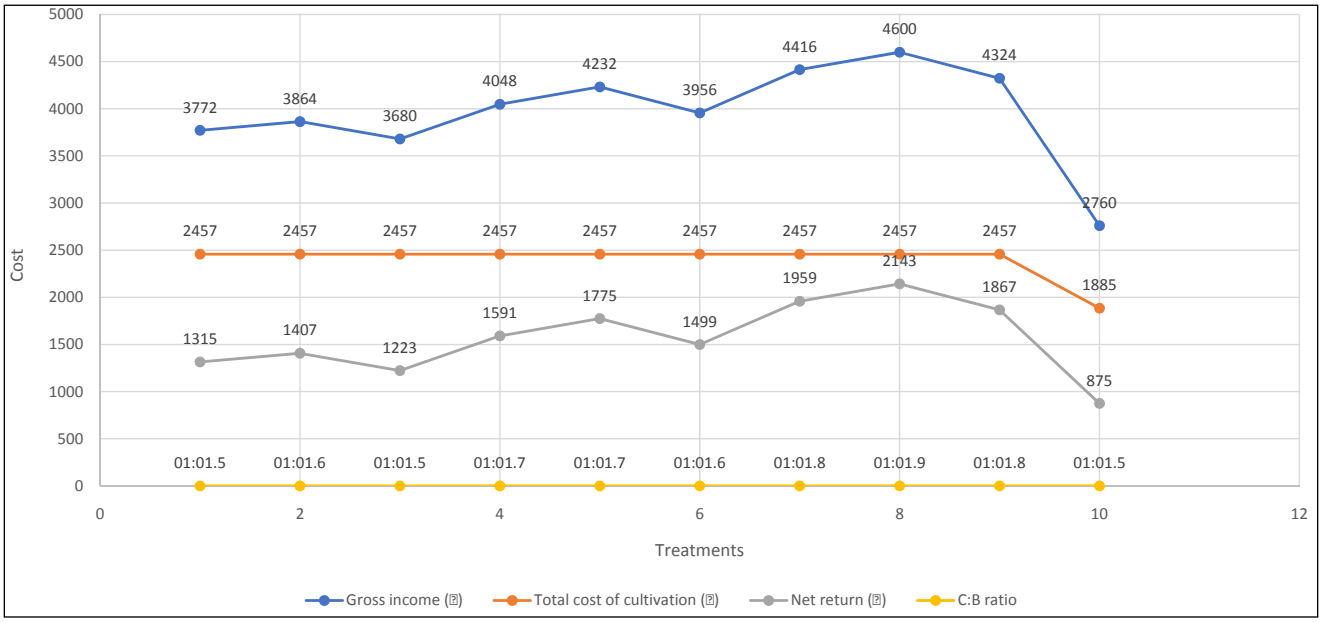

Fig. 1: Effect of Plant Growth Promoting Rhizobacteria (PGPRs) on total cost of cultivation, gross income, net return and C:B ratio of air layered litchi plants cv. Dehradun

The findings are in close association with Radha *et al*. (2006), Luhach *et al*. (2007), Devi *et al*. (2015) and Akter *et al*. (2016) who reported the highest B:C ratio of 1:1.45 in grapes, 1:6.89 in guava plantation, 1:1.97 in phalsa production and 1:1.93 in litchi production, respectively.

CONCLUSION

With the highest cost-benefit ratio of 1:1.87 observed in treatments containing consortia (*Bacillus* sp. + *Pseudomonas fluorescens*) @10^8cfu ml^{-1}, the plant growth-promoting rhizobacteria (PGPRS) were determined to be highly economically viable for use in commercial production. Among the different treatments of PGPRs, consortia (*Bacillus* sp. + *Pseudomonas fluorescens*) @10^8 cfu ml^{-1} is found to be superior for boosting the survival and growth of litchi air layers.

Consequently, based on the current investigation it can be concluded that application of PGPRs reduced the mortality of air layers and recorded maximum net return and were found to be most economical for air layering in litchi cv. Dehradun.

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