International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(9): 60-63
www.biochemjournal.com
Received: 10-07-2025
Accepted: 14-08-2025

Anushika Mishra
M.Sc. Research Scholar, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Dr. Annjoe V Joseph
Assistant Professor, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Anushika Mishra
M.Sc. Research Scholar, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Effect of growth regulators on air layering in Litchi (*Litchi chinensis* Sonn.) under agroclimatic conditions of Prayagraj

Anushika Mishra and Annjoe V Joseph

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i9Sa.5470

Abstract
The present experiment entitled "Effect of growth regulators on air layering in Litchi (*Litchi chinensis*) under agroclimatic conditions of Prayagraj", was conducted at Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. Prayagraj during the session 2024-2025. The experiment was laid out in randomized block design with three replications, and the study consists of 9 treatment combinations as follow control, IBA (2000ppm), IBA (2500ppm), NAA (2000ppm), NAA (2500ppm), IBA (2000ppm) +NAA (2000ppm), IBA (2000ppm) + NAA (2500ppm), IBA (2500ppm) +NAA (2000ppm), IBA (2500ppm) +NAA (2500ppm). The parameters observed includes days to root initiation, root length, rooting percentage, number of roots per layer, fresh and dry root weight, shoot length, number of leaves, and survival percentage of layered plants. The results revealed that the treatment T_8 combined application of IBA @ 2500 ppm + NAA @ 2500 ppm significantly outperformed all other treatments across most parameters. This treatment recorded the earliest root initiation (26.75 days), highest root length (10.70 cm), maximum rooting percentage (89.5%), and the highest number of roots (28.5), highest fresh weight (8.67 g) and dry root weight (1.065 g). Furthermore, it also produced the tallest shoots (45.15 cm) and highest number of leaves (41), with a maximum survival percentage of 86.19%. The study confirms that the synergistic effect of IBA and NAA at higher concentrations considerably enhances rooting and overall success of air layering in litchi. The findings suggest that this method can be effectively used by growers to improve propagation efficiency and productivity of litchi under the agroclimatic conditions of Prayagraj.

Keywords: Air layering, growth regulators, Indole-3-Butyric Acid (IBA), Naphthalene Acetic Acid (NAA)

Introduction

Litchi (*Litchi chinensis* Sonn.), a subtropical evergreen fruit crop belonging to the family Sapindaceae, is known for its juicy aril, attractive red pericarp, and high nutritional content. India is the second-largest producer after China, with Bihar as the leading state contributing over 70% of national production. Popular cultivars include Shahi, China, Bombai, Purbi, and Bedana. Despite its demand and commercial value, litchi cultivation faces challenges such as a short shelf life, fruit cracking, and propagation difficulties. Seed propagation is discouraged due to heterozygosity and variability in fruit quality. Hence, vegetative methods like air layering are preferred, with air layering being the most widely adopted due to its simplicity and cost-effectiveness. However, success remains limited because litchi air layers often produce thick and brittle roots that struggle to establish in the nursery and field.

The use of plant growth regulators (PGRs), particularly auxins like Indole-3-butyric acid (IBA) and Naphthalene acetic acid (NAA), play a vital role in enhancing root initiation and survival in air layering. Earlier studies have demonstrated the effectiveness of auxins in improving rooting percentage, root number, and plant vigour. Research across crops has also highlighted IBA's superior role in rooting. Erturk reported 65% rooting success in kiwi stem cuttings at 4000 ppm IBA, while Abbas showed that NAA (3000 ppm) and IBA (2500 ppm) significantly improved rooting, sprouting, and survival in litchi. Similarly, found better rooting and higher survival in litchi layers treated with IBA at 3000 ppm. Environmental factors such as season, humidity, and media also influence success. Studies suggest that layering during May–July enhances rooting due to active physiological processes (Rani and Ahmad, 2012) [26]. Yadav *et al.* (2020) [32] demonstrated that combining IBA with sphagnum moss and polyethylene wrapping improved results. Further emphasized the benefits of higher auxin concentrations in increasing shoot length, leaf number, and root quality. However, localized research under specific agroclimatic conditions is essential to optimize their application. Therefore, this study aimed to evaluate the effect of IBA and NAA on air layering of litchi under Prayagraj conditions.

Materials and Methods

The investigation entitled "Effect of growth regulators on air layering in Litchi (*Litchi chinensis*) under agroclimatic conditions of Prayagraj" was conducted during July–September 2024 at the Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh. The site falls under the subtropical climate zone of southeast Uttar Pradesh, characterized by hot summers (up to 49°C), cool winters (as low as 2–5°C), and annual rainfall ranging from 850–1100 mm, predominantly received between July and September. Meteorological data for the experimental period were recorded and presented to assess their influence on rooting performance. The trial was laid out in a randomized block design (RBD) with nine treatments replicated thrice. Treatments included: Control, IBA @ 2000 ppm, IBA @ 2500 ppm, NAA @ 2000 ppm, NAA @ 2500 ppm, and combinations of IBA + NAA at both concentrations.

Air layers were prepared on healthy litchi trees by girdling and treating with respective PGR solutions before wrapping with moist sphagnum moss. Data were collected on days to root initiation, root length, rooting percentage, number of roots per layer, fresh and dry root weight, shoot length, number of leaves, and survival percentage. Statistical analysis was performed using ANOVA at a 5% significance level.

The experimental field had sandy loam soil with good drainage and uniform fertility status. Soil samples collected at 0–30 cm depth were analyzed for mechanical and chemical properties. The soil was slightly acidic (pH 6.5) with 0.34% organic carbon, 0.016% available nitrogen, 0.022% phosphorus, and 0.018% potassium, indicating moderate fertility. The texture comprised 48% sand, 22% silt, and 30% clay. Healthy, uniform litchi trees of bearing age were selected for air layering. Girdling was done on semi-hardwood branches of 1–1.5 cm diameter by removing a ring of bark (2.5 cm wide). Growth regulator solutions were prepared by dissolving analytical grade Indole-3-butyric acid (IBA) and Naphthalene acetic acid (NAA) in 95% ethanol and diluting with distilled water to the desired concentrations.

Table 1: Treatment details

Symbols	Treatment Combination
T_0	Control
T_1	IBA (2000ppm)
T_2	IBA (2500ppm)
T_3	NAA (2000ppm)
T_4	NAA (2500ppm)
T_5	IBA (2000ppm) +NAA (2000ppm)
T_6	IBA (2000ppm) + NAA (2500ppm)
T_7	IBA (2500ppm) +NAA (2000ppm)
T_8	IBA (2500ppm) +NAA (2500ppm)

Management Practices

Healthy and uniform litchi trees of bearing age were selected for the experiment, and semi-hardwood shoots of 1.0–1.5 cm diameter were chosen for layering. Prior to the study, light pruning was carried out to remove dried, diseased, and crossing branches, ensuring proper sunlight penetration and sap flow. A 2.5 cm ring of bark was carefully removed from each selected shoot, and the exposed girdled portion was cleaned and treated with the respective growth regulator solutions. Fresh sphagnum moss was sterilized by boiling, moistened with distilled water, and used as the rooting medium. It was wrapped around the treated portion and enclosed with transparent polyethylene film, which was tightly sealed at both ends with jute twine to conserve moisture.

Standard cultural practices were followed during the experiment. The orchard was irrigated at regular intervals to maintain adequate soil moisture, while overhead irrigation near the layers was avoided to prevent waterlogging and fungal attack. Nutrient management included the application of well-decomposed farmyard manure (FYM) @ 20 kg per tree, while no chemical fertilizers were used to avoid interaction effects with the applied growth regulators. Weeding was done manually at regular intervals to minimize competition. Preventive plant protection measures were undertaken, where neem-based bio-pesticides were used against leaf-eating caterpillars and fruit borers, while prophylactic sprays of copper oxychloride (0.2%) were applied at 15-day intervals to check fungal infections.

After 90 days, the rooted layers were detached and transplanted into polythene bags containing a mixture of soil, sand, and FYM in the ratio of 1:1:1. The newly transplanted layers were kept under partial shade for acclimatization and watered regularly to ensure better survival and establishment.

Results and Discussion

The experiment on "Effect of growth regulators on air layering in litchi (Litchi chinensis) under agroclimatic conditions of Prayagraj" revealed significant differences among treatments for all parameters studied. The combined application of IBA and NAA at higher concentrations consistently produced superior results compared to individual treatments and the control.

Root Initiation

Root initiation was significantly influenced by the application of growth regulators. The earliest root initiation (26.75 days) was recorded in T_8 (IBA 2500 ppm + NAA

2500 ppm), whereas the maximum number of days (36.50) was taken in the control. The rapid root initiation in auxin-treated layers could be attributed to enhanced cell division and activation of root primordia by auxins. These findings are supported by Chawla *et al.* (2012) [6], who reported that IBA application at 5000 ppm significantly reduced days to root initiation in litchi. Similarly, Das and Prasad (2014) [+] found that IBA treatments (3000–5000 ppm) induced faster root initiation in cv. Purbi compared to untreated controls.

Root Length

Root length was also markedly affected by treatments. Maximum root length (10.70 cm) was recorded in T_8, followed by T_7 (9.61 cm), while the minimum (6.11 cm) was recorded in the control. The synergistic effect of IBA and NAA may have enhanced root elongation by stimulating cambial activity and mobilization of carbohydrates. *Sarkar et al.* (2016) observed similar effects in guava air layers, reporting that combined auxins enhanced root elongation significantly. Rani and Srivastava also confirmed that the combined application of NAA and IBA promoted greater root elongation in pomegranate compared to individual treatments.

Number of Roots per Layer

The number of roots per layer was significantly higher in treated plants compared to control. T_8 recorded the highest number of roots (28.50), while the control had the least (6.50). Among individual treatments, IBA 2500 ppm (T_2) performed better (24.50) than NAA alone. This confirms the superiority of IBA in promoting root proliferation. Similar findings were reported by Abbas who observed that IBA @ 2500 ppm produced a greater number of roots and leaves compared to untreated layers in litchi. Bharali and Bhagawati also found that IBA @ 2500 ppm significantly increased root number in citrus air layers.

Rooting Percentage

Maximum rooting percentage (89.50%) was recorded in T_8, whereas the minimum (40.50%) was observed in the control. The improved rooting percentage under combined auxin treatments may be due to their complementary roles in root initiation and elongation. Das *et al.* (2014) [8] reported similar results in litchi cv. Shahi, where IBA at 5000 ppm with sphagnum moss achieved 86.8% rooting. Likewise, Rymbai demonstrated that IBA at 3000 ppm significantly improved rooting percentage compared to untreated controls.

Fresh root weight

Fresh root weight was found to be highest (8.67 g) in T_8, followed by T_7, while the lowest (3.12 g) was recorded in the control. The higher fresh root biomass under auxin treatments may be attributed to enhanced cell expansion and greater water and nutrient uptake by roots. These findings agree with Das *et al.* (2014), who reported that IBA and NAA significantly increased fresh root weight in litchi layers.

Dry Root Weight

The maximum dry root weight (1.065 g) was observed in T_8, whereas the control recorded the minimum (0.62 g). The increased dry matter accumulation under auxin treatments may be due to better root system development and higher carbohydrate partitioning. Similar results were reported by in litchi and by Bharali and Bhagawati in citrus, where auxin-treated layers produced higher dry root weights compared to untreated ones.

Shoot Length

Shoot growth showed considerable variation among treatments. The longest shoots (45.15 cm) were recorded in T_8, while the shortest (25.12 cm) were observed in the control. Vigorous shoot growth under auxin treatments may be due to improved root development, which ensured efficient uptake of water and nutrients. Abbas *et al.* (2016) reported that NAA significantly enhanced shoot length in litchi layers, while Yadav *et al.* (2020) [32] found that IBA combined with sphagnum moss promoted stronger vegetative growth in litchi.

Number of Leaves

The maximum number of leaves (41) was observed in T_8, followed by T_7, while the minimum (18) was recorded in the control. Better root development under auxin treatments supported stronger shoot growth and leaf production. Abbas and Rymbai reported similar findings, where auxin-treated litchi layers produced significantly more leaves compared to untreated layers.

Survival Percentage

Survival of transplanted layers was highest in T_8 (86.19%) and lowest in the control (42.30%). Enhanced survival can be attributed to a well-developed root system, ensuring better water nutrient uptake. Kanwar also reported that IBA-treated litchi layers showed better survival and faster establishment compared to untreated layers.

Symbol	Days to Root Initiation	Root length (cm)	No. of roots per layering	Rooting Percentage	Fresh root weight(g)	Dry root weight(g)	Shoot length	No. of leaves	Survival (%)
T_0	36.50	6.11	6.50	46.5	3.58	0.665	11.31	6.5	60.10
T_1	34.00	6.92	15.5	59.5	5.49	0.765	12.21	20.5	71.27
T_2	32.75	6.36	24.5	73.5	6.14	0.865	12.55	31.25	74.60
T_3	31.75	6.95	8.50	51.5	5.34	0.735	12.95	9.5	69.40
T_4	30.75	7.64	10.50	65.5	5.71	0.815	13.27	18	72.83
T_5	29.75	7.92	18.50	66.5	6.82	0.895	13.72	24.5	78.20
T_6	28.75	8.58	20.50	69.5	7.49	0.935	13.5	29	80.30
T_7	27.75	9.61	22.50	76.5	7.94	0.975	13.95	33	82.73
T_8	26.75	10.7	28.50	89.5	8.67	1.065	14.46	41	87.43
F-Test	S	S	S	S	S	S	S	S	S
S.E.M (±)	0.62	0.18	0.19	0.14	0.04	0.46	0.01	0.36	0.03
C.D. at5%	1.8	0.54	0.56	0.4	0.11	0.01	0.03	1.06	0.09
C.V	3.99	4.7	2.03	0.41	1.19	1.01	0.12	3.07	0.07

Conclusion

Based on the results of the present study, it is evident that the treatment T_8 combined application of IBA and NAA at 2500 ppm each was the most effective treatment across all parameters—root initiation, root length, root number, root weight (fresh and dry), survival, shoot length, and number of leaves. The synergistic effect of these growth regulators played a significant role in promoting faster rooting and improved plant development in litchi air layering under the agroclimatic conditions of Prayagraj. Control treatments consistently showed the lowest values across all observations, validating the necessity of using plant growth regulators IBA &NAA in litchi air layering.

REFERENCES

1. Banik AK, Sardar PR, Roy D. Effect of IBA and NAA on rooting of air-layers in Guava. International Journal of Agriculture Sciences. 2016;8(60):3356-3358.
2. Bhosale AM, Patil BL. Response of *Sapota* air layering to different concentrations of IBA and NAA. Asian Journal of Horticulture. 2016;11(2):357-360.
3. Bora LC, Sarmah DK. Effect of plant growth regulators on air layering of *Pomegranate*. International Journal of Current Microbiology and Applied Sciences. 2019;8(4):1196-1203.
4. Bose TK, Mitra SK, Sanyal D. Fruits: Tropical and Subtropical, Vol. 1. Kolkata: Naya Udyog; 2002. p. 556-565.
5. Choudhary R, Tiwari R, Meena ML. Effect of IBA and NAA on rooting and growth of Mango air layers. Journal of Pharmacognosy and Phytochemistry. 2022;11(2):1550-1554.
6. Chawla HKL, Kumar R, Kumar K. Effect of IBA and NAA on rooting and survival of Litchi (*Litchi chinensis*). Progressive Horticulture. 2012;44(1):125-128.
7. Das A, Sahu R. Effect of auxins on rooting in Pomegranate air layering. Research in Environment and Life Sciences. 2018;11(1):22-25.
8. Das B, Prasad VM. Effect of IBA and NAA on rooting of air layers in *Litchi* (*Litchi chinensis SoInn*.). Journal of Agriculture and Veterinary Science. 2014;7(7):26-29.
9. Deka BC, Patel RK, Mishra A. Effect of IBA and NAA on rooting of Litchi air layers under Assam condition. Indian Journal of Horticulture. 2015;72(3):381-384.
10. Das D, Rahman H, Kalita H. Studies on the effect of different concentrations of IBA and NAA on rooting in *Guava*. The Pharma Innovation Journal. 2018;7(12):204-207.
11. Gupta N, Yadav R. Response of IBA and NAA on rooting of *Litchi* air layers. Journal of Plant Development Sciences. 2017;9(10):975-978.
12. Kumar S, Meena MK, Sharma H. Role of growth regulators in air layering of Pomegranate under semi-arid region. Annals of Horticulture. 2021;14(2):119-122.
13. Kumar V, Singh R, Devi R. Effect of growth regulators on air layering success in Jackfruit. Indian Journal of Horticulture. 2022;79(1):126-129.
14. Kumar R, Bhatnagar P, Yadav SS. Effect of different concentrations of IBA and NAA on air layering in Litchi. International Journal of Agriculture Sciences. 2017;9(3):3740-3742.
15. Mishra S, Verma R. Influence of plant growth regulators on rooting in Jackfruit air layering. International Journal of Chemical Studies. 2020;8(2):2556-2560.
16. Mishra RL, Singh G, Sengar SC. Influence of auxins and rooting media on rooting and survival of Litchi (*Litchi chinensis* Sonn.). Indian Journal of Horticulture. 2013;70(2):225-228.
17. Nath V, Bora P. Influence of growth regulators on air layering of Jackfruit (*Artocarpus heterophyllus*). Journal of Applied and Natural Science. 2015;7(2):861-864.
18. Nath D, Hazarika TK. Effect of IBA on rooting of *Citrus* air layers. Environment and Ecology. 2015;33(1):317-320.
19. Nikam AA, Patil DR, Suryawanshi PV. Effect of IBA on rooting of *Sapota* air layers. Journal of Horticultural Research. 2017;25(1):43-47.
20. Patil SS, Chavan RR. Studies on different concentrations of IBA and NAA on rooting of *Sapota*. Journal of Pharmacognosy and Phytochemistry. 2018;7(4):1160-1163.
21. Paydas S, Kaska N, Kara M. Effects of IBA, NAA and rooting media on rooting of air-layers of some *Fig* types. Acta Horticulturae. 1998;480:163-168.
22. Rahman M, Sharma A, Verma P. Effect of auxins on rooting in *Litchi* air layering. Asian Journal of Agricultural and Horticultural Research. 2022;10(1):21-26.
23. Rathod RR, Patil AD, Shinde SH. Impact of IBA and NAA on success of Guava air layering. Plant Archives. 2020;20(2):3537-3540.
24. Rana MK. Scientific Cultivation of Vegetables. New Delhi: CBS Publishers & Distributors; 2011.
25. Shekhar M, Singh P, Kumar D. Effect of IBA and NAA combinations on rooting and survival in *Litchi*. International Journal of Multidisciplinary Research and Development. 2021;8(2):76-80.
26. Sharma SK, Verma A, Rani M, Singh R. Effect of growth regulators on air layering of Litchi under Tarai conditions. Indian Journal of Horticulture. 2012;69(4):559-561.
27. Singh IS, Devi R, Verma M. Effect of growth regulators on rooting and survival of air layers in Litchi (*Litchi chinensis* Sonn.). An International Journal of Environment. 2016;5(1):64-69.
28. Tripathi A, Yadav PK, Sharma RK. Influence of NAA and IBA on air layering in Guava. Journal of Plant Science and Research. 2021;37(1):23-27.
29. Thakur AK, Sharma RK, Sood S. Comparative study on the use of IBA and NAA on air layering in Litchi under mid hill conditions of Himachal Pradesh. Journal of Pharmacognosy and Phytochemistry. 2018;7(6):428-430.
30. Tiwari R, Rai M, Tiwari V. Standardization of PGR concentrations for improved rooting in *Litchi* (*Litchi chinensis*) air layering. The Pharma Innovation Journal. 2021;10(5):539-544.
31. Verma M, Gupta R. Impact of plant growth regulators on rooting in *Mango* air layering. Journal of Agriculture and Biological Research. 2020;36(2):145-148.
32. Yadav PK, Singh R, Gautam H. Response of Litchi (*Litchi chinensis* Sonn.) air layering to plant growth regulators under Eastern U.P. conditions. Journal of Pharmacognosy and Phytochemistry. 2020;9(2):2075-2078.
33. Zaman MM, Dey P, Sarkar S. Influence of IBA on rooting behavior of *Litchi* layers. International Journal of Agricultural Sciences. 2019;11(3):10542-10545.