



RESEARCH ARTICLE

# Effect of biofertilizers on the survival and growth of air-layered saplings of West Indian cherry (*Malpighia glabra* L.)

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## Abstract

This study evaluated the efficacy of air layering in combination with biofertilizer treatments for the successful propagation of West Indian cherry (*Malpighia glabra* L.) during 2022–2023 at the North Farm, School of Agricultural Sciences, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India. Air layering was performed on a 9-year-old tree using 1-year-old, pencil-thick shoots of 60 cm length. Once rooted, the air layers were gradually detached from the mother plant and transplanted into polybags. Biofertilizer treatments were applied to the potting medium and as soil drenches, including *Trichoderma viride* (3 g L<sup>-1</sup>), vermiwash (1 %), humic acid (20 g L<sup>-1</sup>), *Azospirillum brasilense* (2 g kg<sup>-1</sup> planting medium), plant growth-promoting rhizobacteria (PGPR; 10 g plant<sup>-1</sup>) and vesicular-arbuscular mycorrhiza (VAM; 100 g plant<sup>-1</sup>), along with an untreated control. Data recorded at 60 days after detachment (DAD) showed that vermiwash @ 1 % (T3) significantly enhanced shoot and root growth parameters. It resulted in the highest plant height (45.23 cm), number of leaves (38.22), number of shoots (6.45), survival percentage (81.04 %), root length (13.80 cm), primary roots (26.31), secondary roots (78.23) and root diameter (4.88 mm). The improved performance under vermiwash treatment is attributed to its rich content of plant growth regulators, enzymes, micronutrients and beneficial microbes, which positively influenced both vegetative and root development. The results underscore the potential of integrating air layering with nutrient-enriched organic treatments like vermiwash to enhance the propagation efficiency and field establishment of West Indian cherry. The objective of this study was to identify an effective biofertilizer-based strategy to enhance survival, growth and nursery establishment of air-layered West Indian cherry saplings.

**Keywords:** barbados cherry; biofertilizer; gootee; root growth; shoot growth; survivability

## Introduction

West Indian cherry (*Malpighia glabra* L.), commonly known as acerola or barbados cherry, is a tropical fruit-bearing species in the family Malpighiaceae. Although it is believed to have originated in southern Mexico and parts of Central and South America, it is now widely cultivated across tropical and subtropical regions of Asia. This plant typically grows as a large shrub, reaching heights of 3 to 6 m (1). The edible portion of its fruit contains 2000–4000 mg of vitamin C per 100 g (2). Its exceptionally high ascorbic acid content contributes significantly to its antioxidant capacity (3). Additionally, this fruit is rich in beneficial compounds such as carotenoids, flavonoids and anthocyanins (4). Although propagation through seeds is possible, it is often ineffective due to the low germination rate caused by non-viable embryos. Therefore, vegetative propagation methods such as modified crown or cleft grafting, air layering, budding and stem cuttings are commonly used. In natural environments, air layering is a widely occurring method of vegetative reproduction in many plant species. When branches meet the soil, they develop adventitious roots, leading to the formation of new plants. Eventually, these

branches are separated from the parent plant, resulting in an independent plant. Although layering is more challenging than cutting, it offers the benefit of keeping the developing part connected to the parent plant, enabling it to obtain water and nutrients while forming roots (5).

Biofertilizers contribute significantly to enhancing soil fertility by fixing atmospheric nitrogen, either in symbiosis with plant roots or independently. Additionally, they support plants in resisting diseases and tolerating stress through various mechanisms, which differ based on the specific biofertilizer organisms used (6). An effective approach to reducing the environmental buildup of chemical fertilizers is to integrate them with biofertilizers. One of the most well-studied free-living diazotrophs among plant growth-promoting rhizobacteria (PGPR), the *Azospirillum* spp., which can colonize hundreds of different plant species. They promote plant growth by improving the process of nitrogen fixation, by synthesizing phytohormones and releasing compounds that possess antimicrobial activity. As a producer of plant hormones, primarily auxins, which are well known to have a favorable impact on the

rooting process, *Azospirillum* may play a part in this context. Consequently, it would probably enhance the performance of rootstocks, especially those that have low rooting potential. Plant growth-promoting rhizobacteria, such as species from the genera *Azospirillum*, *Azotobacter* and others, enhance plant growth by colonizing the root zone (7). These beneficial microbes not only stimulate growth but can also offer protection against certain plant diseases. Their influence on plant development varies with the bacterial strain, operating through either direct mechanisms or indirectly by producing growth-promoting substances. Vermiwash, a by-product of the vermicomposting process is a brown colour liquid that is formed, is a substance that is brownish in colour that is created when water in the vermicomposting units moves through the earthworms' burrows. Vermiwash has been reported to contain soluble macro- and micronutrients, B-group vitamins and plant growth regulators. Quantitative analyses have shown the presence of auxin ( $0.98 \mu\text{g L}^{-1}$ ) and cytokinin ( $0.68 \mu\text{g L}^{-1}$ ), while gibberellins have been reported qualitatively, along with appreciable levels of potassium, magnesium, phosphorus and trace elements, which collectively contribute to enhanced plant growth and early establishment. It functions as a biostimulant and has been reported to enhance plant growth, yield and disease resistance (8). *Trichoderma* spp. can act as a natural decomposition agent and biological agent of bioremediation (9). It can detoxify pesticides and herbicides in various crops. It provides the agriculture sector an important advantage for overcoming pollution-related problems (10). Humic acid is made up of a variety of organic acids that are aromatic in nature and contain a variety of heterogeneous functional groups that have an impermeable interaction with a variety of metallic ions like Mg, Zn, Ca and Cu. It can be applied as soil and foliar spray. Foliar application of humic acid ensures improved photosynthetic rate, permeability and nutrient uptake (11). Microbial inoculants, particularly the VAM inoculation to fruit plants, increase the possibility of reducing P fertilizers by roughly 50 % without lowering crop production.

## Materials and Methods

### Experimental site and plant material

This study was conducted during 2022–2023 at the North Farm, School of Agricultural Sciences, KITS, Coimbatore, Tamil Nadu, India.

Air layering was performed on West Indian cherry tree which is 9-year-old. For the study, 1-year-old, pencil-thick branches located on the lower part of the tree were selected. These shoots averaged 60 cm in length and had a smooth bark surface (12).

### Air layering procedure

A section of bark containing the cambium and phloem was removed just below a node, leaving the xylem intact. This was done by making two parallel cuts, approximately one inch apart, around the stem with a sharp knife, cutting through the bark and cambium. The cuts were then joined by a vertical incision and the ring of bark was carefully peeled away to expose the underlying wood. The cambial layer over the xylem was carefully scraped to prevent the development of a callus bridge. Finally, the exposed area was wrapped with a ball of sphagnum moss. Once roots had developed, the rooted air layers were partially cut in 3 stages at weekly intervals to minimize shock from sudden separation. After 90 days, they were completely detached from the mother plant.

### Transplanting and growth conditions

After the detachment of rooted air layers from the mother plant, they were planted in the poly bags (5 x 7 inch) containing rooting media (Red soil, Sand and FYM (1:1:1)). All saplings were maintained under a 50 % shade net house. Irrigation was provided once daily using tap water to maintain optimum moisture levels. No additional chemical fertilizers or growth regulators were applied during the experimental period.

### Experimental design

The experiment was laid out in a randomized complete block design (RCBD) with 7 treatments and four replications. Each replication consisted of 5 plants, resulting in 20 plants per treatment.

### Observations recorded

Five air layers were selected at random from each treatment in each replication. Five saplings per treatment were labelled for recording the observations throughout the study.

#### Plant height

Five randomly selected plants from each replication were taken for recording the data on the plant height. The plant height was recorded from ground level to the tip of apical bud with the help of scale at 60<sup>th</sup> day after imposing treatment and mean value was calculated and was expressed in centimetre.

#### Leaves per layer

The number of new leaves per plant was counted at the 60<sup>th</sup> day after planting of detached air-layers from the mother plant and mean leaf number was then calculated and expressed in numbers.

#### Length of roots per layer

It was recorded on 60<sup>th</sup> day after air layering with the help of measuring scale in replicated samples (one longest root in each sample). The mean was calculated and expressed in centimetre.

#### Shoots per layer

The total number of newly emerged shoots was counted at the 15 days interval after planting of detached air-layers from the mother plant up to 60 days and the mean number of shoots per planted layer was then calculated.

#### Primary roots per layer

The number of primary roots per layer was counted in each replication after detachment of air layers from the mother plants from all treatments and these were expressed in numbers.

#### Secondary roots per layer

The number of secondary roots per layer was counted in each replication after detachment of air layers from the mother plants from all the treatments and these were expressed in numbers.

#### Diameter of primary root

Diameter of primary root was recorded on the 60<sup>th</sup> day after air layering with the help of measuring scale in replicated samples (one thickest root in each sample). The mean was calculated and expressed in centimetre.

#### Survival percentage of air layers

The number of successfully developed air layers were counted on the 60<sup>th</sup> day after detachment from the mother plant and the result was calculated in percentage by using the following formula;

$$\text{Survival percent} = \frac{\text{No. of air layers developed}}{\text{Total number of saplings}} \times 100$$

## Results and Discussion

### Shoot parameters

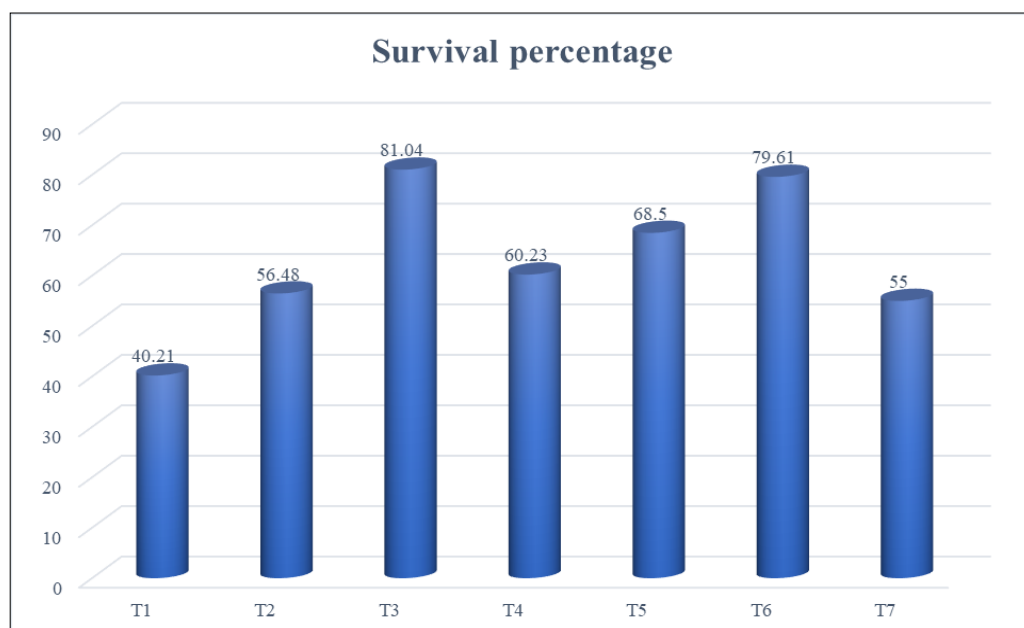
Plant height showed significant variation among the different biofertilizer treatments at 60 DAD. The highest plant height (45.23 cm), the highest number of leaves per layer (38.22), the highest number of shoots per layer (6.45), The enhanced performance under vermiwash treatment indicates improved physiological activity during early establishment (Table 1). Among the various treatments, West Indian cherry air layers showed better nourishment in the medium containing soil, sand and FYM (1:1:1) supplemented with 1 % vermiwash, recording the highest number of leaves (38.22) and survival rate (81.04 %) after 60 DAD (Fig. 1). The rich mixture of plant growth regulators, enzymes, micronutrients and helpful microorganisms found in the vermiwash treatment is responsible for the improved growth and survival shown during the treatment. These elements supported the development of both shoots and roots in a homogeneous growing medium. It was reported that vermiwash being a nutrient-rich liquid extract derived from vermicomposting, is known to contain various plant growth-

promoting substances, such as hormones, enzymes, vitamins and beneficial microorganisms. Newly detached air-layered saplings may quickly absorb the soluble nutrients, enzymes, vitamins and plant growth regulators found in vermiwash, such as auxins, cytokinins and gibberellins. During the early post-detachment period, when saplings are under physiological stress and need quick metabolic support for shoot emergence and root elongation, this instant availability is especially crucial. On the other hand, microbial inoculants like VAM, *Azospirillum* and other biofertilizers mainly work through biological colonization and symbiosis, which take time to form and function well. Vermiwash is therefore more effective in short-term evaluation periods, like 60 DAD. Similar growth enhancement under vermiwash application has been reported under nursery conditions (19). As the young plants are placed in the shade net condition, the prevailing amiable condition boosts the growth of the plant while comparing the plants grown under open field conditions. Other horticultural crops have shown similar improvements in shoot and root growth after applying vermiwash; these improvements have been linked to the presence of easily accessible nutrients, plant growth regulators and advantageous microbial metabolites that promote early vegetative development and root proliferation (20–23). The treatment effects on shoot parameters of West Indian cherry air layers at 60th DAD are presented in Fig. 2.

**Table 1.** Effect of biofertilizers on shoot parameters in air layers of West Indian cherry on 60<sup>th</sup> day after detachment from mother plant

| Treatments  | 60 DAD            | 60 DAD                  | 60 DAD                  | 60 DAD              |
|---|-------------------|-------------------------|-------------------------|---------------------|
|   | Plant height (cm) | No. of leaves per layer | No. of shoots per layer | Survival percentage |
| Control (T <sub>1</sub> )                                     | 30.34             | 25.13                   | 2.17                    | 53.21               |
| <i>Trichoderma viride</i> (T <sub>2</sub> )                   | 32.75             | 28.77                   | 2.78                    | 56.48               |
| Vermiwash (T <sub>3</sub> )                                   | 45.23             | 38.22                   | 6.45                    | 81.04               |
| Humic acid (T <sub>4</sub> )                                  | 37.15             | 30.13                   | 3.83                    | 65.23               |
| <i>Azospirillum brasilense</i> (T <sub>5</sub> )              | 41.07             | 33.69                   | 4.89                    | 72.50               |
| VAM (Vesicular- Arbuscular mycorrhiza) (T <sub>6</sub> )      | 42.16             | 36.12                   | 5.87                    | 79.61               |
| PGPR (Plant Growth Promoting Rhizobacteria) (T <sub>7</sub> ) | 35.89             | 31.56                   | 3.00                    | 60.00               |
| Mean  | 37.80             | 31.95                   | 4.14                    | 66.87               |
| SE. d   | 0.31              | 0.26                    | 0.09                    | 0.65                |
| CD @ 5 %  | 0.68*             | 0.58*                   | 0.21*                   | 1.43*               |

\* Significant @ 0.05, DAD: Days after detachment.



**Fig. 1.** Effect of biofertilizers on survival percentage in air layers of West Indian cherry on the 60<sup>th</sup> day after detachment from mother plant.



**Fig. 2.** Comparison of treatment effects in West Indian cherry air layers on shoot parameters on the 60<sup>th</sup> day after detachment.

### Root parameters

The data of changes in the length of roots on application of different biofertilizers varied significantly (Table 2). The highest length of the roots (13.80 cm), the highest number of primary roots (26.31), the highest number of secondary roots (78.23), the highest diameter of primary roots (4.88 mm) was recorded in the T<sub>3</sub> (Vermiwash). In the present investigation, the root parameters of air layers of West Indian cherry, viz., number of primary and secondary roots, diameter of primary roots and length of roots were significantly influenced by biofertilizers. Among the treatments, better nourishment of air layers of West Indian cherry was seen in the media (soil, sand, FYM, (1:1:1)) with vermiwash at 1 % which showed significant influence on maximum number of primary roots (26.31), secondary roots (78.23), diameter of primary root (4.88 mm) and average length of root s (13.80 cm) at 60 DAD respectively (Fig. 3). This response can be attributed to the biostimulatory effect of vermiwash, which enhances root growth dynamics and soil biological activity (19). Moreover, the use of a balanced media composition, consisting of soil, sand and FYM in equal proportions, provided a suitable substrate for the development of healthy and robust roots. This combination of materials likely provides adequate drainage, aeration and nutrient availability, promoting optimal root growth in the air layers. It was reported that the presence of biochemical constituents in the vermiwash improved the length of tip of the root which in turn increased the root length (24). In safflower, vermiwash has been reported to function as a biostimulant supplying enzymes, hormones, microorganisms and nutrients (25). Vermiwash has been

shown to improve root activity and stress tolerance during early plant establishment in cowpea, gladiolus, chickpea and mango, especially in nursery or early growth conditions (26–29). Collectively, these studies support the view that vermiwash acts as a multifunctional organic input, providing both nutritional and physiological stimuli that are particularly effective during the early stages of plant establishment.

### Conclusion

The present study demonstrated that air layering is an effective method for the vegetative propagation of West Indian cherry (*M. glabra*), particularly when combined with organic and biofertilizer treatments. Among the various treatments tested, the application of vermiwash (1 %) significantly enhanced both shoot and root development of air-layered saplings. This treatment recorded the highest values in key growth parameters including plant height, number of leaves and shoots, root length, number of primary and secondary roots, root diameter and survival percentage at 60 DAD. The superior performance of vermiwash can be attributed to its rich content of plant growth hormones, enzymes, beneficial microbes and micronutrients that promote vigorous growth and better establishment. These findings suggest that integrating air layering with organic inputs such as vermiwash can serve as a cost-effective and sustainable strategy for large-scale propagation of West Indian cherry, especially under the agro-climatic conditions of Coimbatore.

**Table 2.** Effect of biofertilizers on root parameters in air layers of West Indian cherry on 60<sup>th</sup> day after detachment from mother plant

| Treatments  | 60 DAD               | 60 DAD               | 60 DAD                 | 60 DAD                         |
|---|----------------------|----------------------|------------------------|--------------------------------|
|   | Length of roots (cm) | No. of Primary roots | No. of secondary roots | Diameter of primary roots (mm) |
| Control (T <sub>1</sub> )   | 5.22                 | 16.56                | 62.43                  | 2.11                           |
| <i>Trichoderma viride</i> (T <sub>2</sub> )                       | 6.34                 | 18.50                | 65.45                  | 2.37                           |
| Vermiwash (T <sub>3</sub> )                                       | 13.80                | 26.31                | 78.23                  | 4.88                           |
| Humic acid (T <sub>4</sub> )                                      | 8.25                 | 21.62                | 69.66                  | 3.87                           |
| <i>Azospirillum brasilense</i> (T <sub>5</sub> )                  | 10.09                | 22.42                | 72.78                  | 4.03                           |
| VAM ( <i>Vesicular- Arbuscular mycorrhiza</i> ) (T <sub>6</sub> ) | 11.12                | 24.22                | 75.12                  | 4.39                           |
| PGPR (Plant Growth Promoting Rhizobacteria) (T <sub>7</sub> )     | 7.56                 | 19.11                | 67.89                  | 2.72                           |
| Mean  | 8.91                 | 21.25                | 70.22                  | 3.48                           |
| SE. d   | 0.17                 | 0.20                 | 0.32                   | 0.06                           |
| CD @ 5 %  | 0.38*                | 0.44*                | 0.71*                  | 0.13*                          |

\* Significant @ 0.05, DAD: Days after detachment.



**Fig. 3.** Comparison of treatment effects in West Indian cherry air layers on rooting parameters on the 60<sup>th</sup> day after detachment.

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### Authors' contributions

BA conceived and designed the study and carried out data acquisition. GRS performed data analysis and interpretation. DJRT drafted the manuscript. JD critically revised the manuscript. KPY and VTV conducted the statistical analysis. SK provided administrative, technical and material support. UBC supervised the study and approved the final version of the manuscript. All authors read and approved the final manuscript.

### Compliance with ethical standards

**Conflict of interest:** Authors do not have any conflict of interests to declare.

**Ethical issues:** None

### References

- Dey K, Ghosh A, Bauri FK, Bhowmick N, Dey AN, Mishra DK, et al. Barbados cherry: agriculture, breeding, utilization and role in nutritional and economic security – a review. *Agric Rev.* 2018;39(2):144–50. <https://doi.org/10.18805/ag.R-1764>
- Kirker CL, Newman M. *Cherry*. London: Reaktion Books; 2021.
- Cruz RG, Beney PS, Lira TM, Vieira S. Comparison of the antioxidant property of acerola extracts with synthetic antioxidants using an in vivo method with yeasts. *Food Chem.* 2019;277:698–705. <https://doi.org/10.1016/j.foodchem.2018.10.099>
- Prakash A, Baskaran R. Acerola, an untapped functional superfruit: a review on latest frontiers. *Int J Food Sci Technol.* 2018;55:3373–84. <https://doi.org/10.1007/s13197-018-3309-5>
- Hazarika J, Hazarika DN, Langthasa S. Standardization of propagation method of custard apple by air layering. *J Agri Search.* 2021;8(3):222–28.
- Hazarika BN, Ansari S. Biofertilizers in fruit crops – a review. *Agric Rev.* 2007;28(1):69–74.
- Eşitken A, Yıldız HE, Ercisli S, Dönmez MF, Turan M, Güneş A. Effects of plant growth promoting bacteria on yield, growth and nutrient contents of organically grown strawberry. *Sci Hortic.* 2010;124(1):62–66. <https://doi.org/10.1016/j.scienta.2009.12.012>
- Verma S, Babu A, Patel A, Singh SK, Pradhan SSP, Verma SK, et al. Significance of vermiwash on crop production: a review. *J Pharmacogn Phytochem.* 2018;7(2):297–301.
- Sharma BL, Singh SP, Sharma ML. Bio-degradation of crop residues by *Trichoderma* species vis-à-vis nutrient quality of the prepared compost. *Sugar Tech.* 2012;14(2):174–80. <https://doi.org/10.1007/s12355-011-0125-x>
- Vázquez MB, Barrera V, Bianchinotti V. Molecular identification of *Trichoderma harzianum* isolates and their ability to detoxify metsulfuron methyl. *Botany.* 2015;93(11):793–800. <https://doi.org/10.1139/cjb-2015-0085>
- Piccolo A. The nature of soil organic matter and innovative soil managements. In: *Carbon sequestration in agricultural soils*. Berlin: Springer; 2012. p. 1–19. [https://doi.org/10.1007/978-3-642-23385-2\\_1](https://doi.org/10.1007/978-3-642-23385-2_1)
- Kumar R. Off-season air layering in litchi: a prudent and efficient approach. Technical Bulletin No. 6. Muzaffarpur: NRC for Litchi; 2012.
- Domenico P. *Trichoderma viride* inoculation increases vitamin C in *Kalanchoe* leaves and defense against *Pythium* sp. *GSC Adv Res Rev.* 2020;5(2):89–96. <https://doi.org/10.30574/gscarr.2020.5.2.0108>
- Rajasooriya APS, Karunarathna B. Application of vermiwash on growth and yield of green gram. *AGRIEAST J Agric Sci.* 2020;14(2):31–37. <https://doi.org/10.4038/agrieast.v14i2.95>
- Chakraborty S, Rajkumar M. Effect of growth regulators and organic substances on rooting of grape cuttings. *Asian J Sci Technol.* 2018;9(7):8418–21.

16. Singh DI, Sharma TR, Nagar OP, Pal S. Influence of PGRs and growing media on marcottage in pomegranate. *Asian J Sci Technol.* 2021;9(3):255–60.
17. Hemant R, Kirti S, Manju N. Effect of organic manure and biofertilizers on growth and yield of sweet orange. *Asian J Sci Technol.* 2020;9(4):2064–70. <https://doi.org/10.20546/ijcmas.2020.904.247>
18. Hakim A, Jaganath S, Honnabyraiah MK, Mohan Kumar S, Anil Kumar S, Dayamani KJ. Influence of biofertilizer and auxin on growth and rooting of pomegranate cuttings. *Int J Curr Microbiol Appl Sci.* 2018;7(2):1187–93. <https://doi.org/10.20546/ijcmas.2018.702.146>
19. Makkar C, Singh J, Parkash C. Vermicompost and vermiwash as supplements to improve plant growth. *Int J Recycl Org Waste Agric.* 2017;6(3):203–18. <https://doi.org/10.1007/s40093-017-0168-4>
20. Bashir MA, Mushtaq A, Muhammad AA. Effect of potting media on growth of rooted jojoba cuttings. *Int J Agric Biol.* 2007;9(2):147–51.
21. Hiradeve PN, Deotale RD, Deogirkar MS, Gaikwad SB. Effect of vermicompost wash on groundnut. *J Soils Crops.* 2011;21(2):266–72.
22. Jaybhaye MM, Bhalerao SA. Influence of vermiwash on seedling growth of green gram and black gram. *Int J Curr Microbiol Appl Sci.* 2015;4(9):635–43.
23. Vijantie R, Awadhpersad R, Ori L, Ansari AA. Effect of vermiwash on tomato productivity. *Asian J Agric.* 2021;5(1):29–34. <https://doi.org/10.13057/asianjagric/g050105>
24. Sundararasu K, Jeyasankar A. Effect of vermiwash on growth and yield of brinjal. *Asian J Sci Technol.* 2014;5(3):171–73.
25. Taleshi K, Shokohfar A, Rafiee M, Noormahamadi G, Sakinejhad T. Effect of vermicompost on safflower. *Int J Agron Plant Prod.* 2011;2(1):15–22.
26. Murugesan MP. Influence of vermiwash on cowpea and rice. *IOSR J Pharm.* 2012;2(6):31–34. <https://doi.org/10.9790/3013-26403134>
27. Kumar P, Shekhar C, Basoli M, Kumar V. Sequential vermiwash spray in gladiolus. *Ann Hortic.* 2013;6(1):71–75.
28. Kapase PV, Deotale RD, Sawant PP, Sahane AN, Banginwar AD. Effect of humic acid and vermiwash on chickpea. *J Soils Crops.* 2014;24(1):107–14.
29. Sathe TV, Patil SS. Vermiwash for mango growth and yield. *Indian J Appl Res.* 2014;4(6):535–36.

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