



A Study to Evaluate the Effectiveness of Foliar Application of Salicylic Acid against Mosaic Virus Disease in *Capsicum annum*

T. Surekha ^{a++*}, Sushma Patil ^{b#} and T. Udayasree ^{c†}

^a Department of Community Medicine, MNR Homoeopathic Medical College and Hospital, Sangareddy, Telangana, India.

^b Department of Practice of Medicine, MNR Homoeopathic Medical College and Hospital, Sangareddy, Telangana, India.

^c MNR Homoeopathic Medical College and Hospital, Sangareddy, Telangana, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ajraf/2024/v10i3301>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/120081>

Short Research Article

Received: 18/05/2024

Accepted: 20/07/2024

Published: 25/07/2024

ABSTRACT

India is the world's leading producer, consumer, and exporter of chilli, a commodity with significant worldwide value. Pests, diseases, and viruses pose serious risks to chillies, resulting in large losses every year. A phenolic derivative that is widely distributed in the kingdom of plants, salicylic

⁺⁺ Associate Professor;

[#] Assistant Professor;

[†] BHMS Student;

*Corresponding author: E-mail: drsurekha25sep@gmail.com;

acid, is known to regulate a number of physiological and biochemical processes, including thermogenesis, plant signaling or defense, and response to biotic and abiotic stress. Salicylic acid's potential as a plant regulator led to the conduct of this study to ascertain its potentized form's effectiveness in varying potencies in preventing Chilli mosaic virus disease in *Capsicum annum* plants and improving plant parameters. Four groups were used in the study: Group A, B, C and D were administered for placebo, 6C, 12C, 30C respectively. The parameters analyzed in each group are plant height, number of chillies, weight of the chilli, size of the chilli, number of leaves and total yield. The ANOVA single-factor test was used to statistically assess the obtained data. The variations in plant parameters (plant height, number of chillies, weight of the chilli, size of the chilli, number of leaves, and total yield) amongst the four study groups were, respectively, 148.25, 219.58, 67739.8, 14.48, 75.6, and 6.71. At the 5% level, the computed value of F is 11.55, greater than the table value of F crit 2.77 with degrees of freedom $v_1 = 5$ and $v_2 = 18$. Strong evidence to reject the null hypothesis and accept the research hypothesis is provided by the obtained P value of 0.000041, which is less than 0.01. According to the findings of this study, Salicylic acid is effective in enhancing the parameters of *capsicum annum* infected with the Chilli mosaic virus at varying potencies.

Keywords: *Capsicum annum*; chilli mosaic virus; salicylic acid; argo homeopathy.

1. INTRODUCTION

The specific branch of homeopathy that deals with treating plants is called agrohomoepathy. Homeopathic medicines can be used in agriculture from seed germination to crop production for various purposes [1]. Because of the method that homeopathic dynamizations are prepared, using them on plants ensures that the plants will not be contaminated in any way. With assurance that this approach won't harm the organism, the soil, or the plants, they can employ it [2].

The biotypes and pathogenesis levels can be used to determine the suitable mineral therapy for the chronic diseases of the agroecosystem, which include imbalances in plant primary metabolism or cellular levels; on the other hand, the acute conditions (Phyto pathological diseases) may be managed by using the principle of metabolic similarity to identify the plant or animal homeopathic remedy [3]. Economic savings and the maintenance of the natural ecology are two significant advantages of agrohomoepathy [2].

Research on diverse crops has improved germination and growth to combat pests, diseases, and viral infections, among other things [4]. Currently, agricultural homeopathy is being employed more frequently all over the world to lessen the harmful consequences brought on by the careless use of chemical items in traditional agricultural operations [5].

Chilli (*Capsicum annum*) is an important commercial and export-oriented crop in India [6].

Capsicum annum L., a fruit plant from tropical and subtropical regions, contains a range of essential nutrients and bioactive compounds which are known to exhibit a range of bioactivities including free radical scavenging (antioxidant), antimicrobial, antiviral, anti-inflammatory and anticancer [7]. Chilli mosaic virus disease under field conditions spread mainly by different aphid vectors. The important vectors which are actively involved in transmission of Chilli mosaic disease are *Aphisgossypii*, *Aphis craccivora*, *Myzus persicae* [8]. Based on the observations symptoms of chilli mosaic virus are mosaic-mottling, yellow ringspots and chlorotic leaves [9]. As a nutritional material, Chili peppers are in use for a large number of populations not only for the strong flavor and aroma, but also to prolong food spoilage because of their antimicrobial and antifungal action. Thus, chili pepper extracts was tested to be determined instead of artificial preservatives in the food industry to resist pathogens [10,11]. The fruits contain many phytochemicals, including vitamin C, vitamin A, The fiery components of hot peppers, flavonoids, anthocyanins, and carotenoids, along with capsaicinoids [12].

Orthohydroxybenzoic acid, or salicylic acid (SA)—derived from the Latin *Salix*, meaning willow tree—is another name for this phenolic derivative, which is found throughout the plant kingdom and is regarded as a regulator [13]. Salicylic acid (SA) and botanicals (*Eucalyptus* and *Mint*) reduced the disease incidence and severity of ChiVMV in greenhouse study and these were ecofriendly in nature [14]. Enzymatic

activities were increased by the application of SA, showing synergetic effect with auxins and gibberellins [15].

Based on salicylic acid's function in plants as a regulator of multiple physiological and biochemical processes, including thermogenesis, plant signaling or defense, and response to biotic and abiotic stress, this study attempts to determine the efficacy of salicylic acid in potentised form of varying potencies in controlling Chilli mosaic virus disease in *Capsicum annum* plants. The originality of this study is establishing the untapped therapeutic potential of salicylic acid homoeopathic medication in *Capsicum annum* plants infected with Chilli mosaic virus.

In the present investigation, twenty *Capsicum annum* plants infected with the Chilli mosaic virus were cultivated. Out of the twenty plants, there were four groups of five plants each. Groups B, C, and D were given foliar spray containing salicylic acid 6C, 12C, and 30C, respectively, once every 15 days, whereas Group A got no intervention. Plant height, the number of chillies, the weight of the chilli, the size of the chilli, the number of leaves, and the total yield were measured among four groups to assess the efficacy of the recommended intervention in increasing *Capsicum annum* productivity against the Chilli mosaic virus.

2. MATERIALS AND METHODS

2.1 Plan of Study

- The *Capsicum annum* plants selected for the study were identified by the

2.2 Observation



GROUP A (PLACEBO)



GROUP B (6C)

- morphological features - Stem angled, smooth. Leaves alternate, petiolate, glabrous, broadly ovate-acuminate, 7.5 to 15 cm in length. Flowers solitary, axillary, greenish-white or white. Calyx cup-shaped, embracing base of fruit.
- Plants infected with the Chilli mosaic virus were divided into four groups based on Comparative model of research. Placebo (A), salicylic acid 6C(B), 12C (C), and 30C (D) are the salicylic acid potentices. There are five plants in each group.
- The symptoms of the chilli mosaic virus include leaf curl, mottling, and reduced growth.
- Salicylic acid medicine of 6C,12C and 30C potencies are purchased from GMP certified SBL Pvt Ltd. India.
- 10 drops of Salicylic acid is mixed in 1 litre of water and sprayed through foliar application.
- Salicylic acid is given to groups B, C, and D at 6C, 12C, and 30C, respectively; group A receives no treatment at all.
- Chilli mosaic virus symptoms appeared in all four groups, however Group A showed more severe viral toxic effects and less development than the other two groups.
- Each of the four groups' plants displayed viral symptoms on its leaves and shoots; however, group A (no intervention) displayed the worst symptoms, group B and D (salicylic acid at 6C and 30C, respectively) displayed less symptoms, and group C (salicylic acid at 12C) displayed the least symptoms.

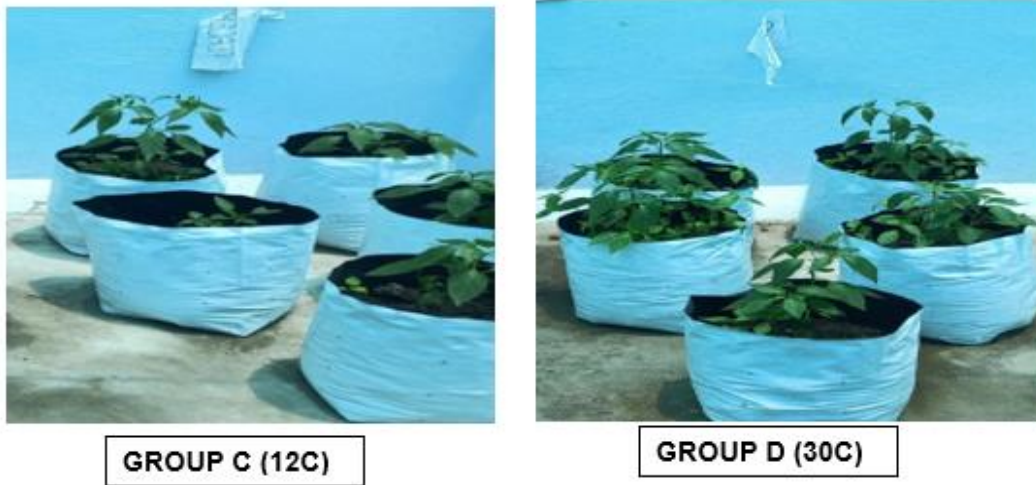


Fig. 1. Study groups of *Capsicum annum*

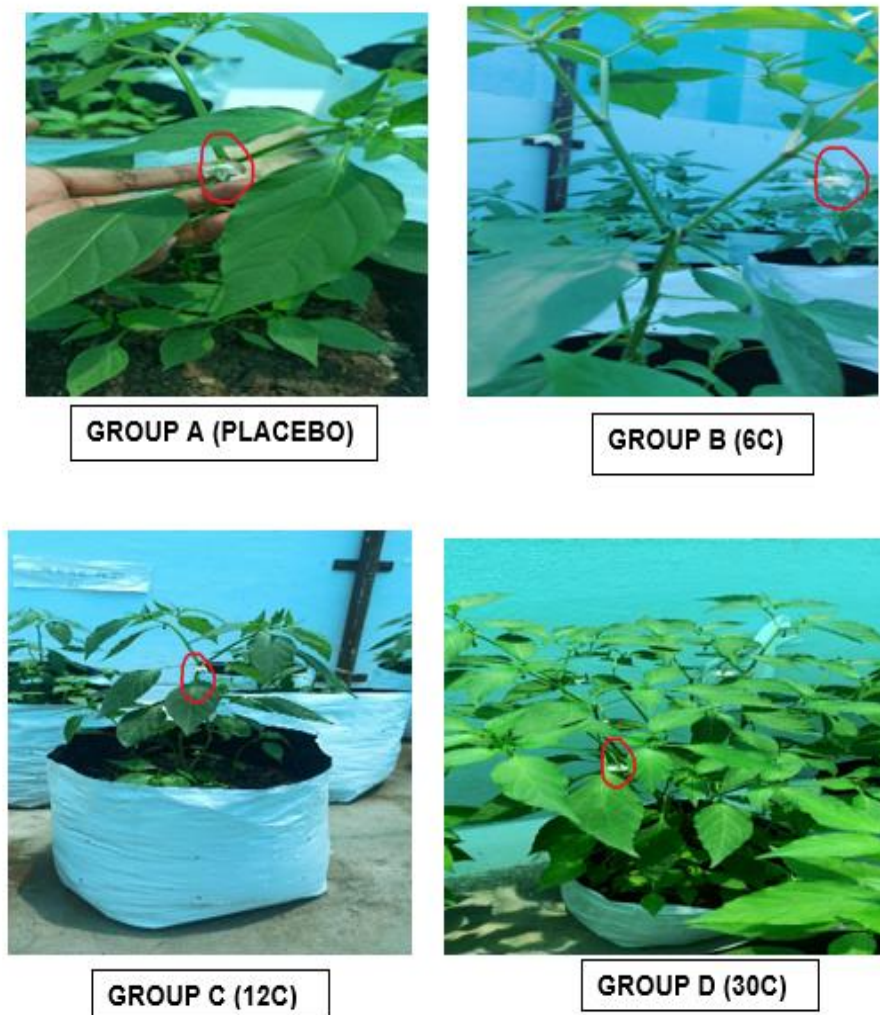


Fig. 2. Flowering stage of *Capsicum annum*

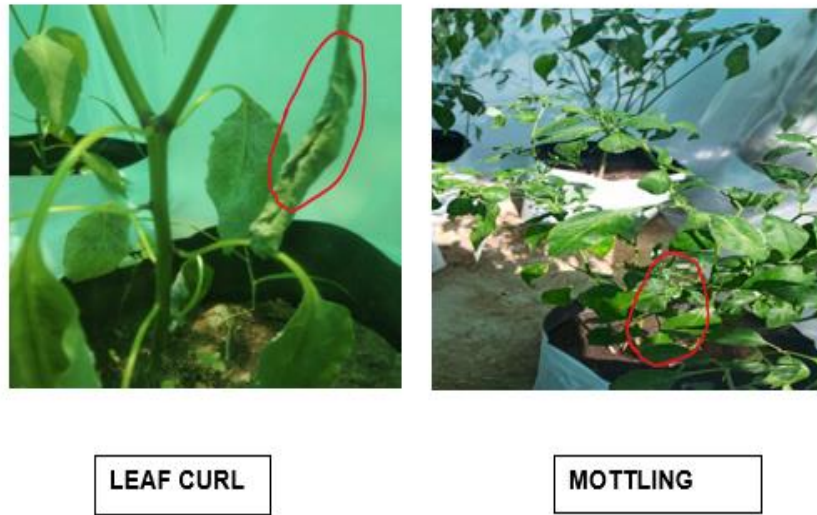


Fig. 3. Images showing infected leaves



Fig. 4. Plants infected with chilli mosaic virus

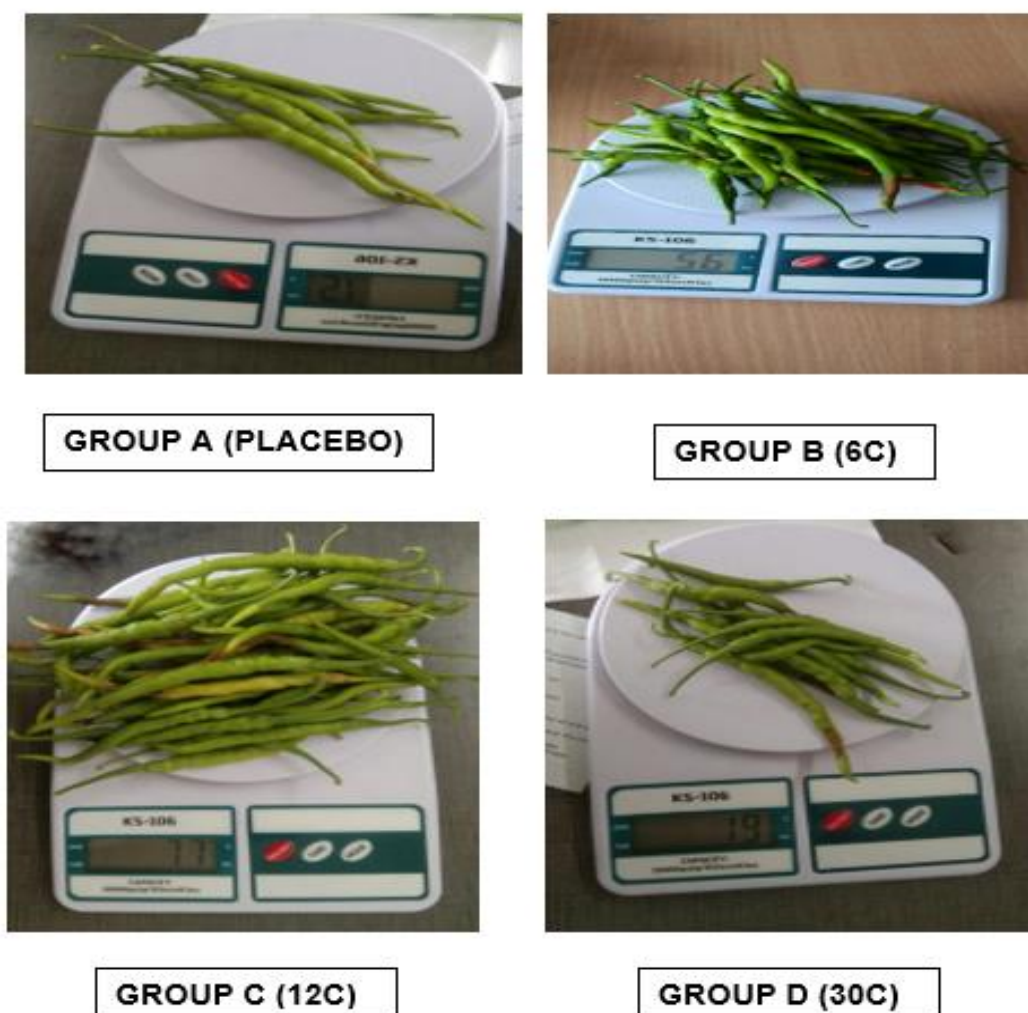


Fig. 5. NO. of chilles in each group

3. RESULTS AND DISCUSSION

3.1 Parameters

Table 1. Average height of the plant

| Name of the group | Average Height of the Plant (cm) |
|------------------------|----------------------------------|
| No Intervention (A) | 41 |
| Salicylic acid 6C (B) | 65 |
| Salicylic acid 12C (C) | 68 |
| Salicylic acid 30C(D) | 61 |

Table 2. Average number of fruits

| Name of the group | Average Number of Fruits |
|------------------------|--------------------------|
| No Intervention (A) | 35 |
| Salicylic acid 6C (B) | 57 |
| Salicylic acid 12C (C) | 71 |
| Salicylic acid 30C(D) | 54 |

Table 3. Average weight of the fruits

| Name of the group | Average Weight of the Fruits (gms) |
|------------------------|------------------------------------|
| No Intervention (A) | 198.8 |
| Salicylic acid 6C (B) | 537.1 |
| Salicylic acid 12C (C) | 811.1 |
| Salicylic acid 30C(D) | 371.1 |

Table 4. Average size of the fruits

| Name of the group | Average Size of the Fruits (cms) |
|------------------------|----------------------------------|
| No Intervention (A) | 4.7 |
| Salicylic acid 6C (B) | 10.2 |
| Salicylic acid 12C (C) | 12.4 |
| Salicylic acid 30C(D) | 5.2 |

Table 5. Average number of leaves

| Name of the group | Average Number of Leaves |
|------------------------|--------------------------|
| No Intervention (A) | 50 |
| Salicylic acid 6C (B) | 66 |
| Salicylic acid 12C (C) | 70 |
| Salicylic acid 30C(D) | 64 |

Table 6. Total yield

| Name of the group | Total Yield |
|------------------------|-------------|
| No Intervention (A) | 5.6 |
| Salicylic acid 6C (B) | 9.3 |
| Salicylic acid 12C (C) | 11.4 |
| Salicylic acid 30C(D) | 6.8 |

3.2 Statistics

According to the recorded data, a one-way Anova statistical test was employed, which is appropriate for this research question by using SPSS Software.

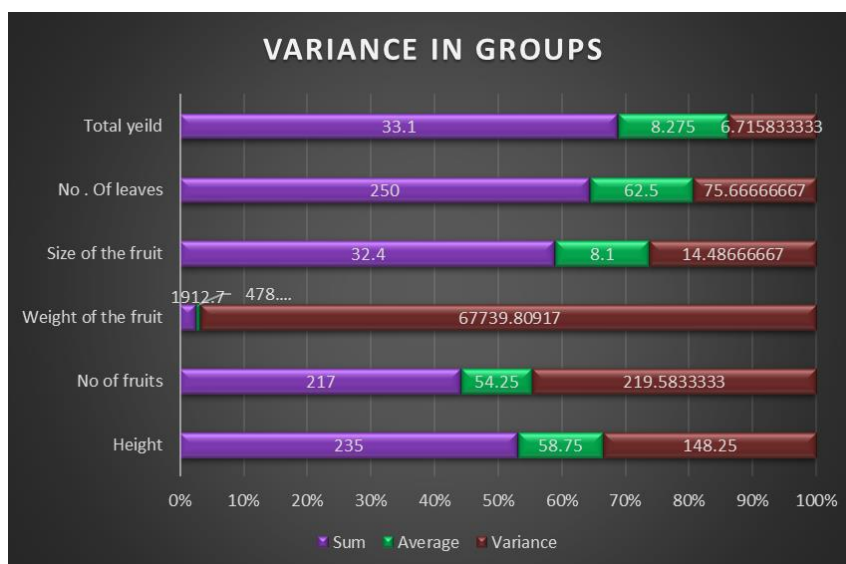


Fig. 6. Data variance in groups

Table 7. ANOVA – single factor

| Parameters | Number of groups | Sum | Average | Variance |
|----------------------|------------------|--------|---------|----------|
| Height of the plant | 4 | 235 | 58.75 | 148.25 |
| Number of the Fruits | 4 | 217 | 54.25 | 219.58 |
| Weight of the Fruits | 4 | 1912.7 | 478.17 | 67739.8 |
| Size of the Fruits | 4 | 32.4 | 8.1 | 14.48 |
| Number of leaves | 4 | 250 | 62.5 | 75.66 |
| Total Yield | 4 | 33.1 | 8.27 | 6.71 |

3.2.1 Anova single factor result

| Source of Variation | Sum of Squares (SS) | Degree of Freedom (df) | Mean Square | F Calculated Ratio | F crit | P value |
|---------------------|---------------------|------------------------|-------------|--------------------|--------|----------|
| Between the Groups | 657033.83 | 5 | 131406.766 | 11.559 | | |
| Within the Groups | 204613.53 | 18 | 11367.418 | | 2.77 | 0.000041 |

With degree of freedom $v_1 = 5$ and $v_2 = 18$, this table demonstrates that the calculated value of F is 11.559, which is greater than the table value of 2.77 at the 5% level and indicates that the difference is statistically significant. With a P value of 0.000041, which is less than 0.01, the research hypothesis is strongly supported and the null hypothesis is rejected.

Chilli, a major crop in India, is a major exporter of chillies, but is vulnerable to viral diseases that can impact crop yield and quality. Mosaic viruses, transmitted by whiteflies and aphids, cause destruction in the crop during early growth stages. Effective management of these diseases is crucial for successful harvests. Salicylic acid, a phenolic derivative found in Willows and Oil of Wintergreen, regulates physiological and biochemical processes in plants, triggering heat production and causing disease resistance. In this study, different salicylic acid potencies in *Capsicum annum* were used to assess its efficacy against mosaic virus disease. Among the different potencies of salicylic acid used in this study, 12C potency showed better results in the parameters of Chilli plant against mosaic virus when compared to other potencies, i.e., 6C and 30C.

3.3 Discussion

Agro-homeopathy could be an integrative approach to improving organic agriculture since homeopathic treatments, due to their ultrahigh dilutions, have few or no ecological side effects [16,17]. Salicylic acid, a phenolic plant hormone,

regulates photosynthesis, respiration, and antioxidant defense mechanism in plants under different abiotic stress such as high temperature, salinity [18]. Salicylic acid (SA) and botanicals (Eucalyptus and Mint) reduced the disease incidence and severity of ChiVMV in greenhouse study and these were ecofriendly in nature [14]. Considering the aforementioned reference research studies, this study aimed to elicit the effectiveness of a potentized form of salicylic acid in various potencies (6C, 12C, and 30C) in controlling the Chilli Mosaic virus in *Capsicum annum*. In regard to height of the plant, number of leaves, size of fruit, number of fruits, weight of fruit, and total yield, salicylic acid 12C acted well compared to 6C and 30C. Plant groups of 6C and 30C showed symptoms of Chilli mosaic virus like mottling, chlorosis, reduction in leaf size, distortion of chillies, and leaf curl, which were not treated to that extent when compared to 12C.

4. CONCLUSION

A comparison of the four experimental groups revealed differences in the parameters which include Plant height, the number of chillies, the weight of the chilli, the size of the chilli, the number of leaves, and the total yield. The study concluded that homeopathic medicine salicylic acid in various potencies, particularly 12C, is efficient in reducing Chilli mosaic virus and its symptoms, as well as greatly boosting *Capsicum annum* plant growth and productivity. This study's results suggest that the potentized form of treatment of homeopathy provides the finest option for farmers in agriculture without any side

effects, making it very competent, non-invasive, safe, and economical. They also suggest the value of homeopathy in agriculture and whether or not farmers may use low-cost homeopathic remedies provided they are equipped with a theoretical and methodological framework that can handle such complexity on their farms.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sen S, Chandra I, Khatun MA, Chatterjee S, Das S. Agrohomoepathy: An emerging field of agriculture for higher crop productivity and protection of plants against various stress conditions. IJRAR. 2018;5(4):52-6.
2. Moreno NM. Agro-Homeopathy—An Alternative for Agriculture. Hpathy Ezine, December. 2008.
3. Di Lorenzo F, Dinelli G, Marotti I, Trebbi G. Systemic agro-homeopathy: a new approach to agriculture. OBM Integrative and Complementary Medicine. 2021 Jul;6(3):1-2.
4. Singhania PK, Singhania A. Homeopathy in agriculture. Building Organic Bridges. 2014; 2:667-70.
5. Manuel MS, Michel OS, Milagro GB, Araceli AQ, Fernando AP, Daulemys BS, Dariel TR, Fabiola AO, Bernardo MA, Alejandra NG, Yarelys FS. Agricultural Homeopathy: A New Insight into Organics. In Multifunctionality and Impacts of Organic and Conventional Agriculture 2019 May 9. Intech Open.
6. Reddy MK, Srivastava A, Kumar S, Kumar R, Chawda N, Ebert AW, Vishwakarma M. Chilli (*Capsicum annum* L.) breeding in India: an overview. SABRAO Journal of Breeding and Genetics. 2014;46(2):160-73.
7. Khan FA, Mahmood T, Ali M, Saeed A, Maalik A. Pharmacological importance of an ethnobotanical plant: *Capsicum annum* L. Natural product research. 2014 Aug 18;28(16):1267-74.
8. Bhagat S, Singh R, Gupta S, Sharma D, Choskit D. Management of mosaic disease of chilli (*Capsicum annum*) through host resistance and chemicals. Plant disease research. 2018;33(2):213-6.
9. Azizan NH, Abidin ZA, Phang IC. Study of cucumber mosaic virus gene expression in *Capsicum annum*. Sci. Herit. J. 2017 Jun 12;1(2):29-31.
10. Kim, S., M. Park, S.I. Yeom, Y.M. Kim and J.M. Lee et al. Genome sequence of the hot pepper provides insights into the evolution of pungency in *Capsicum* species. Nature Genetics. 2014;46: 270-278.
11. Hyyaw SM, Abdulrasool MI, Nadhom BN. The growth susceptibility test of serratia marcescens in the presence of crude *Capsicum annum*.
12. Chen z, Zheng z, Huang j, Lai z, fan b. Biosynthesis of salicylic acid in plants. Plant signaling & behavior. 2009 Jun 1; 4(6):493-6.
13. Sottosanti, Karen. "*Capsicum annum*". Encyclopedia Britannica; 2023.
14. Chandrasekhar B, Umesha S, Kumar HN. Proteomic analysis of salicylic acid enhanced disease resistance in bacterial wilt affected chilli (*Capsicum annum*) crop. Physiological and Molecular Plant Pathology. 2017 Apr 1; 98:85-96.
15. Q. Hayata et al. Effect of exogenous salicylic acid under changing environment: a review Environ. Exp. Bot; 2010.
16. Majewsky V, Arlt S, Shah D, Scherr C, Jäger T, Betti L, Trebbi G, Bonamin L, Klocke P, Baumgartner S. Use of homeopathic preparations in experimental studies with healthy plants. Homeopathy. 2009 Oct;98(04):228-43
17. Betti L, Trebbi G, Majewsky V, Scherr C, Shah-Rossi D, Jäger T, Baumgartner S. Use of homeopathic preparations in phytopathological models and in field trials: a critical review. Homeopathy. 2009 Oct;98(04):244-66.

18. Vlot AC, Dempsey DM, Klessig DF. Salicylic acid, a multifaceted hormone to combat disease. Annual review of phytopathology. 2009 Sep 8; 47:177-206.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/120081>