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Objectives: The study aimed to evaluate the antifungal activity of homoeopathic medicines in vitro and on-farm trials.

Methods: The impact of homoeopathic medicines, Sulphur 30C, Ocimum basilicum 30C and Cuprum metallicum 30C, on inhibiting the mycelial growth of Alternaria solani was studied in-vitro using Agar well-diffusion assay. In an on-farm trial using Solanum lycopersicum (PKM-1 variety) seeds, homoeopathic medicines Sulphur 30C, Cuprum metallicum 30C and Ocimum basilicum 30C, along with a standard fungicide (mancozeb) and water as controls, were evaluated for their impact on plant growth, fruit production and disease resistance, specifically targeting Alternaria solani infection.

Results: In this study, Ocimum basilicum 30C showed the highest mycelial growth inhibition at concentrations of 20 µL, 60 µL and 80 µL (62.15%, 62.64% and 71.14%, respectively), followed by Sulphur 30C (58.07%, 61.53% and 69.61%) and Cuprum metallicum 30C (57.33%, 60.59% and 68.45%). In the on-farm trial, the effects of Sulphur 30C, Cuprum metallicum 30C and Ocimum basilicum 30C were found to be significantly greater than that of Mancozeb ($P < 0.01$).

Conclusion: Agro-homoeopathy is a promising alternative to chemical pesticides used in plants, thus promoting sustainable agriculture. All the homoeopathic medicines demonstrated significant antifungal effects, with Sulphur 30C showing higher inhibition against Alternaria solani, indicating its potential value in agriculture.

Original Article

Antifungal activity of homoeopathic medicines towards *Alternaria solani* of *Solanum lycopersicum* plant – An *in vitro* study and on-farm trial

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Abstract

Background: The overuse of pesticides has damaged biodiversity, raising concerns about the potential for genetic mutations in humans and other organisms caused by pesticide residues in food. The recent research has demonstrated that homoeopathic medicines can act as fertilisers for plant nourishment. **Objectives:** The study aimed to evaluate the antifungal activity of homoeopathic medicines *in vitro* and on-farm trials. **Methods:** The impact of homoeopathic medicines, *Sulphur* 30C, *Ocimum basilicum* 30C and *Cuprum metallicum* 30C, on inhibiting the mycelial growth of *Alternaria solani* was studied *in-vitro* using Agar well-diffusion assay. In an on-farm trial using *Solanum lycopersicum* (PKM-1 variety) seeds, homoeopathic medicines S*ulphur* 30C, *Cuprum metallicum* 30C and *Ocimum basilicum* 30C, along with a standard fungicide (mancozeb) and water as controls, were evaluated for their impact on plant growth, fruit production and disease resistance, specifically targeting *Alternaria solani* infection. **Results:** In this study, *Ocimum basilicum* 30C showed the highest mycelial growth inhibition at concentrations of 20 µL, 60 µL and 80 µL (62.15%, 62.64% and 71.14%, respectively), followed by *Sulphur* 30C (58.07%, 61.53% and 69.61%) and *Cuprum metallicum* 30C (57.33%, 60.59% and 68.45%). In the on-farm trial, the effects of *Sulphur* 30C, *Cuprum metallicum* 30C and *Ocimum basilicum* 30C were found to be significantly greater than that of Mancozeb ($P < 0.01$). **Conclusion:** Agro-homoeopathy is a promising alternative to chemical pesticides used in plants, thus promoting sustainable agriculture. All the homoeopathic medicines demonstrated significant antifungal effects, with *Sulphur* 30C showing higher inhibition against *Alternaria solani*, indicating its potential value in agriculture.

Keywords: Agrohomoeopathy, *Alternaria solani*, Homoeopathic fertiliser

Introduction

Tomatoes (*Solanum lycopersicum* L.) are globally popular vegetable crops; however, the early blight caused by the phytopathogenic fungus *Alternaria solani* poses a significant challenge for their cultivation.[1] Conventional disease management strategies with chemical fungicides have led to escalating costs and concerns about their impact on nutritional profiles and soil fertility.[2] Alternatives, such as homoeopathic medicines, thus, have gained attention as ecofriendly interventions for crop protection, disease resistance enhancement and overall plant health optimisation. Research has substantiated the efficacy of potentised homoeopathic remedies in mitigating both biotic and abiotic stressors in agricultural ecosystems.[3]

The widespread use of chemical pesticides has not only raised concerns about their effectiveness in controlling target pests but also their adverse effects on non-target organisms, including human populations.[4] Prolonged pesticide exposure has been linked to reactive oxidative stress and perturbations in multiple physiological systems, affecting the nervous, respiratory and cardiovascular systems and is potentially associated with diabetes and ageing.[5] As an alternative to pesticides, homoeopathic medicines such as *Sulphur*[6] 30C, *Ocimum basilicum*[7] 30C and *Cuprum metallicum* 30C have demonstrated antifungal properties and growth-promoting

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effects, warranting consideration as eco-friendly alternatives to combat *Alternaria solani* infestations and enhance crop productivity.[8]

Of particular interest, amongst the homoeopathic treatments, *Ocimum basilicum* 30C has emerged as a highly effective contender against various pests and diseases affecting tomato cultivation, including the notorious tobacco mosaic virus, two-spotted mite, red-legged earth mite and blossom end rot.[9-11] Furthermore, *Cuprum metallicum* 30C, a homoeopathic medicine made from a copper-based compound extensively used in agriculture, exhibits antimicrobial and antifungal attributes, making it a potential for integrated disease management strategies.[12,13]

Considering the growing concerns surrounding pesticide usage and the demonstrated usefulness of homoeopathic medicines, these proposed interventions can be explored for protecting tomatoes against *Alternaria solani* infection, while promoting agroecological sustainability as well. Investigating the intricate interplay between these homoeopathic interventions and *Alternaria solani* will facilitate informed decision-making in agricultural practices and catalySe a paradigm shift towards environmentally conscious approaches in modern crop protection.[14]

The present study endeavours to fill critical knowledge gaps related to tomato cultivation and managing early blight caused by *Alternaria solani.* It focuses on exploring alternative homoeopathic approaches to conventional chemical fungicides, which have drawbacks in terms of sustainability and adverse effects on non-target species. The aim of this study was to assess the efficacy of homoeopathic medicines, *Sulphur* 30C, *Cuprum metallicum* 30C and *Ocimum basilicum* 30C*,* in controlling *Alternaria solani* and enhancing crop productivity. By conducting a comparative analysis between homoeopathic remedies and chemical fungicides, this study intends to provide valuable insights into their relative advantages and limitations. The potential of integrating homoeopathic medicines into disease management strategies is explored, which may help promote sustainable agricultural practices with robust and ecofriendly crop protection measures.

Materials and Methods

The present study consisted of *in vitro* experiments conducted for a 20-day duration and on-farm trials for around 90 days.

All media used in the study (Potato Dextrose Broth and Agar) was procured from Hi Media Mumbai, India. All the reagents and chemicals used in this study were of analytical reagent grade. Ethanol (Dispensing alcohol 90%) was used as vehicle control for *in vitro* study. The *Solanum lycopersicum* seeds (PKM-1) were collected from the Horticulture College and Research Institute, situated in Periyakulam, Theni district. Fungus isolation from tomato fruit samples was carried out at the Trichy Institute of Biotechnology Pvt. Ltd. For the study, the homoeopathic medicines *Cuprum metallicum* 30C, *Sulphur* 30C and *Ocimum basilicum* 30C were procured from a GMP-approved standard homoeopathic manufacturing unit. As part of the experimental setup for the field trial, Mancozeb fungicide was used as the positive control, while water was used as the placebo for the negative control.

Collection and isolation of organisms

The fungus *Alternaria solani* was isolated from an infected tomato. The infected tomato was collected from a local farm in Nemam, Sivangangai Dt, Tamil Nadu. The fungus was identified based on its characteristic morphology.

The infected tomato was carefully collected for the study and appropriate steps were taken to prevent its contamination with other microorganisms. The tomato's surface was sterilised by briefly dipping it in a disinfectant solution (e.g. 70% ethanol) and rinsing it with sterile water, removing external microorganisms while preserving those inside the tissues. After surface sterilisation, the tomato was cut into small pieces and placed in potato dextrose agar (PDA) medium. Figure 1 enhances understanding of fungal isolate distribution and density throughout the agar medium, providing crucial data about the occurrence and growth behaviours of *Alternaria solani* on tomato plant specimens. The medium with tomato pieces was then incubated at 28°C for 3 days to allow the growth of any microorganisms present within the tomato tissue. The tests followed the methodology outlined in prior research [Figure 2].[15]

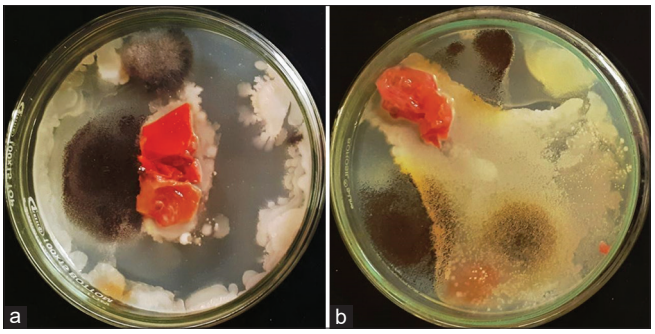


Figure 1: Agar plates viewed from (a) frontal and (b) dorsal perspectives, showing the enumeration process of *Alternaria solani* isolates derived from a *Solanum lycopersicum* test sample.

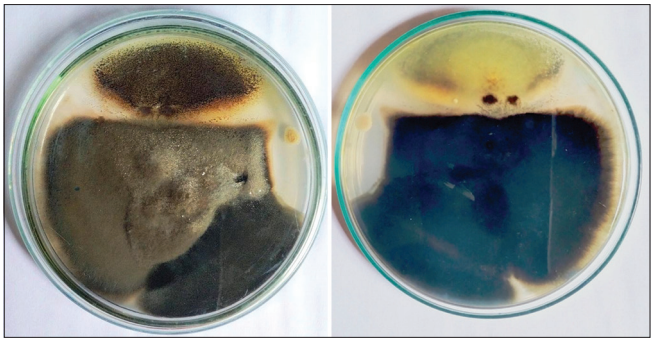


Figure 2: Isolation of microorganism from test sample (*Solanum lycopersicum*)

Identification of organism

The fungus's stock cultures were maintained on PDA medium. For microscopic examination, the lactophenol cotton blue stain, a specialised scientific staining technique, was employed. Microscopic slides were prepared by applying cotton blue and lactophenol to the fungal material. A minute tuft of the fungus, typically containing spores and spore-bearing structures, was carefully transferred to the slide using a flamed and cooled needle. The fungal material was then delicately teased and mixed in the stain using two mounted needles. To ensure accurate observation, a coverslip was positioned over the fungal material to prevent the formation of any air bubbles. The tests were conducted following the methodology outlined in previous work.[16]

Microphotographs were taken of each fungal sample isolated from the fruits, capturing detailed visual records for analysis. These procedures align with the methodology described in previous studies [Figure 3].[17]

Agar well-diffusion assay

The pure cultures of the plant pathogenic fungus *Alternaria solani* were incubated in liquid PDA media at room temperature for 48 h. Culture suspensions were carefully prepared and adjusted based on 0.4–0.5 McFarland turbidity standard tubes. Subsequently, PDA media was poured into sterilised Petri dishes, and each dish was inoculated with the fungal cultures (100 µL) to ensure homogeneity. After allowing the media to solidify, wells were created at the centre of each plate using a sterilised cork borer. The wells were filled with different concentrations (20 µL, 60 µL and 80 µL) of homoeopathic medicines, namely *Sulphur* 30C, *Cuprum metallicum* 30C and *Ocimum basilicum* 30C. The plates were then incubated at 28°C for 4 days. After incubation, the resulting zones of inhibition were measured and tabulated for further analysis. The experiment deliberately omitted control groups to facilitate a focused evaluation of the inherent effects of homoeopathic medicines on *Alternaria solani*. The experiments were performed following the procedure detailed in a prior study.[18]

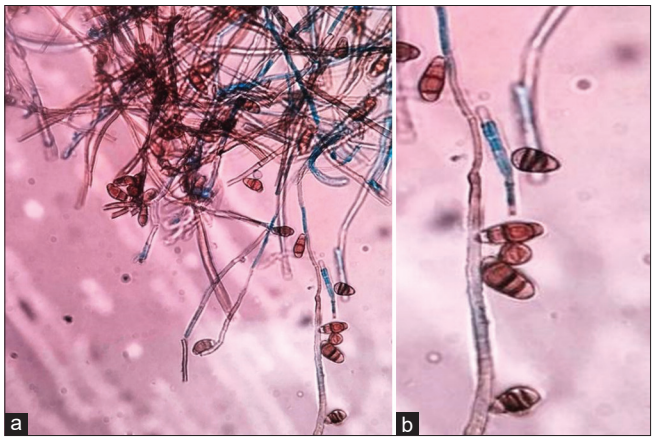


Figure 3: Quantification of microorganism *Alternaria solani* conidia and conidiophores at two magnification levels, (a) 35 µM and (b) 53 µM, through the utilisation of Lacto-phenol cotton blue staining.

On-farm trial method

The total experimental area covered 404.6 m^2. This study was conducted using a randomised complete block experimental design, with four replications, each comprising 10 rows. Before commencing the experiment, for soil analysis, multiple soil samples were collected from various spots within the experimental area. These samples underwent shade drying and were individually packed and sent to Bombay Private Limited, Salem. The land preparation involved digging, ploughing, removal of stems and harrowing, which were repeated 2–3 times. To ensure efficient water distribution, beds were created against the slope and 50 cm wide field canals were established at regular intervals of 1 m. In addition, furrows were provided between rows to guide water for irrigation purposes. To enrich the soil, farm yard manure was applied before the final ploughing.

Seed sowing was performed in trays filled with coco peat, which were then exposed to sunlight to facilitate germination. Regular watering was done every alternate day, to support seed germination. After 45 days, when the seedlings reached a height of 3 inches, they were transplanted into the field, with a spacing of 60 cm between rows and 50 cm between consecutive plants. Each replication consisted of approximately 70 plants and a subset of 20 constant plants was chosen for observation.

Throughout the growth stages of the tomato plants, hand weeding was carried out at regular intervals. Timely watering was ensured through the application of water spray at weekly intervals.

Homoeopathic medicines, namely *Sulphur* 30C, *Cuprum metallicum* 30C and *Ocimum basilicum* 30C, were administered at a rate of 1.2 mL (equivalent to 20 drops) per litre of water. The treatment group underwent foliar spray every 3rd day, targeting both the roots and leaves. In contrast, the positive control group received periodic applications of the Mancozeb fungicide, while the negative control group was treated with water.

Each treatment group comprised 20 plants, with five plants selected from each of the four rows. The foliar application of the homoeopathic medicines was consistently administered from the initiation of the experiment. The experimental procedure continued for approximately 80–100 days until the plants reached maturity.

The outcomes evaluated were the occurrence of *Alternaria solani* infected fruits and leaves, the weight and count of fruits and the height of the plants. *Alternaria solani*-infected fruits and concentric rings in leaves were assessed to determine the effect of the homoeopathic medicines at the fruiting stage. Simultaneously, the number and weight of non-infected fruits were quantified to evaluate their productivity. The height of the plants was also measured to assess the growth efficacy of the homoeopathic medicines at the flowering stage.

Results

In this study, the fungus *Alternaria solani* was isolated from an infected tomato and was identified based on its characteristic

morphology. The isolated fungal colonies exhibited distinctive traits, such as an irregularly shaped colony with a brownish colour, a dark brown substrate colour and a greyish margin. These isolates were further characterised by the presence of septate conidia with three transverse septa and an elongated but unbranched beak.

Subsequently, an *in vitro* investigation was conducted to assess the inhibitory effect of homoeopathic medicines on mycelial growth, using *Alternaria solani*-infected fruits to establish a pure culture of the fungus. All three medicines displayed inhibitory effects at different concentrations (20, 60 and 80 µl). Notably, *Ocimum basilicum* 30C exhibited the highest mycelial growth inhibition at concentrations of 20 µl, 60 µl and 80 µl, with values of 62.15%, 62.64% and 71.14%, respectively, followed by *Sulphur* 30C with inhibitions of 58.07%, 61.53% and 69.61% and *Cuprum metallicum* 30C with inhibitions of 57.33%, 60.59% and 68.45% [Table 1 and Figure 4].

In the on-farm trial experimental study, the treatments included *Sulphur* 30C, *Cuprum metallicum* 30C, *Ocimum basilicum* 30C and Mancozeb as positive control and water as negative control. Significant differences were observed across the characteristics studied [Table 2 and Figure 5].

Plant height

The plants treated with *Sulphur* 30C, *Cuprum metallicum* 30C and *Ocimum basilicum* 30C were taller as compared to those treated with Mancozeb and water [Figure 6].

Concentric ring formation

The plants treated with *Ocimum basilicum* 30C showed the best outcomes amongst the experimental medicines, while *Cuprum metallicum* 30C had lesser favourable results [Figure 7].

Fruit weight

The plants treated with *Ocimum basilicum* 30C yielded the heaviest fruits [Figure 8].

Number of fruits

The number of fruits was highest in the plants treated with *Sulphur* 30C [Figure 9].

The one-factor ANOVA analyses conducted for various agricultural parameters, including plant height, *Alternaria*

Table 1: Efficacy of Homoeopathic medicines against the mycelial growth of *Alternaria* sp.

S. No.	Homoeopathic medicines	Concentration µl					
		Diameter of mycelial growth (mm)*			Percent growth reduction over control		
		20 µl	60 µl	80 µl	20 µl	60 µl	80 µl
1	Cuprum 30 C	27.09	25.03	20.03	57.33%	60.58%	68.45%
2	Sulphur 30 C	26.64	24.37	19.27	58.07%	61.62%	69.65%
3	Ocimum 30 C	24.03	23.72	18.32	62.15%	62.64%	71.14%
4	Control	63.5	63.5	63.5	0.00%	0.00%	0.00%

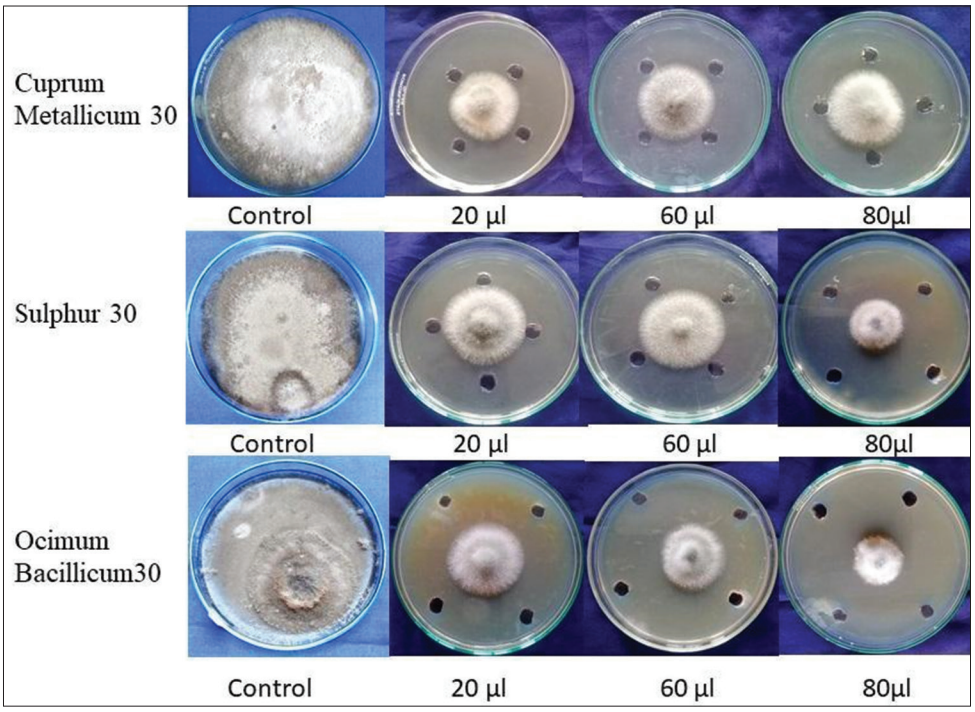


Figure 4: Efficacy of Homoeopathic medicines against the mycelial growth of *Alternaria* sp.

Table 2: Impact of various treatments on tomato plant characteristics

Treatment	No. of healthy fruits (mean±SD)	No. of affected fruits (mean±SD)	Total no. of fruits (mean±SD)	No. of concentric rings (mean±SD)	Weight (kg) (mean±SD)	Height (cm) at 30 days after flowering (mean±SD)
T1–Water	1.70±0.74	0.80±0.44	2.50±0.55	0.50±0.71	0.402±0.0234	34.65±3.5
T2–Sulphur	15.75±14.20	1.60±0.70	17.35±14.26	0.55±0.84	0.934±0.0142	113.5±5.2
T3–Cuprum	10.00±9.14	1.90±0.89	11.90±8.45	0.65±0.91	0.674±0.0196	108.675±4.8
T4–Ocimum	11.40±10.84	1.50±0.54	12.90±10.75	0.50±0.71	1.066±0.0255	103.45±4.0
T5–Mancozeb	8.25±7.18	1.35±0.47	9.60±6.48	0.75±1.07	0.452±0.0078	100.525±3.2

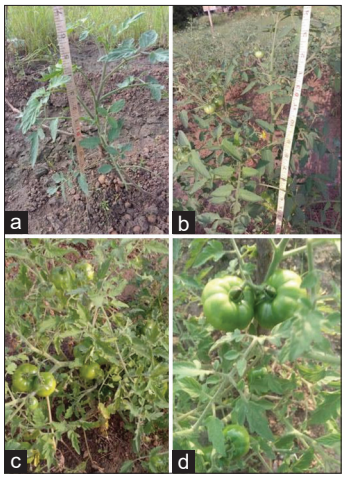


Figure 5: (a) Stunted growth in negative control, (b) *Sulphur* 30C plant height after 30 days of flowering, (c) Number of fruits in *Sulphur* 30 C, (d) *Ocimum basilicum* 30C Fruits

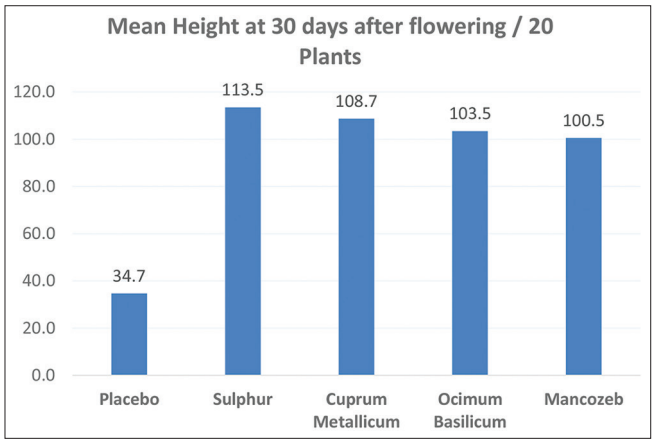


Figure 6: Mean heights (cm) of plants per 20 plants for various treatments, with treatments on the X-axis and mean height on the Y-axis

solanum incidence, concentric rings, fruit weight and the number of fruits, all revealed highly significant differences amongst the treatments. For plant height, the grand mean was approximately 92.16, with a significant F-statistic of 234.59 ($P < 0.01$) and *post hoc* analysis identified *Sulphur* 30C and *Cuprum metallicum* 30C as the most effective treatments. In the case of *Alternaria solanum*, the grand mean was 28.60, with an even more substantial F-statistic of 8571.42 ($P < 0.01$), emphasising the strong impact of treatment effectiveness, with *Sulphur* 30C as the most effective and

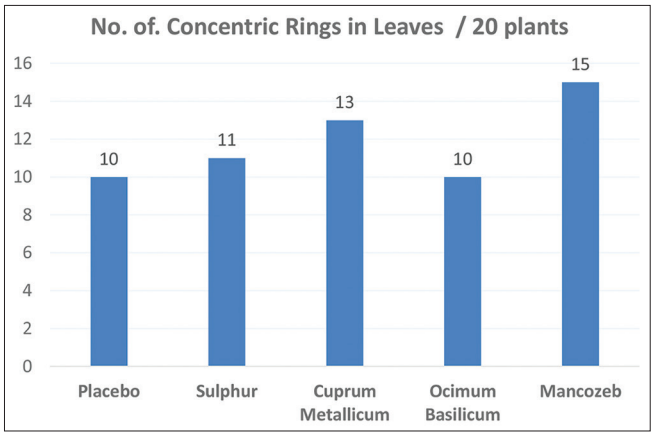


Figure 7: Count of concentric rings in leaves per 20 plants across treatments, with treatments on the X-axis and ring count on the Y-axis

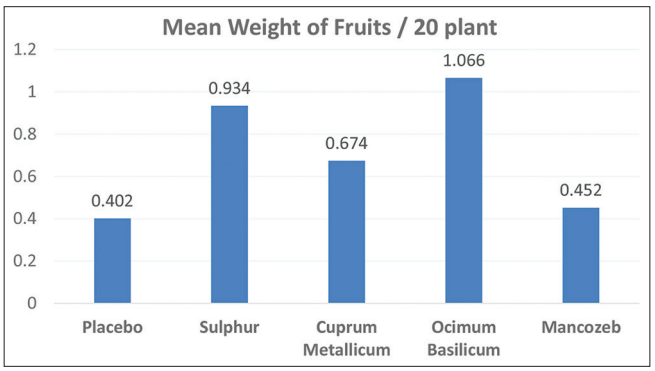


Figure 8: Mean fruit weight (kg) per 20 plants across treatments, with treatments on the X-axis and mean weight (kg) on the Y-axis

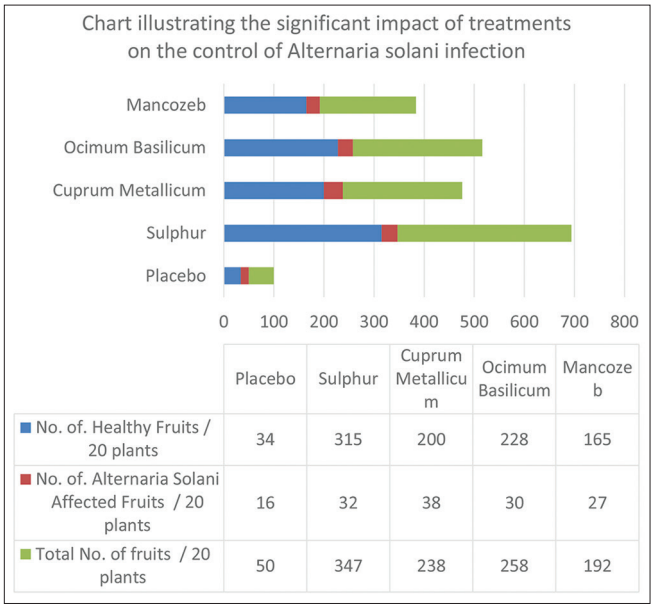
water as the least effective treatment. Similar patterns of significance and strong treatment effects were observed for concentric rings, fruit weight and the number of fruits, all with F-statistics of 8571.42 ($P < 0.01$) and specific *post hoc* rankings of treatment effectiveness [Figure 10]. These findings underscore the treatments' substantial impact on the attributes under study.

Discussion

In the laboratory investigations, all three homoeopathic medicines (*Ocimum basilicum* 30C, *Sulphur* 30C and *Cuprum metallicum* 30C) demonstrated inhibitory effects on *Alternaria solani* mycelial growth at varying concentrations. Notably, *Ocimum basilicum* 30C exhibited the most substantial

inhibition across all concentrations, signifying its potent antifungal properties.

In the on-farm trial, plants exposed to *Sulphur* 30C, *Cuprum metallicum* 30C and *Ocimum basilicum* 30C treatments displayed increased height in comparison to those subjected to Mancozeb and water treatments. Notably, amongst the experimental remedies, sulphur 30C exhibited a more pronounced impact. Moreover, the highest fruit yield was observed in plants treated with *Sulphur* 30C, indicating its positive influence on fruit set and production, indicative of improved overall plant health and resilience. Sulphur, an essential element for plant well-being, exerts its influence over a wide array of biological processes, including the synthesis of critical compounds such as cysteine, methionine, glutathione and gliotoxin.[19] These compounds, in turn, support protein synthesis, chlorophyll production, enzyme activity and resistance to stress. In addition, Sulphur plays a pivotal role in structural development and aids plants in defending against environmental challenges.[20] Its significance for overall plant health and growth suggests that these homoeopathic remedies may potentially contribute to enhanced plant growth, possibly by enhancing nutrient absorption or alleviating stress induced by fungal infections. *Cuprum metallicum* 30C has exhibited positive effects on plant height and displayed moderate efficacy in controlling infections, surpassing the performance of Mancozeb. Copper-based formulations, like *Cuprum metallicum*, are extensively utilised in agriculture due to their antimicrobial and antifungal attributes.[21] They proficiently inhibit fungal colonisation, mitigate infections caused by pathogens such as *Phaeoacremonium minimum* and provide an alternative approach for combating plant diseases



	Placebo	Sulphur	Cuprum Metallicum	Ocimum Basilicum	Mancozeb
No. of. Healthy Fruits / 20 plants	34	315	200	228	165
No. of. Alternaria Solani Affected Fruits / 20 plants	16	32	38	30	27
Total No. of fruits / 20 plants	50	347	238	258	192

Figure 9: Impact of treatments on the control of *Alternaria solani* infection; total fruit counts per 20 plants across treatments, with treatments on the X-axis and fruit counts on the Y-axis

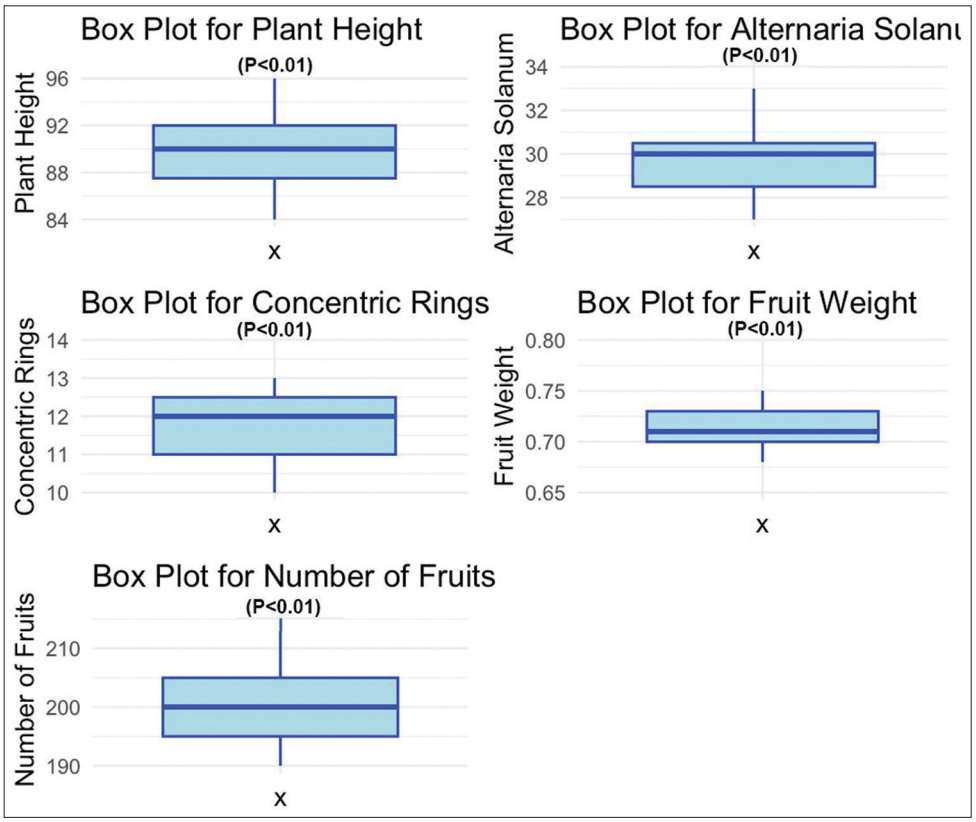


Figure 10: Box plots summarising agricultural parameters such as plant height, alternaria solanum presence, concentric rings, fruit weight and fruit count. They show the interquartile range (IQR), median and data range within 1.5 times the IQR, with significance levels noted

linked to fungi like *Alternaria solani*, all the while fostering plant well-being.[22]

Ocimum basilicum 30C has demonstrated remarkable effectiveness in suppressing concentric ring formation in tomato plants, notably resulting in the production of significantly heavier fruits. This observation aligns with the well-established principle that healthier plants tend to yield larger and superior-quality fruits. Consequently, it implies that *Ocimum basilicum* 30C may not only hinder fungal growth but also play a crucial role in enhancing fruit development and overall fruit quality, highlighting its potential as a valuable asset for promoting plant health and productivity. *Ocimum basilicum* documented antimicrobial activity against various microorganisms, including complete growth inhibition of several fungi such as *Fusarium* species, *Bipolaris hawaiiensis*, *Bipolaris spicifera* and *Cochliobolus cynodontis*, coupled with its demonstrated capability to prevent spore germination in *Bipolaris hawaiiensis*, it further solidifies its potential as a natural antifungal agent.[23,24] This dual ability to curb fungal growth and inhibit spore germination likely serves as the foundation for its effectiveness in controlling concentric rings in plants affected by Alternaria, ultimately leading to improved plant health and reduced damage. These findings underscore the critical importance of selecting appropriate homoeopathic remedies to positively influence specific plant health attributes.

Conclusion

The study suggests that homoeopathic remedies *Sulphur* 30C, *Cuprum metallicum* 30C and *Ocimum basilicum* 30C, outperformed the chemical fungicide Mancozeb in inhibiting the growth of the plant pathogen *Alternaria solani.* This finding points to the potential of using homoeopathic remedies as eco-friendly alternatives for agricultural disease management, enhancing plant health and fostering sustainable crop production.

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Conflicts of interest

None declared.

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Activité antifongique des médicaments homéopathiques contre Alternaria solani de la plante Solanum lycopersicum - Une étude in vitro et un essai en ferme

Contexte: La surutilisation des pesticides a porté atteinte à la biodiversité, suscitant des inquiétudes quant au potentiel de mutations génétiques chez l'homme et d'autres organismes causées par les résidus de pesticides dans les aliments. Des recherches récentes ont démontré que les médicaments homéopathiques peuvent agir comme engrais pour nourrir les plantes.

Objectifs: Évaluer l'activité antifongique des médicaments homéopathiques dans des essais in vitro et à la ferme. Méthodes: L'impact des médicaments homéopathiques, Sulphur 30C, Ocimum basilicum 30C et Cuprum Metallicum 30C, sur l'inhibition de la croissance mycélienne d'Alternaria solani a été étudié in vitro à l'aide du test de diffusion sur gélose. Dans un essai à la ferme utilisant des graines de Solanum lycopersicum (variété PKM-1), les médicaments homéopathiques Sulphur 30C, Cuprum Metallicum 30C et Ocimum basilicum 30C, ainsi qu'un fongicide standard (mancozèbe) et de l'eau comme contrôle, ont été évalués pour leur impact sur la croissance des plantes, la production de fruits et la résistance aux maladies, en ciblant spécifiquement l'infection par Alternaria solani.

Résultats: Dans cette étude, Ocimum basilicum 30C a montré la plus forte inhibition de la croissance mycélienne à des concentrations de 20 µl, 60 µl et 80 µl (62,15 %, 62,64 % et 71,14 % respectivement), suivi par Sulphur 30C (58,07 %, 61,53 % et 69,61 %). %) et Cuprum Metallicum 30C (57,33 %, 60,59 % et 68,45 %). Lors de l'essai à la ferme, les effets du soufre 30C, du Cuprum Metallicum 30C et de l'Ocimum basilicum 30C se sont révélés significativement supérieurs à ceux du mancozèbe ($p < 0,01$). Conclusion : L'agro-homéopathie est une alternative prometteuse aux pesticides chimiques utilisés dans les plantes, favorisant ainsi une agriculture durable. Tous les médicaments homéopathiques ont démontré des effets antifongiques significatifs, le Sulphur 30C présentant une inhibition plus élevée contre Alternaria solani, indiquant sa valeur potentielle en agriculture.

Antimykotische Wirkung von homöopathischen Arzneimitteln gegen Alternaria solani auf Solanum lycopersicum - eine In-vitro-Studie und ein Versuch auf dem Bauernhof

Hintergrund: Der übermäßige Einsatz von Pestiziden hat die biologische Vielfalt geschädigt und gibt Anlass zur Sorge über mögliche genetische Mutationen bei Menschen und anderen Organismen, die durch Pestizidrückstände in Lebensmitteln verursacht werden. Jüngste Forschungen haben gezeigt, dass homöopathische Arzneimittel als Düngemittel für die Pflanzenernährung wirken können. **Zielsetzungen:** Bewertung der antimykotischen Aktivität von homöopathischen Arzneimitteln in einem In-vitro- und einem On-Farm-Versuch. **Methoden:** Die Wirkung der homöopathischen Arzneimittel Sulphur 30C, Ocimum basilicum 30C und Cuprum metallicum 30C auf die Hemmung des Myzelwachstums von Alternaria solani wurde in vitro mit dem Agar Well-Diffusion Assay untersucht. In einem On-Farm-Versuch mit Samen von Solanum *lycopersicum* (Sorte PKM-1) wurden die homöopathischen Arzneimittel Sulphur 30C, Cuprum metallicum 30C und *Ocimum basilicum* 30C zusammen mit einem Standardfungizid (Mancozeb) und Wasser als Kontrollen auf ihre Auswirkungen auf das Pflanzenwachstum, die Fruchtproduktion und die Krankheitsresistenz speziell bei *Alternaria solani*-Infektionen untersucht. Ergebnisse: In dieser Studie zeigte *Ocimum basilicum* 30C die höchste Hemmung des Myzelwachstums bei Konzentrationen von 20µl, 60µl und 80µl (62,15%, 62,64% bzw. 71,14%), gefolgt von Sulphur 30C (58,07%, 61,53% und 69,61%) und Cuprum *metallicum* 30C (57,33%, 60,59% und 68,45%). Im Feldversuch war die Wirkung von *Sulphur* 30C, *Cuprum metallicum* 30C und *Ocimum basilicum* 30C deutlich größer als die von Mancozeb ($p<0,01$). **Schlussfolgerung:** Die Agro-Homöopathie ist eine vielversprechende Alternative zu chemischen Pflanzenschutzmitteln und fördert damit eine nachhaltige Landwirtschaft. Alle homöopathischen Arzneimittel zeigten signifikante antimykotische Wirkungen, wobei *Sulphur* 30C eine höhere Hemmung gegen *Alternaria solani* zeigte, was auf seinen potenziellen Wert in der Landwirtschaft hinweist.

सोलेनम लाइकोपर्सिकम (Solanum lycopersicum) पौधे के अल्टरनेरिया सोलानी (Alternaria solani) के प्रति होम्योपैथी दवाओं का एंटीफंगल प्रभाव - इन विट्रो अध्ययन और ऑन-फ़ार्म परीक्षण

पृष्ठभूमि: कीटनाशकों के अत्यधिक उपयोग से जैव विविधता को नुकसान पहुँचा है, जिससे खाद्य पदार्थों में कीटनाशक अवशेषों के कारण मनुष्यों और अन्य जीवों में होने वाले जेनेटिक म्यूटेशन की संभावना को लेकर चिंताएँ बढ़ गई हैं। हाल ही में किए गए शोधों में दर्शाया गया है कि होम्योपैथी दवाएं पौधों के पोषण के लिए उर्वरक का काम कर सकती हैं। **उद्देश्य:** *इन विट्रो* और *ऑन-फ़ार्म* परीक्षण में होम्योपैथी दवाओं के एंटीफंगल प्रभाव का मूल्यांकन करना। **विधियां:** अल्टरनेरिया सोलानी के मायसीलियल विकास अवरोध पर होम्योपैथी दवाओं *सल्फर* 30C (*Sulphur* 30C), *ओसीमम बेसिलिकम* 30C (*Ocimum basilicum* 30C) *और क्यूप्रम मेटैलिकम* 30C (*Cuprum metallicum* 30C) के प्रभाव का एगर वेल-डिफ्यूजन एस्से का उपयोग से इन-विट्रो अध्ययन किया गया। सोलेनम लाइकोपर्सिकम (Solanum lycopersicum, PKM-1 किस्म) के बीजों का इस्तेमाल से किए गए एक ऑन-फ़ार्म परीक्षण में, होम्योपैथी दवाओं *सल्फर* 30C (*Sulphur* 30C), *क्यूप्रम मैटेलिकम 30C* (*Cuprum metallicum* 30C) और ओसिमम बसैलिकम 30C (*Ocimum basilicum* 30C) के साथ-साथ, नियंत्रकों के रूप में मानक कवकनाशी (मैन्कोजेब, mancozeb) और जल का, पौधों के विकास, फ़ल उत्पादन और रोग प्रतिरोध, विशेष रूप से आल्टरनेरिया *सोलानी संक्रमण* (*Alternaria solani*) पर प्रभाव का मूल्यांकन किया गया। **परिणाम:** इस अध्ययन में, *ओसीमम बेसिलिकम* 30C ने 20µl,

60µl, and 80µl (क्रमशः 62.15%, 62.64% और 71.14%), की सांद्रताओं पर और इसके बाद *सल्फ़र* 30C (58.07%, 61.53% और 69.61%) और *क्यूप्रम मैटेलिकम 30C* (57.33%, 60.59% और 68.45%) ने उच्चतम मायसीलियल विकास अवरोध दर्शाया। ऑन-फ़ार्म परीक्षण में, *सल्फ़र* 30C, *क्यूप्रम मैटेलिकम* 30C और *ओसीमम बेसिलिकम 30C* के प्रभाव मैन्कोजेब ($p<0.01$) की तुलना में महत्वपूर्ण रूप से अधिक पाए गए। **निष्कर्ष:** पौधों में उपयोग किए जाने वाले रासायनिक कीटनाशकों के लिए कृषि-होम्योपैथी एक भरोसेमंद विकल्प है, जो संधारणीय कृषि को बढ़ावा दे सकता है। सभी होम्योपैथी दवाओं ने महत्वपूर्ण एंटीफंगल प्रभाव दर्शाए, जिसमें सल्फर 30C ने *अल्टरनेरिया सोलानी* (*Alternaria solani*) के विरुद्ध उच्च अवरोध दिखाया, जो कृषि में इसके संभावित महत्त्व को दर्शाता है।

Actividad antifúngica de medicamentos homeopáticos frente a Alternaria solani de la planta Solanum lycopersicum - Un estudio in vitro y un ensayo en granja

Antecedentes: El uso excesivo de pesticidas ha dañado la biodiversidad y suscita preocupación por la posibilidad de mutaciones genéticas en humanos y otros organismos causados por residuos de pesticidas en los alimentos. Investigaciones recientes han demostrado que los medicamentos homeopáticos pueden actuar como fertilizantes para la nutrición de las plantas. **Objetivos:** Evaluar la actividad antifúngica de los medicamentos homeopáticos en ensayos in vitro y en granjas. **Métodos:** Se estudió in vitro el efecto de los medicamentos homeopáticos Sulphur 30C, Ocimum basilicum 30C y Cuprum metallicum 30C en la inhibición del crecimiento micelial de Alternaria solani mediante el ensayo de difusión en pocillo de agar. En un ensayo realizado en granja con semillas de Solanum lycopersicum (variedad PKM-1), se utilizaron los medicamentos homeopáticos Sulphur 30C, Cuprum metallicum 30C y Ocimum basilicum 30C, junto con un fungicida estándar (mancozeb) y agua como controles, se evaluó su impacto en el crecimiento de la planta, la producción de fruta y la resistencia a enfermedades, centrándose específicamente en la infección por Alternaria solani. **Resultados:** En este estudio, Ocimum basilicum 30C mostró la mayor inhibición del crecimiento micelial en concentraciones de 20µl, 60µl y 80µl (62,15%, 62,64% y 71,14% respectivamente), seguido de Sulphur 30C (58,07%, 61,53% y 69,61%) y Cuprum metallicum 30C (57,33%, 60,59% y 68,45%). En el ensayo en granja, los efectos de Sulphur 30C, Cuprum metallicum 30C y Ocimum basilicum 30C fueron significativamente mayores que los de Mancozeb ($p<0,01$). **Conclusión:** La agrohomeopatía es una alternativa prometedora a los pesticidas químicos utilizados en las plantas, fomentando así la agricultura sostenible. Todos los medicamentos homeopáticos demostraron efectos antifúngicos significativos, siendo el azufre 30C el que mostró una mayor inhibición contra Alternaria solani, lo que indica su valor potencial en agricultura.

势 法 物对番茄Alternaria solani的抗真菌活性——体外研究和田 .背景： 的过度使用 害了生物多样性，引 了人 对食品中 残留可能 致人类和其他生物基因突 的担忧。最近的研究表明， 势 法 物可以作 植物 的肥料。

目的： 价 势 法 物的抗真菌活性。**方法：**采用琼脂 散法研究 势 法 物硫30C、 勒30C和金属 30C对 格孢菌 生 的抑制作用。在一 使用番茄茄（PKM-1品种）种子的 中， 估了 势 法 物硫30C、金属 30C和 勒30C，以及 准 菌 （代森 ）和水作 对照，以 估其对植物生 、果实生 和抗病性的影响，特别是 对 格孢感染。

果：在本研究中， 勒30C在20μl、60μl和80μl 度下表 出最高的菌 生 抑制作用（分别 62.15%、62.64%和71.14%），其次是硫30C（58.07%、61.53%和69.61%）和金属 30C（57.33%、60.59%和68.45%）， ： 势法是一种很有前景的植物化学 替代品，有助于促 可持 展。所有的 势 法 物都表 出 著的抗真菌作用，其中硫30C对番茄 格孢具有更高的抑制作用，表明其在 中的潜在价值。