

# Potential of Selected Homoeopathic Drugs in Controlling Post-Harvest Fruit Rot of Strawberry Caused by *Penicillium expansum*

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**Abstract:** Blue mold of strawberry, caused by *Penicillium expansum*, is one of the most destructive postharvest diseases affecting strawberries in India. Total twenty-three isolates of *P. expansum* were obtained from infected strawberry fruits collected from the APMC fruit market, Vashi, Navi Mumbai. The isolates were evaluated for their sensitivity to pyrimethanil, wherein isolate Pe-11 was found sensitive, while Pe-19 exhibited resistance. The minimum inhibitory concentration (MIC) values ranged from 766.10 to 982.30 µg/ml. Sensitive isolate was further subjected to chemical and physical mutagenic treatments, leading to the identification of a pyrimethanil-resistant mutant, Pe-EMS-11, with an MIC value of 4962.15 µg/ml. Fourteen homoeopathic medicines were screened against the pyrimethanil-resistant mutant of *P. expansum* (EMS-Pe-12). Among them, *Nux vomica* showed the highest percent control efficacy (PCE) value of 42.75 when applied individually, which further increased to 56.25 when combined with pyrimethanil. Other effective homoeopathic medicines included *Arsenicum album*, *Sambucus nigra*, *Chenopodium*, *Baptisia tinctoria*, *Ustilago maydis*, *Iris versicolor*, *Zincum metallicum*, and *Argentum metallicum*.

**Keywords:** Strawberry, Blue mold, *Penicillium expansum*, homoeopathic medicines, pyrimethanil

## I. INTRODUCTION

Blue mold of strawberry fruits (*Fragaria ananassa* Duchesne.), caused by *Penicillium expansum*, is considered one of the most destructive postharvest diseases of strawberry. Strawberries are rich in vitamins, antioxidants, minerals, and other essential nutrients that contribute significantly to human health. However, their high sugar content, soft texture, and low pH make them highly susceptible to fungal infections and rapid deterioration during storage and transportation<sup>[14]</sup>. Postharvest fungal pathogens not only cause fruit decay but also reduce the commercial and market value of fruits<sup>[2]</sup>. Several fungal pathogens, including *Alternaria alternata*, *Aspergillus fumigatus*, *Aspergillus flavus*, *Colletotrichum acutatum*, *Venturia inaequalis*, *Monilinia fructicola*, *Botrytis cinerea*, *Sclerotinia fructigena*, *Rhizopus stolonifer*, *Mucor piriformis*, *Penicillium digitatum*, and *Penicillium expansum* have been reported on strawberries during storage and transport. Among these, *Penicillium expansum* was found to be the most dominant pathogen in local storehouses and the APMC Fruit Market, Vashi, Navi Mumbai, where considerable damage to packed strawberry fruits was observed. It is estimated that nearly 20–25% of harvested fruits are lost due to pathogenic infections during postharvest handling, even in developed countries<sup>[1]</sup>.

Pyrimethanil is commonly recommended for the management of postharvest fruit rot pathogens; however, reports of fungicide resistance have emerged in India<sup>[4, 7, 8]</sup>. Continuous and excessive application of pyrimethanil may adversely affect both strawberry fruits and the pathogen population, leading to reduced effectiveness and environmental concerns. Therefore, eco-friendly and safer alternatives such as homoeopathic medicines are being explored for disease management. Previous studies have demonstrated the inhibitory effects of homoeopathic drugs, including *Lycopodium*,



*Thuja*, *Arsenicum*, and *Zincum*, against several fungal pathogens such as *Fusarium moniliforme*, *Alternaria alternata*, *Gloeosporium psidii*, *Colletotrichum gloeosporioides*, and *Pestalotia* spp. [5, 10, 11, 15]. In the present investigation, the homeopathic medicine *Nux vomica* showed promising antifungal activity with a Percent Control Efficacy (PCE) value of 42.75 when used alone, while its combination with pyrimethanil further enhanced the PCE value up to 56.25.

## II. MATERIALS AND METHODS

Homeopathic medicines namely *Belladonna*, *Sambucus nigra*, *Thuja occidentalis*, *Argentum metallicum*, *Nux vomica*, *Lycopodium clavatum*, *Ustilago maydis*, *Iris versicolor*, *Cynopodium*, *Zincum metallicum*, *Arsenicum album*, *Baptisia tinctoria*, *Teucrium marum verum*, and *Sepia officinale* were procured from the wholesale market at Vashi. All medicines were used at 200 potencies. The antifungal efficacy of these homeopathic medicines was evaluated individually as well as in combination with pyrimethanil (972.0 µg/ml) against the mycelial growth of the pyrimethanil-resistant mutant (Pe-EMS-11) of *Penicillium expansum* using Potato Dextrose Agar (PDA) medium following the food poisoning technique [12]. The Percentage Control Efficacy (PCE) was calculated using the following formula:

$$PCE = \frac{C - T}{C} \times 100$$

Where:

C - Mycelial Growth in Control

T - Mycelial Growth in Treated

## III. RESULTS AND DISCUSSION

The results presented in Table 1 revealed that fourteen homeopathic medicines were evaluated for the management of the pyrimethanil-resistant mutant (Pe-EMS-11) of *Penicillium expansum*. All tested homeopathic medicines exhibited inhibitory activity against the pathogen. Among them, *Nux vomica* showed the highest Percent Control Efficacy (PCE) value of 42.75 when applied individually, followed by *Cynopodium* (40.00), *Sambucus nigra* (39.85), *Arsenicum album* (39.75), *Iris versicolor* (38.00), *Baptisia tinctoria* (37.82), *Ustilago maydis* (37.25), *Zincum metallicum* (35.50), and *Argentum metallicum* (34.10). The remaining four homeopathic medicines recorded PCE values ranging between 20.80 and 32.89.

Furthermore, when these homeopathic medicines were used in combination with pyrimethanil, the PCE values increased considerably against *Penicillium expansum*. The combination of *Nux vomica* with pyrimethanil produced the highest PCE value of 56.25, which was substantially greater than its individual effect. In contrast, the lowest PCE value (37.50) was observed in *Belladonna*, while the other homeopathic medicine combinations exhibited PCE values above 54.25.

Only a few studies have been reported on the application of homeopathic medicines against plant pathogens; nevertheless, the present results are in agreement with previous findings. Dahiwalé and Suryawanshi (2014) documented the successful management of grape grey mould caused by *Botrytis cinerea* using homeopathic medicines. Similarly, Patil and Suryawanshi (2014) reported the control of strawberry fruit rot caused by *Alternaria alternata* through homeopathic treatments. In their study, *Nux vomica* exhibited a higher PCE value (50) when used individually, whereas *Sulphur 30 CH* showed maximum efficacy (84.45) when combined with mancozeb, followed by *Rhus toxicodendron*, *Cina*, *Arnica montana*, *Sanguinaria canadensis*, *Selenium*, and *Tarentula hispana*.

Baviskar and Suryawanshi (2015) also evaluated thirteen homeopathic medicines against the carbendazim-resistant mutant (Pe-EMS-10) of *Penicillium expansum*. Their results demonstrated that *Sepia officinale* recorded the highest PCE value (40.42) individually, while *Belladonna* showed the lowest PCE value (35.85). All tested medicines exhibited inhibitory effects against the pathogen. Moreover, the combination of *Sepia officinale* with carbendazim increased the PCE value to 53.25 compared with its individual treatment.



Likewise, Jagtap and Suryawanshi (2014) reported the use of certain homoeopathic medicines for managing the thiophanate methyl-resistant mutant (Foc-EMS-10) of *Fusarium oxysporum* f. sp. *cepae*. The study indicated that homoeopathic medicines were highly inhibitory against the resistant mutant. *Nux vomica* was found to be the most effective at 200 potencies with a PCE value of 48.66, whereas *Tuberculinum* (25.66) and *Chelidonium majus* (23.00) showed comparatively lower efficacy, while *Sulphur* also demonstrated significant inhibitory activity with a PCE value of 52.33.

Table 1: Percentage Control Efficacy (PCE) of pyrimethanil individually and in mixture with homoeopathic medicines against resistant mutant of *Penicillium expansum* on PDA medium.

Sr. No.	Homoeopathic medicines	Percentage Control Efficacy *	
		PCE individual	PCE mixture with pyrimethanil
1.	<i>Belladonna</i>	20.80	37.50
2.	<i>Sambucus nigra</i>	39.75	52.50
3.	<i>Thuja occidentalis</i>	29.74	43.75
4.	<i>Argentum metallicum</i>	34.10	46.75
5.	<i>Nux vomica</i>	42.75	56.25
6.	<i>Lycopodium clavatum</i>	32.89	45.75
7.	<i>Ustilago maydis</i>	37.25	50.00
8.	<i>Iris versicolor</i>	38.00	51.55
9.	<i>Cynopodium</i>	40.00	52.85
10.	<i>Zincum metallicum</i>	35.50	49.63
11.	<i>Arsenicum album</i>	39.75	51.00
12.	<i>Baptisia tinctoria</i>	37.82	54.25
13.	<i>Teucrium marum verum</i>	29.75	43.79
14.	<i>Sepia officinale</i>	28.56	39.50
14.	Pyrimethanil (972.0µg/ml)	52.50	---
	SE	2.139	1.816
	CD at 0.05	4.552	3.682
	at 0.05	4.975	4.285

\* Values are replicates.

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