**Evaluation of Different Fungicides Against Powdery Mildew of Pumpkin (*Cucurbita moschata* L.)**

**Abstract**

Erysiphe cichoracearum and Sphaerotheca fuliginea are the primary pathogens responsible for powdery mildew in pumpkin (*Cucurbita moschata* L.), a major fungal disease leading to substantial yield losses. The severity and disease development in pumpkin have led to severe yield losses; hence, a detailed study to assess the efficacy of systemic fungicides and combined fungicides under in vitro conditions is very important. The present study was undertaken during the **Zaid and Kharif seasons of 2024–25** to evaluate the **efficacy of selected fungicides under field conditions** and their effect on **mycelium germination inhibition**. A total of six fungicides were tested against powdery mildew, and all treatments significantly reduced disease intensity compared to the untreated control. Among them, **three sprays of Triadimefon + Bitertanol (Trooper 75 WP) at 0.2%** emerged as the **most effective treatment,** recording the **lowest mean Per cent Disease Intensity (PDI) of 19.01%.** Thiswas followed by **Propiconazole 25% EC + Hexaconazole (Cantof 5% EC) at 0.1%** and **Myclobutanil (Systhane 10 WP) at 0.2%,** with mean PDIs of **22.22%** and **27.89%,** respectively. Based on the overall disease control performance and disease suppression, **Triadimefon + Bitertanol** and **Propiconazole + Hexaconazole** can be recommended for the effective management of powdery mildew in cucumber under field conditions. These treatments can contribute to improved plant health and potentially higher yields when integrated with proper cultural practices. These findings indicate that the use of **systemic and combination fungicides** can provide effective management of powdery mildew in cucumber, thereby contributing to healthier crops and improved yields under field conditions.

**Keywords:** *Erysiphe cichoraciarum and Sphaerotheca fuliginea, pumpkin,* ***Trooper 75 WP.***

# Introduction

# Cucurbita (Latin for gourd) is a genus of herbaceous gourd family, Cucurbitaceae (also known as cucurbits), native to the Andes and Mesoamerica. Five edible and consumed for their flesh and seeds. They are squash, pumpkin, or gourd, depending on species, parlance (WIKI, 2022). The name pumpkin is derived word pepon, which means large melon. The word French as pompon, and later changed to pumpion, the late 17th century, English-speaking immigrants started pronouncing it as pumpkin, which remains the pronunciation to this day (Herbazest, 2021). A member of the Cucurbitaceae family, pumpkin (*Cucurbita moschata* L.), is one of the earliest vegetable crops to be produced. Vegetables like pumpkin are widely grown. The plant is a creeping vine that produces cucumiform blossoms and fruits, which can be eaten by cooked. Although undervalued, pumpkin is a valuable herbaceous plant that contributes to global food and nutritional security. This crop has already been identified as a revolutionary age crop, balanced food, and more adapted to low soil and atmospheric circumstances than other major crops (Hosen et al., 2021; Gabal, 2019).

# The primary objective of cucurbitaceous vegetable research in India is to generate biotic and abiotic-resistant varieties and hybrids with excellent qualities in order to increase productivity on a sustainable basis (Rai *et al*., 2008). Powdery mildew is an important disease of pumpkin crops, particularly pumpkin and cucumber, which are highly susceptible to this disease and suffer heavy losses in all localities of Uttarakhand State of Dehradun. Pumpkin powdery mildew disease is attributed to two fungal species, *Sphaerotheca fuliginea* (Schltdl.) and *Erysiphe cichoracearum* (DC.), which belong to two different genera in the same family*, Erysiphaceae*. The disease initially manifests as small white, powder-like patches on the top sides of mature leaves and stems ([Alavilli et al., 2022](https://www.sciencedirect.com/science/article/pii/S0304423825001736%22%20%5Cl%20%22bib0002)). As the infection progresses, this white coating spreads to cover both sides of the leaves and stems (Sabet et al., 2025). Yield loss due to powdery and downy mildew diseases was estimated to be 50–70 per cent. Though there are many cultural practices employed, such as crop rotation and fall ploughing, and also the use of fungicides. The severity and disease development in pumpkin have led to severe yield losses. Therefore, a detailed study is required to assess the efficacy of systemic fungicides and combined fungicides under *in vitro* conditions.

# 2. Materials and Methods

#### ****2.1 Experimental Site and Season****

The field experiment was conducted at the **Agricultural Research Farm**, Shimla By pass Sihniwala, PO Sherpur 248197, during the Zaid Season to evaluate the Performance of selected fungicides in suppressing powdery mildew disease in pumpkin (*Cucurbita moschata* L).

#### ****2.2 Crop and Variety****

Cucumber variety HB-**Nawab** was used for the study. The crop was sown at a spacing of **1.2 × 1.8 m** under recommended agronomic practices.

#### ****2.3 Experimental Design****

The experiment was laid out in a **Randomised Block Design (RBD)** with **seven treatments** replicated **three times**. Each plot measured **3 m × 2 m** with adequate spacing between replications and plots.

#### ****2.4 Treatment Details****

**Table 1:** **The details of fungicidal treatments and their concentrations are given below**:

|  |  |  |
| --- | --- | --- |
| **Tr. No.** | **Treatment** | **Formulation** |
| T1 | Myclobutanil (Systhane 10 WP) | 0.2 |
| T2 | Hexaconazole (Cantof 5% EC) | 0.2 |
| T3 | Triadimefon + Bitertanol (Trooper 75 WP) | 0.2 |
| T4 | Propiconazole 25% EC | 0.1 |
| T5 | Carbendazim 50% WP | 0.1 |
| T6 | Propiconazole 25% EC + Hexaconazole (Cantof 5% EC) | 0.1 |
| T7 | Control (Untreated) | — |

#### 2.5 ****Disease Assessment****

The **Per cent Disease Intensity (PDI)** was recorded **after each spray** using a 0–5 disease rating scale, where:

* 0 = No symptoms
* 1 = 1–10% leaf area infected
* 2 = 11–25%
* 3 = 26–50%
* 4 = 51–75%
* 5 = >75% leaf area infected

PDI was calculated using the formula:

 Numerical ratings × 100

PDI =

 Total number of leaves observed ×Maximum rating

#### ****2.6 Per cent Disease Control (PDC)****

PDC was calculated based on the difference in disease intensity between treated and control plots using the formula:

 PDI in control−PDI in treatment

PDC= X 100

 PDI in control

#### ****2.7 Statistical Analysis****

The data on disease intensity were subjected to **angular transformation** and analysed statistically using **ANOVA (Analysis of Variance)**. Treatment means were compared using the **Critical Difference (CD) at 5% level of significance**.

**2.8 Fungicidal spraying schedule**

The aqueous solution of the required concentration of various treatments was prepared in water just before spraying. Three sprays of each solution were given at a fifteen-day interval during the Zayad season 2025. The spray was done with the help of a knapsack hand sprayer with a hollow cone nozzle. During spraying of fungicide, complete coverage of the plant surface was ensured, and the spray drifts of different treatments were avoided by taking appropriate precautions.

**3. Results and Discussion**

* 1. The effectiveness of six different fungicidal treatments in managing **powdery mildew** of cucumber was assessed based on **Per cent Disease Intensity (PDI)** and **Per cent Disease Control (PDC)** over three consecutive sprays. The summarised results are presented in **Table 2.**

#### ****3.1 Per cent Disease Intensity (PDI)****

All the fungicidal treatments tested were significantly effective in reducing PDI compared to the **untreated control,** which recorded the highest mean disease intensity of **60.69%,** indicating a severe level of infection under natural field conditions. Among the treatments, **Triadimefon + Bitertanol (Trooper 75 WP) at 0.2%** was found to be **most effective**, with a significantly **lower mean PDI of 19.01%** across three sprays. This treatment not only restricted disease development effectively but also maintained consistent performance across all observations, suggesting strong systemic action and residual effect against ***Erysiphe cichoracearum*** and ***Sphaerotheca fuliginea,*** the primary pathogens responsible for powdery mildew. The **second-best performance** was observed in **Propiconazole 25% EC + Hexaconazole (Cantof 5% EC) at 0.1%,** which recorded a **mean PDI of 22.22%.** Both Triadimefon + Bitertanol and the Propiconazole + Hexaconazole combination belong to the **triazole group,** known for their curative and protective properties, inhibition of ergosterol biosynthesis, and systemic movement within the plant tissues, which possibly explains their superior efficacy. **Myclobutanil (Systhane 10 WP) at 0.2%** also showed a notable reduction in PDI, registering **27.89%,** followed by **Carbendazim 50% WP (34.11%)** and **Hexaconazole alone (36.91%).** Though less effective than the top treatments, these fungicides still maintained a significant control over disease progression compared to the untreated check, suggesting their usefulness in rotational schedules to prevent resistance development.

#### ****3.2 Per cent Disease Control (PDC)****

The comparative analysis of **PDC** further reinforces the effectiveness of systemic fungicides in disease suppression. The **highest disease control** was achieved by **Triadimefon + Bitertanol,** with a **mean PDC of 67.72%,** followed closely by **Propiconazole + Hexaconazole (62.42%)** and **Myclobutanil (52.66%).** These results reflect not only reduced disease incidence but also a likely enhancement in crop vigour and potential yield due to lesser biotic stress. The control plot, which received no fungicidal treatment, showed rapid disease progression, confirming the aggressiveness of powdery mildew under favourable environmental conditions during the cropping period. The stark contrast in PDI and PDC values between treated and untreated plots underscores the necessity of timely fungicidal interventions in managing this disease.

#### ****3.3 Discussion in the Context of Literature****

These findings are in agreement with earlier studies. Anand et al. (2008) reported significant control of powdery mildew in cucumber using systemic fungicides like azoxystrobin and triazoles. Similarly, Ashtaputre et al. (2007) and Shivanna et al. (2006) found triazole-based fungicides effective in managing ***Erysiphe spp.*** on chilli and okra, respectively. The efficacy of combinations and systemic fungicides observed in the present study suggests enhanced spectrum, residual activity, and possibly synergistic effects when used in integrated spray schedules.

#### ****3.4 Agronomic and Practical Implications****

The study demonstrates that **Triadimefon + Bitertanol** and **Propiconazole + Hexaconazole** are highly suitable for inclusion in **Integrated Disease Management (IDM)** programs. Their significant disease suppression capacity, ease of application, and systemic action make them ideal choices for commercial cucumber cultivation. It is also evident that repeated use of single-site fungicides like triazoles should be strategically alternated with other modes of action to prevent the risk of fungicide resistance. Thus, integrating these fungicides with cultural practices, resistant varieties, and biocontrol agents may offer a more sustainable disease management approach.

**Table 2: Average effect of fungicidal spraying on the per cent disease intensity of powdery mildew and the per cent disease control**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Tr. No.** | Treatment Details | Conc. (%) | (PDI) after spray | Mean (PDI) | (PDC) after spray | Mean (PDC) |
| First | Second | Third | First | Second | Third |
| T1 | Myclobutanil (Systhane 10 WP) | 0.2 | 23.58(29.01) | 28.64(32.32) | 31.46(34.11) | 27.89(31.81) | 46.18 | 51.56 | 60.24 | 52.66 |
| T2 | Hexaconazole (Cantof 5% EC) | 0.2 | 33.08(35.17) | 37.03(37.47) | 40.61(39.58) | 36.91(37.41) | 24.50 | 37.37 | 48.67 | 36.85 |
| T3 | Triademefon+Bitertanol (Trooper 75WP) | 0.2 | 16.17(23.62) | 19.38(26.05) | 21.48(27.57) | 19.01(25.75) | 63.09 | 67.22 | 72.85 | 67.72 |
| T4 | Propiconazole25%EC  | 0.1 | 25.30(3015) | 29.63(32.96) | 31.85(34.32) | 28.93(32.48) | 42.26 | 49.89 | 59.74 | 50.63 |
| T5 | Carbendazim50%WP | 0.1 | 29.13(32.64) | 35.30(36.44) | 37.90(37.98) | 34.11(35.69) | 33.52 | 40.30 | 52.10 | 41.97 |
| T6 | Propiconazole25%EC + Hexaconazole (Cantof 5% EC) | 0.1 | 18.51(25.44) | 22.59(28.35) | 25.55(30.34) | 22.22(28.04) | 57.75 | 61.79 | 67.71 | 62.42 |
| T7 | Control | - | 43.82(41.44) | 59.13(50.26) | 79.13(62.28) | 60.69(51.33) | 0 | 0 | 0 | 0.00 |
| SE(m)± | 1.20 | 1.11 | 1.48 | 1.80 | - | - | - | - |
| C.D at5% | 3.71 | 3.42 | 4.55 | 5.54 | - | - | - | - |

# 4. Conclusion

The present investigation revealed that all fungicidal treatments significantly reduced the **Per cent Disease Intensity (PDI)** of **powdery mildew** in pumpkin compared to the untreated control. Among the treatments, **Triadimefon + Bitertanol (Trooper 75 WP)** at 0.2% was found to be the **most effective**, recording the lowest mean PDI (19.01%) and the highest **Per cent Disease Control (67.72%).** It was closely followed by **Propiconazole 25% EC + Hexaconazole (Cantof 5% EC)** at 0.1%, which also showed a significantly lower PDI (22.22%) and high PDC (62.42%). Other treatments like **Myclobutanil, Carbendazim,** and **Hexaconazole** were moderately effective in controlling the disease, while the **untreated control** exhibited the highest disease severity. Based on the overall disease control performance and disease suppression, **Triadimefon + Bitertanol** and **Propiconazole + Hexaconazole** can be recommended for the effective management of powdery mildew in cucumber under field conditions. These treatments can contribute to improved plant health and potentially higher yields when integrated with proper cultural practices.

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, manuscript.

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Details of the AI usage are given below:

1.

2.

3.

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