Research Article

# Integrated Management of Fungal Diseases in Strawberry

Ali Anwar, Mudasir Bhat*, Ghulam Hassan Mir, M. Najeeb Mughal, Uzma Fayaz and Arif Hussain Bhat

Division of Plant Pathology SKUAST-K, Shalimar, 190025

**Abstract**

An experimental trial with eight treatments viz. carbendazim 50 WP (0.05%), hexaconazole 5 EC (0.03%), mancozeb 75 WP (0.3%) cultural control (removal of older leaves + weeding), aqueous extracts of datura leaves, extract of garlic cloves, mulching (polythene) and check (without treatment) in RBD manner was carried out in Research Farm of SKUAST-K. Treatments were replicated thrice. The data on individual effect of treatments revealed that five diseases viz. root rot (*Pythium* sp. *Rhizoctonia solani*), fruit rot (*Botrytis cineria*), Alternaria leaf blight (*Alternaria alternata*), leaf spot (*Hainesia lythri*) and foliage blight (*Sclerotium rolfsii*) were noticed in variable per cent disease index (PDI), whereas, fruit rot caused by *Botrytis cineria* did not appear in beds where three sprays of carbendazim, mancozeb and hexaconazole were given after 15 days interval but mulching with polyethylene in the month of June also gave excellent result and no fruit rot incidence was observed. Minimum root rot (0.23%) was recorded when carbendazim was sprayed than that of other treatments. Cultural practices comprised with removal of basal leaves and weeding had profound effect after the fungicidal sprays. In case of Alternaria leaf blight, spray of the crop with hexaconazole reduced its incidence and recorded minimum PDI (2.67) than other treatments but cultural practices and extract of garlic cloves exhibited almost at par effect against Alternaria leaf blight. Among the major diseases, leaf spot caused by *Hainesia lythri* was significantly checked by all the treatments and minimum leaf spot was recorded when crop was treated with carbendazim and hexaconazole followed by cultural practices (5.67) but effects of extracts and mulching had at par effect. Despite, foliage blight caused by *Sclerotium rolfsii* also occurred on vines, blossom and leaves of crop in variable PDI whereas minimum PDI (2.33) was noticed when crop was sprayed with hexaconazole but cultural practices and mulching showed at par effect (7.33). Similarly, maximum fruits weight was computed in carbendazim followed by hexaconazole while as other treatments also gave significant fruit yield over control.

**Keywords:** Strawberry, Diseases, Management, Cultural practices, Fungicides

***Correspondence**
Author: Mudasir Bhat
Email: mudasirpatho@gmail.com

## Introduction

Strawberry (*Fragariae ananassa* Duch.) is a perennial economically important crop, grown under a wide range of climatic conditions. Wild and cultivated plants are producing small sized fruits with high nutrient value [1] and were also used as remedy for many human diseases like kidney and liver diseases. It is one of the most widely grown small fruit crops in Kashmir. They are highly perishable fruits due to their extreme tenderness, vulnerability to mechanical damage, high level of respiration and their susceptibility to fungal spoilage [2]. Fresh strawberries therefore have a very limited postharvest life and cannot be stored for a long time [3]. Strawberry cultivars are highly susceptible to several destructive and economically important pathogens such as *Alternaria alternata, Colletotrichum acutatum, C. gloeosporioides C. fragariae, Rhizopus nigricans, Phytopthora paracitica, P. cactonum, Botrytis cinerea, Fusarium solani, Aspergillus niger, Aspergillus flavus, Penicillium expansum* [4]. Disease control depends on the correct pathogen identification, the use of pathogen-free transplants, control of fungi and sanitation measurements. Soil-borne pathogens may be controlled by soil disinfestation with systemic fungicides. Application of control measures must be based on the knowledge of disease etiology, epidemiology and on cognizance of the pathogen life cycle. Strawberry growers rely heavily on the use of fungicides for control of various diseases in strawberries. However the frequent and discriminate use of fungicides leads to atmosphere pollution and create imbalance in the microbial community, which may be unfavorable to the activity of beneficial organisms and may lead to development of resistance strains of the pathogen [5]. Resistance cultivars have been used against many diseases of strawberry but it has been overcome by appearance of new races of the pathogen [6]. In recent years biological control has become a promising safer and ecologically acceptable alternative to chemical control in the management of soil borne diseases [7]. Therefore integrated disease management methods were utilized in the production of diseases free strawberries.

## Materials and Methods

An experimental trial with most effective four treatments and their different combinations viz. ($T_1$) carbendazim 50 WP (0.05%), ($T_2$) hexaconazole 5 EC (0.03%), ($T_3$) cultural control (removal of older leaves + weeding), ($T_4$) mulching (polythene), ($T_5$) Carbendazim 50WP (0.05%) + Hexaconazole 5 EC (0.03%) ($T_6$) Carbendazim 50WP (0.05%) + Cultural practices, ($T_7$) Carbendazim 50WP (0.05%) + Mulching (polythene), ($T_8$) Hexaconazole 5EC @0.03% + Cultural practices, ($T_9$) Hexaconazole 5EC @0.03% + Mulching (polythene), ($T_{10}$) Cultural practices + Mulching, ($T_{11}$) Carbendazim 50 WP (0.05%) + Hexaconazole 5 EC (0.03%) + Cultural practices, ($T_{12}$) Carbendazim 50WP (0.05%) + Hexaconazole 5 EC (0.03%) + Mulching, ($T_{13}$)Hexaconazole 5 EC (0.03%) + Cultural practices + Mulching (polythene), ($T_{14}$) Carbendazim 50WP (0.05%) + Cultural practices + Mulching (polythene), ($T_{15}$) Carbendazim 50WP (0.05%) + Hexaconazole 5 EC (0.03%) + Cultural practices + Mulching (polythene) and check (without treatment) in RBD manner was carried out in Research Farm of Plant Pathology at Shalimar Campus. Treatments were replicated thrice. Healthy plants of Confituria cultivar of 2 feet long with three folds were already planted with 45 cm apart on 15 cm raised bed size of 2 x 2 $m^2$. Fifty leaves selected at random from each treatment were observed on 0-5 scale and per cent disease index (PDI) was worked out [8]. Fruit yield was also recorded and analyzed statistically.

## Results and Discussion

During preliminary studies on individual effect of eight treatments revealed that five diseases viz. root rot (*Pythium* sp., *Rhizoctonia solani*), fruit rot (*Botrytis cineria*), Alternaria leaf blight (*Alternaria alternata*), leaf spot (*Hainesia lythri*) and foliage blight (*Sclerotium rolfsii*) were noticed in variable per cent disease index (PDI), whereas, fruit rot caused by *Botrytis cineria* did not appear in beds where three sprays of carbendazim 50 WP (0.05%), mancozeb 75 WP (0.3%), hexaconazole 5 EC (0.03%) were given after 15 days interval but mulching with polyethylene in the month of June also gave excellent results and no fruit rot incidence was observed (**Table 1**). Most effective four treatments and their different combinations revealed that five diseases viz. root rot (*Pythium* sp. *Rhizoctonia solani*), fruit rot (*Botrytis cineria*), Alternaria leaf blight (*Alternaria alternata*), leaf spot (*Hainesia lythri*) and foliage blight (*Sclerotium rolfsii*) were noticed in variable per cent disease index (PDI), whereas, fruit rot caused by *Botrytis cineria* did not appear in beds where three sprays of carbendazim 50 WP (0.05%), hexaconazole 5 EC (0.03%) were given after 15 days interval but mulching with polyethylene in the month of June also gave excellent result and no fruit rot incidence was observed. Minimum root rot (0.25%) was recorded when combination of all the treatments ($T_{15}$) was followed than that of other treatments. Cultural practices comprised with removal of basal leaves and weeding had consistent and profound effect after the fungicidal sprays. In case of Alternaria leaf blight, spray of the crop with hexaconazole 5 EC significantly reduced its incidence and recorded PDI as 3.00 than other treatments but it was at par (2.80) when cultural practices and alternative sprays of carbendazim comprised separately. Among the major diseases, leaf spot caused by *Hainesia lythri* was significantly checked by all the treatments and minimum intensity (1.86) was recorded when crop was treated with combination of carbendazim, hexaconazole, cultural practices and mulching. Fruit rot caused by *B. cineria* was checked when polyethylene mulch was made in the bed during the month of May. Despite, foliage blight caused by *Sclerotium rolfsii* also occurred on vines, blossom and leaves of crop in variable PDI whereas minimum PDI was noticed when crop was sprayed with hexaconazole and with the combination of other treatments but cultural practices and mulching shown at par effect (1.62), similarly maximum fruit weight was also computed in hexaconazole + cultural practices + mulching with polyethylene (330.00) followed by hexaconazole + carbendazim + cultural practices + mulching with polyethylene (328.00) while as other treatments also gave significant fruit yield over control.

Rotation was one of the first management tactics suggested for root rot of strawberry [9]. Rotation away from strawberry to unspecified crops reduced *R. fragariae* isolation from plants to about one third of that seen from continuous strawberry production [10]. *Trichoderma harzianum* (Root Shield) has been an effective biological control of a number of fungi, including *Rhizoctonia* spp. [11]. Oat and sorghum have been shown to produce fungicidal root exudates toxic to soil-borne fungi such as *Fusarium* and *Gaumannomyces* [12]. In the Pacific Northwest, soil solarisation for two months significantly reduced strawberry root necrosis and root infection by a number of fungi, including *R. fragariae* [13]. However, solarisation did not eliminate the pathogens from the soil. [14] Observed that fruit rot of pomegranate caused by *Alternaria alternata* is one of the most important post harvest diseases. It was revealed that 13 homoeopathic drugs were inhibitory against *A. alternata*, out of which *Arsenicum album*, *Argentum metallicum* was highly effective followed by *Zincum metallicum*, *Baptisia tinctoria*, *Belladonna*, *Tabacum*, *Lycopodium clavatum*, *Thuja occidentale*, *Cyanopodium*, *Ustilago maydis*, *Sepia officinale* and *Iris versicolar* in decreasing Percentage Control Efficacy (PCE) values against *A. alternata*. [15] also revealed the control of grey mould of grape caused by *Botrytis cinerea* using homoeopathic drug. Integrated management of strawberry pests by rotation and intercropping using Saia' oats and sorgho-sudan grass has been suggested [16].

**Table 1** Management of fungal diseases in strawberry

| **Treatment** | **Root rot incidence % (*Pythium* sp. *R. solani)*** | **Per cent disease index (PDI)** | | | | **Fruit yield/ bed (gm)** |
|---|---|---|---|---|---|---|
| | | **Fruit rot (*Botrytis cineria*)** | **Alternaria leaf blight (*Alternaria alternata*)** | **Leaf spot *(Hainesia lythri)*** | **Foliage blight (S. *rolfsii*)** | |
| $T_1$ = Carbendazim 50 WP (0.05%) | 0.53 | 0.25 | 6.00 | 3.15 | 4.78 | 265.00 |
| $T_2$ = Hexaconazole 5 EC (0.03%) | 3.15 | 0.15 | 3.00 | 2.90 | 2.00 | 280.00 |
| $T_3$= Cultural practices (removal of basal leaves + weeding) | 6.00 | 1.50 | 6.90 | 6.00 | 8.20 | 240.00 |
| $T_4$= Mulching (polythene) | 7.00 | 0.00 | 7.50 | 8.40 | 7.60 | 210.00 |
| $T_5$= Carbendazim 50 WP (0.05%) + Hexaconazole 5EC (0.03%) | 0.40 | 0.18 | 2.80 | 3.00 | 3.20 | 270.00 |
| $T_6$= Carbendazim 50 WP (0.05%) + Cultural practices | 0.44 | 0.20 | 5.20 | 2.85 | 3.95 | 290.00 |
| $T_7$= Carbendazim 50 WP (0.05%) + Mulching polythene) | 0.35 | 0.00 | 5.30 | 2.40 | 3.65 | 316.00 |
| $T_8$ = Hexaconazole 5EC @0.03% + Cultural practices | 3.00 | 0.14 | 2.80 | 2.60 | 1.62 | 310.00 |
| $T_9$ = Hexaconazole 5EC @0.03% + Mulching (polythene) | 2.90 | 0.00 | 2.90 | 2.50 | 1.62 | 325.00 |
| $T_{10}$= Cultural practices + Mulching | 5.75 | 0.00 | 6.78 | 5.48 | 7.35 | 252.00 |
| $T_{11}$= Carbendazim 50 WP (0.05%) + Hexaconazole 5 EC (0.03%) + Cultural practices | 0.35 | 0.14 | 2.65 | 2.85 | 1.60 | 310.00 |
| $T_{12}$= Carbendazim 50 WP (0.05%) + Hexaconazole 5 EC (0.03%) + Mulching | 0.32 | 0.00 | 2.35 | 2.30 | 1.55 | 318.00 |
| $T_{13}$= Hexaconazole 5 EC (0.03%) + Cultural practices + Mulching (polythene) | 2.80 | 0.00 | 1.75 | 2.60 | 1.60 | 330.00 |
| $T_{14}$= Carbendazim 50 WP (0.05%) + Cultural practices + Mulching (polythene) | 0.30 | 0.00 | 5.10 | 2.30 | 3.40 | 325.00 |
| $T_{15}$= Carbendazim 50 WP (0.05%) + Hexaconazole 5 EC (0.03%) + Cultural practices + Mulching (polythene) | 0.25 | 0.00 | 1.40 | 1.86 | 1.25 | 328.00 |
| Check/ control | 10.20 | 4.80 | 12.00 | 15.00 | 10.45 | 142.00 |
| **CD (P=0.05)** | **1.16** | **0.81** | **1.97** | **1.91** | **1.67** | **12.14** |

## References


[1] Raab, T., Lopez-Raez, J. A., Klein, D., Caballero, J. L., Moyano, E., Schwab, W. and Muñoz-Blanco, J. 2006. FaQR, required for the biosynthesis of the strawberry flavor compound 4-hydroxy-2, 5-dimethyl-3(2H)-furanone, encodes an enone oxidoreductase. Plant Cell 18: 1023–1037.

[2] Dennis, C. 1978. Post-harvest spoilage of strawberries. ARC Res. Rev. 4:38-40.

[3] Dennis, C. and Mountford, J. 1975. The fungal flora of soft fruits in relation to storage and spoilage. Ann. Applied Biol. 79:141-147.

[4] Michel Dignand. 2004. Strawberry weed control guide. Agfact H3.3.4, second edition. The State of New South Wales, NSW Agriculture.
[5] Martin, F. N. and Bull, C. T. 2002. Biological approaches for control of root pathogens of Strawberry. Phytopathology 92:1356-1362.
[6] Koike, S. T., Kirkpatrick, S. C. and Gordon, T. R. 2009. Fusarium wilt of Strawberry Caused by Fusarium and Macrophomina in California. Plant Disease 93:1077.
[7] Shalini, M. and Srivastava, R. 2007. Screening for Antifungal Activity of Pseudomonas Fluorescens against phytopathogenic fungi. The Internet Journal of Microbiology 5: available on http://ispub.com/IJMB/5/2/13231 access on 21 May 2014.
[8] Mckinney, H. 1923. Influence of soil temperature and moisture on infection of wheat seedlings by Helminthosporium sativum. Journal of Agricultural Research 26: 195-217.
[9] Zeller, S. M. 1932. A strawberry disease caused by Rhizoctonia. Ore. Agr. Expt. Sta. Bul. 295:1–22.
[10] Martin, S. B. 1988. Identification, isolation frequency, and pathogenicity of anastomosis groups of binucleate Rhizoctonia spp. from strawberry roots. Phytopathol. 78:379–384.
[11] Yuen, G. Y., Craig, M. L. and Geisler, L. J. 1994. Biological control of Rhizoctonia solani on tall fescue using fungal antagonists. Plant Dis. 78:118–123.
[12] Crombie, W. M. L. and Crombie, L. 1986. Distribution of avenocins A-1, A-2, B-1 and B-2 in oat roots: their fungicidal activity towards 'take-all' fungus. Phytochemistry 25: 2069–2073.
[13] Pinkerton, J. N., K. L. Ivors, P. R. Bristow, and G. E. Windom. 2002. The use of soil solarization for the management of soil-borne plant pathogens in strawberry and red raspberry production. Plant Dis. 86: 645–651.
[14] [14] Dahiwale, M. A. and Suryawanshi, N. S. 2010. Integrated management of carbendazim resistant Alternaria alternata using homoeopathic medicine. Bionano frontier 3(2): 330-331.
[15] Dahiwale, M. A. and Suryawanshi, N. S. 2014. Grey mould of grape caused by Botrytis cinerea- control using homeopathic medicine. Fungi and Agriculture p.3-5.
[16] LaMondia, J. A., Elmer, W. H., Mervosh, T. L. and Cowles, R. S. 2002. Integrated management of strawberry pests by rotation and intercropping. Crop Protection 21: 837–846.




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