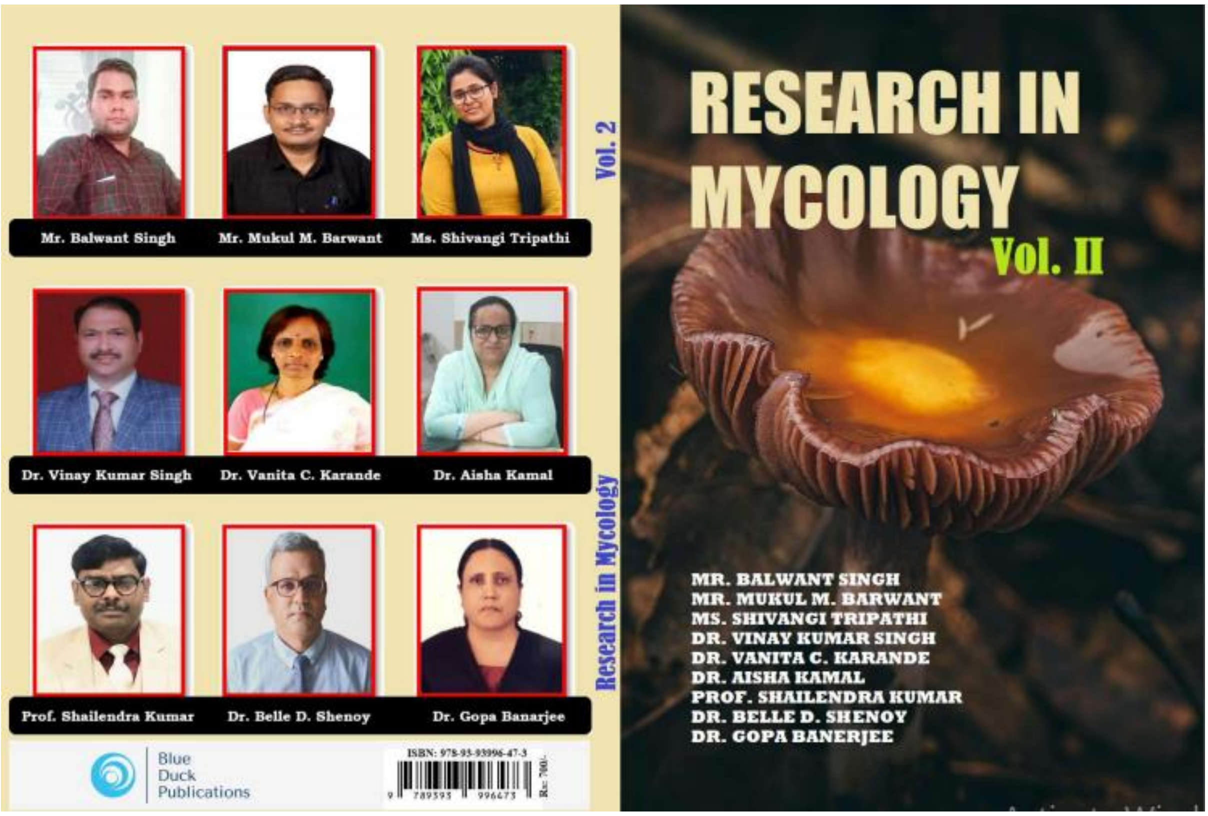

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Chapter **19**

POST-HARVEST FUNGAL DISEASE AND ITS MANAGEMENT ON *ALLIUM CEPA*

S. Kaviyalakshmi, S. Srinithiksha, Dr. K. V. Shalini

Abstract

Onion is one of the most widely cultivated and consumed vegetable crops in the world, with a global production of over 100 million tonnes per year. It is a member of the *Allium* family, which also includes garlic, shallots, and chives. Onion bulbs are used in a variety of culinary preparations due to their distinctive flavour and aroma, as well as their nutritional content. One of the biggest challenges in onion cultivation and marketing is post-harvest storage, as onion bulbs are susceptible to a variety of fungal diseases during storage. These diseases can cause significant losses in bulb quality and quantity, as well as reduce their shelf life. The most common fungal pathogens affecting onion during storage include *Aspergillus, Fusarium, Botrytis, and Penicillium.* To mitigate the impact of fungal diseases on onion storage, various control strategies have been employed including the use of synthetic fungicides and biological control agents. This review article focused on post-harvest fungal disease and its preventive measures in onions.

Keywords: *Allium cepa, post-harvest diseases, Fungicides, Preventive measures.*

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Introduction

Onions are an important agricultural crop worldwide providing essential flavour and nutrition to many cuisines. However, post-harvest losses caused by fungal diseases during storage can significantly impact the quality and shelf-life of onions, resulting in economic losses for growers and suppliers. Fungal pathogens such as *Aspergillus niger, Botrytis squamosa, and Penicillium spp.*, are the main culprits behind onion storage diseases, causing black mold, neck rot, and soft rot respectively. Chemical fungicides have been widely used to manage these diseases, but their overuse has led to the emergence of fungicide-resistant strains and environmental concerns (Mahajan *et al.*,2018). Therefore, there is a growing interest in developing alternative methods for post-harvest onion disease management, such as the use of biocontrol agents. Biocontrol agents are naturally available organisms that can suppress the growth of pathogenic fungi and enhance the quality and shelf-life of onion bulbs. (Sharma *et al.*, 2009). In this review article the current knowledge on managing post-harvest fungal diseases in onions and their preventive measures are focused.

Post- Harvest Fungal Diseases in Onion

Botrytis Leaf Blight

Botrytis neck rot is caused by *Botrytis allii*, a fungus that overwinters on plant debris in soil, on infected bulbs, and as sclerotia in soil. *Botrytis neck rot* is seen primarily in storage. In onions, the disease is more apparent after harvest, while bulbs are in storage. At first, soft neck tissue looks water soaked, and a yellow discoloration moves down the neck into the scales. Bulbs break down to a soft mass. A grey mold develops between the onion scales, later producing small to large black bodies (sclerotia) which develop as a solid layer around the neck of the onions.

Aspergillus niger

Onion black mold rot disease is the most destructive disease of storages and in the field (Wani *et al.*, 2011). Aspergillus niger is a soil borne fungus that can survive on plant debris in the soil. Infections spread from bulb to bulb by direct contact, through bruises or wounds, by mechanical means or by air-borne spores. Spores can germinate within three to six hours under high relative humidity, but germination is inhibited below 75 per cent relative humidity. The optimum temperature for growth of A. niger ranges from 28 to 34 °C, and it is inhibited below 17°C and above 47 °C (Sumner, 1995). Sporulation can take place in 24 h after infection (Salvestrin and Letham, 1994).

Blue Mold

Blue Mold rot of onion may be caused by several *Penicillium* species. Decay of garlic caused by *P. hirsutum* is responsible for decay during storage as well as poor plant growth in the field. Symptoms in the field include bulb decay soon after cultivating due to wilting, leaves becoming yellow or stunted seedlings. Infected plants are weak and stands are poor. Other species of *Penicillium* cause Blue Mold on onions and may be prevalent on fresh plants. This fungus attacks a wide range of fruits, vegetables, bulbs, and seeds. Disease symptoms start with pale blemishes, yellow lesions, and soft spots. A blue-green mold develops on lesions and these pathogens survive in infected bulbs of the onions. (Jonny *et al.*, 2020).

White Rot

White rot is one of the most destructive fungal diseases causing heavy losses reducing potential yield of onion to a considerable degree (Amin *et al.*,2014). White rot disease caused by *Sclerotium cepivorum* Berk. is very destructive to *Allium* crops including onion, leek, Welsh onion, shallot and garlic and the fungus attack the plant at any crop stages and often manifests after harvest as bulb rot and often disseminates on diseased bulbs or seedlings. White rot on shallot, garlic and onion results in death of the roots and semi watery decay of the scale which is associated with superficial growth of white fluffy mycelium of the fungus.

Preventive Approaches of Fungal Diseases in Onion

Biocontrol Agents

Trichoderma spp has a wide range of applications in *in vitro* inhibition of storage pathogens of horticultural crops. Cherkupally *et al.*, (2017) evaluated the antagonistic activities of seven *Trichoderma* species, against fungal pathogen, *Fusarium oxysporum in vitro* conditions. All the biocontrol agents showed considerable decrease in the growth of the fungal pathogens. Out of the seven fungal antagonists studied for their efficacy, *T. harzianum* showed maximum degree of inhibition 81.11%, followed by *T. koningii* 80.00%, *T. pseudokoningii* and *T. viride* 78.88% each, *T. virens, T. atroviride,* and *T. reesei* 77.77% each by non -volatile compounds. The results suggested that *T. harzianum* had a highly antagonistic potential 81.11% and *T. koningii* showed least antagonistic efficacy by 28.88%. (Mahmoud *et al.*,2011).

Synthetic Fungicide

Futane *et al.*, (2018) evaluated *in vitro* antifungal activity against fungal pathogens in *A. niger* and *Fusarium oxysporum.* In *A. niger* pathogen the antifungal activity was most operational with significantly highest mycelial growth inhibitions were SAFF (A Broad spectrum systemic and contact fungicide) (94.55 per cent), mancozeb (90.98 per cent) and carbendazim (92.22 per cent). In *Fusarium oxysporum* fungicides viz SAFF, mancozeb, hexaconazole and carbendazim were found most effective with significantly highest mycelial growth inhibition of 91.74 per cent, 91.38 per cent, 90.81 per cent and 88.42 per cent respectively. Studies were undertaken to control black mold rot of onions through synthetic fungicides *in vitro* and *in vivo.* Turkkan and Erper (2014) investigated efficiency of different sodium salts as substitutes to synthetic fungicides for the control of onion basal rot caused by *Fusarium oxysporum*. Srinivasan and Shanmugam (2006) found that *Aspergillus niger* was predominantly related with black mold rot of onion during storage showed that among fungicides used, 0.1% carbendazim concentration was found to the most effective when applied either as a foliar spray in standing crop or as a post-harvest dip followed by sulphur oxides and acetic acid.

Fumigation

One effective way to control onion disease is through fumigation treatment. Fumigation treatment involves the use of chemicals that release gas when applied to soil, which kills or suppresses soil-borne pathogens. In the case of onion disease, the most commonly used fumigants are methyl bromide, chloropicrin, and 1,3-dichloropropene. Methyl bromide was widely used for fumigation, but it is now banned in many countries due to its negative impact. Chloropicrin is a popular alternative to methyl bromide, but it can cause skin and respiratory irritation. 1,3-dichloropropene is a relatively new fumigant that is gaining popularity due to its lower toxicity.

Onions treated with the thymol solution fumigation method had only a loss of less than 17% from fungal pathogens while maintaining the storage of the onions for 10 months in a low-temperature storage house. Compared to the untreated controls, the storage period of the onions treated with thymol was extended for more than three months. These results confirmed that thymol solution fumigation is a highly successful candidate for the control of fungal diseases during low-temperature storage. Additionally, since thymol residues from onions stored for 10 months were not detected, thymol solution fumigation could be a safe treatment method. Thymol has been shown to be thermally safe up to 100 °C through the heat stability test. (Sang Hye Ji *et al.*,2018). This study proposed that the fumigation treatment method using the thymol solution was ideal for fungal disease control of long-term storage crops such as onions.

Neem Leaf Extract

Neem Extract has been used to prevent numerous fungal plant Pathogens, such as *Aspergillus flavus, Alternaria alternata, Fusarium oxysporum, Fusarium solani, Sclerotinia Sclerotiorum and Rhizoctonia solani* (Jatav and Mathur, 2005; Wang *et al.*, 2010; Obongoya *et al.*, 2010; Mina, 2012). Medicinal properties of neem leaf and its constituents have antifungal, anti-inflammatory, and Antibacterial properties (Subapriya and Nagini, 2005). Krishanti and Prianto (2017) studied five types of neem Seed oil formulation which was sowing antifungal activity against fungi and they could prevent the growth of mycelial pathogenic fungi, *Fusarium oxysporum*, effectively. The results indicated that neem seed formulations were potential to be developed as bio fungicide and it needs a further analysis about active compound that shows an important role in fungal overthrow. Different formulations of neem cake gave the maximum efficacy in inhibition of mycelial growth of fungal pathogens (77.55%) afterward mustard cake (73.53%) and groundnut cake (67.25%) extracts.

Yadav *et al.*, (2014) revealed that neem cake extract (30%) significantly prevented the fungal mycelial growth. Shrivastava and Swarnkar (2014) studied antifungal activity of leaf extract of *Azadirachta indica* (Neem) on different fungal pathogens of *Aspergillus flavus, Alternaria solani and Cladosporium*. Ethanolic and Methanolic extract of this plant in different ranges (25%, 50%, 75% And 100%) were equipped and proven its efficacy against test organisms by disc diffusion indicating the development of an inhibition zone.

Among all the extracts the most effective Methanolic extract of *Azadirachta indica* against *Aspergillus Flavus* has been observed. In the same year Olufemi *et al*. (2014) revealed that the neem seed extract has maximum antifungal properties in *Curvularia sp.* (37.76% inhibition) followed by *Aspergillus* sp. (20.22% inhibition) and Fusarium Sp. (7.56% inhibition).

Hussein *et al*. (2014) tested the antagonistic ability of *Trichoderma harzianum and Trichoderma viride* against *B. Allii,* causal agent of umbel "head" blight disease of onions. The treatment of *T. Viride* demonstrated 30 to 45% reduction of disease severity in a 2-year test.

Mahmoud *et al.* (2011) studied the outcome of aqueous extracts of neem formulations on different fungal growth (*Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus, Aspergillus terreus and Microsporum gypseum, Candida Albicans*) *in vitro* at different range of concentration 5, 10, 15 And 20%. The neem extracts withdrawn the growth of fungal Pathogens in dose dependent manner.

Ghorbanian *et al.* (2008) investigated the efficacy of leaf extract (aqueous neem) in varied concentrations of on development of fungus and due to production of aflatoxin by the fungi *Aspergillus Parasiticus* at change in different time of incubation period. The maximum inhibitions found 80-90% in the existence of 50% formulations. The Inhibitory effect of aflatoxin synthesis by plant-based extracts initiates to be time and dose dependent. In organic alterations of neem cake was given a favourable form for inhibition of the mycelial growth of storage fungi.

Ali *et al.* (1992) studied the effect of leaf extract and neem oil from *Azadirachta indica* along with Tecto-60 and Boric acid, against *Pencillium italium, Alternaria altnnala* and *Aspergillus niger* on decayed vegetables and fruits. The results revealed that neem oil was most effective comparable to thiabendazole in examination growth of fungi on decayed vegetables and fruits.

Conclusion

There is an emergency need to develop environmentally friendly fungicide against global fungal pathogens to combat the toxic residual effects of traditional synthetic fungicides on human health. Fungicide used is important for the control of decay of vegetables and fruits such as green mould, blue mould and sour rot, which can occur during storage. However, fungicides are one of the tools required to effectively manage postharvest decay. Fumigants such as sulphur dioxide (SO_2) are used for controlling post-harvest disease in many vegetable and fruit crops during storage. This treatment results in a residue of 5-18 ppm SO_2 in the vegetables is sufficient to control the decay. Several other management factors such as biocontrol agents, plant extracts can also be used. The use of bacteria as biocontrol agents (BCA) has been very important in the integrated management of cultivations and organic production, where their value as a postharvest control of fungal diseases stands out. Biocontrol methods provide plant protection against fungal diseases, and currently represent a viable alternative for fruit and vegetable protection against phytopathogens at the postharvest stage. Further research is needed to develop more effective and sustainable strategies for the management of post-harvest fungal diseases of onions.

References

1. Ali, T.E.S, Nasir, M.A. and Shakir, A.S. (1992). In vitro evaluation of certain neem products as mould inhibitors against post-harvest fruit rotting fungi of tomato Pakistan, Journal of Phytopathology.4(1-2): 58-61.
2. Amin M, Shiberu T & Selvaraj T. (2014). White rot (Sclerotium cepivorum Berk) – an aggressive pest of onion and garlic in ethiopia. Journal of Agricultural Biotechnology and Sustainable Development, 6(1): 6-15. Doi: 10.5897/JABSD2013.0210.
3. Cherkupally, R., Hindumathi, A. And Reddy, B.N. (2017). In vitro antagonistic activity of Trichoderma species Against fusarium oxysporum f. Sp. Melongenae. International Journal of Applied Agricultural Research, 12(1): 87-95.
4. Futane, A.S. Dandnaik, B.P. Salunkhe, P.P. and Magar, S.J. (2018). Management of storage diseases of onion by using different fungicides and antibiotics international, Journal of current microbiology and applied sciences, 7(02): 1149-1158.
5. Ghorbanian, M., Razzaghi-Abyaneh, M. Al, A. Shams-Ghahfarokhi, M. and Qorbani, M. (2008). Study on the effect of neem (Azadirachta indica A. Juss) leaf extract on the growth of aspergillus parasiticus and production of aflatoxin by it at different incubation Times. Mycoses, 51(1): 35-39.
6. Jatav, R.S. and Mathur, K. (2005). Bio-agents and neem-based seed treatment for management of root rot complex in cluster beans. Indian Phytopathology, 58:235–236.
7. John, Vinny & Kesherwani, Drbhagyashree & Maurya, Amit. (2020). AGRICULTURE & FOOD: e-Newsletter Blue mold rot disease of onion.

8. Krishanti, N.P.R.A. and Prianto, A.H. (2017). In-vitro assay of neem seed formulation against fusarium oxysporum, causal agent of basal plate rot on onion. In the proceeding of the international symposium for sustainable humanosphere, 177-182.
9. Mahmoud, D.A., Hassanein, N.M., Youssef, K.A. and Zeid, (2011). Antifungal activity of different neem leaf extracts and the nimonol against some important human pathogens. Brazilian Journal of Microbiology, 42(3): 1007-1016.
10. Mahajan B.V, Rawal R.D, Bhattacharyya S, (2018). Onion (*Allium cepa L.*) postharvest management practices: A review. J Food Sci Technol. 55:4703-4715.
11. Obongoya. B.O. Wagai. S.O. and Odhiambo. G (2010). Phytotoxic effect of selected crude plant extracts on soil-borne fungi of common beans. African Crop Science Journal, 18(1).
12. Olufemi OS, Agbaje GO, Olusoji JO, Owolabi OA, Olawuyi OJ, Ogunjobi A.A (2014). Phytochemical screening, antifungal and antioxidant activities of neem (Azadirachta indica) seed extracts." Journal of Applied Sciences and Environmental Management. 18(3): 419-423.
13. Salvestrin J and Letham D. (1994). The control of Aspergillus niger in Australia. Acta Horticulture, 358: 289-293.
14. Sang Hye Ji, Joo Yeon Park, Jin Gyeong Lee, Seok Ju Park, and Jae-Hyuk Yu.(2018). Efficacy of thymol and acetic acid vapors against Aspergillus niger and their effects on postharvest quality of cherry tomatoes." Journal of Food Quality; 2018: Article ID 8073423. doi: 10.1155/2018/8073423.
15. Sharma RR, Singh D, Singh R. (2009). Biological control of postharvest diseases of fruits and vegetables by microbial antagonists: A review of Bio control. 50:205-221.
16. Shrivastava, D.K. and Swarnkar, K. (2014). Antifungal activity of leaf extract of neem (Azadirachta Indica Linn). International Journal of Current Microbiology and Applied Sciences, 3(5): 305-308.
17. Srinivasan, R. And Shanmugam, V. (2006). Post-harvest management of black mould of onion. Indian Phytopathology, 59(3): 333-339.
18. Subapriya, R. And Nagini, S. (2005). Medicinal properties of neem leaves: a review. Current Medicinal Chemistry Anticancer Agents, 5(2): 149–160.
19. Sumner DR. 1995. Diseases of bulbs caused by fungi-Black mold. In: Compendium of onion and garlic diseases, H. F. Schwartz and S. K. Mohan (eds.) APS Press, St. Paul. Minnesota: 26- 27.
20. Türkkan, M.U.H.A.R.R.E.M. and Erper, I. (2014). Evaluation of antifungal activity of sodium salts against onion basal rot caused by fusarium oxysporum F.sp. Cepae. Plant Protection Science, 50(1): 19-25.
21. Yadav AK, Singh AK, Raj A, Singh PK. (2014). Evaluation of neem cake extracts for their antifungal, nematicidal and insecticidal activities. Journal of Pharmacognosy and Phytochemistry. 3(1): 53-56.
22. Wang, J., Jian, L., Jiankang. C and Jiang, W. (2010). Antifungal activities of neem (Azadirachta indica) seed kernel extracts on postharvest diseases.
23. Wani AH and Taskeen-Un-Nisa. (2011). Management of black mold rot of onion. Journal of Mycology and Plant Pathology, 9 (1): 43-49.

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