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Review Article

FUNGAL DISEASES OF ONION AND THEIR BIOLOGICAL MANAGEMENT: A REVIEW

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ABSTRACT

Onion (*Allium cepa*) is an important crop grown throughout the world. The crop is attacked by many pathogens. Among them fungal pathogens are important limiting factor in the yield and quality of the crop. The present review is mainly focus on important fungal diseases associated with the crop and their eco-friendly and economical means of biological management. The antagonistic effect of various bioagents and antifungal activity of different plant extracts has been studied to control fungal diseases of onion. The present review paper deals with various biological approaches to control onion fungal diseases such as damping off, purple blotch, neck rot, anthracnose, leaf blight, basal rot and onion smut.

INTRODUCTION

Onion (*Allium cepa*) is an important crop cultivated in India and used as salad, spice and vegetable. It is a temperate crop grown throughout the world with wide range of climatic conditions. The vegetative growth of the crop is supported by lower temperature and short photoperiod whereas bulb development requires high temperature with longer photoperiod. Onion is grown in all types of the soil. The bulb of onion consists of swollen bases of green foliage leaves and fleshy scales. The major onion producing states are Maharashtra, Tamil Nadu, Andhra Pradesh, Bihar and Punjab. The crop is attacked by many fungal, bacterial pathogens, viruses and nematodes. The prevalence of pathogens depends on seasons, variety and region. Many fungal pathogens have been reported causing foliar and bulb diseases of onion. Soil-borne fungal diseases such as Purple blotch (*Alternaria porri*), leaf blight (*Alternaria alternata*), Damping off (*Pythium* spp., *Rhizoctonia solani*), twister (*Colletorichum gloeospoiriodes*; *Gibberilla moniformis*), leaf blight (*Stemphylium vesicarium*), smut (*Urocystis cepulae*), anthracnose (*Colletotrichum* spp.) etc. challenge sustainable onion production and storage in a wide range of agro-ecologies (Ramjegathash *et al.,* 2011; Gupta *et al.,* 2012; Sibi *et al*., 2013; Alberto, 2014). These diseases drastically reduce onion productivity, quality and yield. Fungal pathogens are mostly controlled by chemical compounds (Wainwright, 1979; Mathur and Sharma, 2006; Mathur *et al.*, 2007). These synthesized pesticides cause pollution and disturb the microbiotic balance in the soil. In natural conditions, microbes interact with each other with competition and hyperparasitism, checking the growth and reproduction of several other harmful plant pathogens and maintain ecological balance. In recent times, biological control of plant pathogenic fungi has received a considerable attention due to several advantages such as possibility of multiple pathogen suppression, low cost and maintaining soil fertility over chemical fungicides (Jagtap and Suryawanshi, 2015). Thus, there is a demand for development of eco-friendly and economical tools for the efficient management of fungal diseases of onion. Integrated fungal disease management programme emphasis the use of eco-friendly and cost effective tools such as use of plant extracts and bioagents for control of fungal disease. Many researchers have been worked on the efficacy of botanicals and bioagents to control the growth of fungal pathogens of onion (Bajwa, *et al.,* 2003; Ghewande, 1989; Mishra *et al.* 2014; Singh and Singh, 2005; Rana *et al.,* 2007; Singh *et al.,* 2007). The present review paper deals with various eco-friendly biological management approaches used to control the fungal pathogens associated with onion crop.

Damping off

The symptoms of disease are rapid wilting and decay of seedlings. Plants are infected at soil line or below and roots become dark red or black. Pre emergence damping off destroy

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the radicle and plumule of seeds while post emergence attacks on collar region of seedlings causing seedlings to stunted, weak, wilt and eventually die.

The fungal pathogens associated with damping off are *Pythium* spp., *Rhizoctonia solani* and *Fusarium oxysporium*. Lifshitz *et al.* (1986) found that production of a toxic factor by *Trichoderma harzianum* and *T. koningii* inhibits growth of *Pythium* spp. The antibiotics, gliovirin and gliotoxin isolated from *Trichoderma virens* described as strong inhibitory compound to *Pythium* spp. and *Rhizoctonia solani* (Weindling, 1934; Howell and Stipanovic, 1983).

Loss of gliotoxin production due to induced mutation in *T. virens* had an adverse effect on the efficacy of mutant strains as biocontrol agents of *Pythium* damping-off (Wilhite *et al.,* 1994). Elevated populations of *Pseudomonas* spp., lower pH values, high organic matter, Ca, K and Mg contents in the soil showed suppression of damping off disease by reducing the rate of oospores germination in the soil (Lumsden *et al.,* 1987). Neem oil extract was found effective to reduce colony diameter, dry weight and soprulation of *Fusarium oxysporum*. The extract inhibited the production of fusaric acid, involved in the disease development (Govindachari *et al*., 1998).

Purple blotch

The causal organism of disease is *Alternaria porri* (Ellis) cif. Among the foliar diseases, purple blotch is one of the most destructive diseases prevails in almost all onion growing areas of the world and causes heavy loss in onions under field conditions (Kumar and Palakshapra, 2008). The symptoms are water-soaked lesions with small white centers. Lesions usually appear on older leaves and become purple with light yellow concentric rings on the margins as the disease progresses. Purple blotch pathogen may be associated with many other fungal pathogens and promoted by heavy moisture.

Seed treatment with *Trichoderma harzianum* resulted in less percent disease index and high yield of onion bulb (Kumar and palakshapra, 2008; Chethana *et al.,* 2012). Several other researchers have also reported the efficacy of *T. harzianum* in control of purple blotch pathogen (Sastrahidayat, 1995; Patni *et al.* 2005; Roa, 2006). A significant effectiveness of *Penicillium* spp., *Aureobasidium pullulens*, *Sporobolomyces roseus* and *Cryptococcus luteolus* has been observed in reducing the infection of *A. porri* (Tyagi *et al.* 1990). Clove extract of *Allium sativum* at 10% resulted in inhibition of *A. porri* followed by *Aloe vera* at 10%. *Trichoderma viride* was also found effective to control *A. porri* (Mishra and Gupta, 2012). Neem oil and pongamia oil at 20% showed 76.94 and 69.94 per cent inhibition (Chethana *et al.* 2012). The disease was found significantly controlled by foliar application of *Pseudomonas fluorescens* (41.03%), *Bacillus subtilis* (39.97%), *P. aeruginosa* (37.97%) and *T. viride* (34.23%). Under glass house and field conditions, seed treatment, seedling dip and three foliar sprays of *Trichoderma harzianum* expressed disease reduction and growth promotion in susceptible onion (Yadav *et al*., 2013).

In another study, extracts of *Solanum nigrum, Cleome gynandra* and *Acocanthera schimperi* were used to evaluate their antifungal activity and extract of *S. nigrum* showed fungitoxic while extract of *C. gynandra* showed fungistatic activity against *A. porri* (Makelo *et al.,* 2007). Seed treatment with *P. fluorescens* (5g/kg) followed by two application of difenconazole (0.1%) interspersed with spray of *P. fluorescens* (0.5%) at fortnightly interval were found effective to control the disease (Savitha *et al.,* 2014). Two sprays of neem oil (3%) at the first appearance of the disease and the second on fifteen days later showed significant disease control. *Acorus calamus* rhizome extract (10%) and *Mentha arvensis* extract also reduced the disease incidence (34.78%) (Ramjegathesh *et al.,* 2011).

Neck rot

Neck rot of onion caused by *Botrytis allii* is one of the most serious disease that attack onion plants grown for seed or bulb production (Sayed *et al.,* 2014; Sumner *et al*., 1997). The symptoms appear as water soaked lesions and softening of the scales. Infection become severe when moist conditions prevail before and during harvest. Excessive nitrogen and irrigation increases the disease incidence. The fungus attacks seedling leaves symptomlessly, producing conidiophores after the leaf tissue became necrotic. The infection takes place successively, first invades the tip of leaves and then growing downwards and eventually attacks on the neck of onion bulb (Maude and Presly, 1977).

There are eight Botrytis species known to cause onion diseases (Walkers, 1925; Chilvers and Toit, 2006). *B. aclada* and *B. allii* cause neck rot, bulb rot, scape blight, and umbel blight in onion (Vincelli and Lorbeer, 1989). *Trichoderma harzianum* and *Bacillus subtilis* have an important role in biological control of fungal pathogens affecting onion. The treatment with *T. viride* and *T. harzianum* showed significant reduction in the growth of the fungal pathogen (Hussein *et al*., 2014). *T. harzianum* gave highest inhibition of the fungal pathogen when sucrose is used as carbon source and potassium nitrate as nitrogen source in the medium. Antagonistic activity of *Bacillus subtilis* against *B. allii* was highest when mannitol used as carbon source and glutamic used as nitrogen source (Sayed *et al.,* 2014).

Anthracnose

The causal organism of anthracnose or onion twister or seven curl disease is *Colletotrichum gloeosporioides*. The disease is characterized by curling, twisting, and chlorosis of the leaves which spreads lengthwise covering entire leaf blade. The affected leaves shrivel and droop down. There is abnormal elongation of the necks and formation of slender bulbs.

Biocontrol agents *Trichoderma harzianum, Gliocladium roseum, Bacillus subtilis, Streptomyces noursei* and *Streptomyces natalensis* inhibited mycelial growth and conidial germination of *Colletotrichum acutatum* and *Colletotrichum gloeosporioides*, the causal agents of anthracnose disease in fruit crops (Svetlana *et al*., 2010). Crude culture filtrate extract of an actinobacterial strain *Streptomyces* spp. MJM5763 was found effective alternative to chemical fungicides for suppressing *Colletotrichum gloeosporioides* (Palaniyandi *et al*., 2011). The application of *Chaetomium cupreum*, *Penicillium chrysogenum*, *Trichoderma harzianum*, *C. globosum*, *T. hamatum* and a mixture of those bioproducts in a powder formulation significantly reduced incidence of *Colletotrichum gloeosporioides* (Soytong *et al*., 2005). Aqueous extract of *Lantana camara*, *Lantana viburnoides*, *Echinops* spp. and *Ruta*

chalepensis showed effective inhibitory effects on the growth of *Colletotrichum gloeosporioides* (Ademe *et al.,* 2013).

Leaf blight

The leaf blight or stemphylium blight is a foliar disease of onion caused by fungal pathogen *Stemphylium vesicarium*. The disease is characterized by small yellowish water-soaked lesions that develop into elongated spots which turn dark olive, brown to black during spore development. Leaves may be completely blighted as the lesions coalesce. *Alternaria porri* in conjuction with *S. vesicarium* is responsible for significant qualitative and quantitative destruction of onion crop (Nainwal, 2013).

Application of bioagents, *Bacillus subtilis*, *Pseudomonas fluorescens* and *Trichoderma harzianum* exhibited highest reduction in disease severity (Hussein *et al.,* 2007). Application of *Trichoderma harzianum* and *Stachybotrys chartarum* showed disease incidence reduction by 67.9 and 71.3%, respectively (Kamal *et al.,* 2017). Plant extracts of *Azadirachta indica* and *Datura stramonium* showed reduction in the growth of fungal pathogen *Alternaria porri* and *Stemphylium vesicarium* under green house conditions (Abdel-Hafez *et al.,* 2014). The efficacy of *Pseudomonas fluorescens* and hexaconazole against onion leaf blight pathogen was determined by seed treatment, root dip or foliar spraying, alone or in combination. Treatment with *P. fluorescens* exhibited lower disease severity and higher crop yield (Barnwal *et al.,* 2003). *Azadirachta indica* (66.5%) and *Datura metel* (64.5%) showed restriction in the growth of pathogen over control against leaf blight pathogen. In the evaluation of bioagents, *T. harizianum* and *T. viride* were found significantly effective to restrict the growth of pathogen (Kumar *et al*., 2012). Prasad and Barnwal (2004) also reported antifungal activity of 20% leaf extract of *Azadirachta indica* and *Datura metel* against *Stemphylum vesicarium* and improved bulb yield.

Basal rot

The disease is characterized by yellowing of leaves and stunted growth of plant. At later stage of disease development leaves become dry from tip onwards. Diseased bulbs become discolored and the infected tissue appeared brown in color with watery appearance (Sumner, 1995).

Gupta *et al*., (2008) found that *Trichoderma viride* inhibited mycelia growth of *F. oxysporum*. Rajendran and Rangnathan (1996) also reported effectiveness of soil application of *T. viride* and other species against basal rot pathogen. In another study conducted by Gupta and Gupta (2013) revealed that soil application of *Pseudomonas fluorescens* and *Trichoderma viride* supplemented with root dip method effectively control the pathogen. Seed treatment with *T. harzianum* showed decreased disease incidence and better yield as comparable to imidazole fungicide (Coskuntuna and Ozer, 2008). In another study by Jagtap and Suryawanshi (2015) antifungal activity of *Aspergillus niger*, *A. flavus*, *T. viride*, *T. harzianum*, *T. koningii*, *Curvularia lunata*, *Penicillium expansum*, *Alternaria alternata*, *Xanthomonos axonopodis*, *Bacillus subtilis*, and *Pseudomonas fluorescens* was evaluated against *Fusarium oxysporum* causal agent of basal rot of onion. *T. viride* was found most effective to reduce the radial growth of fungal pathogen followed by *A. niger* and *T. harzianum*. Rauf and Javaid (2013) experimented with methanolic leaf, stem, root and inflorescence extracts of *Chenopodium album* L. to study their antifungal activity against *F. oxysporum*. The highest antifungal activity was exhibited by inflorescence extract against the pathogen *in vitro*. A significant disease reduction was observed with the treatment of *T. harzianum* (88.7%) and *T.viride* (77.3%) (Flori and Roberti, 1993). The antagonistic activity of *T. viride, T. harzianum* and *Pseudomonas* sp. against *F. oxysporum* showed significant inhibition by dual culture technique. Among them *T. viride* was found most effective to control the pathogen. The soil borne diseases can be effectively control by organic amendments including oil cakes. Organic amendment with mahua cake (10%) showed significant reduction of the disease (Malathi and Mohan, 2011).

Onion smut

Onion smut has become a serious problem in many onion growing areas. The causal organism is a soil-borne fungi *Urocystis magica* (syn: *U. cepulae*) is the most destructive fungal pathogen in onion crop. The disease is characterized by longitudinal blisters on cotyledons and in young leaves. The blisters are brown to black in color with silver sheen. These blisters upon rupturing exposed black, powdery masses of spores (teliospores). Diseased plants that survive are often distorted and remain stunted. Seedling onion usually dies within few weeks and plant populations are reduced. Dark pustules also appeared at the base of seedlings near the ground level (Sampangi and Mohan, 2017). The fungal pathogen invades the first leaf (cotyledon) as it grows upward to the soil surface (Edington *et al.*, 1980). Biological control approaches are lesser known or studied to this disease. To control smut disease of onion, disease free sets or transplant must be planted. Crop rotation helps to prevent gradually building up of inoculmn is soil by the smut fungi.

CONCLUSION

Onion crop suffers from various fungal pathogens which cause severe yield and quality losses by causing different diseases. This review concludes that fungal diseases of onion crop can be managed effectively by using different bioagents and plant extracts. Biological control measures are not only environment friendly but are also cost effective. There is need of the time for more research on the evaluation of various biological control measures against fungal pathogens.

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