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REVIEW ARTICLE

AN OVERVIEW OF WHITE ROT DISEASE MANAGEMENT IN SMALL ONION

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Abstract

Onion (*Allium cepa*) is a remunerative and high value vegetable crop in India but it has affected by several disease of fungi, bacteria, virus and nematodes. In this case fungal disease, white rot is caused by Stromatinia cepivora (*Sclerotia cepivorum*) is a major issue for both farmers and researchers. This disease causes heavy yield loss as its impact is more during harvesting stage and storage conditions. In this study we will analyse the causative agent of disease and various strategical approaches in recent years to control the disease incidence such as Cultural method, Biological method, Chemical method, Nanoparticles and use of resistant varieties.

Introduction:-

Onion (*Allium cepa*) is a temperate crop but can be grown under a wide range of climatic conditions such as temperate, tropical and subtropical climate. The best performance can be obtained in a mild weather without the extremes of cold, heat and excessive rainfall. However, onion plant is hardy and in the young stage can withstand freezing temperature also. In India, short-day onion is grown in the plains and requires 10-12 hours day length. The long-day onion is grown in hills requiring 13-14 hours day length. The optimum temperature for vegetative phase and bulb development is 13-24˚C and 16-25˚C, respectively.

The onion is a hardy cool-season biennial but usually grown as annual crop and it has narrow, hollow leaves and a base which enlarges to form a bulb. The bulb can be white, yellow, or red and require 80 to 150 days to reach harvest. In onion has more number of varieties; among them, small onion (*Allium parvum*) fetches high price in market and the duration is 70 to 90 days. The chemical composition varies from variety to variety and with season of production and storage life. Dehydrated onion in the form of rings, powder, kibbles, etc. is in great demand. The processing industries require white onion varieties with high TSS. Various other products, *viz*., onion oil, onion juice, onion salt or onion pickles, can be prepared.

Onion has mostly affected by more number of fungal pathogens. The major fungal diseases are Purple blotch, White rot, Leaf spot, Basal rot, *Botrytis*, Damping off etc. Among them, white rot (*Stromatinia cepivora*) causes heavy yield loss and it can be controlled using biocontrol agent like *Trichoderma* (Mclean and Stewart, 2000), through composted onion waste (Coverty *et al*., 2002), fungicides and nanotechnology (Osama Darwesh, 2021) and so on.

Etiology

White rot is caused by the pathogen *Stromatinia cepivora*(Synonym: *Sclerotium cepivorum* Berk.), an ascomycete that belongs to the Subphylum: Pezizomycotina, Class: Leotiomycetes, Order: Helotiales, and Family:

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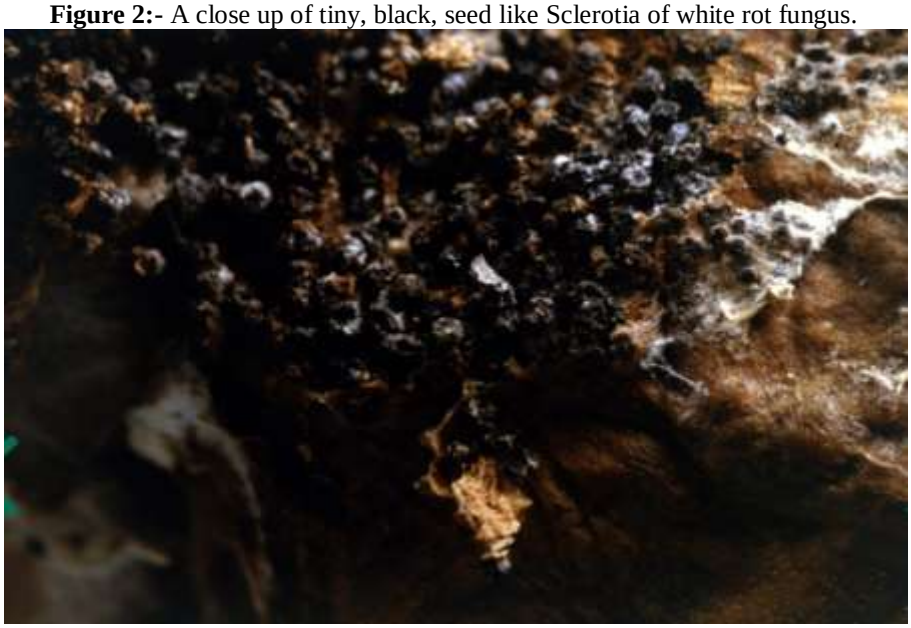
Sclerotiniaceae (Kirk *et al*., 2010; Xu *et al*., 2010; Fuga *et al*., 2012). Although, Xu *et al*. (2010) determined that the fungus belongs to the family Sclerotiniaceae, the generic placement of this species is still uncertain (Farr and Rossman, 2017). *Stromatinia cepivora* infects only species of the genus *Allium* such as onion, garlic, leeks, and chives. The fungus produces sterile mycelium and sclerotia, which are small, brown to black, and uniformly round (0.35 – 0.50 mm in diameter). The germination of sclerotia is triggered by exudation of alkyl and alkenyl-sulphoxides from *Allium* roots which are metabolized by soil microorganisms to produce volatiles thiols and sulphide.

Symptomatology

The infection can occur at any growth stage but it is usually first visible on older plants. It is characterized by the yellowing of the leaves, starting from the tip and progressing downwards. Wilting and later dieback can ensue. When these above-ground symptoms are evident, the pathogen has already colonized the roots, bulb, stems and leaf sheaths. White fungal growth is often visible at the soil line and is a sign of the decay of the roots. When pulled out, the bulb show white fluffy fungus growth, often at its base, a sign of advanced rotting. Tiny, black and roundish specks form amidst the white mold. The main roots are gradually destroyed and may be missing. Secondary roots may develop and extend horizontally, providing a direct path for the contamination of other plants. Plants can decline over a period of just some days to a weeks (Fig. 1 and 2).

Figure 1:- White fluffy fungal growth appears on base of the bulb.

Figure 2:- A close up of tiny, black, seed like Sclerotia of white rot fungus.



Epidemiology

White rot disease is caused by the soil borne fungus *Sclerotium cepivorum*. Plants most commonly are infected through the soil, where the dormant pathogen can survive for periods of up to 20 years. The severity of the disease is strongly associated with the amount of of fungus in the soil. Once established, it is almost impossible to get rid of the pathogen. The life cycle and development of the fungus is favored by *Allium* root extracts. The appearance of the disease is strongly associated with cool (10- 24°C) and moist soil conditions and can be spread by the fungal underground mold network, flood water, tools and plant material. The white rot disease is one of the major threats in onion and can lead to heavy yield losses. Disinfect the tools and equipment before working on another field.

Management

Biological method

There are several levels of control using biological methods, mainly using some antagonists such as, *Trichoderma*, *Fusarium*, *Gliocladium* or *Chaetomium* for example, are parasite of the white rot fungus and can be used to reduce its growth. Other fungi, for example *Trichodermaharzianum*, *Teratospermaoligocladum* or *Laterisporabrevirama* are also also very effective. A treatment with garlic extract can be used to stimulate the development of the fungus and the production of spores when the fields are barren. This reduces the incidence of the disease in later seasons. Garlic bulb needs to be unwrapped, crushed and mixed up with 10^1 of water. Then it can be added to the field at a rate of 10^1 per 2sqm. The ideal temperatures for the application is around 15-18°C because it favors the fungus. *Bacillus* and *Trichoderma* genera are familiar for both their biological control and plant growth promoting properties. *Trichoderma* spp. have an important role against white-rot disease caused by *S. cepivorum* on onion seedlings (Cawoy et al., 2011).

Chemical method

Always consider an integrated approach with preventive measures together with biological treatments, if available. Particularly in case of white rot disease cultural and biological methods can be very significant in reducing the infection. If fungicides are needed, products containing tebuconazole, penthiopyrad, fludioxonil or iprodione can be used as soil applications before planting, or as foliar spray application after planting. The application method depends on the active agent used for the treatment and needs to be checked before. Two chemicals, vinclozolin and iprodione, provided promising results as broadcast treatments on organic muck soils (Utkhede et al, 1979). The highest reduction in diseases severity was obtained with Vitavax -200 at 100 ppm, this effect may be due to its formulation which consists two active ingredients such as Carboxin and thiram. Topsin-70M was found to be aggressive against a wide range of white-rot pathogenic fungi, this effect may be due to disorder and striking changes in the cell wall of hyphae, phialides and conidiophores. On the other hand, this effect may be due to presence of methyl benzimidazole 2-ylcarbamate which is responsible for fungal toxic effect. Topsisn-70M has an important role on enzymes activity. This effect may be due to the presence of Thiophanate methyl, which inhibits the DNA synthesis/ nuclear division (Morsy et al., 2021).

Through composted onion waste

Three mixtures of dry (shale-skins or onion tops) and wet (peelings or chopped whole bulbs) onion waste were incubated for 7 d at 50° C with aeration to simulate a large-scale composting process. Under these conditions, a mixture of 10:1 (w/w) wet/dry 80% moisture content. The 50% incorporation rate of this waste was most effective with a reduction in viability of sclerotia recorded after 1 month exposure produced the desired characteristics of minimal run-off and no unpleasant odour. This ratio of onion wastes was then inoculated with sclerotia of *S. cepivorum* and incubated for 3 or 7 d at a range of temperatures (18–60° C). The pathogen was destroyed after 3 days at temperatures of 48° C and above. The 50% incorporation rate of this waste was most effective with a reduction in viability of sclerotia recorded after 1 month exposure (Coventry et al., 2002).

Control through *Purpureocillium lilacinum* cultural filtrate

The effect of *Purpureocillium lilacinum* culture filtrates in vitro and *in-vivo* conditions on *Stromatiniacepivora* at 75%concentration. Bioagent culture filtrates inhibited the mycelial growth, sclerotial formation and myceliogenic germination of S. cepivora by 82.59, 100 and 93.33%, respectively. The culture filtrates at 75% increased cell membrane permeability of *S. cepivora* compared to the control. The *in-vitro* analysis revealed that 92.5% of the sclerotia were lost its activity in the soil when treated with filtrates and significantly decreased the disease incidence and severity by 95.10 and 98.30%, respectively under greenhouse conditions (Ali, 2020).

Nanoparticles

In recently, disease was managed by using silver nanoparticles (AgNPs), biologically synthesized by *Fusariumoxysporum*. It was noted that AgNPs at all concentrations inactivate sclerotial formation. Significant reduction in the incidence of white rot was obtained with AgNPs applied as transplants/clove dipping or stems base spraying or dipping plus spraying. In general, the combined treatment was more effective than these methods used individually. Application of AgNPs provides an improvement in the growth and yield of bulbs for both onion and garlic plants grown under field conditions. Therefore, AgNPs can be used as nanofungicide against white rot disease and as nanofertilizers for onion and garlic production (Darwesh and Elshahawy, 2021).

Preventive measures

Use healthy seeds or planting material from a certified source. Select varieties that mature quickly. Follow recommended spacing for row planting to ensure good ventilation. Do not plant seed production fields close to onion production. Ensure a good drainage of the soil and do not irrigate in excess. Do not apply fertilizer late in the season when tops are drying. Check your plants or fields regularly for any sign of the disease. Remove weeds and volunteer onions in and around the fields. Remove infected plants and plant parts and destroy them by burning. After harvest remove cull piles and cut onion tops and destroy them by burning. Crop rotation for 2 years is recommended to avoid the increase the infection risk through other diseases. Do not transport bulbs from infected sites to other fields or farms.

Conclusion:-

Considering the importance of onion in recent days, the production is not upto the level. However, there are several factors responsible for low production, the disease plays a major role. "Like the layers of an onion, under the first lie is another, and under that another, and they all make you cry" which exactly depicts the pain of onion farmers. Lack of knowledge on latest technologies will play key role in disease management. The most effective controls for white rot are avoidance and sanitation. Once a field is infested, fungicide applications are necessary to control the yield loss in onion upto economic threshold level.

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