

Organic management of broccoli white mold in Meghalaya hills

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The demand for broccoli crop has led to increase in the acreage and production of this crop throughout the subtropical areas as well as the north-eastern region of the country. Sclerotinia sclerotiorum, a soil-borne necrotrophic and cosmopolitan fungus, is an emerging and dreaded pathogen for crop production systems in the terraces of the north-eastern hills region. This pathogen causes white mold disease in broccoli which can substantially reduce the quality and production, leading to lower supply. The article presents organic management of this disease through Trichoderma species, which is also compatible with the other organic inputs like neem oil cake and essential oil (citronella).

Keywords: Biofungicides, Brassicaceae, Cosmopolitan, Organic inputs

IN agriculture's ever-changing world, sustainable practices have gained more importance, with increasing stress on organic ways and minimising chemical inputs. The demand for organically produced food and functional food has increased in the last decades and this has been recognised as an important consumer trend worldwide. Broccoli is known to be an excellent source of folate and the greatest contributor to lutein and zeaxanthin intakes. Abundant content of glucosinolates, sulforaphane, phenolics and antioxidants in broccoli make it suitable for preventing cancer and heart diseases. The increasing demand for broccoli crop has led to the increase in acreage under the production of this crop throughout the subtropical areas of the country more particularly in the north eastern region. The north-east, India, a biodiversity hotspot region, is home to many phytopathogenic as well as beneficial microbes. Plant pathogenic fungi are the major factors that cause considerable losses to crop yields and limit crop production particularly for vegetables in a state like Meghalaya.

Amongst the soil borne fungi pathogens, *Sclerotinia sclerotiorum* is reported to cause major diseases. *Sclerotinia sclerotiorum* is primarily soil-borne cosmopolitan, necrotrophic and host non-specific with worldwide distribution. This pathogen incite severe damage to vegetable crops and cause total loss up to 50–70% of the produce at times under favourable weather conditions. In the hill states of north-eastern, Meghalaya depends on agriculture and horticulture as the income source, especially for the rural area with vegetable production of 548.146 tonnes from 18,498 ha in 2024. Biotic stresses hinder exploiting and achieving the potential production and productivity of the farming systems in the state. Organic farming has been the mainstay of economy in the hilly state of Meghalaya where vegetable production contributes a major share. Use of native *Trichoderma* isolates with other bioinputs like neem oil cake and citronella oil can contribute to holistic plant disease management under organic farming system.

Disease cycle

S. sclerotiorum is reported mostly from the temperate (cold and moist) regions, however with genetic variability and adaptability, now it is also reported from the warm and dry areas. The life cycle starts, also from the germination of sclerotia in soil or plant debris in warm and moist favourable conditions (>10 °C) with formation of apothecia. Then cup-shaped fruiting bodies release ascospores which infect various parts of broccoli plant especially during wet seasons spread by wind. After the infection, fungus produces mycelium and oxalic acid which leads to form new propagule inside the host plant to complete its life cycle. Plants of the families leguminosae, compositae, polygonaceae, solanaceae, brassicaceae and umbelliferae are more susceptible.

Infection process

Infection begins with a short-term period of biotrophy (12–24 h) whereby the subcuticular hyphae spread without cell destruction, or by suppressing the host defences.

It develops into necrotrophic in which cell wall destroying enzymes, toxins and reactive oxygen species are discharged causing rapid cell mortality and white fluffy lesions with sclerotia.

Symptoms produced by *S. sclerotiorum*

Cottony growth: When disease develop, a dense fluffy white mycelial fungal growth is observed in the infected region.

Water-soaked lesion: Stem, leaves or broccoli head shows a pale-yellow colour with water-soaked lesions.

Sclerotia formation: The fungus produced black colour, hard pea shape resting structure called sclerotia. Fungus can survive in the soil for many years by producing sclerotia and infect the next crop during a favourable season.

Later on, the lesions on the leaves become larger and cause the afflicted plant portion to die. The plant's distal portion eventually become brown, turn yellow and eventually die. The girdled portion, which is frequently visible at the plant's base, kills the plant. *Sclerotinia* rot cause serious losses in the field, market, transit and storage conditions.

Trichoderma spp: A biocontrol agent

The widespread soil borne saprophytic fungi *T. viride* and *T. asperellum*, with the ability to colonise rhizosphere and plant roots thereby parasitise some plant pathogenic fungi. They secrete a variety of volatile and non-volatile compounds with antibiotic properties. Faster metabolic rates, antimicrobial metabolites and physiological conformation are important elements that primarily lead to these fungi's antagonistic interactions. *T. viride* and *T. asperellum* are isolated from the native place effectively manage soil borne disease *S. sclerotiorum*. They are also compatible with the organic inputs like neem oil cake and essential oil (citronella) to suppress the soil borne fungal pathogen.

Citronella oil

Essential oils are aromatic substances which are extracted from various plants many of which exhibit



White mold symptoms in broccoli

antibacterial and antifungal activity. The essential oil from *Cymbopogon nardus* (a perennial grass) is known as citronella oil and can be a potential alternative to chemicals in managing plant diseases and sustainable crop production.

Neem oil cake

Neem tree has great potential to control various soil borne pathogens including many phytopathogenic fungi. The organic product remaining after cold-pressing the neem seeds to get neem oil is known as neem oil cake. It is a natural farm crop and has two uses: a very good organic fertiliser and a powerful botanical fungicide.

Compatibility of *Trichoderma* spp. with other organic inputs

The effectiveness of the potential *Trichoderma* using organic inputs (neem oil cake and citronella oil) was evaluated for managing white mold of broccoli in the field condition.

Pre-planting: Neem oil cake @ 250 kg/ha mixed with soil before transplanting.

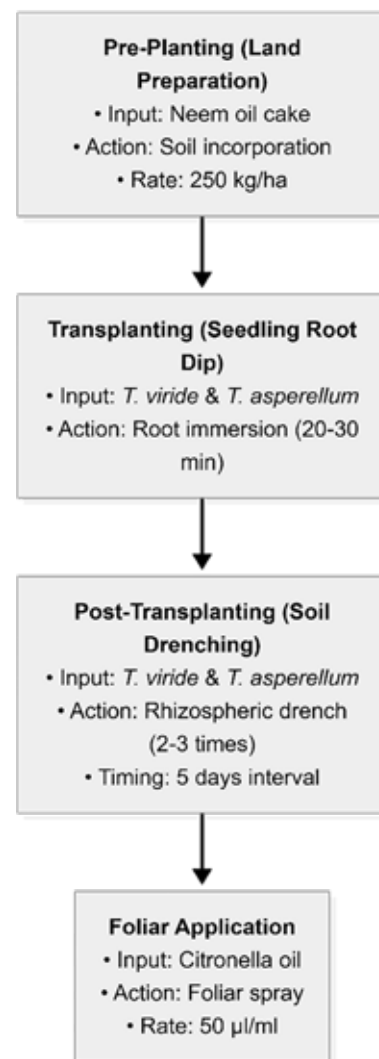
Root dipping: Seedling of the broccoli dipped with the *T. viride* and *T. asperellum* (10^8 spores/mL) for 20–30 min before transplanting.

Soil drenching: Drenching *T. viride* and *T. asperellum* solution (10^8 spores/mL) 2–3 times near the rhizosphere region of crop at 5 days interval of time.

Foliar application: Foliar spray of citronella oil @50 μ L/mL.

Using the eco-friendly management practices in the potential dose before sowing to

harvesting stage can effectively control the soil borne fungus *S. sclerotiorum* and also maintain the soil fertility and beneficial soil microbes.



Schematic diagram of organic inputs to manage broccoli white mold disease

Benefits of disease management

Direct pathogen suppression:

Disrupt fungal growth in broccoli at low concentration (10^8 spores/mL) value with *Trichoderma*.

Environmentally safe: Rapidly degrades fungi without harming beneficial soil microbes.

Boosting yield and crop quality

Other than managing the diseases, these management practices also enhance days to head formation, days to head maturation, circumference and diameter of head, weight as well as yield of the broccoli around 17 q/ha.

Lastly, the chemical dependency might be replaced with the system of three inputs of eco-friendly materials which will make soil not a growing medium but a healthy ecosystem which will not only allow to multiply the harvests and income, but will help produce a healthy crop.

Economic value

Integrating *Trichoderma* spp. into broccoli, management offers substantial economic benefits like:

Higher survival rate: Reducing mortality in broccoli from white mold, increase yield of the crop.

Input cost reduction: Reducing the dependence of the harmful and expensive synthetic fungicides.

Increased yield and quality: *Trichoderma* naturally solubilises soil phosphates and micronutrients. In broccoli, this translates to larger, tighter and heavier curds/heads,



Foliar application in the broccoli field

often yielding a 10–20% increase in marketable weight.

Premium market pricing: Allows farmers to market their produce with lower chemical residues and organically produced, which is increasingly demanded by urban consumers.

SUMMARY

S. sclerotiorum cause white mold disease in broccoli which poses serious threat in the crop during cultivation in the mid hills of Meghalaya. The native *T. viride* and *T. asperellum* can be used with neem oil cake and essential oil (citronella

oil). Combining native *Trichoderma* spp. with these organic inputs at a proper dose effectively manage *S. sclerotiorum* and is a viable alternative to chemical fungicides. This not only manages the disease but also increase the yield, as well as other functional and plant growth promoting attributes in broccoli. The *Trichoderma* isolates (*T. viride* and *T. asperellum*) manage the cosmopolitan soil borne phytopathogen as well as maintain ecological balance in hill farming systems.

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National Pest Surveillance System

Launched on 15th August 2024 to enhance the surveillance and management of pest diseases across the country. The system utilises latest digital technologies such as Artificial Intelligence and Machine Learning (AI and ML) to provide quick and instant solution regarding pest attacks, crop diseases, crop damages, etc. by issuing real time crop protection advisory to the farmers. It includes a user-friendly mobile app and a portal for identification of pests and disease mitigation through integrated pest management.

