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Maize sheath blight disease and its biological control

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Abstract:

One of the significant kharif crop of India is maize. It is unmistakably a summertime annual that needs extremely specific environmental conditions for healthy growth and development. It is grown all over the world in the temperate, subtropical, and tropical regions. Sheath blight, caused by *Rhizoctonia solani*, causes corn grain losses ranging from 11 to 40%, even up to 100% on some cultivars in some warm, humid locations, where the circumstances are suitable for the causative agent (Izhar and Chakrabarty 2013; Gao et.al., 2014). To gradually destroy this causative agent, a number of compounds are utilised. However, this same bacterium has also developed resistance to systemic fungicides like benomyl, carboxin, and thiophenate methyl as well as protectant organic fungicides like captan, maneb, and thiram. To manage this diseases, biological treatment options were tested in the current experiment. A biocontrol agent, *Trichoderma*, was tested in vitro against the pathogen *R. Solani* using several species. As a consequence of its ability to 80% effectively block the growth of pathogens, *T. harzianum* emerged as the most promising of the ten *Trichoderma* strains studied in this study. The pathogen was also exposed to certain botanicals (essential oils), and Neem oil (Azadirechta oil) showed the most promising results in thwarting the growth of the infection, followed by clove oil and mentha oil.

Keywords: Maize, Sheath Blight, *Rhizoctonia solani*, *Trichoderma*,

INTRODUCTION

Zea mays, a significant Kharif crop, is crucial to the nutrition of Indians. After wheat, barley, and rice, corn is the fourth most common cereal crop in terms of area and output. The production of food accounts for 25% of GDP thanks to the main cereal grain. This crop grows quickly and tally yet has a limited lifespan. It may be used in a variety of goods, including industrial ones as well as animal and livestock feed. Andhra Pradesh, Karnataka, Rajasthan, Maharashtra, Uttar Pradesh, Bihar, Chhattisgarh, Madhya Pradesh, and Himachal Pradesh are the states with the largest corn acreage that account for more than 80% of corn output.

Out of the 112 corn diseases that have been recorded thus far from various regions of the world, 65 are known to exist in India (Singh and Shahi 2012; Asif 2013). The main ailments that affect the country's many agro-climatic areas include seed roll seedling blight, leaf blight, downy mildews, stalk rots, banded leaf and sheath blight, smuts, and rust, which cause yearly crop losses of 15% to 20%. The Corn Sheath Blight of Maize (Thanatephorus sasakii (Shirai) Tu and Kimbrough) is the Worse of These (Tu and Kimbrough 1978). Except for the tassel, all of the plant's aerial components exhibit diseases signs.

Rhizoctonia solani is a fungus that causes banded leaf and sheath blight, and it is a soil-borne disease. One of the most infamous, pervasive, harmful, and adaptable pathogens that can be found almost anywhere in the globe is the fungus (Divya Rani et al. 2013). Because R. solani is able to develop sclerotia that can survive in the soil for at least two years, control techniques can only be partially successful (Ou 1985).

Cultural, chemical, and biological techniques have all been proposed as ways to manage this illness. Chemical and cultural control techniques are time-consuming and insufficiently effective. Additionally, it harms the helpful bacteria in the soil, which causes ongoing issues (Monfil and Casas-Flores 2014). Therefore, a biological idea was proposed (Boukaew et al. 2013).

In the current study, biocontrol techniques are chosen because they pose less hazards to human health, have a targeted mode of action, enhance soil quality, don't interfere with the majority of helpful bacteria, and are sustainable from an agricultural standpoint. As a result, this approach can effectively control the *zea mays* sheath blight disease because the bio agent multiplies in the soil and provides protection throughout the crop's growth.

Distribution

Germany, the United States, Nigeria, Venezuela, Sierra Leone, the Ivory Coast, and England have all recorded cases of this illness. In particular, sheath blight is acknowledged as a significant barrier to the development of maize in China, South Asia and Southeast Asia (Bangladesh, Sri Lanka, Indonesia, Cambodia) Philippines, Taiwan, Malaysia, Korea, Japan, Thailand, Laos, Pakistan, Nepal, and Myanmar). Surprisingly, sheath blight has been blamed for yield losses in China that are close to 100%.

Materials and methods

Isolation and culture of the pathogen –

In order to identify the Rhizoctonia solani disease, samples from the local farms. The sample washed twice in double-distilled water after being surface sterilised with a 1 percent sodium hypochloride (NaOCl) solution. The sick material was crushed on sterile petri plates, and a little amount (size: 1-2 mm) of the infected area was transferred to a culture plate made up of PDA media under aseptic conditions. For five to seven days, inoculated plates were incubated at 25°C. Plates were continuously inspected for related microbial proliferation and growth. The fungus were sub-cultured for purification by choosing the desired colonies after five days of incubation. For subsequent research, isolated and purified cultures were kept alive by routine transfers in new PDA media and storage in a refrigerator at 4°C. A different batch of cultures was produced on paraffin-sealed slant and stored at -4°C. Growth pattern, colony diameter, and colour were evaluated as the fundamental identifying characteristics.

In-vitro evaluation of biocontrol methods for the management of disease:

Isolation of *Trichoderma* strains

The places where the diseases brought on by *Rhizoctonia solani* was either very low or nonexistent in the presence of susceptible hosts are where the Trichoderma strains were identified from soil. The sample locations were at Gyanpur's experimental farms. At room temperature, air drying was done on the soil samples that were brought to the lab. On a selective medium, the Trichoderma species were isolated [(TSM) Elad, 1981]. Twenty millilitres of TSM medium were put onto Petri plates and let to harden. Trichoderma from soil samples was isolated using the serial dilution technique. 200 l aliquots of the soil suspension were then spread on TSM after one gramme of dried soil was added to nine ml of sterilised distilled water and serially diluted up to the dilution factor of 104. At 25°C and 20°C, the plates were incubated. On to PDA were transferred the colonies that had formed on the medium. Trichoderma cultures were also kept at 40 C on PDA slants for future research. Trichoderma isolates were identified using Kubicek and Harman's taxonomic keys (1998).

Antagonistic efficacy of *Trichoderma* spp. against *R. solani*

By inoculating a 5 mm agar block of Trichoderma against R. solani on PDA medium, 3 cm apart from each other, antagonistic potential of Trichoderma species was in vitro screened. After 6 days of incubation at 25 2 0C, observations were taken on the inoculation plates. The approach outlined by Upadhyay and Rai was used to analyse the colony interaction in dual culture (1987). The parameter used for evaluation was the percentage of the pathogens' radial growth that was inhibited, calculated using the formula 100 (R1 - R2)/R1 (Fokkema, 1976), where R1 represents the pathogen's radial growth towards the antagonist and R2 represents its radial growth towards the opposite side.

Screening of essential oils against *R. solani*

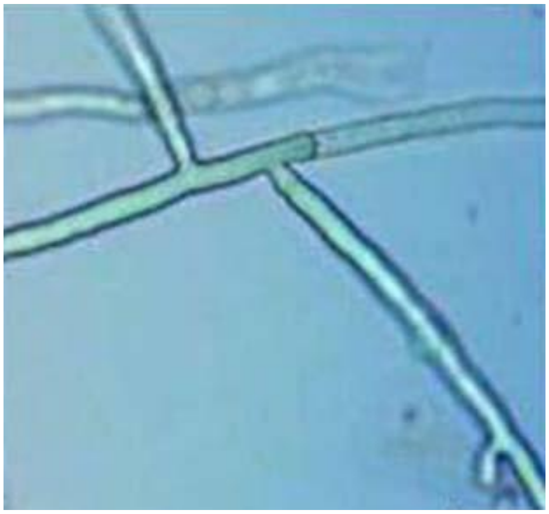
Using the poisoned food technique, the plant extract thus produced together with neem oil and lemon grass oil were evaluated against R. soani. Using the well method on a potato dextrose agar medium, the plant extracts lemon grass oil (0.2%), neem oil (0.1%), mentha oil (0.1%), basil oil (0.1%), and fenugreek oil (0.2%) were evaluated for their effectiveness against the pathogen R. solani. In the solidified medium, a well was made before it was placed onto 90 mm-diameter sterile petri dishes. The opposite side of the well cut in the petri plate was infected with a mycelial disc of 5 mm from a seven day old actively developing culture, and the well was then filled with test essential oil and incubated at 28 2 °C for seven days. Without any therapy, control was kept. Data were obtained 96 hours after inoculation and three replications were kept for each treatment.

The following formula may be used to calculate the percentage of mycelial growth inhibition: (Vardhan2020).

I=C-T/TX100, Where, I = Percentage of mycelial growth inhibition C = Control's colony diameter (mm) T = Treatment for Colony Diameter (mm)

Result:

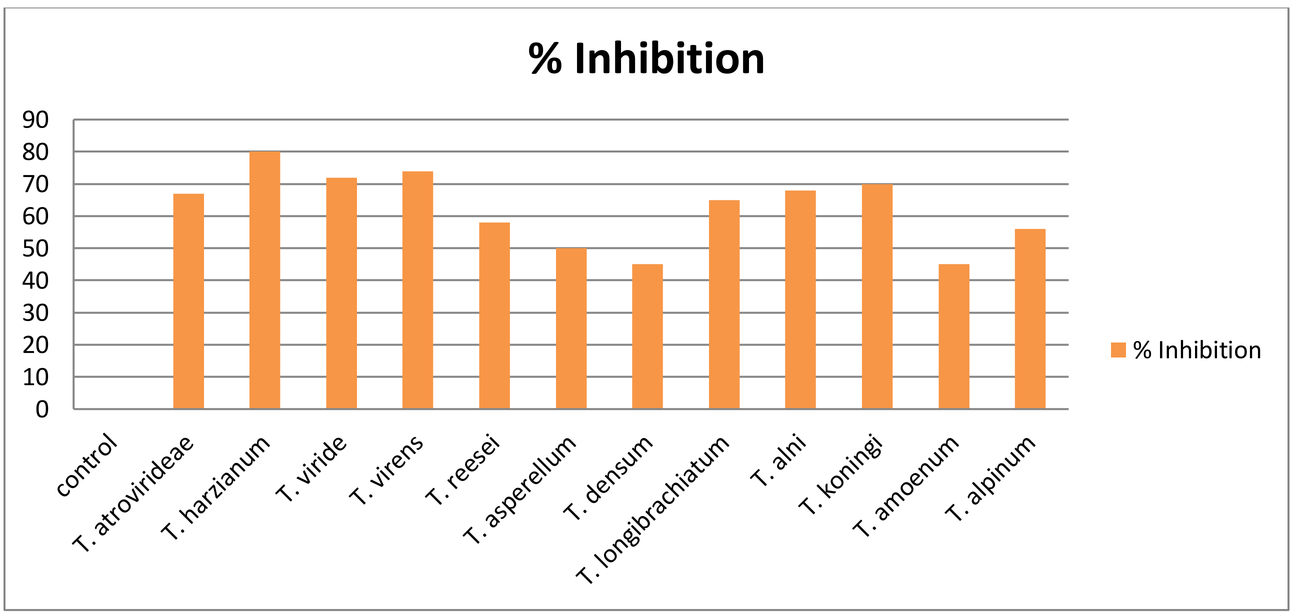
Isolation of Pathogen:



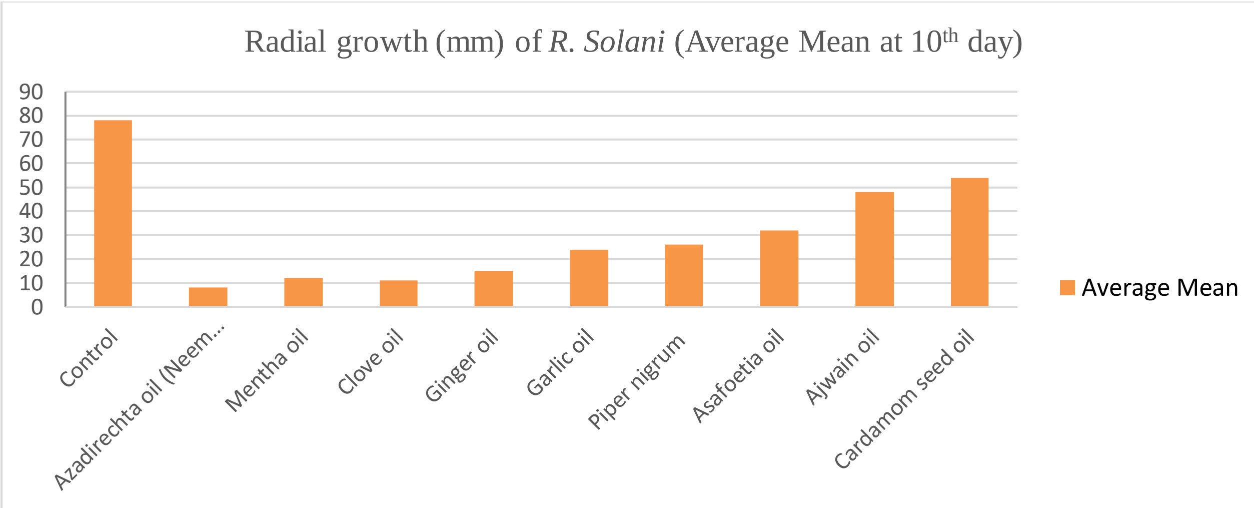
Hyphae of Pathogen

Pure culture of pathogen

Total 12 *Trichoderma* strain were used against *Rhizoctonia solani* in dual plate culture technique. The most effective strain found against *R.solani* are *T. harzianum* (80%) >*T. virens*(74)>*T. viride* (72%). Other strains were also able to prevent the growth of causal agent but at lesser extent (50 – 70) while *T. amoenum* were not found effective against *R. solani* (45%).



Screening of essential oils against the Pathogen- Out of 9 essential oils used against *R. solani* Neem oil (*Azadirechta* oil) shows most promising result in inhibiting the growth of pathogen followed by clove oil and mentha oil.



Discussion-

Historically, efforts have been made to control *Rhizoctoni solani* populations by using fungicides (Du Plessis 1999; Stevenson 2000). To destroy this causative agent sequentially, many compounds are applied (Naz 2006). However, this same bacterium has also developed resistance to systemic fungicides like benomyl, carboxin, and thiophenate methyl as well as protectant organic fungicides like captan, maneb, and thiram (Van Bruggen and Arneson 1984). Additionally, non-selective chemical usage led to the development of disease resistance to some chemicals, unintended impacts on microbial proliferation in ecosystems, and dangerous natural phenomena (Prasad and Kumar 2011; Singh and Shahi 2012). As a result, alternative methods for the management of diseases in maize crops have taken the place of plant pathologists' care.

The current enquiry is a significant study that examines the potential for managing or controlling this condition by testing biological agents, namely *Trichoderma spp*. in dual culture. The results of the dual culture experiment showed that, in terms of the growth diameter of *R. solani*, each of the 12 *Trichoderma spp*. strains examined substantially varied from the control. However, compared to the other isolates, *T. harzianumisolate* demonstrated a stronger growth inhibition of R. solani (80%). Figure 2 shows antagonistic growth outpacing pathogen growth. An antagonist can overgrow when it has a greater growth rate, tolerance for the pathogens' metabolites, and the ability to manufacture antibiotics (Mathivanan et al., 2000). According to Chaudhary et al. (2020) and Abo-Elyousr et al. (2014), Trichoderma's capacity to generate extracellular chitinase enzymes is correlated with mycoparasitism.

Essential oil effects were divided into three categories: weak (0.0-1.9 mm), moderate (2.0-3.9 mm), and powerful (4.0-5.9 mm and above). Neem oil had substantial fungicidal properties when compared to the other essential oils tested against R. Solani, and its fungitoxic action may be caused by the presence of azadirachtin, which contains desactylimbin (Sehajpal et al., 2009)

Neem oil is used as a seed treatment, and spraying is the most effective and environmentally friendly way to manage this disease (Bunker et al. 2012) Divya et al.(2013) and Maravi K. K. (2016)

Conclusion:

In order to maintain plant health and increase crop yield, a promising alternative strategy is the biological control of plant diseases. The findings of this investigation will also be applied to the field level control of this disease.

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