



## Approaches towards Integrated Disease Management of Sheath Blight disease of Corn

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### Abstract

Maize occupies a prominent position in India as each part of the maize plant is of economical importance. Banded leaf and sheath blight disease caused by *Rhizoctonia solani* f. sp. *sasakii* is one of the important disease of maize. The causal organism of this disease has potential to inflict economic loss up to 100 %. Due to its soil borne nature and lack of resistant cultivars, it poses challenge to maize growers. Fungicides or crop rotation alone is not sufficient to control this disease. The present study is on integrated disease management through chemical, biological and botanicals means. The findings of this investigation should help better management and reduce crop loss due to banded leaf and sheath blight. Bavistin showed maximum percent of inhibition i.e. hundred percent (100%) at 10 ppm concentration. In order to replace chemical treatment present study was focused on use of integrated disease management (IDM). For this six treatment were given to maize seed with botanicals, bio-agent, chemical and combination of these out of which it was found that treatment number S6 and S7 which is combination of Bavistin + Neem oil and *Trichoderma harzianum* + Neem oil respectively showed maximum percent diseases index i.e. 2.9 and 4.6 respectively. In another treatment, along with seed treatment foliar spray was also done by using chemicals and botanicals. In this experiment it was found that when treatment was done with bio-agent *T. harzianum* maximum percent disease control was reported 90.9 and minimum 60.6 when foliar spray and seed treatment both were done only by Neem oil.



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### Keywords

Bio-Agents; Botanicals; Concentration; Fungicides; Integrated Disease Management Pathogen Sheath Blight; Soil Borne.

### Introduction


The corn plant is a self pollinated as well as cross pollinated monoecious plant. It is greatest gift to humanity. Corn is originated in Guatemala and

Southern Mexico where Indians cultivated in for many centuries before Whitman stepped on this land. In India Corn production began sometime during 17<sup>th</sup> century introduced by East India

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Company. Corn is the third most important food crops after rice and wheat in India. It contributes nearly 9 % in the national food basket. Sheath blight disease of corn reduces crop grain yield in several Asian countries.<sup>1</sup> There are several methods have been suggested to control this disease such as cultural, chemical and biological. Use of cultural and chemical control methods are time taking and not sufficiently efficacious. Also it is harmful to the beneficial microbes in the soil which creates residual problems.<sup>2</sup> So, biological concept was put forward.<sup>3</sup> Among different fungal diseases that affects corn production, sheath blight proves more serious disease as grain losses ranges from 11 - 40% on some cultivars in some warm and humid regions, where the conditions are favourable for the causal agent grain losses were reported even upto 100%.<sup>4-6</sup> In different districts of Uttar Pradesh efficacious management of sheath blight disease of corn is possible only when the causal organism is eliminated completely or the propagules are below economic entrance confine at field level. Control measures were used partly efficient because *R. solani* produces sclerotia that can continue / persist in the soil for at least two years.<sup>7</sup> Carbendazim, neem oil, and *T. harzianum* were evaluated as seed treatment with spray in various combinations for disease management.<sup>8</sup> Treatments that included both seed treatment and spray application proved to be more effective than seed treatment alone. In present investigation bio-control and botanicals methods are used as it has less human health risks, selective mode of action, improved soil conditions, lack of activity against most beneficial microbes and agricultural sustainability. So, this method can be very effective to use for the sheath blight disease of *Zea-mays* control as the bio - agent multiply in soil and offer protection throughout the crop development. Now the disease is gaining the economic importance in Uttar Pradesh.

### Materials and Methods

The present work was carried out in the year 2022-23 at the Department of Botany, K. N. Govt. P.G College, Gyanpur, Bhadohi, U. P., India. Complete randomized design with three replications were used for *in vitro* experiments. Five fungicides viz., Bavistin, Captan, Propiconazole, Mancozeb, Metalaxyl at concentrations of 10, 20 and 30 ppm were evaluated

against *R. solani* isolated from diseased plant part. Plates without any treatment was served as control. For each treatment three replications were used and after 96 hours of inoculation data were recorded.

Percent inhibition of mycelial growth calculated using the following formula.

$$I = \frac{C-T}{T} \times 100,$$

Where,

I = Per cent inhibition of mycelial growth

C = Colony diameter in control (mm)

T = Colony diameter treatment (mm).

Treatment with botanicals were done by well plate method and twelve species of *Trichoderma* were evaluated against *R. solani*. After 96 hours of incubation, radial growth of the test fungus as well as bio-agent was measured to determine the antagonistic capability of the bio-agents.

For field performance assessment, the trials were conducted in randomized block design with three replications which maintain spacing of 60 cm between rows and 20 cm between plants. Firstly the plant were made sick by by inserting 3-4 fully colonized maize grains with *R. solani* between the rinds and the enclosing sheaths at second or third basal internodes of 35- 45 days old test plants. The population level of *Trichoderma* strains in each soil inoculum was maintained at 10<sup>6</sup> cfu g<sup>-1</sup> dry soils by mixing acid washed and sterilized sand. After treating with fungicides, maize seeds were air dried before sowing. Spray mode was used to apply botanicals and bio-agents on the aboveground parts of maize plants. Spray of only neem oil and water served as check.

### Results

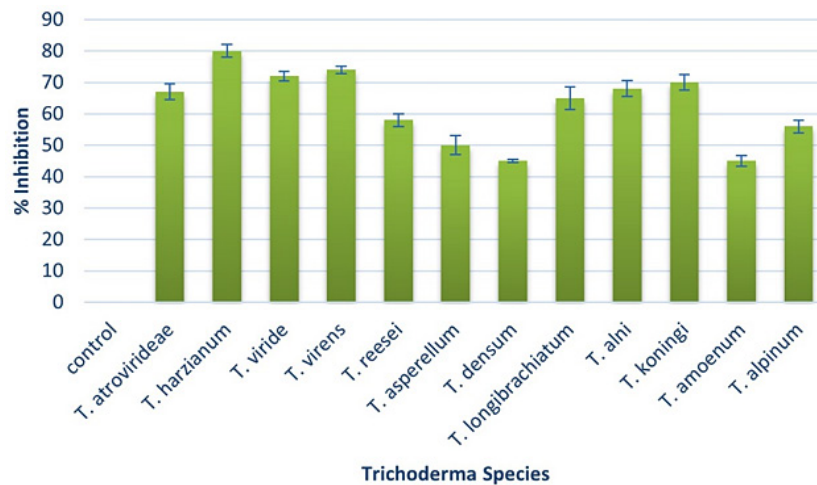
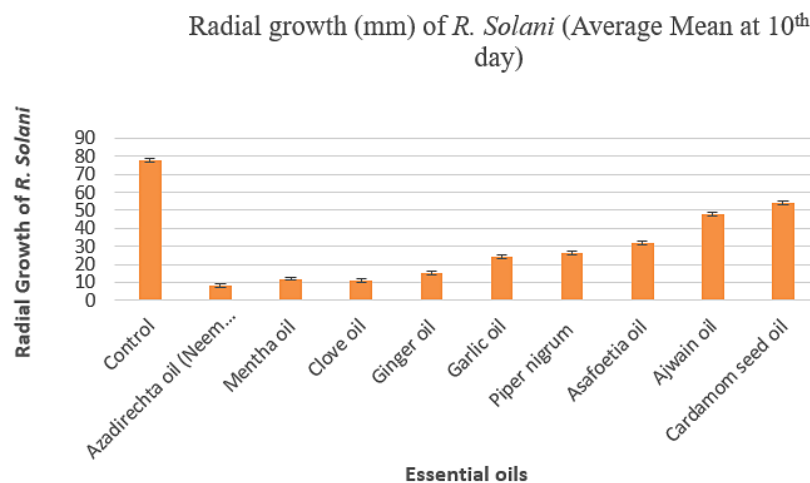
Table-1 showed the result of the evaluation of fungicides against mycelia growth of pathogen. Observation table showed that among five fungicides, Bavistin showed maximum percent of inhibition i.e. hundred percent (100%) at 10 ppm concentration followed by Propiconazol (84.2%) > Mancozeb (81.3%) > Metalaxyl (69.4%). At increasing concentration of fungicides each one showed increased percentage (%) of inhibition of mycelia growth.

**Table 1: Poison food technique for evaluation of fungicides against *R. solani* (mycelial growth inhibition %)**

Concentration	Bavistin	Captan	Propiconazole	Mancozeb	Metalaxyl	Control
10ppm	100 ± Ec	75.5 ± Cc	84.2 ± Ac	81.3 ± Bc	69.4 ± Dc	0 ± F
20ppm	100 ± Eb	76.7 ± Cb	85.1 ± Ab	80.7 ± Bb	69.8 ± Db	0 ± F
30ppm	100 ± Ea	80.4 ± Ca	85.1 ± Aa	80.7 ± Ba	69.8 ± Da	0 ± F

The results of colony interactions have been presented in Fig: 1. Seven strains of *Trichoderma* species showed more efficiency in inhibiting the growth of *R. solani* *in vitro*. The order of their effectiveness were *T. harzianum* > *T. virens* > *T. viride* >

*T. koningi* > *T. alni* > *T. atrovirideae* and *T. longibrachiatum*. The results showed that *Trichoderma harzianum* exhibited maximum inhibition of *R. solani* (80%) followed by *T. virens* (74%) and *T. viride* (72%).

**Fig. 1: Screening of different strains of *Trichoderma* spp. against *R. solani*****Fig. 2: Efficacy of different botanicals on growth of *R. solani***

The data from Fig:2 indicate that with different treatment the mycelial growth inhibition varied significantly. Maximum inhibition of (94%) per cent of mycelial growth was recorded in *Azadirachta indica* oil (nimbidicin) at (6%) per cent concentration which was significantly superior to all other nine treatments followed by clove oil.

**Table 2: Effect of seed treatment with most effective botanicals, chemicals and bio-agents on percent disease index**

Sr. No.	Treatment	Percent disease index (PDI)
1	S1	30.4 ± 0.3
2	S2	2.3 ± 0.2
3	S3	21.2 ± 0.22
4	S4	93.6 ± 0.3
5	S5	2.8 ± 0.3
6	S6	2.9 ± 0.5
7	S7	4.6 ± 0.65

S1 = *T. harzianum*@ 5g/500gm, S2 = Bavistin 50 WP @ 1.625 g/500gm, S3 = Neem Oil 5ppm/500ml, S4 = Control, S5 = *T. harzianum* + Bavistin S6 = Bavistin + Neem Oil, S7 = *T. harzianum* + Neem Oil

The effect of seed treatment with most effective botanicals, chemical and bio-agents were on percent

disease index were also studied. The observation made from table 2 revealed that statistically significant differences among the treatments for Percent Disease Index (PDI). In S1 treatment seeds treated with *T. harzianum* @ 5g/500gm showed maximum PDI i.e. 30.4% whereas in S2 treatment when seeds were treated with Bavistin 50WP @ 1.625 g/500gm, PDI was of 2.3 %. In S3 seed treatments PDI was noted 38.4% applying neem oil @ 5ppm/500ml. The S4 seed treatments i.e control PDI was recorded 93.6%. The S5 seed treatment showed more or less equivalent PDI as Bavistin (2.8 and 2.3 respectively).

Different combinations were used to assess the possibility of control of disease during field experiment which was conducted during *Kharif (rainfed)* season of 2022-23. Table 5 showed the evaluation of foliar spray with botanicals, chemicals and antagonists on grain yield. The maximum disease control was reported when *T. harzianum* applied @ 5 g/500gm with foliar spray of neem oil in S1 treatment (90.9%) followed by seed treatment with chemical Bavistin 50WP @ 1.625/500 gm with foliar spray of neem oil in S2 treatment, whereas in S3, seed treatment with foliar spray both of neem oil the disease control was recorded 75.9%. The minimum disease control was noted when seed treatment and foliar spray both done by neem oil (75.9%).

**Table 3: Effect of seed treatment and foliar spray with botanicals, chemicals (Bavistin) and bio-agents on grain yield.**

Grain Yield (q/hectare)					
Sr. No.	Foliar Spray	Seed Treatment			
			S1	S2	S3
1	F1	Neem Oil	90.9	80.3	75.9
2	F2	Control	70.6	74.6	60.6

S1 = *T. harzianum* @ 5g/500gm, S2 = Bavistin 50WP 1.625/500gm, S3 = Neem oil @5ppm/500ml  
F1 = Neem oil, F2 = Control

### Discussion

Absence of resistant cultivars lead the use of fungicides to control sheath blight in practice. In this investigation, five fungicides were used for their effect on mycelial

growth of *R. solani* i.e. Bavistin 50% WP, Captan 70%, propiconazole 25% EC, Mancozeb 75% WP, Metalaxyl 72%WP. Result presented in table 1 showed that all fungicides significantly inhibited

mycelial growth of *R. solani* as compare to the control at all the test concentration viz. 10, 20 and 30 ppm. The result clears that among five fungicides, Bavistin showed maximum percent of inhibition i.e. hundred percent (100%) at 10 ppm concentration followed by Propiconazol (84.2%) > Mancozeb (81.3%) > Metalaxyl (69.4%). At increasing concentration of fungicides each one showed increased percentage (%) of inhibition of mycelial growth.

These results showed similarity with the work done by<sup>9</sup> who reported that Propiconazole @ $5.2 \times 10^{-2}$  µg a.i. ml<sup>-1</sup> very effective against *Rhizoctonia solani* in *in vitro* condition.<sup>10</sup> reported that Carbendazim was most effective chemical for *Rhizoctonia bataticola*.<sup>11-12</sup> also observed the similar results. In the present investigation foliar spray with Bavistin (Carbendazim) 50% WP, was found effective in reducing the severity of sheath blight disease of maize.

Generally for control of phytopathogenic fungi, systematic fungicides were used. In recent years awareness regarding toxic hazards of chemicals to crop consumers and environment has been increased. So, the importance of indigenous plant products in plant disease control has been emphasized. In the present study, investigations were carried out to evaluate indigenous plant extracts (botanicals) for the possible presence of fungitoxic substances against *Rhizoctonia solani* f.sp. *sasakii* *in vitro* and management of the disease. Out of nine essential oil tested against *R. solani* for their fungicidal activity, Neem oil showed strong fungicidal property and its fungitoxic activity may be due to the presence of azadirachtin.<sup>13</sup> Respectively, by applying of neem oil as seed treatment and adding spray which is most effecting and eco-friendly technique in controlling this disease.<sup>8,14-15</sup>



**Fig. 3: Screening of *Trichoderma* species against *R. solani* by dual culture plate technique**



**Fig 4: *Trichoderma harzianum* showing mycoparasitism over *R. solani***

*Trichoderma* is an effective biocontrol agent of *Sclerotium rolfsii*, *Rhizoctonia solani* and *Pythium aphanidermatum*.<sup>16-17</sup> There are only few reports of its effectiveness as a biocontrol agent controlling Sheath Blight disease of Corn caused by *R. solani*. Therefore, an attempt has been made to manage leaf sheath blight (LSB) disease of corn through *Trichoderma* species. Screening is an important step in the development of bio-control agents. Screening procedure helps to identify an appropriate candidate and the success of all

subsequent stages depends on it.<sup>18-19</sup> The screening by dual culture involve mostly interaction studies and potential antagonists identified on that basis ranked according to their ability to inhibit the growth of the pathogen.<sup>20,21</sup> studied the interaction between pathogens and antagonists in dual culture on PDA media, by measuring the percent inhibition of growth. The present investigation is an important study regarding the possibility of controlling / managing this disease by screening with bio agents *Trichoderma* spp. in dual culture. The data of dual culture assay



showed that all 12 *Trichoderma* spp. strains tested significantly differed from the control in relation to growth diameter of *R. solani* (Fig-1 and 3). On agar media, different inhibition zones were produced by the interaction of the antagonists and the pathogen which could be considered as a result of the production of antibiotics, cell wall degrading enzymes and competition for nutrients and space.<sup>22</sup> However, *T. harzianum* isolate showed higher growth inhibition of *R. solani* (80%) compared to the other isolates. Fig. 4 showed the faster growth of antagonist over pathogen. The over growth of antagonist is achieved when a fungus exhibits higher growth rate, tolerance against metabolites produced by the pathogens<sup>23</sup> and capacity to produce antibiotics.

It is clear from the study that *Azadirachta indica* (neem oil) at 10 per cent concentration showed significant inhibition of mycelial growth of the pathogen. These results are in accordance with Singh et al. (1980) who studied the fungitoxic properties of plant extract against *Rhizoctonia solani* and reported that sclerotia formation in *Rhizoctonia solani* can be suppressed by *Azadirachta indica*. Similar results on antifungal activity of aqueous extracts of different plants have been reported by Rajput 2013 where neem oil extract were found to be effective as growth inhibitors. In present investigation mentha

leaf extract and clove bud extract was not at all inhibitory to the pathogen even at 10% concentration. Combining Seed Treatment with spray application improved the efficacy of treatments compared to seed treatment alone. Over the other treatments and the control, the Seed Treatment with *T. harzianum*+ spray of neem oil, produced the higher grain yield (90.9 percent) while both treatment with Neem oil application provide less grain yield as compared to other combination.

We therefore, conclude that management of this disease can be achieved by integrating seed or soil treatment by *Trichoderma harzianum* along with foliar application of neem oil.

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#### Conflict of Interest

There is no conflict of interest.

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