Efficacy of Various fungicides and herbicides for the management of Wheat foot rot disease

ABSTRACT

The present research was conducted to investigate and assess the effectiveness of fungicides and herbicides in controlling the foot rot disease caused by the fungus *Sclerotium rolfsii* in wheat crops. Foot rot of wheat caused by *Sclerotium rolfsii Sacc*. has a major constraint and potential threat to successful wheat cultivation. Therefore affords were made to screen the different systemic, contact and combination of fungicides and herbicides in vitro condition *against Sclerotium rolfsii*. Different fungicides against *S. rolfsii* were tested in vitro. The efficacy of two systemic fungicides (Tricyclazole 75%W.P. & Carbendazim 50% WP); two non-systemic fungicides (Mancozeb 75%WP & Copper oxychloride 50% WP); one contact fungicides Propineb 70%WP and one combo fungicides (Metalaxyl 8%+Mancozeb 64%) were evaluated at different concentrations (50,150 and 250 ppm) on the development of *S. rolfsii* on Potato dextrose agar (PDA) medium using poisoned food technique. Among thesix fungicides,Mancozeb was found best at all the concentrations followed by Tricyclazole at higher concentrations which inhibit the growth of *S. rolfsii*. Another method used for management strategy was herbicide for inhibiting the mycelial growth of *S. Rolfsii. In vitro* efficacy of selective herbicides *viz.* (Metribuzin 70% WP& Oxadiargyl 80% WP), systemic herbicide *viz.* (Pyrazosulfuron Ethyl 10% WP & Metsulfuron Methyl 20% WP) and one combo herbicides *viz.* (Bensulfuron Methyl 0.6% + Pretilachlor 6% GR) were tested at their recommended concentrations. Among themmetribuzin showed 80.00 % growth inhibition, succeeded by Pyrazosulfuronethyl (51.85%) and Bensulfuron methyl + Pretilachlor (45.92%).

Keywords- *Wheat, Foot rot, Fungicide, Herbicide, In- Vitro.*

Introduction

Wheat is an important cereal crop and a staple food for majority of the human population. Presently in the world, wheat is grown over an area of 240.4 m ha with a production of 757.92 mt and a productivity of 3,438 kg ha-1. India stands fourth among wheat producing countries both with respect to area and production. In India, it is grown over an area of 30.71 m ha with a production of 101.20 mt and a productivity of 3,295 kg ha-1 (Anon., 2019). Karnataka is unique in wheat cultivation where in all three cultivated species, viz., *Triticumaestivum L.,* (Bread wheat),*T. durum* (Marconi wheat) and *T. dicoccum* (Khapli, Sadaka or Emmer wheat) are grown in tropical climates characterized by the prevalence of high temperature during the crop growth.*Sclerotiumrolfsii*Sacc.is a significant soil-borne crop disease. Peter Henery Rolfs (1892) was the first to report the fungus in the United States as a cause of tomato blight in Florida.Saccardo named the fungus *Sclerotiumrolfsii* in 1911, and it causes 25-50 % loss by infecting herbaceous woody plant seedlings, fleshy roots, bulbs, and fruits.*Sclerotiumrolfsii*, also known as southern blight or white mold, is a devastating soil-borne fungal pathogen that affects a wide range of crops, including wheat. It can lead to significant yield losses and reduce the overall quality of the crop. To mitigate the impact of this pathogen on wheat production, farmers and researchers explore various management strategies, and chemical control using fungicides and herbicides is one of the common approaches. Efficient management strategies are crucial to combat *Sclerotiumrolfsii* and protect wheat crops from its destructive impact. Among the diverse approaches available, the application of fungicides and herbicides has shown promise in mitigating the spread and severity of this fungal pathogen (Zhang et al., 2022).

The primary objective of this study is to evaluate the efficacy of fungicides and herbicides for the management of *Sclerotiumrolfsii* in wheat crops. The research will focus on understanding the impact of these chemical treatments on disease suppression, overall plant health, and crop yield. Additionally, we will investigate the potential ecological implications and safety concerns associated with their use.

To accomplish this, a series of field trials will be conducted over multiple cropping seasons in diverse geographical regions. Various commercial fungicides and herbicides, recommended for fungal and weed control, respectively, will be assessed for their effectiveness against *Sclerotiumrolfsii*. Data on disease incidence, severity, and crop yield will be recorded, and statistical analyses will be employed to determine significant differences among treatments.Furthermore, this research aims to address the issue of resistance development in the fungal population against fungicides and explore alternative strategies to minimize resistance risks. In doing so, the study seeks to devise integrated disease management approaches that encompass cultural practices, biological control agents, and reduced-risk chemicals.

The findings of this study are anticipated to contribute valuable insights to the scientific community, agricultural stakeholders, and farmers alike. Ultimately, the goal is to provide evidence-based recommendations for sustainable and effective management practices against *Sclerotiumrolfsii* in wheat crops, ensuring food security and safeguarding agricultural productivity in the face of fungal challenges.

Methodology

The present studies were accomplished at the Department of Plant Pathology, College of Agriculture, Indira Gandhi KrishiVishwavidyalaya, Raipur (C.G.).The efficacy of two systemic fungicides (Tricyclazole 75%W.P. &Carbendazim 50% WP); two non-systemic fungicides (Mancozeb 75%WP & Copper oxychloride 50% WP); one contact fungicides Propineb 70%WP and one combo fungicides (Metalaxyl 8%+Mancozeb 64%) and herbicides viz (Metribuzin 70% WP&Oxadiargyl 80% WP), systemic herbicide *viz.* (Pyrazosulfuron Ethyl 10% WP &Metsulfuron Methyl 20% WP) and one combo herbicides *viz.* (Bensulfuron Methyl 0.6% + Pretilachlor 6% GR) were tested at their recommended concentrations.

Isolation of pathogen from infected plants

Isolation was made from the diseased plant samples collected during the survey at the seedling and vegetative stages of the crop. The roots of diseased plants showing symptoms were properly washed with water and a small portion of infected roots were cut with the help of a sterilized blade. These pieces were surface sterilized with 1:1000 mercuric chloride ($HgCl_2$) solution for 1 minute, then washed three times with sterilized distilled water to eliminate residues of $HgCl_2$. The pieces were then placed aseptically to Petri dishes containing sterilized PDA. Inoculated Petri plates were incubated at 25± 1 ºC for 3-5 days and inspected at regular intervals to see the growth of the fungus developing on various sections. The fungus was appeared on tissues of infected parts of the plants and was transferred on PDA slants.

Identification of the Pathogen

Based on growth characteristics and appearance, the fungus was identified as *Sclerotiumrolfsii*.

1.The fungus generates a lot of white, puffy, branched mycelium and its development began in a radial pattern.

2. Initially whitish sclerotia and finally turn brown mustard seed like sclerotia with watery drops on the surface.

Fig 1: Field symptoms of foot rot disease of wheat (A) White mycelium growth on foot region of wheat (B) Sclerotia on collar region of stem (C) Pure culture of *Sclerotiumrolfsii*

***In vitro* evaluation of fungicides against *Sclerotiumrolfsii* by poison food technique**

Fungicides against *S. rolfsii*were tested in vitro. The efficacy of two systemic fungicides (Tricyclazole 75%W.P. &Carbendazim 50% WP); two non-systemic fungicides (Mancozeb 75%WP & Copper oxychloride 50% WP); one contact fungicides Propineb 70%WP and one combo fungicides (Metalaxyl 8%+Mancozeb 64%) were evaluated at different concentrations (50,150 and 250 ppm) on the development of *S. rolfsii* on Potato dextrose agar (PDA) medium using poisoned food technique (Nene and Thapliyal, 1982).

To get the appropriate fungicide concentration, the required quantity of each fungicide was put individually into sterilized molten and lukewarm potato dextrose agar. The poisoned medium was then put into sterilized Petri plates in a volume of 20 ml. A sterile cork borer was used to cut 5 mm mycelium discs from a 5-day-old culture, and one disc was put in the center of each plate. As a control, a plate without any fungicide was used. For each concentration, three replications were kept. The plates were cultured at 25±1ºC temperature and the radial growth was measured when the fungus reached maximal growth in control plates.The fungicide effectiveness was evaluated as a percentage suppression of mycelial growth above control, calculated by using the formula given by Vincent (1947).

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

Where I = per cent inhibition

C = growth in control

T = growth in treatment

Table1 :- In *vitro* evaluation of different fungicides against foot rot fungus caused by*Sclerotiumrolfsii*

S.N.	Name of fungicides	Formulation	Doses (ppm)
1.	Mancozeb	Wettable powder	50, 150, 250
2.	Carbendazim	Wettable powder	50, 150, 250
3.	Propineb	Wettable powder	50, 150, 250
4.	Metalaxyl + Mancozeb	Wettable powder	50, 150, 250
5.	Copper oxychloride	Wettable powder	50, 150, 250
6.	Tricyclazole	Wettable powder	50, 150, 250

7.	Control	-	-

In vitro evaluation of different herbicides againstSclerotiumrolfsii by poison food technique

In vitro efficacy of selective herbicides *viz.* (Metribuzin 70% WP&Oxadiargyl 80% WP), systemic herbicide *viz.* (Pyrazosulfuron Ethyl 10% WP &Metsulfuron Methyl 20% WP) and one combo herbicides *viz.* (Bensulfuron Methyl 0.6% + Pretilachlor 6% GR) were tested at their recommended concentrations. For each treatment, 100 ml PDA was autoclaved in a 250 ml conical flask. At a lukewarm temperature, a specific concentration of herbicide was added to the medium and well mixed by shaking the flask. In 9 cm Petri plates, 20 ml of this medium was poured. Five mm diameter mycelial disc from a 5-days old pathogen culture were inoculated in the center and incubated at 25±1°C. A suitable control was maintained by growing the pathogen on herbicides free PDA medium. For each treatment, three replications were kept, and the percentage of growth inhibition was determined using the formula below.

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

Where, I = Percent inhibition,
C = Colony diameter of the test fungus in Control and
T = Colony diameter of the test fungus in Treatment

Table 2: - *In vitro* evaluation of different herbicides against foot rot fungus caused by *Sclerotiumrolfsii*

S.N.	Name of herbicides	Formulation	Doses (gm/ lit.)
1.	Bensulfuron methyl + Pretilachlor	Granule	20.00
2.	Oxadiargyl	Wettable powder	0.20

3.	Metsulfuron methyl	Wettable powder	0.008
4.	Pyrazosulfuron ethyl	Wettable powder	4.00
5.	Metribuzin	Wettable powder	0.65
6.	Control	-	-

Result

In *vitro* evaluation of different fungicides against foot rot fungus caused by *Sclerotiumrolfsii*

To evaluate the efficacy of fungicide against the *S. rolfsii*. In present investigations, six different fungicides, including mancozeb (75 % WP), carbendazim (% WP), propineb (% WP), metalaxyl 4 percent + mancozeb (64 % WP), and copper oxychloride (% WP), on radial growth and inhibition (%) of *S. rolfsii*, were evaluated and the results were presented in Table and illustrated in Plate.

At 50 ppm, significantly minimum radial growth (38.67mm) and maximum percent inhibition was observed in Mancozeb (57.03%) growth inhibition while other fungicide not effect the growth of S.*rolfsii*.

At 150 ppm, significantly minimum radial growth (0.00mm) and maximum percent inhibition was observed in Mancozeb 100% while other fungicide like Tricyclazole, Metalaxyl+ Mancozeb, Propineb, had least effective as compared to control.

At 250 ppm showed that significant minimum radial growth (0.00mm) and maximum percent inhibition (100%) was observed in Mancozeb while other fungicide like Tricyclazole, Metalaxyl+ Mancozeb, Propineb, had least effective as compared to control. Carbendazim, Copper oxychloride and Tricyclazole not effect the growth of *S. rolfsii.*

Archana*et al*., (2018) also observed to cause rapid mortality in chilli plantations. Among nine fungicides and two bio control agents tested in vitro against S. rolfsii the result revealed that the fungicides Carbendazim (0.1 %) +Mancozeb (0.2%), Thiram (0.2 %) and Mancozeb (0.2 %) recorded 100 % growth inhibition and were significantly superior over rest of the fungicidal treatments. Manu *et al*., (2012) also revealed that 14 fungicides viz., (Tricyclazole, Propiconazole, Difenoconazole, Hexaconazole, Carbendazim, Thiophanate methyl, Captan, Chlorothalonil, Mancozeb, Thiram, Hexaconazole 4% + Zineb 68%, Tricyclazole 18% + Mancozeb 62%, Tebuconazole 50% + Trifloxystrobin 25% and Carboxin 37.5% + Thiram 37.5%) were screened *in-vitro* against *S. rolfsii* causing foot of ragi. Hexaconazole, propiconazole, difenoconazole, and combi products such as Avatar, Nativo, and Vitavax power were found to be effective as systemic fungicides, while mancozeb, a contact fungicide, was found to be effective only at higher dosages. Bhuiyan*et al*. (2012) reported that Carbendazim was not effective in inhibiting the radial growth of *S. rolfsii* which support the present finding. Bhatt (2015) also reported that Mancozeb and Captan completely inhibited *S. rolfsii* growth at 125 and 250 ppm. Mancozeb were found very effective in present study also.

Table 3: -In *vitro* evaluation of different fungicides against foot rot fungus caused by *Sclerotiumrolfsii*

S.N.	**Treatment**	**Radial growth (mm) at different Concentrations**					
		50 ppm		150 ppm		**250 ppm**	
		Radial growth (mm) *	Inhibition (%)	Radial growth (mm)	Inhibition (%)	Radial growth (mm)	**Inhibition (%)**
1.	Mancozeb (75% WP)	38.67	57.03	0.000	100.00	0.000	100.00
2.	Carbendazim (50 % WP)	90.00	0.00	90.00	0.00	90.00	0.00
3.	Propineb (70% WP)	90.00	0.00	74.00	17.77	53.67	40.36
4.	Metalaxyl 4%+ Mancozeb 64% WP	90.00	0.00	71.67	20.36	43.33	51.85

5.	Copper oxychloride (50 % WP)	90.00	0.00	90.00	0.00	90.00	0.00
6.	Tricyclazole (75% WP)	90.00	0.00	42.67	52.58	16.67	81.47
7.	Control	90.00	-	90.00	-	90.00	**-**
	SEm±	0.025		0.028		0.022	
	C.D.(P=0.05)	0.077		0.086		0.067	
	C.V.	**0.528**		**0.745**		**0.69**	

***Average of three replications**

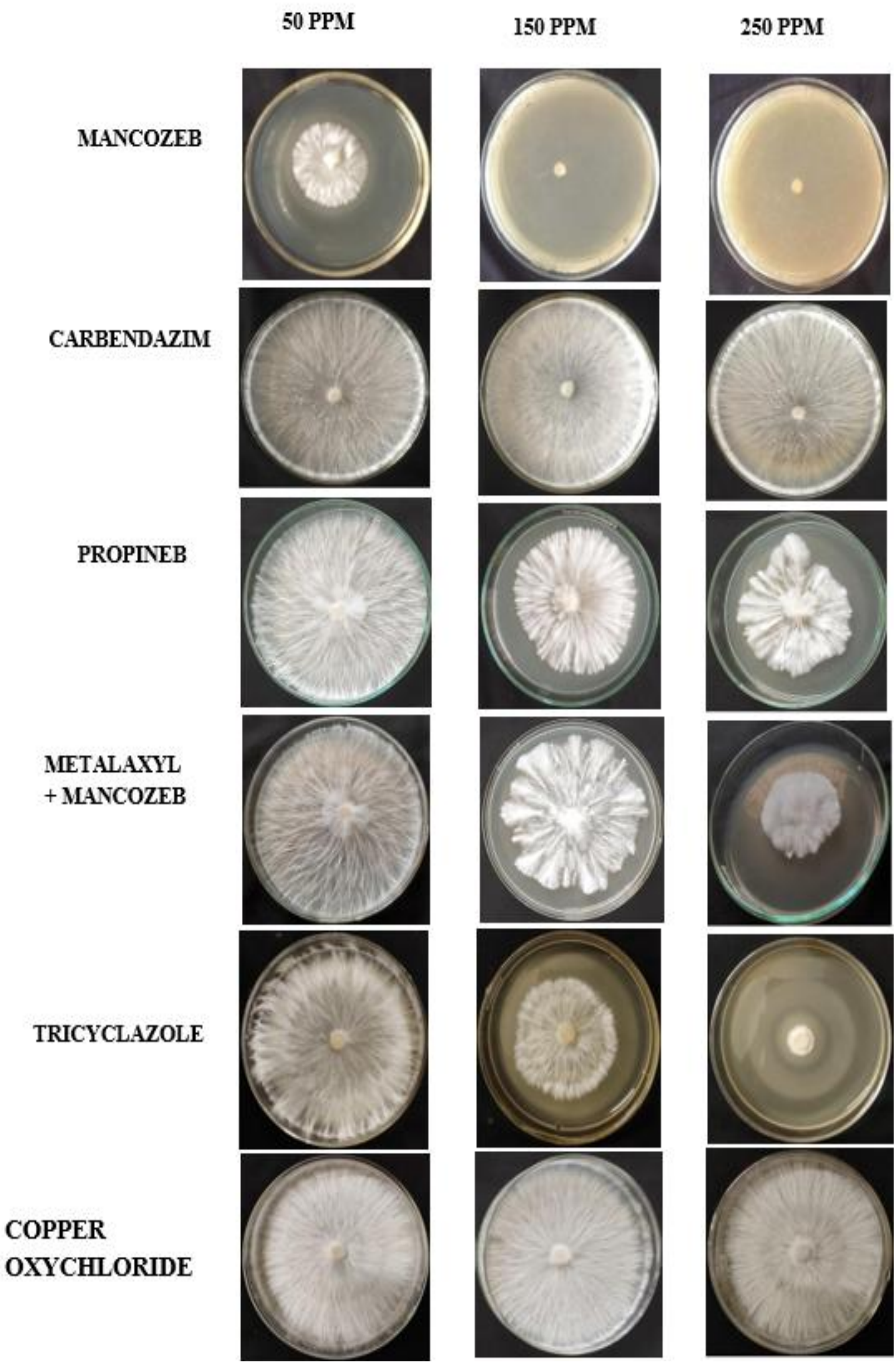


Plate 1: - In *vitro* evaluation of different fungicides against foot rot fungus caused by *Sclerotiumrolfsii*

In vitro* evaluation of different herbicides against foot rot fungus caused by *Sclerotiumrolfsii

To evaluate the efficacy of herbicide on *S. rolfsii*. In present study five herbicides, namely Bensulfuron Methyl 0.6 % + Pretilachlor 6 % GR, Oxadiargyl 80 % WP, Metsulfuron Methyl 20% WP, Pyrazosulfuron Ethyl 10 % WP, and Metribuzin 70 % WP, were studied on the mycelial growth of *S. rolfsii in-vitro* by using the poisoned food technique.

Significantly minimum mycelialgrowth(18.00mm) was recorded in Metribuzin with 80% growth inhibition which was followed by Pyrazosulfuron ethyl (51.85%) and Bensulfuron methyl + Pretilachlor (45.92%). However, the maximum mycelial growth and minimum % inhibition was observed 65.33mm (27.41%) and 81.33mm (9.63%) in Oxadiargyl and Metsulfuron methyl respectively as compare to control.

Sandhya*et al*., (2018) used the poisoned food technique to test herbicides such as Glyphosate, 2,4-D Sodium salt, Butachlor, Pretilachlor, Oxadiargyl, Pyrazosulfuron ethyl, Bensulfuron methyl 0.6 %+ Pretilachlor 6 %, Cyhalofop-butyl, Bispyribac sodium, and Ethoxysulfuron at recommended concentrations Glyphosate, Butachlor, and Pretilachlor all inhibited the growth of *R. solani* to 100%. WhileRangarani*et al*., (2017) also evaluated three herbicides and found that Pendimethalin and Quizalofop p-ethyl completely inhibited the pathogen. The growth of *S. rolfsii* was inhibited by 65.6 percent in 2,4-D Na salt. Awasthi and Dasguptha (2011) revealed that herbicides namely Glyphosate, 2,4-D. Ozadiazone and Paraquat were significantly effective against the *S. rolfsii*.Pathak*et al*., (1996) observed the effect of herbicides on *R. solani*. Paraquat was most potent in reducing the mycelial growth followed by thiobencarb, Butachlor and 2,4-D.The results of the present study on Glyphosate are in agreement with the work of Black *et al*., (1996).

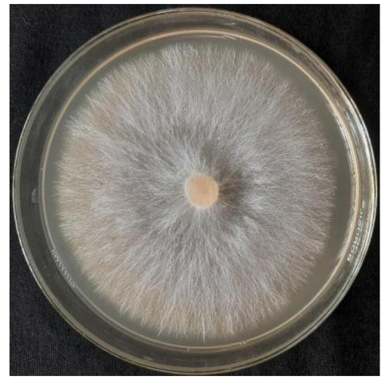
Table 4-*In vitro* evaluation of different herbicides against foot rot fungus caused by *Sclerotiumrolfsii*

S.N.	Treatment	Concentrations	Radial growth (mm)*	Inhibition (%)
1.	Bensulfuron methyl 0.6% + Pretilachlor (6.0% GR)	20.00 gm/lit.	48.67	45.92
2.	Oxadiargyl (80% WP)	0.20 gm/lit.	65.33	27.41
3.	Metsulfuron methyl (20% WP)	0.008 gm/lit	81.33	9.63
4.	Pyrazosulfuron ethyl (10% WP)	4.00 gm/lit.	43.33	51.85
5.	Metribuzin (70% WP)	0.65 gm/lit.	18.00	80.00
6.	Control		90.00	-
	SEm±		0.027	-
	C.D. (P= 0.05)		0.085	-
	C.V.		0.816	-

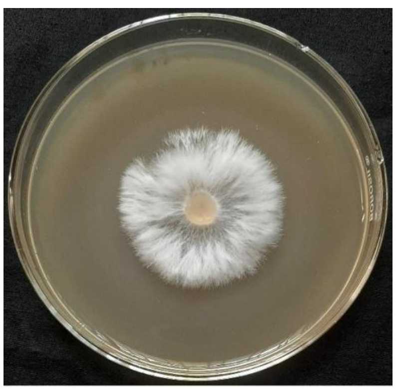
*Average of 3 replications.

Bensufuron methyl + Metsulfuron methyl

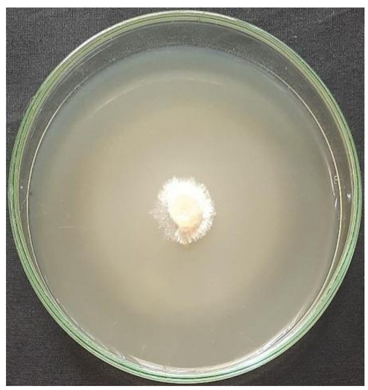
Pretilachlor



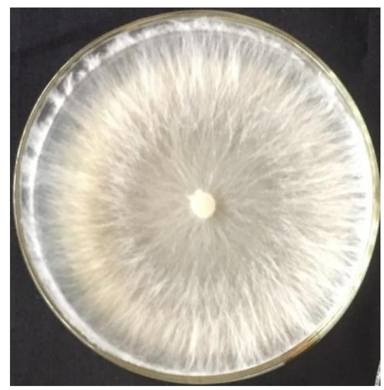
Oxadiargyl



Pyrazosulfuron ethyl



Metribuzin



Control

Plate 2: - *In vitro* evaluation of different herbicides against foot rot fungus caused by *Sclerotiumrolfsii*

Conclusion

Different fungicides were tested for the management of *Sclerotiumrolfsii* among them mancozeb was found to be the best fungicide against *S. rolfsii*, entirely inhibiting radial growth of*S. rolfsii*, followed by Tricyclazole at higher concentrations. Five herbicides were evaluated on the mycelial development of *S. rolfsii*, with metribuzin showing the maximum growth inhibition at 80 %, followed by Pyrazosulfuron ethyl (51.85 %).

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