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Efficacy of herbicides against mycelial growth and sclerotial germination of *Sclerotium rolfsii*, Incitant of stem rot of groundnut

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Abstract
In the present study, different herbicides i.e., Quizalofop ethyl (5% EC), Pendimethalin (30% EC) and Imazethapyr (10% SL) were tested against the mycelial growth at four different concentrations (i.e., 100 ppm, 250 ppm, 500 ppm and 1000 ppm) and sclerotial germination of *Sclerotium rolfsii in vitro.* Effect of different herbicides against mycelial growth of *S. rolfsii* was tested by means of poison food technique. For evaluating the effect on sclerotial germination, soil was taken into plastic cups and sclerotia of *S. rolfsii* were mixed with the soil. The soil in the cups was moistened upto saturation with herbicidal solution at recommended dosage and incubated for 10 days, later the germination of sclerotial bodies was observed by placing them on the media. Among the herbicides tested, *S. rolfsii* was highly sensitive to quizalofop ethyl for both mycelial growth (100% @ 1000 ppm) and sclerotial germination (26.66% @ 0.65%) compared to others. Least sensitivity was observed with imazethapyr at 100 ppm with 21.46% inhibition against mycelial growth and zero per cent inhibition against sclerotial germination.

Keywords: Herbicides, sclerotial germination, poison food technique, *Sclerotium rolfsii*

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the important oil seed crop grown in India and is popularly called as the king of oil seed crops. It is one of the important legume, grown mainly for its oil content and edible seeds. Groundnut seeds contains oil content of 43 to 55 per cent, protein content of 43 to 55 per cent and carbohydrate content of 18 per cent. Not only in carbohydrate, protein and oil content, it is also very good source of minerals (calcium, magnesium and iron) and vitamins (B1, B2 and Niacin). According to USDA report, in India during 2020-21, groundnut is grown in an area of 6000 thousand hectares with the total production of 6700 thousand MT and productivity of 1.1 MT per hectare. Groundnut is prone to large number of biotic and abiotic plant stresses. Among different biotic stresses plant diseases plays a very important role. Several diseases such as tikka leaf spots, rust, stem rot, alternaria leaf spot affects groundnut crop. Among them, stem rot caused by *Sclerotium rolfsii* Sacc. is a potential threat to successful groundnut cultivation. This disease causes severe damage near maturity and yield losses over 25%. It causes pod yield losses of 10-25%, but under severe diseased conditions yield losses may range up to 80% (Rodriguez-Kabana *et al*., 1975) [9]. It forms brownish colour round sclerotia that can survive for long periods in the soil. These sclerotia contains melanin in the outer membrane and helps in tolerating biological and chemical degradation (Chet, 1975) [2]. In the recent years, this disease has become one of the major constraints. Because of its soil borne nature, management of this pathogen is difficult. For effective disease management, integration of bio agents with chemicals gives satisfactory results. Among chemicals, in the recent days, herbicides are also reported to control mycelial growth and sclerotial viability of *S. rolfsii*.

Lal and Nagarajan (1988) [3] evaluated different herbicides i.e., Alachlor, Basalin and Trifluralin against mycelial growth of *S. rolfsii* causing collar rot disease of tobacco *in vitro* at different concentrations and found that cent per cent mycelial inhibition. Singh and Dwivedi (1990) [10] tested the herbicide nitrofen and the insecticide nuvacron against the sclerotial viability of *S. rolfsii* and found that both are effective in reducing the germination of sclerotia. Pastro and March (1999) [6] found that trifluralin and pendimethalin greatly reduced the production of viable sclerotia of *S. rolfsii*. Bhoraniya *et al*. (2002) [1] tested several pesticides *viz.*, metalachlor, fluchloralin, alachlor, pendimethalin, 2,4-D sodium salt, mancozeb, captan, copper oxychloride tridemorph and carboxin against the sclerotial germination of *S. rolfsii* through soil plate technique. They found that carboxin (98.99 per cent) followed by tridemorph (97.89 per cent) and fluchloralin (94.02 per cent) are effective in inhibiting the sclerotial germination. Madhuri and Sagar (2016) [5] tested different herbicides against the mycelial growth of *S. rolfsii in vitro*. According to them, quizalofop ethyl showed cent per cent inhibition followed by pendimethalin (92.22%), imazethapyr (68.88%) and oxyflourfen (51.85%). Rangarani *et al*. (2017) [8] evaluated different herbicides against mycelial growth of *S. rolfsii* and reported that pendimethalin and quizalofop are effective.

Materials and Methods

A. Effect of herbicides against mycelial growth of *Sclerotium rolfsii*

In vitro efficacy of three herbicides were evaluated against the *S. rolfsii*, incitant of stem rot of groundnut. The details of herbicides, their recommended dosage and the concentrations tested in the present study were given in Table 1. Poisoned food technique was employed to evaluate the efficacy of these chemicals. Firstly, stock solution of 30,000 mg a.i. ml^{-1} was prepared from each herbicide, later from the stock solution required quantity was pipetted out and added to required quantity of PDA medium in conical flasks to obtain final test concentration. Twenty ml of herbicidal stock solution was amended to the medium in each pre-sterilized Petri plate. Small disc (0.5cm diameter) was cut with sterilized cork borer from 15 day old culture of *S. rolfsii* under aseptic conditions and placed at the centre of each poisoned plate. The experiment was laid out in CRD with four replications per treatment. Control was maintained by placing fungal discs in plates containing untreated (non poisoned) medium. The inoculated Petri plates were incubated at 28 ± 2 °C in BOD incubator.

Table 1: Details of fungicides herbicides employed in the study

Herbicides	Active ingredient	Concentration tested (ppm)
Pendimethalin	30 EC	1000, 500, 250, 100
Imazethapyr	10 SL	1000, 500, 250, 100
Quizalofop ethyl	5 EC	1000, 500, 250, 100

B. Effect of herbicides against sclerotial germination of *Sclerotium rolfsii*

For the current experiment, dry red loamy soil was used. Ten grams of soil was taken into plastic cups and ten sclerotia of *S. rolfsii* were mixed with the soil. This is a unit representing a replication of a treatment. All the herbicides presented in the Table 1 was tested at recommended dose. The required dose of herbicide solution was prepared and added to the plastic cup containing sclerotia. The soil in the cups was moistened upto saturation and incubated for 10 days at 28 ± 2°C. Control was maintained with distilled water. After 10 days the sclerotia were retrieved and placed on PDA medium and incubated at 28 ± 2 °C for testing their viability. Number of sclerotia germinated was recorded and per cent inhibition of sclerotial germination was recorded using the formula,

$$\text{Per cent inhibition} = \frac{\text{Total number of sclerotia - number of germinated sclerotia}}{\text{Total number of sclerotia}} \times 100$$

Results and Discussion

A. Effect of herbicides against mycelial growth of *Sclerotium rolfsii*

Among the herbicides tested, *S. rolfsii* was highly sensitive to quizalofop ethyl and showed 100 per cent inhibition at 1000 ppm of quizalofop ethyl. Sensitivity decreased with decrease in concentration. Least sensitivity was observed with imazethapyr at 100 ppm and showed 21.46 per cent inhibition over control. The sensitivity of *S. rolfsii* to imazethapyr and pendimethalin has increased with increase in the concentration i.e., 58.46 per cent and 96.96 per cent respectively at 1000 ppm concentration. The results were presented in the Table 2 and Fig. 1.

The efficacy of herbicides in inhibiting the mycelia growth in descending order was as follows:

Quizalofop ethyl > pendimethalin > imazethapyr > control.

Current results agree with the results of Lal and Nagarajan (1988) [3], where they had evaluated different herbicides *i.e.*, alachlor, basalin and trifluralin against *S. rolfsii* at various concentrations and reported that all of them reduced the mycelial growth of the pathogen, while cent per cent inhibition was noticed at higher concentrations (1000 and 2000 ppm). Madhuri and Narayan Reddy (2013) [4] reported that oxyflourfen, alachlor, quizalofop ethyl and 2, 4-D sodium salt completely inhibited the growth of *S. rolfsii*. The efficacy of quizalofop ethyl, pendimethalin, imazethapyr and oxyflourfen on *S. rolfsii* was reported by Madhuri and Sagar (2016) [5]. Rangarani *et al*. (2017) [8] evaluated three herbicides against *S. rolfsii* and reported that pendimethalin and quizalofop ethyl was highly effective. As the usage of herbicides is gaining importance due to increased labour costs, the present study is important as management of weeds plays a key role in suppressing stem rot. Besides, herbicides themselves were reported to show inhibitory effect on *S. rolfsii* and the present study is in agreement with the reports earlier carried out.

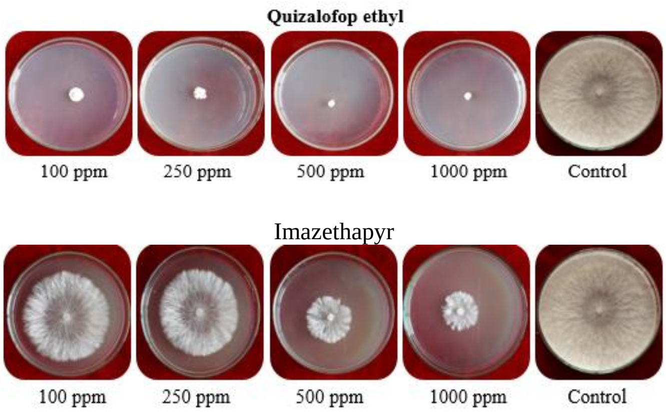

Fig 1: Effect of herbicides on the mycelia growth of *S. rolfsii* after 4 days of incubation

Table 2: Effect of herbicides on the mycelia growth of *S. rolfsii* after 4 days of incubation

	Trade name	Mycelium growth (cm)				Per cent inhibition over control			
		100 ppm	250 ppm	500 ppm	1000 ppm	100 ppm	250 ppm	500 ppm	1000 ppm
Pendemethalin (30% EC)	Dhanutop	2.00	1.67	0.86	0.13	55.53 (48.16**)	58.46 (49.92)	80.70 (63.94)	96.96 (80.07)
Quizalofopethyl 5% EC)	Targa super	0.60	0.26	0.06	0.00	85.10 (67.54)	94.03 (75.88)	98.46 (84.16)	100.00 (90.00)
Imazythpyr (10% SL)	Guard	2.86	2.66	2.03	1.76	21.46 (27.58)	25.86 (30.54)	48.83 (44.31)	58.46 (49.85)
Control		4.5				0.0			
		C.D.				4.66			
		SE(m)				1.59			
		SE(d)				2.25			
		C.V.				5.04			

**Figures in parentheses are angular transformed values

B. Effect of herbicides against sclerotial germination of *Sclerotium rolfsii*

Among the three herbicides tested, quizalofop ethyl was highly effective in inhibiting the germination of sclerotia and recorded 36.66 per cent reduction of sclerotial germination over control followed by pendimethalin (73.33%) and were significantly different from each other. Imazethapyr did not show any effect in inhibiting the sclerotial germination. The results were presented in the Table 3 and Fig. 2.

Efficiency of herbicides in inhibiting the scerotial germination was in the following order:

Quizalofop ethyl > pendimethalin > imazethapyr = control

Singh and Dwivedi (1990) [10] reported that nitrofen and nuvacron greatly reduced the germination of sclerotia. Pathak *et al*. (1996) [7] observed the viability of buried sclerotia of *R. solani*, and found that paraquat was the most potent in reducing the mycelial growth and production of sclerotia followed by thiobencarb, butachlor and 2, 4-D. Pastro and March (1999) [6] evaluated the effects of herbicides on the production and viability of *S. rolfsii in vitro* and found trifluralin and pendimethalin were the most efficient compounds because they notably reduced the production of viable sclerotia.

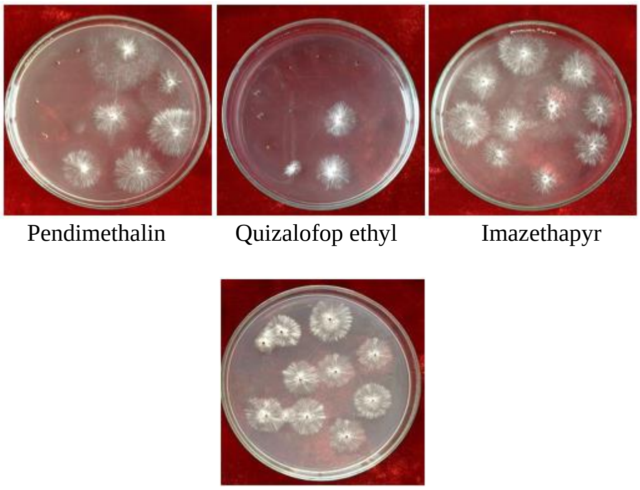

Fig 2: Effect of herbicides on sclerotial germination of *S. rolfsii*

Table 3: Effect of herbicides on sclerotial germination of *S. rolfsii*

Herbicide	Trade name	Concentration (%)	Sclerotial germination (%)	Per cent inhibition over control
Imazethapyr (10% SL)	Guard	0.15	100.00 (90.00**)	0.00 (0.00)
Quizalfop ethyl (5% EC)	Targa super	0.2	36.66 (37.21)	63.33 (52.75)
Pendimethalin (30% EC)	Dhanutop	0.65	73.33 (58.98)	26.66 (30.98)
Control			100.00 (90.00)	0.00 (0.00)
C.D.			4.94	4.94
SE(m)			1.49	1.49
SE(d)			2.11	2.11
C.V.			3.74	12.36

** Figures in parentheses are angular transformed values

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