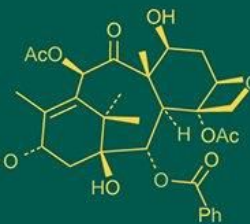
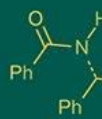


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Distribution and eco-friendly management of *Rhizoctonia solani* by medicinal plant extracts

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Abstract

This study investigates the distribution of black scurf disease in potatoes within Meerut district and evaluates the effectiveness of various medicinal plant extracts against this disease. It was conducted at the Department of Plant Pathology at IFTM University, Moradabad, Uttar Pradesh. The survey results showed that black scurf affected potato tubers were present in all locations visited. A total of nine sites were explored, focusing on three potato varieties—Kufri Bahar, Kufri Jyoti, and Kufri Chipsona—commonly cultivated by local farmers. Most farmers treated their stored potato tubers with Carbendazim fungicide, while one farmer opted for Sartaz, a combination of Carbendazim and Mancozeb. The highest disease incidence and intensity, recorded at Bhagwanpura cold store, were 76% and 38%, respectively. In contrast, Badaun and Modipuram had the lowest disease incidence at 25% and intensity values of 12.05 and 13.60. The remaining six locations—Shamli, Pablikhas, Lawad, Bhatipura, Sheikupura, and Machhra—reported disease incidences between 28% to 60%, with intensity measurements ranging from 15.06 to 20.05. Furthermore, the study tested several aqueous extracts from medicinal plants, including tulsi, neem, ginger, turmeric, and clove. Even at a 50% concentration, these extracts demonstrated considerable antifungal potential, with effectiveness ranging from 70.73% to 77.64%. At a 100% concentration, the extracts almost eliminated the pathogen, achieving between 88.23% to 100% reduction in growth. Notably, clove extract stood out, achieving complete elimination of fungal growth at both 50% and 100% concentrations. Overall, the results highlight the promising antifungal properties of these plant extracts against the fungus *R. solani*, showing significant potential for managing black scurf in potatoes.

Keywords: Eco-friendly, medicinal plant extract, survey and *R. solani*

Introduction

Potato (*Solanum tuberosum*) is one of the important food crops after rice, wheat and maize and diseases are one of the yields reducing factors, which causes low yield of potato. Black scurf of potato caused by *Rhizoctonia solani* Kuhn (*Thanatephorus cucumeris* (Frank) Donk) is a serious disease of potato worldwide and distributed in India in different regions in low to severe form. The disease results in formation of black, irregular lumpy encrustations on the surface of potato tubers which reduce their quality and market value (Arora 2008) ^[1]. The disease is ubiquitous in India and it is serious in fields where potato is grown year after year (Khurana *et al.* (1998) ^[2] and Arora (2012) ^[3]. *Rhizoctonia solani* primarily attacks below ground plant parts such as the seeds, hypocotyls, and roots, but is also capable of infecting above ground plant parts (e.g. pods, fruits, leaves and stems).

R. solani has often been associated with root rot and yield decline in field crops. The pathogen is predominantly a plant pathogenic, soil inhabiting. *R. solani* (Carling and Leiner, 1990) ^[4], damages crop during growing season and is multifaceted in nature and attacks almost all plant. The fungus is troublesome for cabbage, lettuce and sugar beet but it is particularly destructive to beans, soybean, pepper, and rubber plants causing considerable losses. Through cross pathogenicity of *R. solani*, the isolates collected from wheat, rice, maize and cotton, it was observed that there is no evidence of virulence to cotton (yan *et al.*, 1984) ^[5].

The survival of various *Rhizoctonia* strains may be due to other crops or weeds acting as secondary hosts. Considerable loss is incurred for potato as well as for other crops viz., lentil, chick pea and mung bean grown in potato field in the following season (Khandaker *et al.*, 2006) ^[6].

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Disease symptoms include development of canker of root and stems (Banville and Carling, 2001) [7]. Above ground symptom of disease such as plant stunting, chlorosis, puckering of leaves and formation of *Rhizoctonia* patches may also be apparent (Banville and Carling, 2001) [7]. Early season infection can result in delayed emergence (Frank and Leach, 1980) [9]. Chemical fungicides are commonly used successfully for control of *Rhizoctonia* root-rot. However, there field application may not always be desirable. The persistent, injudicious use of chemicals was discouraged owing to their toxic effects on non-target organisms, the undesirable changes they inflict upon the environment and due to the development of resistant strains of pathogens against various chemicals fungicide. Keeping in view the drawback of chemical control of plant disease, the use of plant extract in the control of plant disease is gaining importance.

In the present experiment various medicinal plant extracts were used to find out reaction of different crop leaves against *R. solani*

Materials and Methods

A survey was done before the start of potato planting; various cold stores were visited for the collection of data on the distribution of disease incidence and intensity during first week of October 2019. In total, nine locations, namely Shamli, Pablikhas, Lawad, Bhatipura, Sheikupura, Machhra, Modipuram, Badaun and Bhagwanpura were visited twice. At each location, infected tubers were collected from five different locations and from these observations percent disease incidence was calculated by using formula A. The disease intensity was rated 0 to 4 scale where 0 means no infections and 4 means more than 75% infection, and was calculated by using formula B.

$$A. \% \text{ disease incidence} = \frac{\text{No. of infected tubers}}{\text{total no. of tubers}} \times 100$$

$$B. \% \text{ disease intensity} = \frac{\text{Summation of all ratings}}{\text{No. of tubers observed} \times \text{max. rating (4)}} \times 100$$

Since black scurf (*Rhizoctonia solani*) disease of potato is a seed and soil borne disease with high level of survival, managing it has become difficult task field and lab experiments conducted with various medicinal plant extract along with control at Department of Plant Pathology IFTM University Moradabad, Uttar Pradesh. during kharif 2020 to understand the antifungal efficacy of medicinal plant extract medicinal plant materials (Tulsi, Turmeric, Ginger, and Neem) were washed with distilled water and dried in shade. The selected Leaf samples PDA with 50% and 100% concentration of aqueous extracts of test plant Neem, Ginger, Tulsi, Turmeric and Clove were prepared. About (10 gm) of all plant's leaves were thoroughly washed; blot dried and macerated 10 ml sterile distilled water in a blender. The macerate was first filtered through double layered muslin cloth and the supernatant was filtered through Whitman no. 1 filter paper and sterilized at 121 °C for 20 min. which served as the mother extract for carrying out anti-fungal activity of the plant extract by technique given by (Nene and Thapliyal 1979) [14]. Potato Dextrose Agar medium (20 ml of medium was poured into each Petri plate and allowed to solidify. 5 mm disc of 72h old *R. solani* culture was placed aseptically at the centre of each plate and inoculated at 28± for 4 days. After completion of incubation

period radial fungal growth (cm) was measured and recorded in each treatment. Each treatment had 3 replications. PDA medium without aqueous extract served as control. Antifungal activity of medicinal plant extract as high, medium and low based on percent inhibition of mycelia growth was calculated using following formula.

$$\% \text{ inhibition} = \frac{dc-dt}{dc} \times 100$$

Where dc = average mycelia growth in control, dt = average mycelia growth in treatment

Table 1: List of plant species tested for antifungal activity against *R. solani*

S. No	Name of the plant	Botanical name	Family
1	Turmeric	<i>Curcuma longa</i>	Zingiberaceae
2	Neem	<i>Azadirachta indica</i>	Meliaceae
3	Ginger	<i>Zingiber officinale</i>	Zingiberaceae
4	Tulsi	<i>Ocimum tenuiflorum</i>	Lamiaceae
5	Clove	<i>Syzygium aromaticum</i>	Myrtle

Results and Discussion

Isolation of Black scurf of potato

Rhizoctonia solani isolated from naturally diseased potato tubers showing typical symptoms of scruffy sclerotia was cultured on PDA medium Petri plates. After three days of incubation, the plates were observed for cultural characteristics. The microscopic examination of the mycelium revealed that the *Rhizoctonia* species had septate mycelium. Each mycelium cell contained a nucleus. The mycelium of *Rhizoctonia* species showed no color when viewed in the early stages of growth. The slide prepared from the old culture exhibited a change from colorless to brown or black mycelium.

Identification of *Rhizoctonia Solani* Pathogen

The branching pattern under high power (400x) revealed the presence of germinating hyphae at approximately right angles to the main hypha, with a slight constriction at the junction. Since *Rhizoctonia* was isolated from potato, it was presumed that the *Rhizoctonia* species belonged to the solani species. The characteristics of *Rhizoctonia solani* observed here in the present study were found to be similar to those already reported in the literature, thus confirming earlier reports of (Banville *et al.* 1996) [8].

Distribution of Black Scurf of Potato in Meerut and Around

Black scurf disease of potato is prevalent wherever potatoes are grown. This disease causes economic losses to potato crops, resulting in both qualitative and quantitative damage in potato production. Realizing its importance, various cold stores were visited twice during the time of potato planting, and data on the percentage of disease was collected. The results of the survey revealed that black scurf-infected potato tubers were found at every location. In total, nine locations were visited, and observations were recorded on three potato varieties, namely: K. Bahar, K. Joyti, and K. Chipsona, which are commonly grown by almost all the farmers. In addition to this, nearly all the farmers treated stored potato tubers with Carbendazim fungicide, except for one who used Sartaz (a combination of Carbendazim and Mancozeb). The highest percentage of disease incidence and disease intensity (76.0 and 38.0) were recorded in

Bhagwanpura cold store, while the lowest incidence was 25.0 and intensity was 12.05 and 13.60 in the Badaun and Modipuram locations. In the other six locations, namely Shamli, Pablikhas, Lawad, Bhatipura, Sheikupura, and Machhra, the percentage of disease incidence ranged between 28.0 to 60.0, and intensity varied between 15.06 to 20.05 (Table 3 & table 4).

In general, the results reveal the existence of black scurf disease of potato was common in all the nine surveyed locations. These results conform the earlier reports where it is stated that black scurf of potato is widespread in all the potato growing areas and causes significant losses (Khurana *et al.* 2001)^[10].

Table 2: Distribution of black scurf disease of potato caused by *Rhizoctonia solani* in Meerut and around.

S. No.	Location	Potato Cultivar	Disease incidence of Black Scurf		% Average disease incidence
			No. of tubers observed	No. of disease	
1	Bhagwanpura	Kufri Bahar	250	190	76.0
2	Shamli	Kufri Bahar	300	84	28.0
3	Budaun	Kufri jyoti	200	50	25.0
4	Pablikhas	Kufri Bahar	200	80	40.0
5	Sheikupura	Kufri jyoti	200	110	55.0
6	Modipuram	Kufri chipsona	200	50	25.0
7	Lawad	Kufri chipsona	200	60	30.0
8	Bhatipura	Kufri chipsona	300	180	60.0
9	Machhra	Kufri chipsona	300	120	40.0

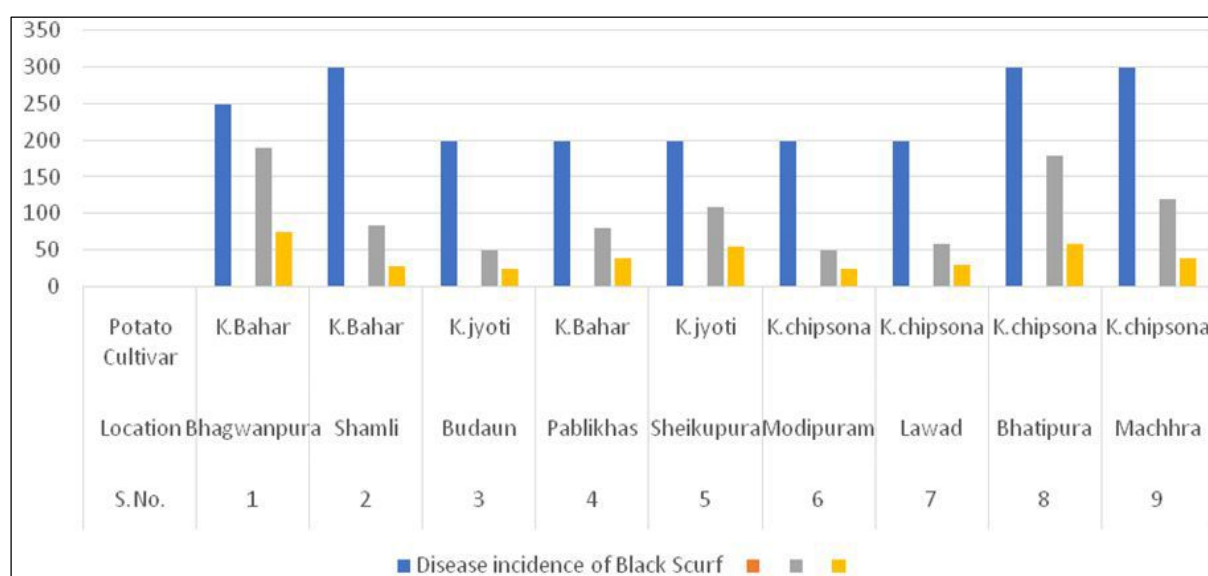


Fig 1: Distribution of black scurf disease of potato caused by *Rhizoctonia solani* in Meerut and around.

Table 3: Percent Black scurf intensity in potato cultivars located at different place in Meerut district

S. No	Location	Potato Cultivar	Fungicide Use	Disease intensity
1	Bhagwanpura	Kufri Bahar	Carbendazim and mancozeb	38.08
2	Shamli	Kufri Bahar	Carbendazim	11.06
3	Budaun	Kufri.jyoti	Carbendazim	12.05
4	Pablikhas	Kufri.Bahar	Carbendazim	16.08
5	Sheikupura	Kufri.jyoti	Carbendazim	18.05
6	Modipuram	Kufri.chipsona	Carbendazim	13.60
7	Lawad	Kufri.chipsona	Carbendazim	15.08
8	Bhatipura	Kufri.chipsona	Carbendazim	19.50
9	Machhra	Kufri.chipsona	Carbendazim	20.05

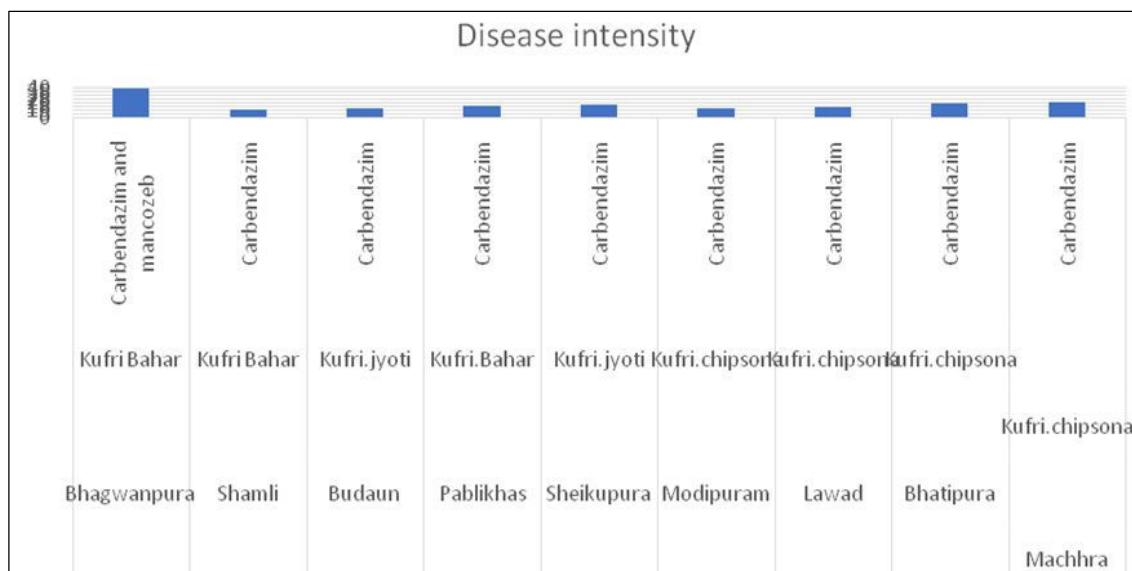


Fig 2: Percent Black scurf intensity in potato cultivars located at different place in Meerut district

Antifungal Activity of Medicinal Plant Extracts Against *Rhizoctonia Solani* Growth

The antifungal potential of tested aqueous medicinal plant extracts, namely Tulsi, neem, ginger, turmeric, and clove even at 50% concentrations, was found very effective and recorded more than moderate potential. All these plant extracts revealed significantly high antifungal activity ranging between 70.73 to 77.64% at their 50% conc. whereas these treatments recorded almost near elimination of pathogen growth, ranging between 88.23 to 100% at their 100% conc. (Table 5). Apart from this only the clove extract recorded complete elimination of fungal growth at both the concentration. (50% and 100%).

All tested plant extracts had an antifungal potential against radial growth of *R. solani*. The pathogen growth decreased significantly with increasing concentration of plant extracts. Highest antifungal activity was observed in clove extract which even at low concentration. The difference in degree of antifungal potential is only due to the chemical composition of individual plant extract. Many previous research findings have already identified the presence of

different types of chemical fractions in these extracts (Nalina and Rahim, 2009 and Ali *et al.* 2010) [11, 12]. Further, these results indicate that effective conc. of plant extracts is needed to suppress the mycelia growth and sclerotia formation of *R. solani* pathogen.

Table 4: Average percent growth reaction of *R. solani* in response to tested medicinal plant extracts

S. No.	Plant Extracts	Percent concentration	Average radian <i>R. solani</i> (in cm)		Percent growth reduction
			Control	Treatment	
1	Turmeric	50.00	8.50	2.00	76.47
		100.00	8.50	0.50	94.11
2	Tulsi	50.00	8.20	2.40	70.73
		100.00	8.50	1.00	88.23
3	Neem	50.00	8.50	1.90	77.64
		100.00	8.40	0.70	91.66
4	Ginger	50.00	8.60	2.50	70.93
		100.00	8.50	0.00	100
5	Clove	50.00	7.88	0.00	100
		100.00	8.00	0.00	100

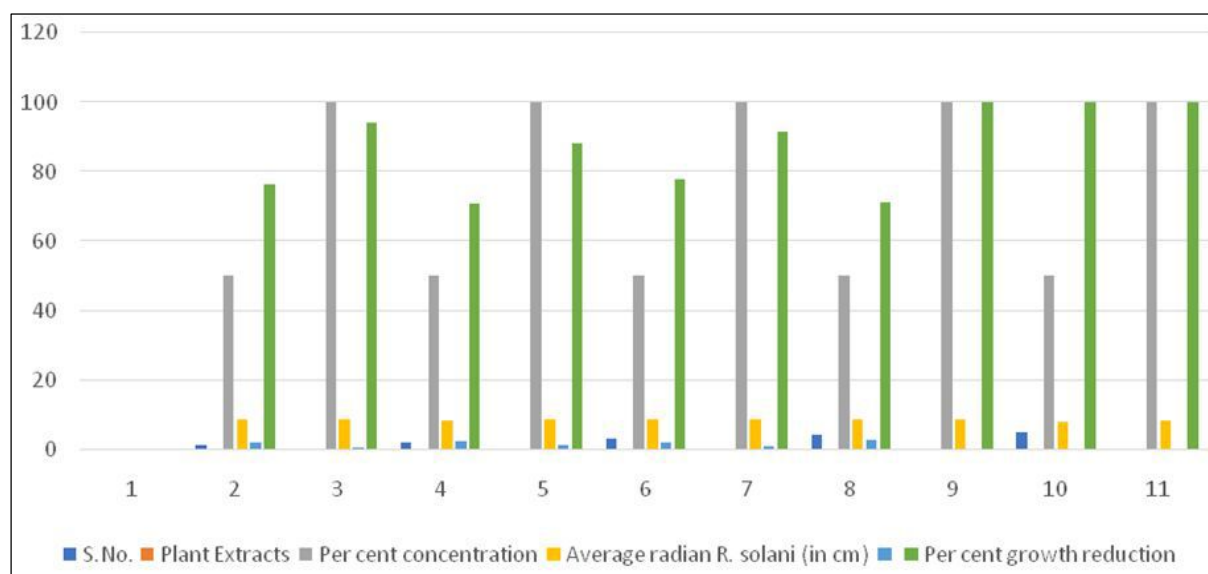


Fig 4: Average percent growth reaction of *R. solani* in response to tested medicinal plant extracts

Efficacy Rating of Plant Extract Against *R. solani*

Results in Table 6 indicate that the aqueous extracts of all the medicinal plants namely turmeric, Tulsi, neem, ginger and clove were found very effective in reducing redial growth of *R. solani* even at low conc. of 50%. At higher conc. of 100% all the five medicinal plant extracts exhibited near elimination of *R. solani* growth and had very high efficacy against this pathogen.

These results agree with research findings (Nalina and Rahim, 2007 and Ali *et al.*, 2010) ^[13, 12] where it has been reported that medicinal plant extracts have got high antifungal properties to restrict the mycelia growth of *R. solani*. Further elaborate research work is required to identify bioactive chemicals having antifungal activity in these plants' extracts.

Table 5: Efficacy rating of plant extract against *R. solani*

S. No.	Plant Extract	Botanical Name	Treatment efficacy	
			50%	100%
1	Turmeric	<i>Curcuma longa</i>	Medium to high	High to near elimination
2	Tulsi	<i>Ocimum tenuiflorum</i>	Medium to high	High
3	Neem	<i>Azadirachta indica</i>	Medium to high	High to near elimination
4	Ginger	<i>Zingiber officinale</i>	Medium to high	High to near elimination
5	Clove	<i>Syzygium aromaticum</i>	Medium to high	High to near elimination

Conclusion

The survey in Meerut district showed that black scurf is a serious problem for potatoes in all areas studied. Among the three potato varieties— Kufri Bahar, Kufri Jyoti, and Kufri Chipsona—there were notable differences in how much the disease affected them, with the Bhagwanpura cold store having the highest rates. Most farmers used Carbendazim fungicide to treat their potatoes, but one used a mix that included Mancozeb. The study also tested extracts from medicinal plants like Tulsi, neem, ginger, turmeric, and clove for their antifungal effects. Even at half concentration, these extracts showed good antifungal activity, and at full concentration, they were nearly 100% effective in stopping fungal growth. Clove extract was especially effective. This study highlights that black scurf is a major issue for potato farmers in the region, and it also suggests that clove extract could be a good natural alternative to chemical fungicides for fighting this disease.

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