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Efficacy of bioagents and Fungi toxicants against black scurf (*Rhizoctonia solani*) of Potato

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Abstract
Potato (*Solanum tuberosum* L., Family Solanaceae), popularly known as "The King of Vegetables" is a native of South America and occupies the largest area under any single vegetable crop in the world. It is affected various disease including early and late blight, brown rot, sclerotium wilt, black scurf. black scurf is one of the most destructive diseases of potato caused by *Rhizoctonia solani* Kuhn. This disease caused yield loss and reduced the quality of potato crop. An experiment was conducted to test the efficacy of bioagents and fungi toxicant against Black scurf disease reduction as well as germination and yield parameter, at department of plant pathology, Rama University, Kanpur during rabi season 2023-24. Result of study revealed that foliar application of Pencycuron 250 SC @ 0.25% led to minimum disease incidence (5.33%) and maximum disease incidence reduction (52.67%) and foliar application of Mencozeb 75% WP @ 0.25% led to promote the germination (88.67%) and tuber treatment with 3% boric acid led to maximum yield (265.33 q/ha). Among the bioagent *Bacillus subtillis* was effective to reduction of disease incidence (36.33%) and promoting the germination (86.33%) and yield (224.67q/ha) of potato crop.

Keywords: Potato, bioagents, fungi toxicants, black scurf, disease incidence

Introduction
Potato (*Solanum tuberosum* L., Family Solanaceae), popularly known as "The King of Vegetables" is a native of South America and occupies the largest area under any single vegetable crop in the world. Potato is also a key crop in Indian agriculture, around 85-90 per cent of the potato crop in India is grown as a *rabi* crop in the plains, in October, while rest in *kharif* season from the states of Maharashtra, Himachal Pradesh, Jammu and Kashmir as well as Uttarakhand and as summer crop from the hilly areas of Karnataka (Pant *et al.*, 2019) [18]. India is second largest potato producer country in world after China with 59.79 million metric tons of production from 2.35 million hectares area and productivity is 24.55 tons per hectare. (National Horticulture Database, 2022-2023). Uttar Pradesh rang first in potato production with 29.3 percent share in total production of the country. In Uttar Pradesh potato occupies an area of 5.05 lakh hectares and production of 15.89 million tons with productivity of 22.42 tons per hectare in the year 2022. Potato has been declared as the "food for future" and is ideal for consumption by human because of its high nutritive value which consist of mostly all the macro nutrients as well as micronutrients. Potatoes are part of the diet of half a billion people in the developing countries. FAO statistics estimates world utilization of current potato production as 45% for human food, 30% for animals, 15% for seed, 2% for starch, and about 8% as waste. The incidence of black scurf has been reported up to 37% from different parts of state (Khana and Sharma, 1996) [7]. The characteristic symptoms of the disease include the presence of stem canker and black colored hard masses of sclerotia on the tuber which are superficial resulting in irregular shape and reduced size of tubers. Apart from the reduction in yield it also greatly diminishes the market acceptability of potato due to the presence of black sclerotia on the tuber surface. The sclerotia develops on tuber even under low inoculum level and as the inoculum level increases so is the increment in the black scurf severity. Control of soil-borne plant pathogens is usually done by cultural, physical, mechanical, biological, and last one chemical method.

Materials and Methods

The impacts of Bioagents Such as *Trichoderma harzianum* and *Bacillus subtillis* and fungicide under the field condition was investigated during Rabi season 2023 24 at Department of Plant Pathology, Rama University, Kanpur Uttar Pradesh between 26º 56°'N latitude and 80.21º'E longitude at an altitude of 318 meters above the mean sea level. The Randomized block design wase use for this experiment. Six different treatment were applied *viz*., Tuber treatment, Foliar application using Bioagents such as tubers treatment with *Trichoderma harzianum*, tubers treatment with *Bacillus subtillis*, Pencycuron (250 SC) foliar spray, Boric acid @ 3% tubers treatment, Mencozeb 75% WP foliar spray.

Bioagents

Pure Culture of *Trichoderma harzianum* and *Bacillus subtillis*, were obtained from the department of plant Pathology, Rama University, Kanpur. *Trichoderma harzianum* mass multiplication on sorghum grain in 250ml conical flask and kept in BOD incubator at 28 °C temperature for 15 days and make powder formulation and *Bacillus subtillis* was mass multiplied in Nutrient broth and kept in shaker BOD for 48hr after 48 hr check CFU. Tuber treatment with bioagent @10gm bioagents formulation for 1kg of potato tuber seed.

Fungicide

Three different fungi *viz*, Pencycuron (250 SC), Boric acid @ 3%, Mencozeb 75% WP were use for foliar spray and tuber treatment @ 0.25%. Stock solution of each treatment (fungicides) was prepared by using following formula: -

$C1V1 = C2V2$

Where, C1 = Concentration of stock solution (gm/ml), C2 = Desired concentration (gm/ml), V1 = Volume (ml) of the stock solution to be added and V2 = Measured volume (ml) of the PSA medium.

Preparation of Pathogen Inoculum

Rhizoctonia solani was isolated from infected tuber sample which was collected from farmer field. The infected sample was isolated in PDA media than purified and check in microscopic. The pathogen inoculum obtains from pure petri dish transfer into Potato dextrose broth (PDB), kept in BOD incubator for 10 days. after complete pathogen growth, the mycelial mat was harvested. The conidia concentration was calculated by using hemocytometer and adjusted at 6×10^{7} /ml

Mode of application

Potato tuber seed were treated with *Trichoderma harzianum* and *Bacillussubtillis* at the rate of 10 gm *Trichoderma* powder, 10 ml *Bacillus* suspension and, 3% Boric acid per kg potato tuber applied 30 minutes before sowing. Foliar application of Pencycuron (250 SC), Mencozeb 75% WP at the rate of 0.25% at 30 to 35 days after sowing.

Effect on growth and yield parameters.

Germination percent

Number of sprouts emerged were noted after ten days of sowing and percentage of germination was calculated.

Plant height

Ten plants were selected at random from each plot and plant height was measured after 30 and 60 days of sowing.

Yield

Tuber yield was recorded for each plot at harvesting in terms of kg/plot which was converted to q/ha.

Effect on disease incidence

After harvest number of tubers having scurf were recorded and percentage of infected tuber was calculated for each plot. The percent disease incidence was calculated by using the formula devised by Mathur *et al*. 1972 [1].

$$\text{Disease incidence (\%)} = \frac{\text{No.of tuber exhibiting black scurf of potato}}{\text{Total number of plants observed}} \times 100$$

$$\text{Disease severity} = \frac{\text{Sum of all numerical ratings}}{\text{Total number of tubers counted x maximum rating}} \times 100$$

Results and Discussion

Effect on growth and yield parameters.

Germination %

As the data present in table 1&2, indicates that among all treatments the height germination percent (88.67%) was observed in plots where foliar sprayed with Mencozeb 75% WP (88.67%) followed by foliar sprayed with Pencycuron 250 SC (87.33%), whereas minimum germination was recorded in tubers treatment with *Trichoderma harzianum* (83.67%). This finding was accordance with Goswami *et al*., (2018) [17].

Plants height

Asdata present in table 1&2 and graph 3&4, indicates that highest plant height (34.66cm in 30 DAS, 45.67cm in 60 DAS) were observed in the plot sprayed with Mencozeb 75% WP followed by tubers treatment with Boric acid @ 3% (33.33cm and 43.33cm) and lowest plants height were recorded in tubers treatment with *Trichoderma harzianum* (30cm, 41cm). the similar finding was also reported in Bagri *et al*., (2017) [16].

Yield (q/ha)

As data is present in table 1&2, and graph 2&3, indicates that the highest yield265.33 q/ha were observed in plot which tubers treatment with Boric acid @ 3% i.e. followed by foliar sprayed with Pencycuron 250 SC (263.44 q/ha), and the minimum yield q/ha were recorded in tubers treatment with *Trichoderma harzianum* (207.22 q/ha). The similar finding was also reported in Bagri *et al*., (2017) [16].

Effect of disease incidence

The data present in table 2, and graph 3, disease incidence varies in treated plots from 5.33% to 38.6%. The minimum disease incidence5.33% were observed in plots where foliar sprayed with Pencycuron 250 SC followed by foliar sprayed with Mencozeb 75% WP (11.33%), whereas the maximum disease incidence was recorded in tubers treatment with *Trichoderma harzianum* (38.6%). The similar finding was also reported by Goswami *et al*., (2018) [17], Bagri *et al*., (2017) [16].

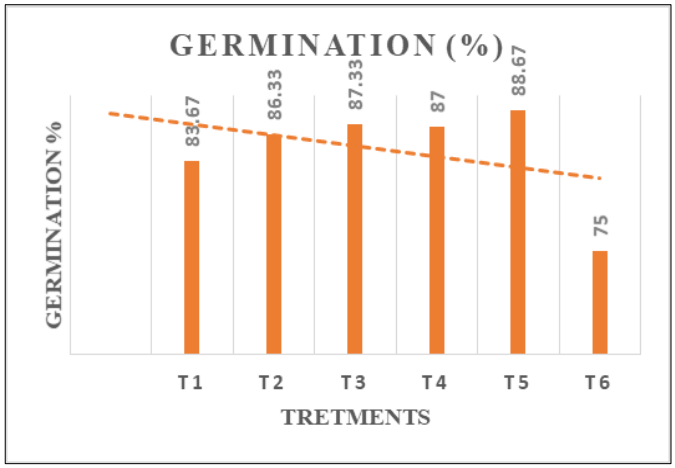

Fig 1: Germination %

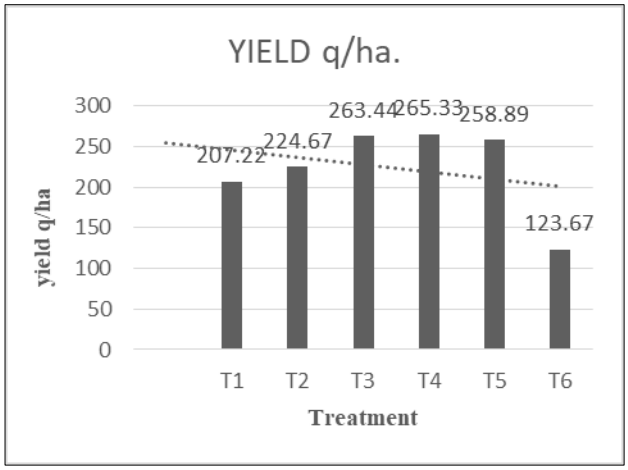

Fig 2: Yield q/h

Table 1: Test the efficacy of different bio-agents and fungi toxicants on growth and yield parameters of Potato crop *in-vivo* conditions.

Treatment	Germination (%)	Plant height		Yield q/ha.
		30 DAS	60 DAS	
T_1	83.67	30	41	207.22
T_2	86.33	32.67	42.67	263.44
T_3	87.33	32.67	42.33	263.44
T_4	87	33.33	43.33	265.33
T_5	88.67	34.67	45.67	258.89
T_6	75	22.67	35	123.67

Table 2: Effect of different bio-agents and fungi toxicants against the black scurf of potato *in vivo* conditions

Sr.No.	Treatment	Treatment detail	Germination (%)	Plant height		Disease incidence (%)	Yield q/ha.	Disease reduction
				30 DAS	60 DAS			
1	T1	Seed treatment with *T. harzianum*	83.67	30	41	38.6	207.22	19.4
2	T2	Seed treatment with *Bacillus subtillis*	86.33	32.67	42.67	21.67	224.67	36.33
3	T3	Pencycuron (250 SC) foliar sray	87.33	32.67	42.33	5.33	263.44	52.67
4	T4	Boric acid @ 3% tubers treatment	87	33.33	43.33	15.33	265.33	42.67
5	T5	Mencozeb 75% WP foliar sray	88.67	34.67	45.67	11.33	258.89	46.67
6	T6	Control	75	22.67	35	58	123.67	0
		CD at 5%		**2.186**	**2.019**	**1.849**	**2.754**	
		SE (d)		**0.969**	**0.894**	**0.819**	**1.22**	
		SE(m)		**0.685**	**0.632**	**0.579**	**0.863**	
		CV		**3.827**	**2.629**	**4.007**	**0.668**	

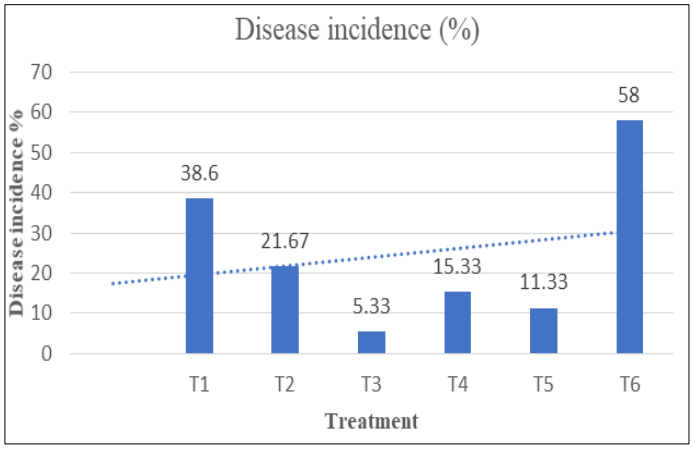

Fig 3: Disease incidence % of *R. solani*

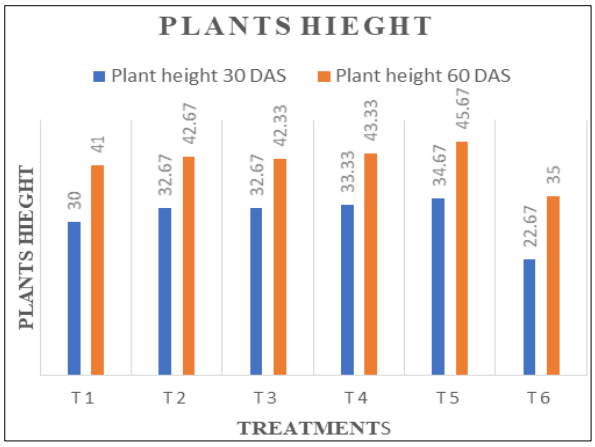

Fig 4: Plants Hieght

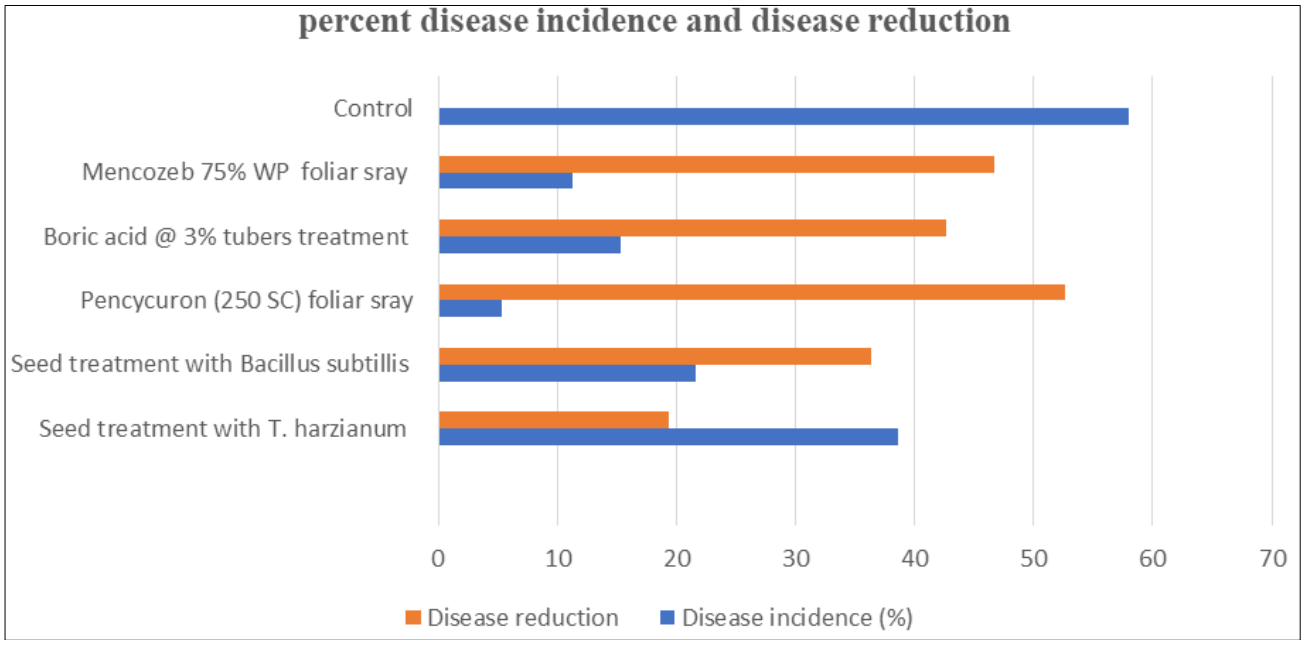

Fig 5: Percent disease incidence and disease reduction of *R.solani* on potato crop

Conclusion

Foliar spray with Pencycuron 250 SC was found most effective for reduction of disease incidence of *Rhizoctonia solani* on potato but quite less effective than Mencozeb 75% WP to promoting growth and yield of potato crop. Mencozeb 75% WP was found most effective for promote the germination and tuber treatment with 3% boric acid led to maximum yield (q/ha) of potato crop over the control. Among the bioagents *Bacillus subtillis* was effective to reduction of disease incidence and promoting the germination and yield of potato crop, but present investigation to control of *Rhizoctonia solani* caused black scurf disease of potato, fungi toxicants was found highly effective than bioagents.

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