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MANAGEMENT OF BLACK SCURF DISEASE OF POTATO

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Abstract

Management of black scurf (*Rhizoctoni solani*) of potato (*Solanum tuberosum* L.) through determining level of susceptibility in various breeding lines/cultivars of potato and tuber treatment with various fungicides was investigated by using *R. solani* AG-3 isolate CL-58 (a known aggressive). Greenhouse screening of fifteen potato breeding lines and cultivars for host plant resistance to isolate CL-58 by soil inoculation revealed potato cvs. Cardinal and Desiree, resistant and susceptible, respectively. Management of disease by using susceptible cv. Desiree through potato tuber treatment with fungicides viz., Dithane M-45, Monceren and Benlate and then sowing them in potting mixture previously inoculated with inoculum of the fungus revealed Dithane M-45, a promising fungicide for management of this disease. It significantly checked eyes germination inhibition and decreased sprout killing, stem girdling, stem canker, black scurf incidence and severity over non-treated inoculated control. Based upon the results achieved, it is necessary to adopt this practice as seed treatment of chemicals is not a regular exercise in Pakistan. This in-turn will protect potato crop from seed-borne infection and will ultimately lead to better and healthy crop stand.

Introduction

The management of *Rhizoctonia solani* Kühn (teleomorph *Thanatephorus cucumeris* (A. B. Frank) Donk), the cause of potato black scurf, is complex due to its soil-borne nature and high level of survival. This pathogen is present in most of the soils and if once established in a field, remains there for an indefinite period. Dry sclerotia of the fungus are described to stay alive up to six years when stored at room hotness (Kumar, 1976). *Rhizoctonia* disease commence by seed or soil-borne inoculum and both inocula are equally damaging. Presently, it is not possible to entirely control this disease, but severity may be limited by following a combination of crop protection strategies for successful disease management. As the most significant measures are cultural, chemical controls should also be employed. Variability in resistance to the pathogen may be accredited to the pathogen or the host. Hence, it is vital to know the variability in the pathogen in relation to its host resistance for a successful breeding plan. Resistance to fungal diseases for instance *Rhizoctonia* canker, *Fusarium* wilt, *Fusarium* dry rot, *Verticillium* wilt, *Phoma* rot and *Cercospora* leaf blotch, have been hardly taken into account in potato breeding. Differences in disease expression of potato cultivars have been reported by Frank *et al.*, (1976). Although, many seed-borne diseases including black scurf have been reported on potato in Pakistan but their quantitative role in seedling mortality and field performance has not been investigated. A number of fungicides such as benomyl, chloroneb, iprodione and pentachloronitrobenzene (quintozene) are effective in managing diseases incited by *Rhizoctonia* on numerous crops. Seed, soil and foliar applications of these chemicals have controlled *Rhizoctonia* induced diseases on snap bean, lima bean, cowpea, celery and other crops (Lewis *et al.*, 1983; Sumner, 1987; Pieczarka & Lorbeer, 1997). Various workers have reported successful control of *R. solani* through seed dressing with chemicals. Leadbeater & Kirk (1992) found commercially

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suitable control with fenpiclonil to combat black scurf and *Rhizoctonia* canker (*R. solani*), silver scurf (*Helminthosporium solani*), skin spot (*Polyscytalum pustulans*), dry rot (*Fusarium* spp.), gangrene (*Phoma exigua* var *foveata*) and black dot (*Colletotrichum coccodes*) by applying as a pre-planting treatment. They reported that fenpiclonil is likely to make an important contribution to potato diseases management. Rudkiewicz & Sikorski (1983) also reported control of rhizoctoniosis, together with Chitting by using Dithane M-45 as seed dressing to early potato varieties. The findings manifested delay in emergence, improved uniformity of plants and significantly better plant and fruit health. In another study by Read & Hide (1995), fenpiclonil and propiconazole seed dressing lessen black dot disease on roots, stem bases and tubers early in the crop season but at harvesting time , fenpiclonil only lessen disease on tubers.

Few fungicides are registered in Pakistan for the management of potato diseases especially early and late blight caused by *Alternaria solani* and *Phytophthora infestans*, respectively. No fungicide is registered for the management of potato black scurf. Moreover, cultural strategies are inadequate. Therefore, alternative fungicide treatment against *R. solani* needs to be developed. This study was carried out with the objective, of management of black scurf of potato based on host plant resistance and through fungicides.

Materials and Methods

Investigations for the management of black scurf were conducted during autumn of year 2004. In the first trial, 15 available breeding lines and cultivars (cv) of potato obtained from Potato Program of the National Agricultural Research Centre, Islamabad, were screened against *R. solani* AG 3 isolate CL-58 (a known aggressive). In the second trial, susceptible cv. found during germplasm screening, Desiree and selected fungicides were used in integrated disease management studies through potato tuber treatment under greenhouse conditions at 25°C.

Screening of potato breeding lines and cultivars against *R. solani* isolate CL-58*:* Eight potato breeding lines and seven potato cultivars were evaluated during this study. The experiment was conducted in earthen pots (24 x 30 cm^2) in the greenhouse. Ten gm 15-20 days-old culture of isolate CL-58 was added in each pot of each treatment. Non-inoculated pots served as control. There were two sets with four replications of the trial. The data regarding eyes germination and sprouts killing was taken after one month (30 days) of sowing by harvesting one set of experiment, whereas, the data on stem girdling, stem canker, stolon canker, black scurf incidence (BSI) and black scurf severity (BSS) was recorded after 3 months (90 days) of sowing by harvesting second set of experiment. Data were subjected to statistical analysis by using t-test to know the resistance and susceptibility in the breeding lines and cultivars.

Management of black scurf disease by potato tuber treatment: For the management of black scurf disease by potato tuber treatment, the experiment was conducted in earthen pots (24 x 30 cm^2) in greenhouse at 25°C. Ten gm 15-20 days-old culture of isolate CL-58 was added in each pot. Prior to sowing, tubers of cv. Desiree were treated in a steel mixture at the rate of 25g active ingredient (a.i.), 3g a.i. and 3g a.i. /kg seed tuber, with Monceren 25 SC, Benlate 50 WP and Dithane M-45, respectively. Inoculated but non-treated tubers served as control. There were two sets with four replications of the experiment. The experiment was conducted in completely randomized design and the data were subjected to statistical analysis.

Results and Discussion

Screening of potato breeding lines and cultivars against *R. solani* isolate CL-58: Screening of 15 potato breeding lines and cultivars against 7 disease producing symptoms of black scurf used as parameters revealed that *R. solani* isolate CL-58 significantly reduced the number of eyes in lines CIP 9663, 9732 and cvs. Dragha and Desiree as compared to non-inoculated control (Table 1). The effect of inoculated treatment in the remaining breeding lines and cvs., was non-significant. Significant reduction in number of sprouts occurred in breeding lines CIP 9643, 9663 and cv. Desiree, respectively. In rest of the treatments, the difference was non-significant. Stem girdling and stem canker in cv. Desiree and stem canker produced in cv. Sante was found significant when compared with the control. However, stolon canker was induced by isolate CL-58 only in cv. Desiree and it was statistically significant with respect to control. The effect of inoculated treatments in the remaining breeding lines and cvs. for stem girdling, stem and stolon canker were non-significant Significant differences in majority of breeding lines and cvs., was found for BSI and BSS.

Table 1. Reaction of potato breeding lines and cultivars for symptoms expression inoculated with *R. solani* AG 3 isolate CL-58.

	Eyes[1] germination	Sprout[2] killed	Stem[3] girdling	Stem[4] canker	Stolon[5] canker	Black[6] Scurf incidence	Black[7] scurf severity
CIP 9663	0.0074^{**}	0.0155^{*}	0.4677^{NS}	0.1161^{NS}	0.4677^{NS}	0.1321^{NS}	0.1646^{NS}
CIP 9732	0.0074^{**}	0.5071^{NS}	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.0022^{**}	0.1259^{NS}
CIP 9606	0.1161^{NS}	0.0600^{NS}	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.0306^{*}	0.0638^{NS}
CIP 9610	0.1583^{NS}	0.3486^{NS}	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.0018^{**}	0.0062^{**}
CIP 9626	0.1011^{NS}	0.1583^{NS}	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.0090^{**}	0.0041^{**}
CIP 9643	0.3739^{NS}	0.0401^{*}	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.0885^{NS}	0.0003^{**}
Sante	0.4677^{NS}	0.3045^{NS}	0.4677^{NS}	0.0161^{*}	0.4677^{NS}	0.0014^{**}	0.0000^{**}
RZ-89-1232	0.3739^{NS}	0.1161^{NS}	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.0000^{**}	0.0018^{**}
Dragha	0.0074^{**}	0.1398^{NS}	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.0686^{NS}	0.0492^{*}
9607	0.3739^{NS}	0.6917^{NS}	0.4677^{NS}	0.1161^{NS}	0.4677^{NS}	0.0080^{**}	0.0005^{**}
Johar	0.3739^{NS}	0.3739^{NS}	0.4677^{NS}	0.3739^{NS}	0.4677^{NS}	0.0000^{**}	0.0028^{**}
Desiree	0.0074^{**}	0.0022^{**}	0.0161^{*}	0.0074^{**}	0.0213^{*}	0.0009^{**}	0.0009^{**}
Kiran	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.3739^{NS}	0.4677^{NS}	0.0077^{**}	0.0032^{**}
Cardinal	0.4677^{NS}	0.3739^{NS}	0.4677^{NS}	0.4677^{NS}	0.3739^{NS}	0.1330^{NS}	0.0541^{NS}
Diamant	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.4677^{NS}	0.0070^{**}	0.0058^{**}

*= Significant, **= Highly significant, NS= Non-significant, 1= Number, 2= Percentage, 3= 0-4 rating scale where 0= No stem girdling; 1= Slight; 2 = Moderate; 3= Severe; and 4= Very severe stem girdling, 4= 0-4 rating scale where 0= No stem canker (avirulent); 1= upto 25% (slightly virulent); 2= 26-50% (moderately virulent); 3= 51-75% (virulent); and 4= 76-100% (highly virulent) stem canker, 5= 0-4 rating scale where 0= No stolon canker (avirulent); 1= Upto 25% (slightly virulent); 2= 26-50% (moderately virulent); 3= 51-75% (virulent); and 4= 76-100% (highly virulent) stolon canker, 6= Percentage, 7= 0-5 rating scale where 0= No symptom; 1= less than 1%; 2= 1-10%; 3= 11-20%; 4= 21-50%; and 5= 51% or more tuber area affected.

Overall, statistically non-significant difference between inoculated and non-inoculated treatments was found in cv. Cardinal for all the parameters viz., eyes germination inhibition (EGI), sprout killing, stem girdling, stem canker, stolon canker, black BSI and BSS. EGI, stem girdling and stem canker could not be induced by the test isolate. Cv. Cardinal was found the most resistant when compared with rest of the breeding lines and cvs. Whereas, cv. Desiree was the most susceptible as significant differences for EGI, sprout killing, stem girdling, stem canker, stolon canker, BSI and BSS were found. In the remaining breeding lines and cvs, non-significant differences between inoculated and non-inoculated treatments were found in most of the parameters, whereas, significant differences were found mostly for EGI, BSI and BSS.

Table 2. Efficacy of fungicides as potato tuber treatment of cv. Desiree for management of black scurf.

Parameters	Treatment (Fungicides)			
	T_1 (Dithane M-45)	T_2 (Benlate)	T_3 (Monceren)	T_4 Control (inoculated and non-treated)
Eyes germinated[1]	3.00 a*	2.33 ab	2.67 a	1.67 b
Sprouts killed[1]	10.62 b	8.25 c	3.81 d	30.25 a
Stem girdling[2]	0.00 b	0.00 b	0.00 b	0.67 a
Stem canker[3]	0.00 b	0.00 b	0.67 a	1.00 a
Disease incidence[1]	36.11 c	63.89 b	64.88 b	95.00 a
Disease severity[4]	0.61 b	1.17 ab	1.00 ab	1.67 a

*Mean separation by DMRT at 5% level of significance.
[1]Percentage
[2]where 0= No stem girdling; 1= Slight; 2= Moderate; 3= Severe; and 4 = Very severe stem girdling.
[3]where 0= No stem canker (avirulent); 1= Upto 25% (slightly virulent); 2= 26-50% (moderately virulent); 3= 51-75% (virulent); and 4= 76-100% (highly virulent) stem canker.
[4]where 0= No; 1= Less than 1%; 2= 1-10%; 3= 11-20%; 4= 21-50%; and 5= 51% or more tuber area affected.

Black scurf disease management by seed treatment varied in terms of number of eyes germinated, sprouts killed, stem girdling, stem canker, BSI and BSS with respect to the fungicides tested. Dithane M-45 was found the most effective fungicide in increasing eyes germination and controlling stem girdling, stem canker, BSI and BSS over control (Table 2). However, its performance was statistically similar with Monceren in increasing eyes germination and controlling stem girdling. Sprout killing of 3.81% in case of Monceren treated tubers and 8.25% with Benlate treated tubers. On the other hand, Benlate was as effective as Dithane M-45 in controlling stem girdling and stem canker. Performance of Benlate and Monceren in controlling BSI and BSS was statistically similar. Dithane M-45 treated tubers showed the minimum BSI and BSS of 36.11%, and 0.61, respectively, as compared to others.

Reports about resistance in potato cultivars against *R. solani* are lacking. Therefore, breeding lines received from Potato Program (NARC), Islamabad and cvs., of potato presently under cultivation in the country, were evaluated for host resistance against this pathogen. Screening of potato breeding lines and cultivars for host plant resistance to *R. solani* revealed cv. Desiree the most susceptible. This variety was permitted in year 1969 and since then, is being widely grown in all the potato producing zones of the country. It is well-liked in Punjab province. It is susceptible to black scurf, highly susceptible to common scab (*Streptomyces scabies*), powdery scab (*Spongospora subterranea*), *Verticillium* wilt (*Verticillum albo-atrum*) and cold and frost (Zanoni, 1991). Consequently, cultivation of Desiree may be discouraged to avoid increase of *R. solani* inocula (Zanoni, 1991). Cv. Cardinal was found the most resistant comparing to other breeding lines and cvs. during our investigations. Eyes germination inhibition, stem girdling and stem canker could not be induced on this cv. by the test isolate CL-58. Cv. Cardinal is a red skin and as well an old variety, which was permitted in 1975 and is being cultivated in all the three potato cultivation seasons and eight production zones for the last several years. It is a high yielding cv. which is moderately resistant to common and powdery scab, *Verticillium* wilt, *Fusarium* dry rot and black scurf (Zanoni, 1991). Thus, it could be grown as a resistant cv. against black scurf, mainly, in locations where disease is a problem.

At present, no fungicide is registered for the management of black scurf of potato in Pakistan. Fungicides viz., Benlate and Dithane M-45 which were used for potato tuber treatment against black scurf are registered chemicals and are being used against fungal pathogens of numerous crops including potato for seed dressing and foliar applications.

Monceren is an old product and is being used especially against *R. solani* worldwide. Black scurf management through potato tuber treatment under greenhouse conditions, revealed that treatment of tubers of cv. Desiree with Dithane M-45 and then sowing them in potting mixture previously inoculated with *R. solani* isolate CL-58, significantly increased eyes germination and decreased sprout killing, stem girdling, stem canker, BSI and BSS over non-treated inoculated control. Dithane M-45 is often used for controlling *Phytophthora infestans* on potato foliage and has activity against a broad spectrum of fungi (Thomson, 1993). Monceren and Benlate were found next to Dithane M-45 in controlling different symptoms of black scurf. However, their performance in controlling disease was almost similar. Monceren was found to be the best fungicide in reducing sprout killing, whereas, Benlate was better than Monceren in controlling stem canker symptoms of disease. Effective control of *R. solani* on seed potatoes or seed pieces can increase the rate of eyes germination and would decrease sprout killing which will ultimately contribute to better crop stand. However, the fungicides being applied as seed potatoes treatment should have action against *R. solani*. Moreover, if an appropriate fungicide is applied to potato seed pieces prior to infestation with *R. solani*, transmission of the *R.solani* from seed to the sprouts may be reduced. Unluckily, seed treatment of fungicides is not a normal and common practice in Pakistan. It is necessary to adopt this practices which in turn will protect this crop from seed-borne pathogen and ultimately lead to better and healthy potato crop stand.

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