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CHEMOTHERAPY OF BLACK SCURF OF POTATO THROUGH TUBER TREATMENT

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A B S T R A C T

Potato (*Solonum tuberosum* L.) is suffering from an imperative fungal disease black scurf (*Rhizoctonia solani* Kühn) which is also a yield limiting factor by decreasing market value and quality of potato. *In vitro* and *in vivo* management trials were conducted to manage this disease using three fungicides Moncerene (pencycuron), Curon (pencycuron) and Topsin M (thiophenate methyl). Under *in vitro* conditions Moncerene and Curon performed the best at 700 ppm with 96% and 87% inhibition of the fungus, respectively while Topsin M was efficient at 2500 ppm with 74% inhibition using poison food technique. Potato tubers when treated with aforementioned fungicides resulted in maximum number of stems, minimum black scurf disease index and higher yield as compared to control. Moncerene was most an effective fungicide at a concentration 48 mL 80 kg^{-1} potato tubers. Therefore, farmers are suggested to treat potato tubers with moncerene @ 48 mL 80 kg^{-1} potato tubers before sowing.

Keywords: Black scurf, fungicide, *in vitro*, *in vivo*, management, moncerene.

INTRODUCTION

Potato (*Solonum tuberosum* L.), belongings to the Solanaceae family of flowering plants, is the fourth most important staple crop of the world after wheat, rice and maize. It is a reasonable source of iron while their vitamin C contents help in iron absorption. Its consumption is increasing because it is not only cheap but also a rich source of carbohydrates, starch and contributed a lot in the reduction of food shortage globally (Han *et al*., 2005). It is grown all over the world and its area under production is increasing year after year due to its high demand. Annually 325 million tons of potatoes are produced all over the world while the top potato growing countries are China, India, Russia, Ukraine and U.S.A. In Pakistan, potato is among the main cash crops. The area under potato cultivation is about 158000 hectares with 3.1 million tones production annually (Anonymous, 2011). It is susceptible to wide range of pathogens. Twenty different pathogens have been reported out of which 11 are frequently occurring with varying percentages in different potato producing zones which ultimately influence the yield of potatoes in Pakistan (Ahmad *et al*., 1991). Some of the important fungal diseases of potato in Pakistan are; early blight (*Alternaria solani* Sorauer), late blight [*Phytophthora infestans* (Mont.) de Bary] and Black surf (*Rhizoctonia solani* Kühn).

Black scurf of potato is economically important disease caused by fungus *R. solani* (teleomorph: *Thanatephorus cucumeris* (A.B. Frank) Donk (Frank *et al*., 1976). Brownish black sunken lesions on stolons and stems are the distinguishing above ground symptoms produced by *R. solani*. Later on tubers contain small, hard, black sclerotia on its surface called as black scurf. Tuber deformity, cracking and pitting ultimately decreases its quality and also causes reduction in the size of young tubers (Carling and Leiner, 1986; Dillard *et al*., 1993; Leach and Webb, 1993). Black scurf usually do not affects yield of potato crop if it is low in intensity but the quality of tuber is affected resulting in poor market value (Yao *et al*., 2002; Grosch *et al*., 2005; Wharton and Kirk, 2007). The pathogen can survive on tuber and persist in the soil for several years and have a wide host range (Ogoshi, 1987). Dry sclerotia are reported to survive for upto six years at room temperature (Kumar,

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1976). Its control is difficult because it is soil borne pathogen and can survive for several years under different environmental conditions (Hyakumachi and Ui, 1982). Black scurf of potato has created alarming situation in most of the potato production zones of Pakistan (Ahmad *et al*., 1995; Khan *et al*., 1995).

The growers need to plant clean seed, practice good crop rotation (at least 3 years or more), promote rapid emergence, and use effective seed piece treatments and in-furrow fungicides in order to obtain the most effective disease control (Peters *et al*., 2003). Some of the fungicides are registered for the control of potato diseases but not for black scurf of potato (Rauf *et al*., 2007). Derosal and Topsin-M gave significant protection against seed borne inoculum of *R. solani* (Idrees *et al*., 2009). Complete control of *Rhizoctonia* is not possible, as the amount of *Rhizoctonia* on seed increases; the efficacy of the fungicides will decrease.

There is need for suitable control of black scurf of potato to cope with this disease as it is very difficult to control because of the soil borne as well as seed borne nature of the pathogen. Therefore, this study was designed to evaluate fungicides, both under laboratory and in field conditions, for the management of black scurf of potato.

MATERIAL AND METHODS

The experiment was carried out at Mycology and Bacteriology Laboratory of Department of Plant Pathology, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan, Pakistan. The infected potato tubers were collected from local market while three fungicides viz. Moncerene-FS (pencycuron) of Bayer CropScience, curon-SC (pencycuron) of FMC and topsin-M (thiophanate methyle) of Arysta Life Science were purchased from pesticide market near Multan.

Isolation: Diseased samples containing lump like black sclerotia of *Rhizoctonia solani* from infected potato tubers were removed carefully and disinfected by 0.2 percent mercuric chloride for two minutes then washed with distilled water for three times. For the preparation of potato dextrose agar (PDA) medium, 20 g dextrose, 20 g starch and 20 g agar were dissolved in 1.0 L distilled water and autoclaved at 121 ºC temperature for 20 minutes at 103 kPa pressure. The diseased samples were aseptically transferred to 90 mm petri plates containing PDA medium with the help of sterile forceps. Petri plates were incubated for 48 hours at 25 ±2 ºC. The growing fungus on PDA medium was purified by sub-culturing. The culture was examined under compound microscope for cultural and morphological characters to identify the isolated pathogen (Burgess *et al*., 1994).

Poison food technique: Efficacy of three fungicides viz., Curon, Moncerene and Topsin M were evaluated at three different concentrations i.e. 500, 600 and 700 ppm in case of former two and 1500, 2000 and 2500 ppm in later one against *R. solani* using poison food technique (Dhingra and Sinclair, 1985). Fungicides were added to growth medium before autoclaving. Then medium was poured in Petri plates of 90 mm diameter and allowed to solidify. Culture of *R. solani* was cut into 4 mm diameter disc from actively growing margins using cork borer and placed it at the center of each treatment. Media without fungicide served as a control. Four replications were maintained for each treatment. These plates were kept in an incubator for 7 days at 25 ±2 ºC under 12 h 12 h^{-1} light and dark condition. The radial mycelial growth of the pathogen was measured on 8th day and growth inhibition percentage was calculated by the formula: Inhibition (%) =100 × (C−T)/C

Where C is growth of fungus in the control and T is growth of fungus in the treatment.

Evaluation of fungicides under field conditions: The experimental trial for chemotherapy of Black Scurf of potato through tuber treatment was carried out at Suraj Miani Bait near Multan city. A susceptible variety Kruda was used for this purpose. To serve as untreated control, T1 was Moncerene @ 48 mL 80 kg^{-1}seed tuber, T2 was Curon @ 48 mL 80 kg^{-1}seed tuber and T3 was Topsin-M @ 160g 80 kg^{-1}seed tuber. All potato seed tubers were washed with water and then dried on plastic sheet before fungicides application. For fungicide treatment, tubers were placed on sheets and a fine spray of fungicide liquid was sprayed through a hollow cone nozzle onto potato tubers spread loosely on sheet. The tubers were smoothly inverted to expose all surfaces to the spray. After completion the potato tubers were completely dampened, then left to air dry. Potato tuber seed 80kg per treatment was selected. After treatment the tubers were sown into plots by hand with 70 cm inter row and 25 cm inter plant distance on ridges. All the four treatments were arranged in randomized complete block design with three replications. Data regarding different parameters i.e. number of stems, black scurf disease index (BSDI) and yield was recorded 20, 40 and 60 DAS (days after sowing) in case of former and after harvesting in later 2 parameters.

Parameters studied: Black scurf disease severity was expressed as black scurf disease index and was calculated by using the formula suggested by Naz *et al.* (2008).

$$BSDI\% = \frac{0(n1) + 1(n2) + 2(n3) + 3(n4) + 4(n5) + 5(n6)}{N \text{ (Total number of tubers)}} x \frac{100}{5}$$

Where n1 = Number of tubers in 0 rating, n2 = Number of tubers in 1 rating, n3 = Number of tubers in 2 rating, n4 = Number of tubers in 3 rating, n5 = Number of tubers in 4 rating, n6 = Number of tubers in 5 rating

Black scurf disease severity was calculated by using visual disease rating scale (0-5) described by Ahmed *et al.* (1995).

Table 1. Black scurf disease severity rating scale.

Rating grades	Disease (%)
0	No symptoms on tubers
1	Less than 1% potato tuber area affected
2	1-10% potato tuber area affected
3	11-20% potato tuber area affected
4	21-50% potato tuber area affected
5	51% or more potato tuber area affected

Yield of potato tubers from each treatment was also determined at the time of harvest and yield increase per treatment was calculated by using the following formula Guo *et al.,* (2004).

$$\text{Yield increase (\%)} = \frac{(\text{treatment yield} - \text{control yield})}{\text{control yield}} \times 100$$

Statistical analysis: Data of all the parameters were recorded according to the procedure described and was subjected to analysis of variance (ANOVA). Treatment means were compared with Fisher's least significance difference test at P≤0.05. Statistical analysis was performed by using statistical software Statistix 8.1.

RESULTS

In vitro evaluation of the pathogen was done with three different fungicides at three different concentrations, Moncerene (500, 600, 700 ppm), Curon (500, 600, 700 ppm) and Topsin M (1500, 2000, 2500 ppm) by using poison food technique (Dhingra and Sinclair 1985). The data of percentage inhibition of *R. solani* was statistically significant. Least inhibition was observed in topsin-M followed by curn and moncerene. Minimum mycelial inhibition was 65% at 1500 ppm followed by 73% and 74 at 2000 and 2500 ppm of topsin-M respectively. The most effective fungicide was moncerene with 91, 95 and 96% mycelia growth inhibition at its 500, 600 and 700 ppm concentrations respectively. Results of mycelial growth retardation in case of curon were intermediate between topsin-M and moncerene. Highest mycelial inhibition (87%) was observed at 700 ppm followed by 85% and 79% at 600 and 500 ppm respectively by curon as compared to control with zero percent inhibition (Table 2).

Table 2. Efficacy of different concentrations of different fungicides against mycelial growth of *R. solani.*

Fungicides	Doses	Mycelial growth (mm) + S.E	Growth Inhibition (%) + S.E
Topsin M	1500 ppm	31 ± 1.190 b	65 ± 1.701 f
	2000 ppm	23 ± 0.853 c	73 ± 0.902 e
	2500 ppm	23 ± 1.322 c	74 + 1.321 e
Moncerene	500 ppm	08 ± 0.750 f	91 ± 0.604 b
	600 ppm	04 ± 0.408 g	95 ± 0.346 a
	700 ppm	03 ± 0.250 g	96 ± 0.260 a
Curon	500 ppm	19 ± 1.040 d	79 ± 1.039 d
	600 ppm	13 ± 0.853 e	85 ± 0.924 c
	700 ppm	12 ± 0.645 e	87 ± 0.574 c
Control		87 ± 1.250 a	
LSD value		2.892	3.091

Efficacy of different fungicides on number of stems of potato plant was checked at three time intervals i.e. 20, 40 and 60 days after sowing (DAS). Data of number of stems among all four treatments was statistically non-significant at 20 and 60 DAS but they are more than in control treatment. Potato plants treated with fungicides produced 67, 64 and 61 in Moncerene, Topsin-M and Curon, respectively

compared to control with 39 stems at 20 DAS. While Number of stems was 78, 90 and 97 in Curon, Topsin-M and Moncerene, respectively compared to 59 in control. The data regarding number of stems 60 DAS was calculated which showed that maximum 115 stems were produced by Moncerene followed by 91 and 90 by Curon and Topsin-M respectively compared to control with 83 stems. Overall highest number of stems was produced by moncerene treated potato seeds followed by topsin-M and curon (Table 3).

Table 3. Effect of different fungicides on number of stems, BSDI, yield and yield increase of potato crop.

Treatments	No. of Stems (Days After Sowing)			BSDI*	Yield (Kg)	Yield Increase (%)
	20	40	60			
Control	39 b	59 c	83 b	70 a	52 c	
Moncerene	67 a	97 a	115 a	03 d	61 a	16
Curon	61 a	78 b	91 b	07 c	59 ab	13
Topsin-M	64 a	90 a	90 b	32 b	54 bc	4

Means followed by same letter are statistically similar according to LSD test (P= 0.05).

Black Scurf Disease Index (BSDI) was statistically significant in all treatments. Less BSDI (2.50) was in Moncerene followed by 32 and 07 BSDI in Topsin-M and Curon respectively in comparison to control with 70 BSDI (Table 3). Treatment of potato tubers with fungicides resulted in their yield increase. Highest yield (61 kg) was of tubers treated with Moncerene while lowest (54 kg) was of Topsin-M treated tubers compared to control with 52 kg yield (Table 3). Black scurf disease (BSD) significantly reduced the potato yield and seed treatment with different fungicides decreased BSD and ultimately increased the yield. Potato tubers treated with Moncerene showed maximum yield increase (16%) while minimum increase in yield was observed in Topsin-M (04 %) followed by Curon (13%) (Table 3).

DISCUSSION

Different fungicides were evaluated to cope with serious problem of black scurf of potato (*R. solani*). The objective of study was to evaluate various fungicides to find out the best option which can reduce the black scurf disease. This disease greatly affects the quality of potato tuber which ultimately results in less market value and also affects the yield of potato crop. *R. solani* produced dark brown to black lump like masses on tubers reduces progeny, quality and market value of potato tubers (Errampalli and Johston, 2001). Isolation of black scurf of potato fungus from infected samples was also carried out in laboratory and *R. solani* was isolated and identified. Efficacy of different concentrations of three fungicides was checked out by using poison food technique *in vitro*. Moncerene and Curon at 700 ppm were significantly superior while Topsin M was effective at 2500 ppm in retarding mycelial growth of *R. solani*. In a similar study, ten protective and curative fungicides at 5, 10, 20, 50 and 100 ppm a.i. were mixed with PDA against three isolates of *R. solani*. Benomyl, Thiabendazole (TBZ) and Carboxin were efficient *in vitro* (Wenham *et al.,* 1976).

Results of many researchers are in conformity with the findings of this experiment. Dithane M-45, Benlate and Moncerene were found equally effective against black scurf disease symptoms while Moncerene performed best in controlling sprout killing. Benlate was best in decreasing stem canker. Dithane M-45 gave best result for high eyes germination, BSDI, stem canker, stem girdling and also decreased black scurf severity (Rauf, 2004). Naz *et al.,* (2006) carried out an experiment with plant diffusates and fungicides for the control of *R. solani* and concluded that tuber treatment with boric acid and Daconil was found effective. Copper oxychloride, Score, Topsin-M and Derosal were used as potato tuber dressing against wilt and black scurf of potato. Topsin-M and Derosal provided statistically significant results against seed borne pathogen of black scurf of potato by reducing incidence and less sprout killing as compared to all other seed treatments. Similarly, Derosal was found statistically significant in reducing the mortality of potato plant because of *Fusarium oxysporium* followed by Score and Topsin-M (Idrees *et al*., 2009). The seed tuber dressing with Atamoni and PresStop were not efficient for the management of *R. solani* disease symptoms in the experiment. Yield and emergence results were noticeably weaker with Atamoni and PreStop than with Maxim 100 FS or Moncut 40 SC treatments (Peppi, 2005).

The effective dose of fungicide was used to treat seed tubers. All the treatments gave significant results as

compared to the non-treated one. An increase in the number of stems of potato was observed in all treatments. It confirmed that treating potato tubers with fungicides is an excellent practice which resulted in increased number of stems. For the observation of number of stems data was taken three times during the potato crop in field. Moncerene-FS and Curon-SC showed excellent results while Topin-M was better too. Moncerene-FS showed high number of stems throughout the crop duration. Fungicide treatments were also evaluated for the yield of potato tubers and showed an increase in the yield as compare to the untreated one. The high yield was obtained in tubers treated with Moncerene-FS. Full control of *Rhizoctonia* is not possible, as the quantity of *Rhizoctonia* on tuber seed increases; the effectiveness of the fungicides will decrease. The farmers need to grow diseased free seed, encourage rapid emergence, practice rotation of crops (at least three years or even more), and use efficient seed dressings and application of fungicides in-furrow in order to get the most efficient disease management/control (Peters *et al*., 2003). Phenylpyrrole and Fenpiclonil based tuber treatment with fungicide was conducted, for the management of *Helminthosporium solani* (silver scurf) and *Rhizoctonia solani* (black scurf/stem canker). Dressing of tubers (seed potatoes) with fenpiclonil (50 g t^{-1}) resulted in same level of management of *R. solani* as benomyl and toclofos-methyl at crop growth and harvest. Fungicide treatments considerably minimized the level of infection caused by *R. solani* as compared to control treatment (untreated). In case of *Helminthosporium solani* treatment, fenpiclonil (50 g t^{-1}) gave satisfactory disease control on potato tubers harvested after haulm desiccation (Welsh, 1996).

Use of fungicides is considered as the shortest way to attain proficient results of disease management. Obtained data revealed that seed treatment with fungicide is an appropriate method for controlling black scurf of potato. As the fungus is soil-borne as well as seed borne and is difficult to control but seed dressing fungicides can control it up to maximum level as Moncerene-FS showed satisfactory results. Potato seed dressing is rarely practiced in Pakistan as a result they face low market value of their potato crop. So, there is a need to work on this serious problem of black scurf of potato to secure future of potato crop.

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