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Management of Black Scurf Disease Caused by *Rhizoctonia Solani* Kuhn through Research and Farmers Participatory Trials in Major Potato Growing Regions of Northern Karnataka

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Abstract **– Results of the experiment on bioefficacy of penflufen 240 FS (w/v) against potato black scurf disease (*Rhizoctonia solani*) carried out during Kharif 2011, 2012 and 2013 along with farmers participatory trials indicated that all the treatments with different concentrations tested and standard checks against black scurf in potato varied significantly. Over the years least mean disease incidence was observed with Penflufen 240 FS @ 0.083% with 10.52 mean percent disease incidence compared to control (29.79 %) with highest mean yield of 12.16 t/ha as against 8.73 t/ha in untreated check. Although tuber treatment with Emisan 6 FS @ 0.25% resulted in effective control of the disease (16.36 %) yield wise it was inferior (9.62 t/ha). No adverse effect on germination, plant stand and plant height was observed when penflufen 240 FS was tested at higher doses (0.083%, 0.0 62% and 0.42%). Economic analysis of the technology indicated significant increase in incremental cost benefit ratio and treatment involving Penflufen 240 FS @ 0.083% resulted in highest incremental cost benefit ratio of 95.62 compared to other treatments under study. Results of eight farm trials in farmers fields were encouraging, at all the location's there was an increase in yield levels and overall there was 10.81 mean percent increase in mean yield with penflufen 240 FS 0.083%.**

Keywords **– Potato, Black Scurf, *Rhizoctonia Solani*, Fungicides, Disease Severity.**

I. INTRODUCTION

Potato (*Solanum tuberosum*) is one of the important food crops after rice, wheat and maize and diseases are one of the yield reducing factors, which causes low yield of potato. Black scurf of potato caused by *Rhizoctonia solani* Kuhn (*Thenatephorus 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 (Plate 1) (Arora 2008). The disease is ubiquitous in India and it is serious in fields where potato is grown year after year [Khurana et al. (1998) and Arora (2012)].

Pathogen affects roots, stolen, stems and tubers. The disease has two phases, viz. stem canker and black scurf. Stem canker phase is the girdling on the stem with brown colour and sometime upward rolling of the leaves also observed. Black scurf phase is formation of sclerotia on the surface of the tubers. This phase is more common in the field particularly at the stage of plant senescent. *Rhizoctonia solani* has wide host range and it is soil and seed borne in nature. Seed treatment by chemicals is effective against seed borne scurf (Mehi Lal et al 2014).

Management of *Rhizoctonia solani* Kuhn (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 temperature (Kumar, 1976). Rhizoctonia disease commences 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 (Banyal, 2002).

Under minimum disease severity it just lower down the market price but may not reduce the yield. Under severe conditions, when sclerotia cover more than 50% area hinders germination of tubers, if get germinated there will be poor plant growth and leads to low yield. Although yield losses associated with this disease are not well documented. In Nepal, considerable yield loss due to this disease have been frequently reported (Sharma and Ram 2007). As the most significant measures are cultural, chemical controls should also be employed. Various workers have reported successful control of *R. solani* through seed dressing with chemicals.

In another study by Read & Hide (1995), fenpiclonil and propiconazole seed dressing reduced the black dot disease on roots, stem bases and tubers early in the crop season but at harvesting time, fenpiclonil only lessen disease on tubers. No fungicide is registered for the management of potato black scurf. Moreover, cultural strategies are inadequate. Earlier organomercurials had been in use for the management of this disease, but due to health hazards, they have been banned now. The disease is also managed through seed treatment with benomyl, carbendazim, thiabendazole, pencycuron etc. [Banyal (2002) and Thind et al (2002)]. Therefore, alternative fungicide treatment against *R. solani* needs to be developed. Hence, present study was carried out with the objective, of management of black scurf of potato through new fungicides (NPRP 1994).

II. Materials and Method

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 experiments were conducted with various fungicides along with treated and untreated checks at Main Agricultural Research Station, (MARS) UAS Dharwad during Kharif 2011, 2012 and 2013 to understand their bioefficacy. Tubers were dipped in solutions of various fungicides for 30 minutes along with control dipped in plain water and spread in shade till the tubers got dried completely (Plate 2). Tubers of potato variety Kufri Chandrmukhi were planted in medium black soils under rainfed situation with 60 X 20cm spacing. Each treatment had 5m X 5m plot in a Randomized Block Design (RBD) with three replications.

Observations were recorded in six rows leaving the two border rows one on each side and normal cultural practices were followed. To evaluate various fungicides against potato black scurf disease 0-4 disease rating scale was used and crop was harvested at 90-95 DAP. After washing the tubers, black scurf disease incidence, intensity and tuber yields were recorded and then disease index was calculated as per the scale and method used by Somani (1986). Yield of the each plot was recorded and converted into per hectare basis. Individual season's data, then second seasons' and pooled data were analyzed statistically.

Disease Rating Scale

Observations to be determined by using 0 – 4 scale and Percent Disease Incidence was calculated.

0 - Healthy
1 – up to 25% tuber area affected
2 – 26-50% tuber area affected
3 – 51-75% tuber area affected
4 – more than 75% tuber area affected

To verify the research results farm trials were conducted at eight different locations of northern Karnataka with the help of scientists working with Krishi Vigyan Kendra's (KVK) and Extension Education Units (EEU) along with one Large Scale Demonstration at MARS Dharwad. In these trials only promising treatments involving Penflufen 240 FS @ 0.083% and recommended fungicide Carbendazim 50 WP 0.3% were used to study their bioefficacy in 20 gunta areas with farmer's participation.

III. Results and Discussion

The management of *Rhizoctonia solani* Kuhn (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. Rhizoctonia disease commences 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.

Earlier organomercurials had been in use for the management of this disease, but due to health hazards, they have been banned now. Therefore, to develop alternative fungicide treatment against *R. solani* present study was carried out with the objective, of management of black scurf of potato through new fungicides. Results of present study for three consecutive years indicates that treatment involving Penflufen 240 FS @ 0.083% resulted in least mean disease incidence (10.52 %) and highest mean tuber yield (12.16 t/ha) compared to (29.79 % and 8.73 t/ha) control. Although treatment involving Penflufen 240 FS @ 0.062% was effective in reducing the disease (11.56 %) with increased tuber yield (11.01 t/ha) it was on par with Emisan 6 FS @ 0.25% treatment which was equally effective in controlling the disease (16.36 % and 9.62 t/ha) (Table 1). However, Carbendenzim 50 WP fungicide recommended earlier to control seed borne diseases of potato resulted in mean disease incidence of 19.93 percent with least mean tuber yield of 8.98 t/ha (Plate 2).

Various workers have reported successful control of *R. solani* through seed dressing with chemicals. Leadbeater & Kirk (1992) found commercially suitable control with fenpiclonil to combat black scurf and Rhizoctonia canker (*R. solani*) by applying it as a pre-planting treatment. Rudkiewicz & Sikorski (1983) also reported control of rhizoctoniosis, together with chitting by using Dithane M-45 as seed dressing to early potato varieties. Tuber treatment with Penflufen 240 FS @ 0.083% manifested in good seedling emergence, improved uniformity of plants and significantly better plant and fruit health. Economic analysis of the technology indicated significant increase in incremental cost benefit ratio and treatment involving Penflufen 240 FS @ 0.083% resulted in highest incremental cost benefit ratio of 95.62 compared to other treatments under study (Table 2).

Similar trials were conducted in farmer's fields with their participation at different locations in Karnataka as farm trials with the help of Krishi Vigyan Kendras (KVK) and Extension Education Units (EEU's). Even in farmers fields results were encouraging, at all the locations there was an increase in yield levels and overall there was 10.81 mean percent increase in yield (Table 3). Farmer's perception was that by tuber treatment with Penflufen quality of tubers has improved and there was marginal increase in market price for quality potatoes. Treatment of scurf infected tubers with penflufen for 10 minutes provided maximum disease control during both the years and both these (0.083% and 0.062 %) concentrations were statistically at par. The yield of scurfed tubers was also drastically reduced without affecting the total yield at both the above concentration of penflufen. Therefore, penflufen 0.062 % can be used in field trials for the management of black scurf of potato.

IV. Conclusion

All the treatments with different concentrations of test and standard checks tested against black scurf in potato varied significantly. Over the years least mean disease incidence was observed in Penflufen 240 FS @ 0.083% treatment (11.95 %) compared to control (29.85 %) with

highest yield of 11.72t/ha as against 8.66 t/ha in untreated check. Apart from managing the disease tuber treatment with Penflufen quality of tubers has improved with highest marketable tubers.

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Table 1. Bioefficacy of Penflufen 240 FS (w/v) against Potato black scurf disease

Sl. No.	Treatment	Dose (ml/kg seed)	Per cent Disease Index (PDI)				Yield (t/ha)			
			Kharif - 2011	Kharif - 2012	Kharif - 2013	Pooled	Kharif - 2011	Kharif - 2012	Kharif - 2013	Pooled
1	Control		29.41 (32.83)	30.29 (33.39)	29.67 (32.99)	29.79 (33.08)*	9.14	8.18	8.86	8.73
2	Penflufen 240 FS	0.042%	20.19 (26.70)	21.79 (27.82)	17.67 (24.84)	19.88 (26.48)	9.27	8.25	9.66	9.06
3	Penflufen 240 FS	0.062%	13.70 (21.72)	11.36 (19.69)	9.62 (18.06)	11.56 (19.87)	11.32	10.64	11.07	11.01
4	Penflufen 240 FS	0.083%	12.90 (21.05)	11.01 (19.37)	7.67 (16.06)	10.52 (18.93)	12.19	11.26	12.33	12.16
5	Monoceren 250 SC	0.25%	21.47 (27.60)	22.42 (28.26)	20.65 (27.02)	21.51 (27.63)	9.15	8.52	9.32	9.00
6	Carbendazim 50 WP	0.3%	20.19 (26.70)	18.98 (25.83)	20.62 (26.99)	19.93 (26.51)	9.22	8.43	9.28	8.98
7	Emisan 6 FS	0.25%	16.80 (24.19)	14.28 (22.20)	18.00 (25.10)	16.36 (23.86)	10.22	8.89	9.77	9.62
	S.Em±		1.18	1.46	1.42	0.96	0.57	0.54	0.65	0.68
	CD (0.05)		3.65	4.51	4.37	2.96	1.77	1.68	1.99	2.10
	CV (%)		10.65	10.30	13.87	10.44	9.87	10.29	11.13	12.04

* - Figures in parenthesis are arcsine transformed values

Table 2. Economic analysis and cost benefit ratio of the technology

Sl. No.	Treatments	Con (%)	% Increase in yield over control	Income (Rs/ha)*	Quantity of fungicide (g/ml/ha)	Cost of fungicide (Rs/ha)	Cost of fungicide + Wages (Rs/ha)	Net income (Rs/ha)	Additional Benefit (Rs/ha)	ICB ratio
1	Control	-	-	87300	-	-	-	87300	-	-
2	Penflufen 240 FS	0.042%	3.78	90600	42	50	300	90300	3000	10.00
3	Penflufen 240 FS	0.062%	26.12	110100	62	78	328	109782	22482	68.54
4	Penflufen 240 FS	0.083%	39.29	121600	83	105	355	121245	33945	95.62
5	Monoceren 250 SC	0.25%	3.09	90000	250	200	450	90550	3250	7.22
6	Carbendazim 50 WP	0.3%	2.86	89800	300	230	480	89320	2020	4.21
7	Emisan 6 FS	0.25%	10.19	96200	250	225	475	95725	8425	17.74

Table 3. Farm trial results over the locations during 2014

Sl. No.	Place / Institution	Yield (t/ha)		Disease (PDI)	
		T1	T2	T1	T2
1	KVK Dharwad	9.50	8.70	4.40	7.77
2		11.00	9.90	3.33	8.88
3	EEU Dharwad	10.75	9.80	2.00	3.00
4		9.70	9.15	3.00	5.00
5	KVK Belgaum	15.55	14.20	14.92	18.30
6	EEU UHS Bagalkot	10.20	9.70	2.70	7.40
7		11.40	10.25	5.20	9.50
8	Large Scale Demonstration	11.25	9.00	5.55	9.99
	Mean	11.17	10.08	5.13	8.73
	% increase in yield	10.81			

* T1: Penflufen 240 FS, 83 g/100 l/ha T2: Carbendazim 50WP @ 300g/110 l/ha

Plate 1: Soaking potato tubers in Penflufen solution and shade drying

Plate 2: Experimental field with infected seedling and healthy tubers