Management of Collar rot disease of Potato caused by *Sclerotium rolfsii* Sacc. through plaster of paris

BHOLANATH MONDAL AND PAPIYA DEBBARMA

J. Mycopathol, Res, 55(1) : 31-36, 2017;
ISSN 0971-3719

Department of Botany,
University of Calcutta,
Kolkata 700 019, India

J. Mycopathol. Res. ***55(1)*** *: 31-36, 2017;* (ISSN 0971-3719)

Management of Collar rot disease of Potato caused by *Sclerotium rolfsii* Sacc. through plaster of paris

BHOLANATH MONDAL* AND PAPIYA DEBBARMA
Department of Plant Protection, Palli-Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan 731 236, West Bengal

Received : 24.10.2016 Accepted : 14.12.2016 Published : 24.04.2017

Sclerotium rolfsii Sacc. is a soil borne fungal pathogen infects more than 500 species of plants in about 100 families. Management of this pathogen is much difficult because of its wide host range and soil borne in nature. An experiment was conducted to manage collar rot in potato using plaster of paris ($CaSO4.½ H_2O$) and microbes. Effect of plaster of paris (@ 2.5g/infected collar region of plant) on two different growth stages (mycelial stage and sclerotial stage) of *S. rolfsii* isolated from infected potato plant was determined. Plaster of paris was applied directly as powder form over the infected area and adverse effect on the fungus was recorded. The whitish mycelial growth of the fungus from collar region of all the treated plants was found to disappear. Further formation of sclerotia was stopped. The existing sclerotia became deformed and dried. The sclerotia and small bits of treated infected plant tissue when transferred to PDA medium no mycelial growth and sclerotial germination was observed. Whereas, from the untreated infected plants, growth of thick whitish fan-shaped mycelial growth was observed with huge numbers of sclerotia. A field experiment was also conducted using four biological agents (*Pseudomonas fluorescens* (Flügge) Migula,*Trichoderma viride* Pers.*, Azotobacter chroococcum*, *Glomus fasciculatum* (Thaxt.) Gerd. and Trappe emend. C. Walker and Koske), two organic amendments (vermicompost and neem cake enriched with neem oil), and one building material (plaster of paris) for managing the disease at Benuria under Red and Lateritic Agroclimatic Zone of West Bengal during 2014-15. Randomized Block Design was adopted with three replications. The treatments, vermicompost @ 6kg/plot *i.e.* 5.5t/ha, neem cake enriched with neem oil @ 2.2kg/plot *i.e.* 2t/ha,*Pseudomonas fluorescens* @ 10g/plant, *Trichoderma viride* @ 10g/plant*, Azotobacter chroococcum* @10g/plant, *Glomus fasciculatum* @10g/plant were applied directly once in the field just before planting. The plaster of paris @ 2.5g/plant was dusted twice at the collar region of plant at fifteen days interval starting from 15 days after planting. Severity of the disease recorded highest in control plots (8.95 and 19.88%) followed by*Glomus fasciculatum* (4.92 and 8.11%), neem cake (4.55 and 5.51%) and *Trichoderma viride* (2.50 and 4.74%) treated plots while lowest disease severity recorded in plaster of paris (0.70 and 2.65%) followed by vermicompost (1.05 and 3.80%),*Pseudomonas fluorescens* (1.41 and 4.30%) and *Azotobacter chroococcum* (1.38 and 4.20%) treated plots at 60 and 75 days after planting, respectively. The per cent disease control (PDC) at 75 days after planting was highest in plaster of paris (90.24%) followed by vermicompost (85.82%), *Azotobacter chroococcum* (83.73%) and *Pseudomonas fluorescens*(83.38%) treated plots. *Trichoderma viride* (73.96%) revealed better than Neem cake (62.33%) and *Glomus fasciculatum* (52.21). No phytotoxicity has been developed on host plants for the application of plaster of paris. These effective treatments can be incorporated in Integrated Disease Management Programme for sustainability.

Key words: Collar rot, integrated disease management, management, plaster of paris, potato, *Sclerotium rolfsii*

INTRODUCTION

Sclerotium rolfsii Sacc. is a soil borne fungal pathogen produced various kind of symptoms in different crops on infection. It attacks more than 500 species of plants in about 100 families including vegetables, flowers, cereals, forage plants and weeds (Madhavi and Bhattiprolu, 2011).

The fungus is characterized by white fluffy, branched, septate mycelium, and spherical or irregular shaped brown sclerotia, which range from 0.5-2.0 mm in diameter and at maturity, resemble mustard seed. The mycelium of *S. rolfsii* survives

*Corresponding author : bholanath.ppvb@gmail.com

best in sandy soils, whereas, the sclerotia survive best in moist, aerobic conditions found at the soil surface (Arunasri *et al.* 2011).

Use of fungicides is not practical to manage this soil borne pathogen due to exorbitant cost and environmental hazards involved. Thus, integrated disease management practice is the best alternative. Selection of a proper non-host rotational crop is difficult due to its extensive host range. Biological management of soil borne pathogens offers environmentally safe, durable and cost effective alternative to chemicals. Several strains of *Trichoderma* and *Chaetomium* have been found to be effective as biocontrol agent of various soil and seed borne plant pathogenic fungi. The present investigation was undertaken with a view to explore various aspects of the fungal pathogen causing collar rot disease of potato in Sub-humid Lateritic Red and Undulating Agro-climatic Region of West Bengal.

MATERIALS AND METHODS

Plaster of paris on different growth stages of S. rolfsii

Effect of plaster of paris (@ 2.5g/infected collar region of plant) on two different growth stages (mycelial stage and sclerotial stage) of *S. rolfsii* was determined. Plaster of paris ($CaSO_4$, ½ H_2O) was applied directly as powder form over the infected area and observation was taken at 10 days after application. Adverse effect of it on the fungus was recorded in Table 4. Further, the sclerotia (25 numbers) and small bits from treated and untreated infected plant tissue (20 numbers) were collected and transferred aseptically to PDA medium for mycelial growth and sclerotial germination, and incubated at 28±1^{0}C in BOD incubator. Observation was recorded at an interval of 3 days up to 12 days.

Determination of phytotoxic effect of plaster of paris on crops

To know the phytotoxic effect of plaster of paris five crops (*viz.* potato, brinjal, chilli groundnut and elephant foot yam) were chosen. Experiment was conducted in PSB Agricultural Farm, demonstration plot of Rathindra Krishi Vigyan Kendra and in the nearby farmers' fields at Binuria and Bahadurpur. Eighty numbers of healthy plants were selected randomly for each crop and tagged accordingly. Three different doses (2.0, 5 and 10 g/plant) of plaster of paris applied around the collar region of plants. Untreated control was also maintained. There were four treatments with four replicates, and five plants/replication. Randomized Block Design (RBD) was employed for the experiment. Observation recorded at an interval of five days up to 15 days. The phytotoxic effect such as leaf chlorosis, leaf tip burning, leaf necrosis, leaf epinasty, leaf hyponasty, vein clearing, resetting, stem injury and wilting were critically observed (Mondal and Khatua, 2013) and tabulated in Table 3. The extent of phytotoxicity was recorded based on the standard scale (Table 1) prescribed by Central Insecticide Board and Registration Committee.

Eco-friendly management option for the disease in field condition

A field experiment was conducted during 2014-2015 in farmers' field situated at Benuria under Bolpur-Sriniketan Block of West Bengal. The experiment was conducted to know the efficacy of different soil amendments (vermicompost and neem cake enriched with 2% neem oil), building material (plaster of paris) and biological agents (*Trichoderma viride, Pseudomonas fluorescens, Glomus fasciculatum, Azotobacter chroococcum*) against collar rot disease of potato (var. Kufri Jyoti).

The field having previous history of the disease was selected. The prior crop of that field was brinjal where massive infestation of the disease was noticed. Besides, mass multiplied culture of the pathogen (two numbers conical flask containing 400g of sand-corn meal medium) was added evenly to the field for developing sick plot. The size of the plot was 3.6 m × 3.0 m. Potato tubers were planted in the sick plot and general agronomic practices were employed for the growth of crop. Well decomposed FYM @ 15 t/ha, along with N:P:K @ 200:150:150 kg/ha were applied in the experimental field. Four biological agents namely antagonistic rhizobacteria - *Pseudomonas fluorescens* (10 g/plant), fungal antagonist -*Trichoderma viride* (10 g/plant), bacterial biofertilizer-*Azotobacter chroococcum* (10 g/plant), vesicular arbuscular mycorrhizal fungus (VAM) - *Glomus fasciculatum* (10 g/plant), and two organic amendments such as vermicompost (6 kg/plot *i.e.* 5.5 t/ha) and neem cake enriched with neem oil (2.2 kg/plot *i.e.* 2 t/ha) were directly applied once in the field just before planting. The

building material *viz.* plaster of paris (2.5g/plant) was dusted at the collar region of the plant twice at 15 and 30 days after planting. Starting from counting the first appearance of the disease subsequent progress was recorded followed by calculation of per cent disease index (PDI) and Per cent disease control (PDC). For scoring the disease 0-4 scale was used (Table 2).

The data were subjected to statistical analysis and necessary transformations were made whenever required.

RESULTS AND DISCUSSION

Adverse effect of plaster of paris on different growth stages of S. rolfsii

Adverse effect of plaster of paris on two different growth stages (mycelial stage and sclerotial stage) of *S. rolfsii* was recorded. The whitish mycelial growth from collar region of all the treated plants was disappeared. Further formation of sclerotia was stopped. The existing sclerotia became deformed and dried. The sclerotia (25 numbers) and small bits of treated infected plant tissue (20 numbers) when transferred aseptically to PDA medium for mycelial growth and sclerotial germination, no further growth were recorded up to 12 days of incubation. Whereas, from untreated infected plant bits thick whitish fan-shaped mycelial growth was observed with huge numbers of sclerotia. Progression of rotting of plant tissue was fast. Each of the sclerotium collected from untreated infected plant was germinated, and growth of the fungus was prominent (Table 4). The result was corroborated with the observation of Mondal and Khatua (2013). Though, they got strong adverse effect of plaster of paris on mycelial growth and survival of sclerotia of *S. rolfsii* causing foot rot of elephant foot yam, the present study was also showed an important role for management of the pathogen through inhibition of mycelial growth and loosening of sclerotial viability.

Table 1 : Scale used for assessment of phytotoxicity

% injury	Rating
0	No phytotoxicity
1 – 10	1
11 – 20	2
21 – 30	3
31 – 40	4
41 – 50	5
51 – 60	6
61 – 70	7
71 – 80	8
81 – 90	9
91 – 100	10

Visual phytotoxicity of plaster of paris on different crops

It was revealed from the experiment that application of plaster of paris at three different doses did not cause any phytotoxic symptoms like leaf chlorosis, leaf tip burning, leaf necrosis, leaf epinasty, leaf hyponasty, vein clearing, resetting, stem injury and wilting on five different crops *i.e.* potato, brinjal, chilli, elephant foot yam and groundnut (Table 3). The observation was agreed with the earlier workers (Mondal and Khatua, 2013).

Effect of different non-chemicals on collar rot of potato

Field trial was conducted to know the efficacy of different treatment against the fungal plant pathogen causing collar rot of potato. The result of the experiment was tabulated in Table 5. The symptom appeared as early as 30 DAP (days after planting) in VAM, neem cake and *Trichoderma viride* treated and untreated control plots. Disease severity recorded at 30 DAP was 0.33% in *Trichoderma viride*, 0.69% in neem cake and 0.75% in VAM treated plots. In untreated control plot it was 1.85%. Delayed appearance of the disease observed (*i.e.* at 60 DAP) in case of vermicompost, *Pseudomonas fluorescens, Azoto-*

Table 2 : Scale used for evaluation of the collar rot disease of potato

Score	Description
0	Healthy, no disease symptom
1	Yellowing of lower leaves
2	Leaf fall up to 25% together with discolouration or rotting of cortical tissue in collar region along with slight mycelial growth
3	Partial wilting and leaf fall up to 50%. Rotting extended both upward and downward, huge mycelial growth, sclerotia formation start
4	Total wilting and rotting of below ground parts with abundant mycelia mat and sclerotia formed on rotted portion

Table 3 : Phytotoxic effect of plaster of paris on crops

Dose (g/plant)	Category of phytotoxicity					
	leaf chlorosis, leaf tip burning	Necrosis	Epinasty, hyponasty	Vein clearing and resetting	Stem injury	Wilting
	Phytotoxicity rating					
2.5	0*	0	0	0	0	0
5.0	0	0	0	0	0	0
10.0	0	0	0	0	0	0
Untreated control	0	0	0	0	0	0

*0 = No phytotoxicity

Table 4 : Effect of plaster of paris on sclerotial germination and mycelial growth of *S. rolfsii*

Treatment	Field condition		Laboratory condition	
	Mycelial stage	Sclerotial stage	Sclerotial germination	Growth from infected plant bit
Treated plant	Mycelial growth vanished.	Mycelial growth vanished, rotting stopped and no further formation of sclerotia noticed. Recorded sclerotial deformation.	Among 25 sclerotia transferred in PDA medium from treated plant no sclerotial germination recorded.	No mycelial or sclerotial growth was recorded from infected small bits (20 no.) of treated plant.
Untreated plant	Thick white fan-shaped mycelial growth observed with huge numbers of sclerotia. Rotting recorded at the collar region.	Thick mycelial growth with abundant sclerotia were prominent. Recorded complete rotting at the collar region.	All the sclerotia (25 no.) germinate to produce huge myce lial growth in PDA medium in case of untreated plant.	Huge mycelial growth and formation of sclerotia were prominent from infected small bits (20 no.) of untreated plant.

Table 5 : Effect of different non-chemicals on collar rot disease of potato in field condition

Treatment	PDI at				Average PDI at 75 DAP	Average PDC at 75 DAP
	30 DAP	45 DAP	60 DAP	75 DAP		
Vermicompost	0.00 (0.71)*	0.00 (0.71)	1.05 (1.24)	3.80 (2.05)	1.22 (1.18)	85.82 (57.86)
Pseudomonas flourescense	0.00 (0.71)	0.00 (0.71)	1.41 (1.37)	4.30 (2.19)	1.43 (1.25)	83.38 (55.36)
Plaster of Paris	0.00 (0.71)	0.00 (0.71)	0.70 (1.07)	2.65 (1.75)	0.84 (1.06)	90.24 (62.15)
VAM	0.75 (1.09)	2.64 (1.74)	4.92 (2.32)	8.11 (2.94)	4.11 (2.03)	52.21 (27.50)
Azotobacter chroococcum	0.00 (0.71)	0.00 (0.71)	1.38 (1.35)	4.20 (2.14)	1.40 (1.23)	83.73 (56.08)
Neem Cake	0.69 (1.06)	2.19 (1.64)	4.55 (2.23)	5.51 (2.45)	3.24 (1.85)	62.33 (33.93)
Tricoderma viride	0.33 (0.88)	1.38 (1.35)	2.50 (1.71)	4.74 (2.27)	2.24 (1.56)	73.96 (44.29)
Control	1.85 (1.53)	3.70 (2.04)	8.95 (3.09)	19.88 (4.53)	8.60 (2.80)	-
SEm(±)	0.17	0.20	0.19	0.12	-	-
CD (p=0.05)	0.36	0.41	0.37	0.26	-	-

PDI-Per cent disease index, PDC- Per cent disease control, DAP-Days after planting, VAM- Vesicular Arbuscular Mycorrhizae, *Figures in parentheses indicates angular transformed values

bacter chroococcum and plaster of paris treated plots compared to other treatments. In this case disease severity was recorded 1.05%, 1.41%, 1.38% and 0.70% in vermicompost, *Pseudomonas fluorescens, Azotobacter chroococcum* and plaster of paris treated plots, respectively. Severity of the disease gradually increased with the increase of age of the plant. All the treatments showed significant differences from control up to 75 DAP. Severity of the disease was highest in control plots (8.95 and 19.88%) followed by VAM (4.92 and 8.11%), neem cake (4.55 and 5.51%) and *Trichoderma viride* (2.50 and 4.74%) treated plots whereas lowest disease severity recorded in plaster of paris (0.70 and 2.65%) followed by vermicompost (1.05 and 3.80%), *Pseudomonas*

fluorescens (1.41 and 4.30%) and *Azotobacter chroococcum* (1.38 and 4.20%) treated plots at 60 and 75 DAP, respectively (Table 5).

The disease data, starting from 30 DAP up to 75 DAP were made average and it was observed that all the treatments were superior to untreated control (Table 5). Maximum disease severity was recorded in control plot (8.60%) followed by VAM (4.11%), neem cake (3.24%), and *Trichoderma viride* (2.24%) treated plot. However, lowest of that was observed in plaster of paris (0.84) followed by vermicompost (1.22%), *Azotobacter chroococcum* (1.40%) and *Pseudomonas fluorescens* (1.43%).

The per cent disease control after 75 days of observation was found highest in the treatment plaster of paris (90.24%) followed by vermicompost (85.82%), *Azotobacter chroococcum* (83.73%) and *Pseudomonas fluorescens* (83.38%). *Trichoderma viride* (73.96%) was better than neem cake (62.33%) and VAM (52.21). Lowest PDC was recorded in VAM treatment that was found less effective against the pathogen. It was concluded from the study that plaster of paris, vermicompost, *Azotobacter chroococcum* and *Pseudomonas fluorescens* can be used to manage the disease in field level effectively (Table 5).

Kulkarni and Kulkarni (1994) and Virupaksha Prabhu *et al.* (1997) showed that seed and soil treatment with *T. viride* and *T. harzianum* were the most effective in reducing the mortality percentage of groundnut and cotton seedlings. Vanitha and Suresh (2002) recorded the lowest collar rot of brinjal when seed was treated with *T. harzianum* along with soil application of adathoda leaf powder and FYM.

PSB (*Bacillus polymyxa*) and *Azotobacter chroococcum* are commonly used to promote growth of different plants. The disease suppression mechanisms of antagonistic rhizobacteria may involve induced resistance or active colonization around the rhizosphere zone (Chen and Echandi, 1984), or competitive exclusion (McLaughlin and Sequeira, 1988). It should be stressed that very few of these approaches to biological control of the disease has reached a point of commercial application and much more work is needed. The PSB has been used earlier for management of bacterial wilt diseases and reported efficacious (Mondal *et al.* 2010). *Azotobacter chroococcum* has been used effectively earlier in disease management programme by Mahato and Mondal (2014). In present study, treatment with *Azotobacter chroococcum* showed significant effect in disease suppression, this may be due to rhizospheric colonization and induction of systemic resistance on potato systems.

Vermicompost may directly influence the disease incidence through its effect on growth of the plant and indirectly its influence on the growth promoting bacteria and antagonistic microorganisms of the pathogen (Mondal *et al.* 2010).

Application of Gypsum decreased disease development in pea nut. (James Grichar *et al.* 2002). High levels of Ca could manage the plant diseases by inducing host resistance or increasing productivity of the host plant (Garren and Jackson, 1973). Plaster of paris perhaps absorbs moisture from the sclerotial body of the fungus, which may results in deformation and drying of the fungal structure. Mondal and Khatua (2013) reported about the good inhibitory effect of plaster of paris on *Sclerotium rolfsii* causing foot rot of elephant foot yam. Management of collar rot disease of brinjal through plaster of paris was also reported by Mahato and Mondal(2014). Though, gypsum (calcium sulphate dihydrate, $CaSO_4$, $2H_2O$) and plaster of paris (calcium sulphate hemihydrates, $CaSO_4$, ½ H_2O) are very closely related chemicals, performance of the plaster of paris appeared to be better as it showed lethal action against this pathogen. Plaster of paris is low cost, easily available and can be incorporated in disease (caused by *Sclerotium rolfsii*) management programme.

The exploitation of rhizosphere microorganisms for management of collar rot disease of potato under field condition was found to be an effective tool. Therefore, further research on isolation, characterization and mass production of specific indigenous antagonistic rhizosphere microorganisms for commercial production should be taken up with utmost importance. Plaster of paris ($CaSO_4$,½ H_2O) had strong adverse effect on mycelial growth and sclerotial viability as well as it checked the collar rot disease without causing phytotoxicity in standing crop. Plaster of paris is comparatively cheap than the fungicides available in the market and may be recommended to the farming community for management of the disease of economically important crops by incorporating it into Integrated

Disease Management (IDM) programme. Details of application, standardization of dose of plaster of paris and its detail mode of action have to be explored.

ACKNOWLEDGEMENT

The authors are grateful to Dr. D. C. Khatua, ex-Professor, Department of Plant Pathology, BCKV, Mohanpur, Nadia for helping us to conduct the experiment

REFERENCES

Arunasri, P., Chalam, T.V., Eswara Reddy, N.P. and Tirumala Reddy, S. 2011. Collar rot disease of crossandra induced by *Sclerotium rolfsii* and its management: A critical review. *International Journal of Applied Biology and Pharmaceutical Technology,* **2**: 307-314.

Chen, W.Y. and Echandi, E. 1984. Effect of avirulent bacteriocin-producing strains of *Pseudomonas solanacearum* on the control of bacterial wilt of tobacco. *Plant Pathology,* **33**: 245-253.

Garren, K.H. and Jackson, C. 1973. Peanut diseases. In: Peanut Culture and Uses. Amer. Peanut Res. and Educ. Assn. Inc., Stillwater, OK. pp. 429-494.

James Grichar, W. Besler, A.B. and Brewer, D.K. 2002. Comparison of Agricultural and Power Plant By-Product Gypsum for South Texas Peanut Production. *Texas Journal of Agriculture and Natural Resources*, **15**: 44-50.

Kulkarni, S.A. and Kulkarni, S. 1994. Biological control of *Sclerotium rolfsii* a causal agent of stem rot of groundnut. *Karnataka Journal of Agricultural Sciences,* **7:** 365-367.

Madhavi, G.B. and Bhattiprolu, S.L. 2011. Integrated disease management of dry root rot of chilli incited by *Sclerotium rolfsii* (Sacc.). *International Journal of Plant, Animal and Environmental Sciences,* **1:** 31-37.

Mahato, A. and Mondal, B. 2014. *Sclerotium rolfsii*: its isolates variability, pathogenicity and an eco-friendly management option. *Journal of Chemical, Biological and Physical Sciences (Section B: Biological Sciences),* **4:** 3334-3344.

McLaughlin, R.J. and Sequeira, L. 1988. Evaluation of an avirulent strain of *Pseudomonas solanacearum* for biological control of bacterial wilt of potato. *American Potato Journal,* **65**: 255-268.

Mondal, B. and Khatua, D. C. 2013. Evaluation of Plaster of Paris and Some Fungicides for Management of Foot rot of *Amorphophallus campanulatus* Blume Caused by *Sclerotium rolfsii* Sacc. *International Journal of Agriculture, Environment & Biotechnology*, **6**: 585-589.

Mondal, B., Bhattacharya, I., Dutta, S. and Khatua, D.C. 2010. Field evaluation of non-chemical agents against bacterial wilt of brinjal. *Journal of Soil Biology and Ecology*, **30**: 26-30.

Vanitha, S. and Suresh, M. 2002. Management of collar rot of brinjal (*Sclerotium rolfsii*) by non-chemical methods. *South Indian Horticulture*, **50**: 602-606.

Virupaksha Prabhu, H., Hiremath, P.C. and Patil, M.S. 1997. Biological control of collar rot of cotton caused by *Sclerotium rolfsii* Sacc. *Karnataka Journal of Agricultural Sciences,* **10:** 397-403.