International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 06-09

Received: 06-01-2019
Accepted: 08-02-2019

Abhishek Shiwangi
Department of Plant Pathology
N.D. University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

SP Pathak
Department of Plant Pathology
N.D. University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

Correspondence
Abhishek Shiwangi
Department of Plant Pathology
N.D. University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

Effect of eco-friendly treatments on important fungal foliar and tuber borne diseases of potato (*Solanum tuberosum* L.)

Abhishek Shiwangi and SP Pathak

Abstract
Early (*Alternaria solani*) and late blight (*Phytophthora infestans*) are very destructive diseases which cause heavy economic yield loss of potato. The early and late blight diseases of potato appear every year in varying intensity and cause heavy yield losses in potato tuber. An experiment was conducted at Main Experiment Station (MES) of Vegetable Science, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad during *Rabi* Season of 2011-2012. Seven treatments including control *i.e.* T_1 (Control), T_2 (Tuber treatment with *Trichoderma viride* @ 8g/kg at planting), T_3 (Tuber treatment with *Bacillus subtilis* @ 0.25 per cent at planting), T_4 (Tuber treatment with spray of Boric acid @ 3 per cent before storage), T_5- Bio-fumigation (mustard were sown at least one month before potato planting and used as green manure), T_6 (Bleaching powder @ 12 kg/ha with fertilizer at the time of planting) and T_7 (Gypsum application @ 200 kg/ha at the time of planting) with four replications were taken up using RBD. The maximum plant emergence (88.00%) was recorded with T_5. Minimum disease intensity (10.05 and 34.14%) was recorded with T_2 against early and late blight of potato as compared to T_1. Maximum tuber yield (225.83 q/ha) was also recorded with T_2 as compared to T_1. *Trichoderma viride* was most effective in reducing the disease intensity and increasing tuber yield.

Keywords: *Trichoderma viride*, *Bacillus subtilis*, bio-fumigation, boric acid, gypsum

Introduction
Potato (*Solanum tuberosum* L.) is one of the most important vegetable crop growing all over the world which belongs to *Solanaceae* family. Potato is the third most important food crop in world after rice and wheat (Anonymous, 2012) [2]. The total cultivated area of potato in India is 2.15 mha with an annual production of 48.23 mt. Uttar Pradesh is the leading state, which produces 13.45 mt of potato from an area of 0.54 mha (Anonymous, 2017). Potato today increasingly finds use in the form of chips or wafers as snacks food. Potato contains significant levels of phenolic compounds and vitamin C as potent antioxidants (Brown, 2005) [5], which inactivate reactive oxygen species, reduce oxidative damage, lead to improved immune functions and reduce risk of cardiovascular diseases, cancer, cataract, diabetes and aging (Kour *et al.*, 2004) [9]. The potato chips and wafers are popular processed food items that give considerable value addition to potato. It is a rich food in carbohydrate, protein, vitamins C, B1, B6, folic acid, potassium, magnesium, zinc and copper. Potato crop suffers from a number of diseases caused by fungi, bacteria, viruses viroid and nematodes, *viz.*, early blight, late blight, leaf spots, dry rot, charcoal rot, black scurf, common scab, soft rot, bacterial wilt, potato leaf curl, potato mosaic, leaf roll, spindle tuber and many nematode diseases causes considerable loss in yield. In freshly harvested potato tuber, black scurf (*Rhizoctonia solani* Kuhn.) is the major disease on tuber. Among the fungal diseases, leaf blights, leaf spots and black scurf are most important fungal diseases of potato. The losses in tuber yield caused by disease have been estimated upto 20-60 per cent depending upon the severity of infection (Khurana, 2000) [8]. Indiscriminate use of fungicides has resulted in various environmental and health hazards along with socio-economic problems. The primary goal of eco- friendly managed potato production is optimize the production and productivity of crop for the betterment of soil, plant and environment. Eco-friendly managed grown crop produced better food quality than traditionally grown crops, using chemical fertilizers and pesticides. Eco-friendly tuber treatments reduce seed borne as well as foliar pathogen along with better yield and improving soil health.

Materials and methods

The experiment was conducted during *Rabi* seasons 2011-12 by sowing susceptible variety Kufari Pukhraj in Randomized Block Design with seven treatments including control, [T_1 (Control), T_2 (Tuber treatment with *Trichoderma viride* @ 8 g/kg at planting), T_3 (Tuber treatment with *Bacillus subtilis* @ 0.25 per cent at planting), T_4 (Tuber treatment with spray of Boric acid @ 3 per cent before storage), T_5 [Bio-fumigation (mustard was sown at least one month before potato planting and used as green manures)], T_6 (Bleaching powder @ 12 kg/ha with fertilizer at the time of planting) and T_7 (Gypsum application @ 200 kg/ha at the time of planting)] in four replications. The plot size, Spacing and Variety (susceptible) was 3.0m x 2.0m, 60cm x 20cm and Kufri Pukhraj respectively. The application of treatments is given below:

Tubers treatment with Bio-agents (T_2 and T_3)

Trichoderma viride (8g/kg) mixed with tubers and soaked with few ml of water so that bio-agent gets adhered to the surface of tubers. The *Trichoderma* coated tubers were incubated for 24 hours to germinate the spores. A jaggery solution was prepared with *Bacillus subtilis* for the treatment of potato tuber by dissolving 100g of jaggery in 1 litre of water and 2.5g *Bacillus subtilis* culture mixed by hands to obtain uniform coating. Treated tubers were kept in shade for drying. After drying the tubers were planted in experimental field immediately.

Tuber treatment with Boric acid (T_4)

To treating the potato tubers, prepared 3% boric acid solutions was used 20 minutes before sowing through knapsack sprayer on potato tubers and after 20 minutes treated potato tubers were used for sowing.

Biofumigation (T_5)

The biofumigation process done by using the Mustard was sown in the second week of September and after one month the standing crop was ploughed in the field with the help of disc plough and used in the form of green manures.

Bleaching powder application (T_6)

28.8g bleaching powder well mixed with 240g NPK and the mixture of bleaching powder and NPK fertilizer applied before planting in experimental field.

Gypsum application (T_7)

480g gypsum powder broadcast in prepared field and well mixed in soil before potato planting.

Method of planting

The seed tubers of potato were planted in prepared plots on November 15th during the year "2011-2012". The tubers were placed on the surface of plots at the spacing 60cm x 20cm and covered with soil to make the ridges.

Hand weeding was done in order to reduce the major population of weeds time to time. Irrigation was applied by tube well at fort nightly intervals after germination. Earthing up was done at 30 days after planting of tubers with the help of shovel. The plot size was 3.0m x 2.0m, row to row and plant to plant spacing was 60cm x 20cm respectively. Recommended agricultural practices for better cultivation of potato were accepted.

Observations recorded

Data were recorded on per cent plant emergence, disease intensity, per cent infected tuber and tuber yield (Q/ha).

Per cent plant emergence

The plots of each replication were regularly observed and data was recorded on per cent plant emergence at 40 days after sowing.

Per cent disease intensity

The disease severity was recorded; using 0-4 disease rating scale (Horsfall and Heuberger, 1942) [7] for early blight and 1-9 disease rating scale (Malcolimson, 1976) [10] for late blight disease. The data on disease severity were recorded at first appearance of the disease. To recording the PDI of early and late blight disease 10 plants were randomly selected from each plot of all the replications. Out of 10 plants, 50 leaves were selected for disease scoring in each plot. The per cent disease intensity (PDI) was calculated using the following formula:

$$\text{PDI} = \frac{\text{Sum of numerical rating}}{\text{Total number of leaves examined} \times \text{maximum rating}} \times 100$$

Table 1: Disease rating scale for early blight (0-4) as suggested by Horsfall and Heuberger (1942) [7] and Ramkrishan *et al*. (1971) [11]

Rating	Disease reaction	Description
0	Free	No disease
1	Resistant	1-25% leaf area affected
2	Moderately resistant	26-50% leaf area affected
3	Moderately susceptible	51-75% leaf area affected
4	Susceptible	76-100% leaf area affected

Table 2: Disease rating scale for late blight (1-9) suggested by Malcolimson (1976) [10]

Grade	Per cent infestation
1	(91-100) collapsed
2	81-90
3	71-80
4	61-70
5	41-60
6	26-40
7	11-25
8	10
9	(1-9) Trace infestation

Per cent tuber infection

For per cent tuber infection, observations were recorded on randomly selected one hundred tubers from each replication of the treatment. Per cent tuber infection was recorded by the following formula:

$$\text{Per cent tuber infection} = \frac{\text{Number of infected tubers}}{\text{No. of tubers randomly selected}} \times 100$$

Tuber yield

The tuber yield was recorded after harvesting the crop at maturity. Collected potato tubers from each plot were measured by using electronic balance and evaluate the weight of every treatment potato tubers.

Result and discussion

Per cent plant emergence

The results of various parameters obtained from the study are discussed as follow, whereas relevant data is given in Table 3. The maximum plant emergence (88.00%) was recorded with T_2 while, minimum plant emergence (76.81%) was recorded in T_1 (control) at 40 days after sowing. All the treatments (T_3-84.50%, T_4-85.50%, T_7-86.24%, T_6-86.25% and T_5-86.75) were significantly superior to control.

Per cent disease intensity

Results indicated that all the treatments were superior over control against early blight of potato. Each treatment was found significantly superior in reducing the disease severity of alternaria blight (*Alternaria solani*) as compared to control. However, minimum disease intensity 10.05% was recorded in T_2, which was most effective treatment against early blight of potato followed by 11.30, 14.46, 18.15, 22.08 and 22.54 per cent in T_3, T_4, T_6, T_7 and T_5 respectively, as compared to control (25.48%) against early blight. The similar findings of Swain *et al.* (2008) [12] showed that disease caused by *Alternaria solani* exhibit different types of symptoms which differs to a large extend to the normal leaf spot and blight symptoms caused by *A. solani*. The *in-vitro* growth and spore germination of *A. solani* was effectively controlled by bio-agent (*Trichoderma harzianum*).

The minimum per cent disease intensity (34.14%) was recorded in T_2 against late blight of potato followed by 39.35, 45.19, 46.18, 50.83 and 53.53 per cent in T_4, T_5, T_3, T_6 and T_7 respectively, as compared to control (55.28%). The above findings are also supported by Dey *et al.* (2010) [6] that biological agents like *Trichoderma harzianum*, *T. viride*, *Penicillium* sp., and *Chaetomium* sp., collected from *Phyllosphere* have been tested against late blight. Some of these proved effective against *Phytophthora infestans* when applied as prophylactic.

Table 3: Effect of different treatments against foliar and tuber borne diseases of potato in 2011-2012

Treatments	Per cent plant emergence	PDI								Per cent infected tuber by		Yield (Q/ha)
		Early blight				Late blight						
		31 DAS	46 DAS	61 DAS	76 DAS	27 DAS	34 DAS	41 DAS	48 DAS	Black scurf	Common scab	
T_1	76.81	5.10	9.13	19.07	25.48	9.09	23.55	43.24	55.28	50.00	23.00	164.50
T_2	88.00	1.08	3.76	5.54	10.05	1.03	8.19	23.36	34.14	13.50	15.44	225.83
T_3	84.50	1.53	5.12	7.03	11.30	3.06	16.16	38.77	46.18	31.12	14.25	185.50
T_4	85.50	2.11	6.22	11.32	14.46	2.31	14.37	33.08	39.35	19.88	10.94	203.17
T_5	86.75	4.33	8.93	17.85	22.54	3.00	17.79	33.82	45.19	37.56	13.50	183.67
T_6	86.25	2.36	7.00	13.81	18.15	4.98	20.82	39.59	50.83	37.75	14.63	193.17
T_7	86.24	3.21	7.63	13.99	22.08	5.63	23.15	41.11	53.53	33.94	13.94	194.83
CD at 5%	3.877	2.052	1.670	1.486	1.055	2.595	1.141	0.668	0.623	1.006	1.165	22.275

PDI= Per cent disease intensity,
DAS= Days after sowing

Per cent Tuber Infection

Black scurf (*Rhizoctonia solani*) and common scab (*Streptomyces scabies*) were found as major tuber borne diseases in freshly harvested potato tubers.

The minimum per cent tuber infection of Black scurf (*Rhizoctonia solani*) was recorded (13.50%) in T_2 as compared to rest of the treatments. The above results also supported by Arora and Sharma (2007) that treatment of seed tubers with a biocontrol agent (*Trichoderma viride*) reduced black scurf disease incidence and disease index in the progeny tubers with 37.7 and 43.6 per cent over the control.

The minimum per cent tuber infection of common scab (*Streptomyces scabies*) was recorded (10.94%) in T_4 against all the treatments. All the treatments (T_4-10.94%, T_5-13.50%, T_7-13.94%, T_3-14.25%, T_6-14.63% and T_2-15.44%) were found significantly superior to control (23.00%). Similarly Khan *et al.* (2003) [4] evaluated two chemicals (3% boric acid solution and 3% elemental sulphur solution) each for two different duration of time *i.e.* 10 and 20 minutes were evaluated against common scab (*Streptomyces scabies*) of potato at Battakundi farm in Kaghan valley (Pakistan) in summer (2001). Both the chemicals gave significant control for the disease incidence as compared to control.

Yield (Q/ha)

Results revealed that all the treatments increase tuber yield q/ha as compared to control (T_1). Maximum tuber yield (225.83 q/ha) was recorded in T_2 followed by T_4, T_7, T_6, T_3 and T_5 as compared to all the treatments including control. The minimum tuber yield 164.50q/ha was recorded in T_1 (control). The above findings are also supported by Arora and Sharma (2007) that treatment of potato tubers with a bio-agent (*Trichoderma viride*) which increase the yield of all plots treated with antagonist.

Acknowledgement

The authors are thankful to Department of Plant Pathology, N.D. University of Agriculture and Technology, Kumarganj, Faizabad for providing field facilities and potato tubers.

References

1. Anonymous. National Horticulture Board, 2009, 248.
2. Anonymous. Small farmer's agriculture consortium and Indian Agriculture Systems Pvt. Ltd., 2012. http://sfacindia.com.
3. Arora RK, Sharma J. Eco-friendly alternatives to pesticides in management of soil and tuber borne diseases of potato in organic farming. Sustainable environmental management: Dr. Jayashree Deshpande Festschrift, 2007, 1-6.
4. Khan AUR, Khan DI, Haq I, Hussain I, Sajid M, Siddiqui SA. Control of common scab of potato through seed treatment. Pakistan Journal of Plant Pathology. 2003; 2(3):141-144.
5. Brown CR. Antioxidants in potato. American Journal of Potato Research. 2005; 82:163-172.
6. Dey TK, Hossain M, Kadian MS, Hossain S, Bonierbale M, Mahmud AA. Prevalence, epidemiology and management of potato late blight in Bangladesh. Potato Journal. 2010; 37(3/4):99-102.
7. Horsfall JG, Heuberger JW. Measuring magnitude of a defoliation disease of tomato. Phytopathology. 1942; 32(2):226-232.
8. Khurana SM, Paul. Diseases and pest of potato. CPRI, Shimla, 2000, 66.
9. Kour C, George B, Deepa N, Singh B, Kapoor HC. Antioxidant status of fresh and processed tomato. A Review Journal of Food Science and Technology. 2004; 41:479-486.

10. Malcolimson JF. Assessment to late blight (*Phytophthora infestans*) in potatoes. Trans. Br. Mycol. Soc. 1976; 67:321-325.
11. Ramkrishan Laxmi, Kamalnathan S, Krishnamurthy CS. Studies on Alternaria leaf spot of tomato. Madras Agric. J. 1971; 58(4):275-280.
12. Swain NC, Biswal G, Behera B, Ramakrishna P. Detection of *Alternaria solani* causing leaf blight diseases of potato and its management. Journal of Plant Protection and Environment. 2008; 5(1):102-105.