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Efficacy of certain bio agents and fungicides against early blight of potato (*Solanum tuberosum* L.)

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ABSTRACT

An experiment was conducted to evaluate the effect of bio agents (*Trichoderma harzianum* and *Pseudomonas fluorescens*) and fungicides (mancozeb) against early blight of potato caused by *Alternariasolani* (Ell. and Mart.) at the experimental field of Department of Plant Protection, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad during *Rabi* Season of 2013-2014. Seven treatment including control with three replications were taken up using RBD. The treatments comprised of seed treatment and foliar spray (once and twice) of bio agents *Trichoderma harzianum* and *Pseudomonas fluorescens* while fungicide taken up was mancozeb and control (spray of plain water) was applied. Observation for per cent disease intensity was recorded at 60 and 80 days after sowing. Lowest disease intensity was recorded in mancozeb (15.07% and 18.40%, respectively) as compared to control which recorded highest disease intensity (20.91% and 33.80%, respectively).Mancozeb not only reduced disease intensity but also recorded highest yield (253.00 q/ha) as compared to control which recorded 157.83 q/ha.The bio agents *Trichoderma harzianum* and *Pseudomonas fluorescens* (seed treatment +foliar spray) were also effective in reducing the disease intensity and increasing tuber yield.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is the third most important food crop in world after rice and wheat (Anonymous, 2012). It belongs to family Solanaceae. It is well known as the king of vegetables. Potato is a unique crop which can supplement the food needs of the country in a substantial manner. Potato is grown in an area of 1.3 m/ ha, with production 24 mt and productivity 18.5 t/ha. Today, India ranks fourth in the area and fifth in the production of potato in the world (Shailbala and Pathak, 2008). 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), 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). 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, B_1, B_6, folic acid, potassium, magnesium, zinc and copper. Early blight is an economically important fungal disease caused by *Alternaria solani* (Sorauer, Ell. and Mart.) Jones and Grout. This disease affects a wide range of Solanaceous plants, including potato, tomato, pepper, eggplant and other species. Early blight takes the form of brown leaf spots marked with concentric rings to give a target effect. These spots enlarge slowly and may eventually destroy the leaves. The fungus causes stem canker or collar rot of young seedlings, sunken spots or cankers on older stems, blossom drop and loss of young fruits and dark leathery fruit spots, usually about the point of attachment of decayed lesions may form on the tubers, permitting the entrance of decay organisms on potato. In severe attacks, lesions appear on upper stems and petioles (Raziq and Ishtiaq, 2010). *Alternaria solani* is an imperfect fungus with no sexual stage known so far. The mycelium consists of septate, branched, light brown hyphae which become darker with age. The hyphae in the host are at first intercalary, later penetrating into the cells of the invaded tissues. Conidiophores emerge through the stomata from the centres of the spots.They are relatively shorter, 50-90×9 ìm and dark coloured. Conidia are 120-296×12-20 ìm in size, beaked, muriform, dark-coloured and borne singly (Singh, 2009). The disease initially appears on the older leaves causing premature senescence and leaf area reduction (Johnson and Teng, 1990). Control of early blight has been accomplished primarily by the application of chemical fungicides. Several effective fungicides have been recommended for use against this pathogen, but they are not considered to be long-term solutions, due to concerns of expense, exposure risks, fungicide residues and other health and environmental hazards. In an attempt to modify this condition, some alternative methods of control have been adopted. Pathogen can derive resistance against fungicide application so repeated application of fungicides in an unplanned manner and its wide use often leads to serious environmental problems besides affecting the health of users and consumers. So, it is necessary to minimize the use of chemicals for controlling disease(Chourasiya *et al*., 2013). Biological control of plant pathogens has emerged as a potential control strategy in recent years and has increased the search for potential biological agents has increased. *Trichoderma* is the most commonly used fungal bio control agent and have long been known as effective antagonists against plant pathogenic fungi (Chet *et al.*, 1981; Kumar and Mukerji, 1996). *Pseudomonas fluorescens*, also a common bacterial bio-control agent is an obligate aerobe, gram negative Bacillus. These bacteria are able to inhabit many environments, including: plants, soil, and water surfaces and *P. fluorescens* strains have bio control properties, protecting the roots of some plant species against parasitic fungi such as *Fusarium* or *Pythium*, as well as some phytophagous nematodes. Optimal temperatures for growth of *P. fluorescens* 25-30°C. Several effective fungicide have been recommended for use against this pathogen, but they are not considered to be long-term solutions, due to concerns of expense, exposure risks, fungicide residues and other health and environmental hazards. Bio agents are used as seed and soil treatments like the synthetic fungicides. Foliar spray of bio agents has also emerged as a satisfactory, effective and new eco-friendly technique for the management of the disease of crop plants (Wu, 1995, Chand, 2005; Singh, 2009).

MATERIAL AND METHODS

The experiment was carried out during 2013-2014 at the field of Department of Plant Pathology, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed University) Allahabad, Uttar Pradesh, India. The soil of the experimental field was sandy loam with pH 5.6. The experiment was laid out in a Randomized Complete Block Design with three replications. The unit plot size was 2 m×1 m which was separated by 1.0 m wide drains. Row to row and plant - to-plant distances were 50 cm. The soil was raised and drains were made to remove excess water. The disease symptoms appeared after 50 days of sowing (DAS). First spray of the bio agent and the fungicide was carried out at 60 DAS after recording the disease intensity (Table A). The second spray as per the treatment combination was given after an interval of 10 days (*i.e.* 70 DAS) and the data were recorded at 80 DAS as given in Table A.

Fig. A : Symptoms of early blight on (A, B) leaves of potato and (C) Conidia of *Alternaria solani*

Application of bio agents and fungicides against early blight of potato :

A field experiment for the evaluation of bio- agents and fungicides as seed treatment and foliar spray (once and twice) was conducted against early blight of potato. Seed treatment with *Trichoderma harzianum* @5g/kg, *Pseudomonas fluorescens*@ 5g/kg and mancozeb @ 2.5g/kg while the foliar spray were carried out @ 5g/l, 6g/l and 2.5g/l, respectively. The control seeds were treated with plain water. The disease intensity of early leaf blight was recorded after 60 days before spray and recorded at 80 days after the second spray. The disease intensity was recorded on 0 - 5 scale. Five infected plants were selected randomly from each plot and five leaves were selected from each selected plant for scoring the disease intensity data (Table A) (Singh, 2004).

Table A: Score of disease intensity of early blight of potato

Disease score	Disease severity
0	No infection
1	0.1- 1.0 per cent leaf area affected
3	1.1- 10.0 per cent leaf area affected
5	10.1- 25.0 per cent leaf area affected
7	25.1-50.0 per cent leaf area affected
9	< 50.1 per cent leaf area affected

Per cent disease intensity (PDI) was calculated based on the following formula- Disease intensity (%) was calculated by using the following formula :

$$\text{PDI} = \frac{\text{Sum of all disease rating}}{\text{Total number of leaves} \times \text{maximum grade}} \times 100$$

RESULTS AND DISCUSSION

Fungicides and bio agents differed in respect of early blight disease intensity (%) at different growth stages (Table A). At 60 DAS, the lowest disease intensity (15.07%) was recorded in mancozeb as compared to control (20.91%). At 80 DAS, the lowest disease intensity (18.40%) was recorded in the seed treatment combined with two foliar sprays of mancozeb followed by seed treatmentcombined with one foliar spray of mancozeb (20.97%), seed treatment combined with two foliar sprays of *Trichoderma harzianum* (23.27%), seed treatment combined with two foliar sprays of *Pseudomonas fluorescens* (23.57%), while the highest (33.80%) was recorded in control plot. Among the fungicide and bio agents mancozeb performed better than other bio agents to reduce per cent disease intensity of the early blight disease (Table 1).

The investigation on effect of fungicides and bio agents on disease intensity and yield indicated that yield obtained from all fungicidal and bio agents treated plants significantly differed from untreated control. Maximum yield (253.00 q/ha) of potato tuber was recorded in the seed treatment with two foliar sprays of mancozeb followed by seed treatment with one foliar spray of mancozeb (244.67 q/ha), as against the yield in control plots of (157.83 q/ha).

In the present study, the minimum disease intensity of early blight and maximum yield was found when mancozeb was used as seed treatment and foliar spray (FS1 + FS2). The probable reason for such finding may be that, mancozeb would have affected the spore germination and mycelial development, which may have resulted in the inhibition of disease producing activity of pathogen in the plant and induced resistance. This resulted in better overall growth and good health of potato plants. This may be the reason for minimum disease intensity and maximum yield as compared to other treatments. Raziq and Ishtiaq, 2010; Yadav *et al*., 2002 and Osowski, 2004 have also reported that mancozeb was the most effective fungicide and recorded minimum disease intensity against early blight of potato.

Mancozeb was the most effective fungicide in managing the disease intensity of early blight on potato caused by *Alternaria solani*. The fungicidal treatment also recorded higher yield (253.00 q/ha). Amongst the bio-agents *Trichoderma harzianum* was the most effective whereas *Pseudomonas fluorescens* was also found to be significantly effective in comparison to control as such bio agents tested in the present experiment have proved their potential and can be used in future for the management of early blight of potato and thus can reduce the indiscriminate use of fungicides by the potato growers. The results found are more or less similar to the results founded by Pawar *et al.* (2013) worked on safflower, Meena *et al.* (2008) on Indian mustard and Sharma *et al.* (2002) worked on maize.

Table 1 : Effect of bio-agents and fungicide on disease intensity against early blight of potato

Treatment no.		PDI		Yield
		60 DAS	80 DAS	(q/ha)
T_0	Control	20.91	33.80	157.83
T_1	*Trichoderma harzianum* (ST@ 5g/kg + FS1@ 5g/l)	17.87	27.37	206.17
T_2	*Trichoderma harzianum* (ST@ 5g/kg + FS1@ 5g/l + FS2@ 5g/l)	18.03	23.27	221.83
T_3	*Pseudomonas fluorescens* (ST@ 5g/kg + FS1@ 6g/l)	18.54	27.87	195.67
T_4	*Pseudomonas fluorescens* (ST@5g/kg + FS1@ 6g/l + FS2@6g/l)	18.54	23.57	204.83
T_5	Mancozeb (ST@ 2.5g/kg + FS1@ 2.5g/l)	15.36	20.97	244.67
T_6	Mancozeb (ST@ 2.5g/kg + FS1@ 2.5g/l + FS2@ 2.5g/l)	15.07	18.40	253.00
S.E. (±)		0.784	1.645	15.105
C.D. (P = 0.05)		1.663	3.488	32.022

PDI= Per cent disease intensity, DAS= Days after sowing, ST: seed treatment, FS1: One foliar spray, FS2: Two foliar sprays (at an interval of 10 days)

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