Environment & Ecology 35 (4C) : 3241—3244, October—December 2017
Website: environmentandecology.com ISSN 0970-0420

Effect of *Pseudomonas fluorescens* on Early Blight of Potato (*Solanum tuberosum* L.) under Allahabad Condition

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Received 25 February 2017; Accepted 28 March 2017; Published online 13 April 2017

Abstract An experiment was conducted to evaluate the effect of *Pseudomonas fluorescens* on early blight of potato (*Solanum tuberosum* L.) in the experimental field in *rabi* season. A survey was conducted during *rabi* in two district of UP. Maximum disease severity was noticed at Shekhupar village (71.15%) in Pratapgarh district. However, minimum disease severity was noticed at Central field (SHIATS) (50.67%) in Allahabad district. Foliar spray of *Pseudomonas fluorescens* (3.5%), *P. fluorescens* (3%), *P. fluorescens* (2.5%), *P. fluorescens* (2.0%), *P. fluorescens* (1.5%), *P. fluorescens* (1.0%) and control (spray of plane water) were applied at the onset of disease symptoms at 60 and 75 DAS. Observation for per cent disease intensity was recorded at 10 and 25 days after spray. Minimum disease intensity was recorded in *Pseudomonas fluorescens* dose recorded 3.5% (14.64% and 27.36%, respectively) as compared to control which recorded maximum disease intensity (39.20% and 59.36%, respectively). Effect of treatments on plant height at 10 and 25 days after the spray was observed. Maximum plant height was recorded in *P. fluorescens* dose recorded 3.5% (36.4 cm and 41.1 cm, respectively) as compared to control which recorded minimum plant height (21.66 cm and 25.3 cm, respectively).

Keywords Potato, Early blight, *Alternaria solani, Pseudomonas fluorescens.*

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Introduction

Potato (*Solanum tuberosum* L.) is the most important food crop of the world. Potato is well known as the king of vegetables has emerged as one of the most important food crop in India. The potato is a crop which has always been the poor man's friend. The origin of potato is South America (Peru) in the Central Andean region. Potato was introduced to India from Europe in the beginning of the seventeenth century, probably by the Portuguese, who were the first to open trade routes to the East. Potato is an economical food, provides a source of low cost energy to the human diet. Potato is a rich source of starch, vitamins especially C and B_1 and minerals [1]. Potato is the world's fourth largest food crop, following rice, wheat and maize [2]. It is grown in more than 150 countries in world with a total production of 374.4 MMT (Million metric tones) during the year 2011. India is the second largest potato producing country in world during the year 2011. The area under potato cultiva-

tion in India was 1.86 Million ha with total production of 42.33 MMT in 2011. India contributes approximately 7.5% of the world's total potato production. Uttar Pradesh is largest producer of potato in India [3]. Uttar Pradesh alone produces nearly 35% of India's total production of potato [3].

The potato crop attacked by a number of pathogen like late blight of potato *(Phytophthora infestans),* early blight of potato *(Alternaria solani),* Wart disease of potato (Synchytrium endobioticum), scab disease of potato *(Repitomyces scabies)* but *Alternaria solani* causing early blight, plays an important role in potato production. The pathogen causes considerable damage to the crop throughout the country wherever the crop grown. Primary damage by early blight is attributed to premature defoliation of the potato plants, resulting in tuber yield reduction. Yield loss estimates resulting from foliar damage incited by early blight on potato vary by location. cropping season, cultivar, and the stage of potato maturity. In India it may cause up to 40% loss in yield of tubers [4].

Potato early blight symptoms first occur on the lower senescing leaves, which become chlorotic and abscise prematurely. Excessive defoliation may lead to death of the plant and consequent yield loss. The mycelium and conidia of the fungus remains viable in soil and plant debris and serve as a source of primary inoculum for the next season while secondary spread takes place by air borne conidia produced in new lesions [1]. Biological control has become known to have a high impact on the management of soil-borne plant pathogens. Biological control makes management of diseases less dependent on the use of high-risk chemicals and it is environmentally friendly. Fluorescent *Pseudomonas* are among the most effective rhizosphere bacteria used to suppress diseases caused by soil-borne plant pathogens [5]. *Pseudomonas fluorescens* is one of the most important biocontrol agents against certain seed and soil-borne plant pathogens.Positive results were achieved with *P.fluorescens,* which controlled blast of rice [6]. *P. fluorescens* was also used as a biocontrol agent to manage *Alternaria* blight of sunflower [7], early blight of potato [8], early blight of tomato []9], *Alternaria* blight of mustard [10], leaf blight of onion [11].

Materials and Methods

Field survey

A survey was conducted during *rabi* in different villages of Allahabad and Pratapgarh districts to know the severity of early blight discase of potato. From the survey it is revealed that the disease was severe in Allahabad and Prathapgarh district during *rabi* 2012 and diseases severity ranged from 50.67 to 71.15% in different parts of the districts surveyed. The highest disease severity (71.15%) of early blight was noticed in field of Shekhupar village in Pratapgarh district, where as lowest (50.67%) severity of the disease was recorded at Cental field (SHIATS) in Allahabad district. During survey various symptoms of the disease was noticed on leaves, large irregular to circular dark brown spots on the lower (older) leaves, the older leaves were more susceptible than younger leaves. Leaf lesions were easy to identify in the field because lesion devolopment is characterized by series of dark concentric rings alternating with hands of light tan tissue.

Field experiment

The experiment was carried out at the field of Department of Plant Protection, Sam Higginbottom Institute of Agriculture, Technology & Sciences, 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 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 and 20 cm, respectively. The symptoms appeared after 90 days of sowing (DAS).

Isolation and identification of
Alternaria solani (Ell and Mart)

The infected plant, showing characteristic symptoms of disease was cut with healthy portion into small pieces (2-5 mm), surface sterilized with 0.1% NaClO (Sodium hypochlorite) solution, thrice rinsed with sterilized distilled water and then transferred aseptically on PDA medium in petri plates. These petri plates were incubated at 25 ± 2^0C. After 3 days, a whitish

Table 1. Survey of early blight *(Alternaria solani)* in two district of UP.

	Village name	Month	Per cent disease index
	Manaipurva	1 Mar	49.08%
	Bhita	1 Mar	54.41%
Allahabad	Nagarpura	1 Mar	54.2%
district	Ghusianva	1 Mar	56.46%
	Baribojha	1 Mar	53.12%
	Central field (SHIATS)	2 Mar	50.67%
	Dadulpur	3 Mar	61.2%
	Shekhupar	3 Mar	70.15%
Pratapgarh	Burra	3 Mar	56.5%
district	Rhatua	3 Mar	63.0%
	Kahala	3 Mar	65.8%

colony growth was observed from this colony and a portion from the periphery having single hyphal tip was separated and transferred to other petri plates having medium to get pure culture and identification of the pathogen was confirmed by observing the morphological features of colony. The characteristic feature of genus is the production of beaked, pigmented conidia with relatively thin transverse and longitudinal septa (muriform). The pathogen *Alternaria* has septate, dark colored mycelium and produce short, simple, erect conidiophores that bear single and branched chains of conidia in acropetal chains. The main character of the pore conidial ontogeny is the formation of minute pore in the wall of conidiophores and the pure culture was maintained in PDA petri plate kept in refrigerator [12-13].

Application of *Pseudomonas fluorescens* against early blight disease of pomato

The treatments comprised of application of *Pseudomonas fluorescens* (3.5%), *P. fluorescens* (3.0%), *P. fluorescens* (2.5%), *P. fluorescens* (2.0%), *P. fluorescens* (1.5%), *P. fluorescens* (1.0%), and untreated (control) (Table 1). The crop was sprayed three times at 60 and 75 DAS .The disease intensity of early leaf blight was recorded after ten days of spray. The disease intensity was recorded on 0–9 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 2. Effect the different doses of *Pseudomonas fluorescens* on early blight of disease intensity (%) and plant height (cm) of potato. PDI= Per cent disease intensity and DAS = Date after sowing.

Treatments	Disease intensity (%)		Plant height (cm)	
	60 DAS	75 DAS	60 DAS	75 DAS
Pseudomonas fluorescens (1.0%)	33.3	49.1	26.4	30.5
Pseudomonas fluorescens (1.5%)	29.7	44.7	27.6	31.8
Pseudomonas fluorescens (2.0%)	25.9	40.3	29.4	33.7
Pseudomonas fluorescens (2.5%)	21.2	35.0	31.8	36.2
Pseudomonas fluorescens (3.0%)	18.1	31.1	34.2	38.6
Pseudomonas fluorescens (3.5%)	14.6	27.3	36.8	41.1
Control	39.2	59.3	21.6	25.3
SEd (±)	1.29	2.39	1.13	0.98
CD (p = 0.05)	3.88	7.17	3.39	2.96

Per cent disease incidence (PDI) was calculated based on the following formula [13].

$$\text{Disease intensity (\%)} = \frac{\text{Sum of all disease rating}}{\text{Total number of leaves} \times \text{maximum grade}} \times 100$$

Results and Discussion

Field survey

Survey was conducted in two districts of Uttar Pradesh to know the severity of early blight disease of potato. Maximum disease severity of early blight was observed at Shekhupar village (70.15%) in Pratapgarh district. Minimum disease severity was observed at Central Research Field (SHIATS) (50.67%) in Allahabad district.

Effect of on the disease intensity and plant height of early blight of potato

The results of the field experiment presented in Table 2 it was very clear that per cent disease intensity was recorded at 10 and 25 days after spray. Minimum disease intensity was recorded in *Pseudomonas*

fluorescens (3.5%), (14.64% and 27.36%, respectively) performed significantly the best as evident, followed by *P. fluorescens* (3%), (18.13% and 30.9%, respectively), *P. fluorescens* (2.5%), (21.2% and 35%, respectively), *P. fluorescens* (2.0%), (25.59% and 40.31%, respectively), *P. fluorescens* (1.5%), (29.73% and 44.7%, respectively) and *P. fluorescens* (1.0%), (33.36% and 49.1%, respectively) as compared to control (39.2% and 59.36%, respectively).

Maximum plant height was recorded in *Pseudomonas fluorescens* (3.5%) at 10 days and 25 days after the spray (36.4 cm and 41.1 cm, respectively) followed by *P. fluorescens* (3%), (34.2 cm and 38.6 cm, respectively), *P. fluorescens* (2.5%), (31.8 cm and 36.2 cm, respectively), *P. fluorescens* (2.0%), (29.4 cm and 33.7 cm, respectively), *P. fluorescens* (1.5%), (27.6 cm and 31.8 cm, respectively) and *P. fluorescens* (1.0%), (26.4 cm and 30.5 cm, respectively) as compared to control T_0 (21.6 cm and 25.3 cm, respectively).

Conclusion

A survey was conducted during *rabi* 2012 in two district of Uttar Pradesh. Maximum disease severity was recorded at Shekhupar village (71.15%) in Pratapgarh district. Minimum disease severity was recorded at Central Research Field (SHIATS) (50.67%) in Allahabad district. Seven treatments were evaluated against early blight caused by *Alternaria solani.* Based on the evaluation of results it was found that *Pseudomonas fluorescens* 3.5%, proved to be most effective against *Alternaria solani* including maximum plant height and minimum disease intensity was found. The results of present experiment were limited to one season under Allahabad agro-climatic conditions as such more trials should be carried out in future to validate the findings.

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