Management of early blight of potato using bio control agents and plant extracts

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Abstract: The early blight of potato is mainly controlled by using chemical fungicides but chemical fungicides have got some adverse effect on environment as well as human beings. Keeping this in mind an experiment was conducted to test the efficacy of four plant extracts (tea, garlic, onion and neem leaf extract) and four bio-control agents (*Trichoderma viride*, *Pseudomonas fluorescence*, *Streptomyces graseoviridis* and *Bacillus substilis*) in controlling early blight of potato under field and in *in vitro* condition. These antifungal compounds were applied 3 times at 7days interval after first appearance of the disease in the field. Among the bio control agents *T. viride* was found highly effective in per cent disease reduction (52.39%) of disease over control treatment. The tuber yield (25.51 t/ ha.) was also highest in this treatment compared to control treatment (19.53 t/ha). This was followed by treatment T_2 i.e. *P. fluorescens* where per cent incidence and intensity of disease were (65.00%) and (19.10%) respectively with 38.97% reduction of disease over control with tuber yield 23.65 t/ha. It was followed by *S. graseoviridis* where per cent incidence and intensity of disease were (68.00%) and (22.90%) respectively with 26.30% reduction of disease over control with tuber yield 21.07 t/ha. Among plant extracts, only neem leaf extract exhibited per cent reduction of disease (33.18%) over control treatment in field condition and inhibition of radial growth (59.85%) and spore germination (81.95%) in *in vitro* condition. Therefore both *T. viride* and neem can be used for managing the early blight of potato.

Keywords: Bio control agents, Early blight, management, Potato

INTRODUCTION

The potato (*Solanum tuberosum*) is one of the most important vegetable crops in the world, belonging to the family solanaceae and is an important starchy food crop in both sub-tropical and temperate regions. Even in tropical regions it is widely grown during winter season. Potato (*S. tuberosum*) is a native of South America (Hijmans and Spooner, 2001). In India the potato has been cultivated since its introduction in the early part of the 17th century. In India potato is grown in almost all the states under diverse climatic conditions except Kerala and 82% of potatoes are grown in plains during the short winter days from October to March. Potato is the most popular crop in West Bengal next to cereals (Chakraborty, 2012).

Potato plants are subjected to attack by numerous diseases wherever the crop is grown. Among them, early blight of potato caused by *Alternaria solani* (Ellis and Martin) Jones and Grout is of major cause of concern in potato production at present. The disease causes losses to crop productivity in the field and to tuber quality in storage. Average annual yield loss of potato due to this disease was approximately 75% of the total production depending upon the nature of the disease, weather condition and type of variety grown (Dey and Chakraborty, 2012).

The wide and indiscriminate use of chemical fungicides has been the cause of development of resistance among plant pathogens, leading to the occurrence of serious diseases. Due to this, there is an increasing interest to obtain alternative antimicrobial agents (bio-control agents) and plant extracts for using in plant disease control systems. Plant products of recognized antimicrobial spectrum could appear in food conservation systems as main antimicrobial compounds or as adjuvant to improve the action of other antimicrobial compounds (Kaur and Arora, 1999).The development of such disease resistance to the pathogens and problems of environmental pollution due to excessive reliance on pesticides are the major causes today. Therefore, to avoid or minimize these problems, experiments have been conducted on management of early blight of potato by using the natural products such as medicinal plant extracts and bio-control agents during 2012-2013 crop seasons. The objectives of present investigations were to evaluate the efficacy of selected bio control

agents and plant extracts in controlling the early blight disease of potato in field conditions as well as in *in vitro* condition by using poisoned food technique and spore germination inhibition technique.

MATERIALS AND METHODS

To study the management response against early blight disease of potato by bio control agents and plant extracts, the variety Kufri Jawahar was used. The experiment was conducted during the Rabi season at Adisaptagram Block Seed Farm, Hooghly, West Bengal during 2012-2013 crop season. Potato was sown on 4th December 2012. The size of the each plot for management trial with bio-control agents and plant extracts was 3 m × 2 m .The field experiment for each factor was laid out in randomised block design (RBD) and there was 4 treatments with 4 replications in each of bio control agents and plant extracts respectively. The chemical fertilizers, N, P_2O_5 and K_2O was applied @ 200 kg/ha, 150 kg/ha and 150 kg/ha respectively. The 50 % of nitrogen and full dose of P_2O_5 and K_2O were applied during planting and rest 50% nitrogen was applied as top dressing during earthing up.

The percent disease incidence and intensity was recorded at 7 days interval after first appearance of the disease. Bio control agents and plant extracts were sprayed after taking each observation for percent disease incidence and intensity with their recommended dose such as *Trichoderma viride*, *Bacillus subtilis,*, *Pseudomonas fluorescens, Streptomyces graseoviridis* @ 4gm/lit of water*,* and plant extracts- tea, neem, garlic and onion extracts @ 2ml/lit of water. For percent disease incidence, first total no. of plants (healthy + infected plants) and then total no. of infected plants in each plot were recorded and the percent disease incidence was calculated by the following formula:

$$\text{Disease Incidence (\%)} = \frac{\text{No. of Plants Infected}}{\text{No. of Plants Observed}} \times 100$$

The intensity percent was recorded following descriptive (0-5) scale which is described in table no.1.

For the study of disease intensity 17 plants per plot was randomly selected and 1 upper leaf, 1 middle leaf and 1 lower leaf of each plant was selected for recording data of PDI using above mentioned rating scale and percent disease index (PDI) or disease intensity percent for each plot was calculated using following formula-

$$\text{PDI} = \frac{\text{Sum of all numerical ratings}}{\text{Total no. of compound leaves observed} \times \text{Maximum ratings}} \times 100$$

Simultaneously, *in vitro* management practice was carried out using two methods namely spore germination inhibition technique and poisoned food technique. Therefore the pathogen *A. Solani* was isolated from naturally infected leaf of potato using PDA at 28°c. In case of spore germination inhibition technique, the per cent inhibition of spore germination was calculated by using following formula given by Vincent (1947).

$$\text{Inhibition \%} = \frac{C - T}{C} \times 100$$

Where, C = Number of germinated spores in control T= Number of germinated spores in treatment.

In case of poisoned food technique (Falck, 1907) the inhibitory activity of each treatment was expressed as the percent growth inhibition which was calculated using the following formula (Pandey *et al.*, 1982):

$$\text{Growth inhibition \%} = \frac{DC - DT}{DC} \times 100$$

Where, DC = Diameter of control and DT = diameter of fungal colony with treatment.

RESULTS AND DISCUSSION

The results of the experiment under field condition as well as *in vitro* condition regarding in management of early blight of potato caused by *A. solani* were presented here. Management trials of the disease under field condition as well as *in vitro* condition were carried out with four bio control agents and four plant extracts.

Management studies against early blight disease of potato through different bio-control agents under field condition: The results presented in table 2 reveals that the bio control agent *T. viride* (T$_1$) exhibited best results in terms of per cent incidence (61.50%) and intensity (14.90%) of the disease compared to control treatment (T$_5$) where per cent incidence and intensity of the disease were (92.39%) and (31.30%), respectively. The per cent reduction of the disease was 52.39% over control treatment (T$_5$). The tuber yield (25.51 t/ ha.) was highest in comparison to all other treatments. This was followed by treatment T$_2$ i.e. *P. fluorescens* where per cent incidence and intensity of disease were (65.00%) and (19.10%) respectively with 38.97% reduction of disease over control with total tuber yield 23.65 t/ha. Among all the bio control agents tested the efficacy of *B. subtilis* was least in terms of per cent incidence (72.50%) and intensity (24.75%) of the disease. The total tuber yield was also less i.e. 20.23 t/ha.

These findings are also in agreement with Yadav and Pathak (2011) who observed that *T. Viride* @ 0.5% was efficacious in controlling early blight of potato.

Management studies of early blight of potato through different plant extracts: Some plant extracts were tested to observe their efficacy on management of

Table 1. Rating scale (0-5) for measuring disease intensity of early blight of potato.

Description	Rating
Free from infection (no visible symptoms).	0
1 – 10% leaf area damaged.	1
10.1 – 20% leaf area damaged.	2
20.1 – 50% leaf area damaged.	3
50.1 – 75% leaf area damaged.	4
Above 75% leaf area damaged.	5

Table 2. Efficacy of different bio-control agents on management of early blight of potato under field condition.

Treatment	Dose (g/L)	Disease incidence (%)				Disease intensity (%)				Percent Disease reduction over control	Average yield (t/ha.)
		59 DAP	66 DAP	73 DAP	80 DAP	59 DAP	66 DAP	73 DAP	80 DAP		
T_1	4	39.00 (38.93)*	47.50 (43.85)	55.50 (48.45)	61.50 (51.96)	3.70 (11.81)	5.05 (14.12)	10.85 (19.67)	14.90 (23.07)	52.39	25.51
T_2	4	38.00 (38.35)	49.50 (45.00)	58.00 (49.92)	65.00 (54.04)	3.60 (11.58)	6.15 (14.93)	12.35 (21.00)	19.10 (26.25)	38.97	23.65
T_3	4	38.50 (38.64)	56.50 (49.03)	65.50 (54.35)	72.50 (58.78)	3.50 (11.53)	6.90 (15.78)	14.20 (22.54)	24.75 (30.16)	20.92	20.23
T_4	4	38.50 (38.64)	52.00 (46.44)	61.50 (51.96)	68.00 (55.90)	3.30 (11.24)	6.80 (15.67)	13.50 (21.97)	22.90 (28.91)	26.30	21.07
T_5	-	39.50 (39.22)	62.50 (52.54)	77.00 (61.73)	92.50 (74.98)	4.00 (12.24)	9.75 (18.67)	17.55 (25.14)	31.30 (34.32)	-	19.53
SEm (±)		0.78	.72	1.25	1.39	0.50	0.40	0.37	0.72		1.24
CD (5%)		2.34	2.18	3.77	4.18	1.51	1.20	1.12	2.18		3.74
CV%		4.01	3.05	4.70	4.69	8.55	5.01	3.37	5.08		

* Data in the parenthesis are angular transformed values. T_1=*Trichoderma viride*; T_2=*Pseudomonas fluorescens*; T_3= *Bacillus subtilis*; T_4= *Streptomyces graseoviridis*; T_5=Control.

Table 3. Efficacy of different plant extracts on management of early blight of potato under field condition.

Treatment	Dose (ml/L)	Disease incidence (%)				Disease intensity (%)				Percent disease reduction over control	Average yield (t/ha.)
		59 DAP	66 DAP	73 DAP	80 DAP	59 DAP	66 DAP	73 DAP	80 DAP		
T1	2	39.50 (39.23)*	63.50 (53.16)	68.50 (56.17)	76.00 (61.01)	4.60 (13.00)	7.30 (16.21)	14.75 (22.97)	26.55 (31.33)	20.27	21.47
T2	2	40.50 (39.81)	54.50 (47.87)	66.00 (54.64)	73.50 (59.38)	4.45 (12.81)	7.20 (16.08)	14.40 (22.70)	26.30 (31.18)	21.02	23.67
T3	2	41.50 (40.39)	51.00 (45.86)	63.50 (53.14)	70.00 (57.14)	4.65 (13.09)	6.85 (15.72)	13.95 (22.32)	25.65 (30.74)	22.97	24.79
T4	2	40.00 (39.52)	48.50 (44.43)	59.50 (50.78)	66.50 (54.96)	4.75 (13.24)	6.70 (15.56)	13.25 (21.76)	22.25 (28.49)	33.18	25.31
T5	-	42.00 (40.68)	68.50 (56.21)	86.00 (68.47)	95.50 (78.88)	4.80 (13.31)	9.15 (18.09)	18.35 (25.73)	33.30 (35.55)	-	18.41
SEm (±)		0.74	1.16	0.69	1.32	0.57	0.36	0.41	0.49		0.97
CD (5%)		2.23	3.49	2.08	3.99	1.72	1.10	1.25	1.49		2.92
CV%		3.71	4.68	2.44	4.25	8.73	4.47	3.59	3.14		

* Data in the parenthesis are angular transformed values. T1= Tea extracts; T2= Garlic extracts; T3= Onion extracts; T4= Neem extract; T5= Control

Table 4. Efficacy of plant extracts on growth inhibition of *A. solani* in *in vitro* condition.

Treatment	Conc. (ppm)	Colony growth at 24 hours interval (cm)					Growth inhibition over control (%)
		(48 hrs)	(72 hrs)	(96 hrs)	(120 hrs)	(144 hrs)	
T_1: Garlic	2000	3.87	4.37	5.10	6.77	7.97	5.90
T_2: Garlic	4000	3.63	4.27	4.73	6.57	7.73	8.73
T_3: Onion	2000	3.70	3.90	4.27	6.30	7.53	11.09
T_4: Onion	4000	2.77	3.33	4.37	5.67	7.00	17.35
T_5: Neem	50	1.60	2.03	2.53	3.40	4.03	52.42
T_6: Neem	100	1.10	1.67	2.13	2.40	3.40	59.85
T_7: Tea	2000	3.03	3.57	4.53	6.10	7.50	11.45
T_8: Tea	4000	2.17	2.77	3.50	4.40	6.53	22.90
T_9: Control	-	4.37	4.87	5.60	7.27	8.47	-
SEm (±)		0.05	0.06	0.13	0.17	0.11	
CD (5%)		0.16	0.18	0.40	0.50	0.33	

Table 5. Efficacy of plant extracts on inhibition conidial germination of *A.solani* in *in vitro* condition.

Treatment	Conc. (ppm)	Spore germination% at 24 hours interval		Spore germination inhibition over control (%)
		(24 hrs)	(48 hrs)	
T_1: Garlic	2000	96.22 (79.58)*	98.33 (84.26)	0.34
T_2: Garlic	4000	94.12 (76.60)	98.00 (82.97)	0.67
T_3: Onion	2000	92.13 (74.30)	96.87 (80.71)	1.84
T_4: Onion	4000	86.52 (68.89)	95.11 (78.05)	3.60
T_5: Neem	50	30.95 (34.09)	35.74 (37.00)	63.77
T_6: Neem	100	14.90 (23.07)	17.81 (25.26)	81.94
T_7: Tea	2000	77.45 (62.00)	82.77 (65.89)	16.11
T_8: Tea	4000	45.66 (42.80)	48.75 (44.57)	50.59
T_9: Control	-	98.49 (84.33)	98.67 (84.95)	-
SEm (±)		0.78	1.14	
CD (5%)		2.33	3.39	

* Data in the parenthesis are angular transformed values.

early blight disease. Though the efficacy was not at par with chemical management but considering the human health hazard and huge cost involvement in chemical management, the disease management with plant extracts has got their relevance in modern day agriculture. It is indicated from the result presented in table (3) that neem extract @ 2 ml/lit. exhibited the best result in terms of per cent disease incidence (66.50%) and intensity (22.25%) as compared to control treatment(T_5) at 80 DAP where per cent disease incidence and intensity were 95.50% and 33.30% respectively. The per cent reduction of disease over control was 33.18% and total tuber yield was also highest i.e.25.31 t/ha compared to control treatment where only 18.41 t/ha was recorded. The next best result was obtained with onion extract which @ 2 ml/L exhibited 22.97% reduction of disease over control. In comparison to other treatments tea extract exhibited lesser effect, where 76.00% disease incidence and 26.55% intensity was recorded. Naturally the total tuber yield (21.47t/ha.) was also less as compared to other treatments. These findings are also in agreement with Chaudhary

and Chaudhary (2003) who reported the efficacy of leaf extracts of *Eucalyptus globulus*, *Datura stramonium*, *Solanum xanthocarpum*, *Azadirachta indica*, *Lantana camara*, *Ricinus communis* and *Lawsonia inermis*; bulb extracts of *Allium sativum* and *Allium cepa* and rhizome extracts of *Zingiber officinale* in controlling *Alternaria solani* causing early blight in potato in *in vitro condition*.

***In vitro* efficacy of plant extracts on inhibition of mycelial growth of *A. solani*:** Four plant extracts were tested for their efficacy against inhibition of radial growth of *A. solani* through bio-assay technique. It is evident from results presented in table (4) that highest per cent growth inhibition i.e. 59.85% and 52.42% over control was achieved by neem extract (*A. indica*) at 100 and 50 ppm concentration respectively. In case of other plant extracts like tea (2000 and 4000 ppm) and onion (2000 and 4000 ppm) 11.45%, 22.90%, and 11.09% and 17.35% growth inhibition respectively over control were achieved. But garlic extracts had least effect i.e. 5.90% and 8.73 % over control at 2000 and 4000 ppm respectively.

The above findings are also in line with those of Neeraj and Shilpi (2010), who studied that the neem leaf extract was highly effectine in inhibition of the radial growth of *A. solani*.

Maya and Thippanna (2013) were of opinion that leaf and seed extracts of *A. indica* recorded maximum mycelial growth inhibition of *A.Solani.*

Efficacy of plant extracts on inhibition conidial germination of *A. solani* in *in vitro* condition: It is evident from the table (5) that except neem (*A. indica),* no other plant extracts had any marked effect on conidial germination. Neem extract at 50 and 100 ppm concentration exhibited 63.77 % and 81.94 % inhibition of conidial germination, respectively over control. Tea extract at 4000 ppm concentration exhibited 50.59 % inhibition of conidial germination but at 2000 ppm concentration per cent inhibition of conidial germination was only 16.11 % over control. But in case of onion and garlic negligible per cent inhibition of conidial germination was observed at 2000 and 4000 ppm concentration over control.

Conclusion

It was concluded that *T. viride* and neem extract can be used for controlling of early blight of potato and in the contest of adverse effect of chemical fungicides the use of bio control agents and plant extracts are of great significance in present day agriculture.

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