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Original Research Article

Efficacy of Newly Fungicides on Early Blight of Potato Under *In vivo* and *In vitro* Conditions

Ajay Kumar[1*], S. P. Pathak[1], Abhimanyu[2] and Jai P. Rai[3]

[1]Department of Plant Pathology, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad-224 229, UP, India
[2]Krishi Vigyan Kendra, C. S. Azad University of Agriculture & Technology, Daleepnagar, Kanpur-209204, UP, India
[3]Krishi Vigyan Kendra, Institute of Agricultural Sciences, RGSC, Banaras Hindu University, Barkachha, Mirzapur-231001, UP, India
**Corresponding author*

A B S T R A C T

Combinations of systemic and contact fungicides in alternation observed effective in controlling early blight. Among five fungicides evaluated in *in vitro* condition against *A. solani*, Fenamidone 10% + Mancozeb 50% (sectin) gave the maximum inhibition (83.79%) of mycelial growth of *A. solani* followed by Propiconazole 25% EC (83.62%), Dimethomorph 9% + Mancozeb 60% (79.07%), Cymoxanil 8% + Mancozeb 64% (79.03%) and Mancozeb (56.85%) were also inhibited maximum growth of the fungus. The field evaluation of different fungicides indicated that Fenamidone 10% + Mancozeb 50% (0.2%) was most effective followed by Propiconazole 25% EC, Dimethomorph 9% + Mancozeb 60%, Cymoxanil 8% + Mancozeb 64% (0.2%) and Mancozeb (0.25%) and also economical in reducing severity of the early blight and increasing yield over control.

Keywords

Early blight, *Alternaria solani*, Management, Efficacy, Potato and Fungicides

Introduction

Potato (*Solanum tuberosum* L.) is the most important food crop grown throughout the world. It is emerged as one of the most important food crops. At global level annual production of potato during 2013 was 453.44 million tonnes covering an area of 19.92 million hectare with the productivity of 22.8 tonnes per hectare. Indian contribution to the world's production was 45.34 million tonnes from 1.99 million hectare area with average productivity of 22.8 tonnes per hectare (Anonymous, 2013). Early blight caused by *Alternaria solani* (Ell. and Mart.) Jones and Grout is the most important disease attacking potato plants in different countries of the world.

Several components are available on their management. Basically, this disease is controlled with chemicals. Shailbala and Pundhir (2008); Chowdhury and Hitra (2006) and Naskar *et al.*, (2006) have reported the inhibiting effect of mephenoxam and mancozeb combination, a weaker effect of carbendazim and mancozeb and an insignificant effect of cupric hydroxide. Several chemicals, derivatives of chlorothalonil, are more effectiveness for

potato late blight control and early blight also, compared to copper based products (Hariki, 2006). In the present study, investigation was carried out to evaluate the fungicides in different spray schedules for management of early blight disease.

Materials and Methods

The experiment was carried out on spray schedules of different fungicides for the management of early blight of potato, cultivars Kufri Bahar was sown on dated 18th November, with three replications and ten treatments in RBD design along with recommended package and practices during 2012-14 at Vegetable Farm of Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad. The ten treatments were *viz*: Spray with Mancozeb @ 0.25% at disease initiation stage followed by three more spray at 15 days intervals (T_1), Spray with Mancozeb @ 0.25% at disease initiation stage and 2nd spray of Fenamidone @ 0.2% followed by Mancozeb @ 0.25% at 15 days intervals (T_2), Spray with Fenamidone @ 0.2% at disease initiation stage and 2nd spray of Mancozeb @ 0.25% followed by Mancozeb @ 0.25% at 15 days intervals (T_3), Spray with Mancozeb @ 0.25% at disease initiation stage and 2nd spray of Cymoxanil @ 0.2% and 3rd spray of Mancozeb @ 0.25% at 15 days intervals (T_4), Spray with Cymoxanil @ 0.2% at disease initiation stage and 2nd spray of Mancozeb @ 0.25% followed by Mancozeb @ 0.25% at 15 days intervals (T_5) and Spray with Mancozeb @ 0.25% at disease initiation stage and 2nd spray of Dimethomorph @ 0.2% followed by Mancozeb @ 0.25% at 15 days intervals (T_6), Spray with Dimethomorph @ 0.2% at disease initiation stage and 2nd spray of Mancozeb @ 0.25% and 3rd spray of Mancozeb @ 0.25% at 15 days intervals (T_7), Spray with Mancozeb @ 0.25% at disease initiation stage and 2nd spray of Tilt @ 0.2% followed by mancozeb @ 0.25% at 15 days intervals (T_8), Spray with Tilt @ 0.2% at disease initiation stage and 2nd spray of Mancozeb @ 0.25% followed by Mancozeb @ 0.25% at 15 days intervals (T_9) and T_{10} serve as untreated.

The observations on appearance and progression of severity of disease at weekly intervals were recorded. Data of severity were used for calculating area under disease progress curve (AUDPC). At the end of experiment yield was recorded from individual plot in q/ha. *In vitro* studies were conducted to investigate a possible integrated use of chemical and biological approaches to control potato early blight through food poison technique. Observations on disease severity were recorded on the basis of percent leaf area affected in newer and older leaves of 10 plants selected randomly in each field using 0-5 rating scale (Kaul, 1983) to early blight. Area under disease progress curve was calculated by the formula given by Shanner and Finney (1977).

$$AUDPC = \sum_{i=1}^{N} \left[\left(Y_{i+1} + Y_i \right) x\, 0.5 \right] \left[T_{i+1} - T_i \right]$$

Results and Discussion

A perusal of Table (1&2) showed that the disease first appeared after 40 days of sowing on 3rd January 2012 in control plots in year 2012-13 while, during 2013-14 the disease was first appeared after 43 days on 6th January 2013 in control plots in respective manner. Appearance of the disease was delayed about one week on treated plots in both crop seasons.

In crop season 2012-13 earliest disease appeared during first week of January 2013 in control and treated plots, respectively.

Table.1 Effect of different fungicidal spray on appearance and progress of early blight in potato cv. Kufri Bahar (2012-13)

Treatment	Appearance		Per cent disease severity at weekly intervals								AUDPC
	Date	DAS	04. 01.13	11. 01.13	18.01.13	25.01.13	01.02.13	08.02.13	15.02.13	22.02.13	
T_1	03.01.2013	40	0.80	2.79	3.93	5.20	6.35	9.70	14.30	16.20	355.39
T_2	03.01.2013	40	0.40	1.50	2.10	2.70	3.20	4.80	7.00	10.06	185.71
T_3	09.01.2013	46	0.00	1.40	1.90	2.50	3.04	4.60	6.86	8.93	173.35
T_4	09.01.2013	46	0.00	1.63	2.25	2.93	3.50	5.30	7.70	10.90	201.32
T_5	07.01.2013	44	0.00	1.40	2.00	2.70	3.20	5.00	7.40	10.50	189.11
T_6	03.01.2013	40	0.60	2.13	2.81	3.50	4.10	5.91	8.41	11.49	231.42
T_7	09.01.2013	46	0.00	1.90	2.50	3.21	3.79	5.60	8.10	11.00	215.92
T_8	06.01.2013	43	0.00	2.50	3.30	4.90	5.90	9.13	11.50	13.62	336.28
T_9	06.01.2013	43	0.00	1.90	3.24	4.48	5.50	8.80	10.12	11.50	319.48
T_{10}	03.01.2013	40	1.70	5.80	8.42	11.20	13.56	20.90	28.90	32.50	741.16

DAS- Days After Sowing, AUDPC-Area Under Disease Progress Curve

Table.2 Effect of different fungicidal spray on appearance and progress of early blight in potato cv. Kufri Bahar (2013-14)

Treatment	Appearance		Per cent disease severity at weekly intervals								AUDPC
	Date	DAS	07. 01.14	14. 01.14	21.01.14	28.01.14	04.02.14	11.02.14	18.02.14	25.02.14	
T_1	10.01.2014	47	0.90	2.60	3.70	6.30	8.27	10.66	14.20	19.63	391.96
T_2	11.01.2014	48	0.00	1.60	3.00	5.30	6.87	9.20	12.37	14.07	317.62
T_3	11.01.2014	48	0.00	1.30	2.30	4.10	6.70	8.87	11.36	12.30	288.96
T_4	11.01.2014	48	0.00	1.60	2.80	4.90	7.26	9.47	12.30	11.50	319.06
T_5	09.01.2014	46	0.00	1.50	2.60	5.10	7.37	9.26	12.10	14.20	315.121
T_6	09.12.2014	46	0.80	2.30	3.60	6.10	8.17	10.07	13.00	15.30	360.32
T_7	10.01.2014	47	0.00	1.80	3.40	6.20	7.96	9.80	12.87	15.00	347.41
T_8	10.01.2014	47	0.60	2.30	3.50	6.30	8.07	9.67	12.90	16.27	358.23
T_9	11.01.2014	48	0.00	2.40	3.50	6.10	7.67	9.67	12.67	15.67	347.62
T_{10}	06.01.2014	43	1.30	4.30	7.40	9.20	11.56	14.20	22.67	38.53	624.15

DAS- Days After Sowing, AUDPC-Area Under Disease Progress Curve

Table.3 Effect of fungicidal spray on disease severity (%) and tuber yield (q/ha) in potato (2012-13 and 13-14)

Treatment	Early blight severity (%)			Yield (q/ha)		
	2012-13	2013-14	Mean	2012-13	2013-14	Mean
T_1	16.20	19.63	17.69	194.00	190.50	192.25
T_2	10.06	14.07	12.07	203.90	197.00	200.45
T_3	8.93	12.30	10.62	223.70	222.00	222.85
T_4	10.90	11.50	10.70	220.10	219.70	219.90
T_5	10.50	14.20	12.35	221.90	220.50	221.20
T_6	11.49	15.30	13.66	218.70	215.00	216.85
T_7	11.00	15.00	13.00	220.12	218.90	219.51
T_8	13.62	16.27	16.94	207.50	203.20	205.35
T_9	11.50	15.67	16.25	218.00	213.20	215.60
T_{10}	32.50	38.53	40.01	178.50	175.00	176.75
S.Em±	**0.37**	**0.43**		**1.09**	**1.87**	
CD at 5%	**1.09**	**1.20**		**1.89**	**3.25**	

Table.4 Effect of different fungicides on per cent inhibition of *Alternaria solani in vitro*

S. No.	Fungicides	100 ppm	150 ppm	200 ppm	Mean
1.	Mancozeb	29.63	62.78	78.15	56.85
2.	Fenamedone	79.83	81.33	90.23	83.79
3.	Cymoxanil	65.92	81.55	89.64	79.03
4.	Dimethomorph	67.08	81.11	89.03	79.07
5.	Propiconazole	79.25	81.41	90.21	83.62
Mean		64.34	77.83	87.45	

	S.Em±	CD at 1%
Fungicide (F)	0.65	2.58
Conc. (C)	0.29	1.12
Fx C	1.18	4.65

The per cent disease severity increased gradually till maturity and reached its maximum i.e. 8.93, 10.06, 10.50, 10.90, 11.00, 11.49, 11.50, 13.62, 16.20 and 32.50 per cent on cultivar K. Bahar in treatment third, second, fifth, fourth, seven, six, nine, eight, first and ten, respectively. Among the treated plots minimum AUDPCs was 173.35 noted in treatment third while maximum AUDPCs 355.39 recorded in treatment first. In the control plots maximum AUDPCs 741.16 was noted on cultivar K. Bahar (Table 1).

During 2013-14 progression of the disease severity was noted at weekly intervals. The per cent disease severity increased gradually till maturity of the crop in February and reached up to 11.50, 12.30, 14.07, 14.20, 15.00, 15.30, 15.67, 16.27, 19.63 and 38.53 per cent on cultivar K. Bahar in treatment fourth, third, second, fifth, seven, six, nine, eight, first and ten, respectively. Among the treated plots, minimum AUDPCs was 288.96 noted in treatment third while, maximum AUDPCs 391.96 was recorded in treatment first. Maximum reduction percentage of disease over control was found in treatment third followed by treatment fourth in both crop seasons (Table 2).

Lowest severity of early blight was recorded in T_3 (spray with Fenamidone @ 0.2% at disease initiation and 2nd spray of Mancozeb @ 0.25% followed by Mancozeb @ 0.25% at 15 days intervals) which was best treatment but at par with T_2 (spray with Mancozeb @ 0.25% at disease initiation and 2nd spray of Fenamidone @ 0.2% followed by Mancozeb @ 0.25% at 15 days intervals) and T_4 (spray with Mancozeb @ 0.25% at disease initiation and 2nd spray of Cymoxanil @ 0.2% and 3rd spray of Mancozeb @ 0.25% at 15 days intervals) and these were differed from other treatments. T_2 (spray with Mancozeb @ 0.25% at disease initiation and 2nd spray of Fenamidone @ 0.2% followed by Mancozeb @ 0.25% at 15 days intervals) was superior than T_1 (spray with Mancozeb @ 0.25% at disease initiation followed by three more spray at 15 days intervals) but at par and both treatments were significantly found superior than control in both crop seasons (Table 3).

The maximum tuber yield 223.70 and 222.00 q/ha in first and second years, respectively, were recorded with T_3 i.e., spray with Fenamidone @ 0.2% at disease initiation and 2nd spray of Mancozeb @ 0.25% followed by Mancozeb @ 0.25% at 15 days intervals in both respective years whereas, minimum tuber yield 178.50 and 175.00 q/ha and among the treated plot minimum tuber yields 194.00 and 190.50 q/ha in first and second years, respectively, were noted in T_{10} & T_1 i.e., untreated and spray with Mancozeb @ 0.25% at disease initiation followed by three more spray at 15 days intervals. These observations are in accordance with Kapsa (2010) reported that the effectiveness of new chemicals *viz.*, Curzate, Fenamidone Acrobat to management of early and late blight. Singh *et al.,* (1997) also reported that the Efficacy of different fungicides for control of early blight of potato caused by *A. solani*. Similar results were also revealed by Singh (2008) and Yadav and Pathak (2011).

One contact and four systemic fungicides were screened at three concentrations in the laboratory for their efficacy against *A. solani*. Poisoned food technique was followed as detailed in material and methods. The data are presented in the table 19 and plate 12. The results indicated that there was a significant difference among contact fungicides in inhibiting the growth of *A. solani*. The one contact fungicide

mancozeb evaluated, in which per cent inhibition was 56.85%. The tested contact fungicide against *A. solani* mancozeb at 200 ppm (78.15%) was very effective. Among the systemic fungicides evaluated against *A. solani* fenamedone (83.79%) gave maximum inhibition of the mycelial growth of pathogen. This was followed by propiconazole (83.62%). Least inhibition of mycelial growth was observed in cymoxanil (79.03%) at 200 ppm concentration. Similar findings were also revealed by Amaresh (2000) and Monaco *et al.*, (2001). It can be concluded that the all treatments were found effective to manage the disease however, the field evaluation of different fungicides indicated that Fenamedone (0.2%) was most effective including *in vivo* followed by Propiconazole, Cymoxanil, Dimethomorph (0.2%) and Mancozeb (0.25%) and also economical in reducing severity of the early blight and increasing yield over control.

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