

# International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452

Maths 2024; SP-9(1): 330-333

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<https://www.mathsjournal.com>

Received: 17-12-2023

Accepted: 23-01-2024

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## Management of late blight disease (*Phytophthora infestans*) of potato in the plateau region of Maharashtra

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### Abstract

The Potato crop is susceptible to many diseases, some of which are widespread and others are localized. Late blight of potato, caused by *Phytophthora infestans* (Mont. De Bary), is among the most important diseases, being especially devastating in the major potato growing areas. It is the most widespread throughout the world and causes serious tuber losses globally. Worldwide losses due to late blight are estimated to exceed \$6.7 billion annually and thus the pathogen is regarded as a threat to global food security.

Efforts were made in the present investigation to evaluate sequence of few commonly used fungicides for their comparative efficacy against *Phytophthora infestans* (Mont.) De Bary, with a view to select the most effective fungicide for the management of the disease. An experiment on "Management of late blight disease (*Phytophthora infestans*) of potato in the plateau region of Maharashtra" was conducted for 3 consecutive years during Rabi season of 2020-21, 2021-22 and 2022-23 and the data was pooled. The experiment was laid out in RBD design with four treatments and five replications. The results revealed that the first spray of mancozeb (75% WP) @ 0.25% followed by cymoxanil (8%) + mancozeb (64%) @ 0.3% and one more spray with mancozeb (75%) @ 0.25% was found significantly superior in controlling the late blight disease of potato and also recorded significant highest yield (t/ha) compared to other treatments.

**Keywords:** Potato, late blight, phytophthora, mancozeb, disease

### Introduction

Potato (*Solanum tuberosum* L.) is a global crop planted in a wider range of altitude, latitude and climatic conditions. Potato is the most important and useful member of the family *Solanaceae* and is grown in tropics as well as sub-tropics during the cool as well as dry seasons under irrigation. India is the second largest producer of potato in the world. Nutrition analysis showed that potato is a healthy food in terms of vitamins, minerals, proteins, antioxidants, essential amino acids and carbohydrates. Potato is one of the most widely grown food crops after the three cereals like maize, rice and wheat. Under such increasing pressure on the fixed land, increasingly degraded environment and uncertainties resulting from climate change, producing crops like potato with high plasticity to environmental regimes and higher yield per unit area is indispensable. It is a cool season crop and a temperature up to 24°C is considered best for the growth of young plants. However, the production of tubers is ideal at 20°C. The various factors limiting yield of potato include lack of high yielding varieties, inadequate supply of healthy seed tubers and high incidence of disease and insect pest.

The crop is susceptible to many diseases, some of which are widespread and others are localized. The causal agents of these diseases include fungi, bacteria, viruses, phytoplasmas, viroids and nematodes. Late blight of potato, caused by *Phytophthora infestans* (Mont. De Bary), is among the most important diseases, being especially devastating in the major potato growing areas. Late blight symptoms appear on potato leaves initially as pale green, water-soaked spots, often beginning at leaf tips or edges (Draper *et al.*, 1994) <sup>[1]</sup>. Circular or irregular leaf lesions are often surrounded by a pale yellowish-green border that merges with the healthy tissue. Lesions enlarge rapidly and turn dark brown to purplish-black.

During periods of high humidity and leaf wetness, cottony white mould growth is usually visible on lower leaf surfaces at the edges of lesions. Infected areas on stems appear brown to black and entire vines may be killed in a very short spell when moist weather persists. Tuber symptoms are characterized by irregular reddish-brown staining of the tissue immediately below the potato skin. Serious economic consequences often result from complete or partial devastation of infected fields. It is the most widespread throughout the world and causes serious tuber losses globally. Worldwide losses due to late blight are estimated to exceed \$6.7 billion annually and thus the pathogen is regarded as a threat to global food security (Sheikh, 2019) <sup>[11]</sup>. Late blight was responsible for the worst ever famine Irish potato famine during 1844-45 (Mercure, 1998) <sup>[6]</sup>. Because of the famine, millions of Irish died or emigrated.

Late blight may cause total destruction of all plants in a field within a week or two when weather is cool and wet. The disease is also very distractive to tomatoes and some other members of the family *Solanaceae*. Late blight may kill the

foliage and stems of potato and tomato plants at any time during the growing season. It also attacks potato tubers and tomato fruits in the field, which rot either in the field or while in storage.

### Materials and Methods

The experiment was conducted under All India Coordinated Research Project, on Potato, Zonal Agricultural Research Station, Ganeshkhind, and Pune. The field experiment was carried out during *Rabi* season of 2020-21, 2021-22 and 2022-23 in the farmer's field at Kodit Tal: Purandar Dist: Pune. The experimental plot was well ploughed. Recommended doses of fertilizers and manure were applied as per standard agronomic practices. Seeds of potato variety, *Kufri Pukhraj* were used. The experiment was laid out in a Randomized Block Design (RBD) with five replications. The unit plot size was 3.0 × 2.4 m<sup>2</sup>. Spacing of row to row (within plot) and tuber to tuber (within row) was 60 cm and 20 cm, respectively. Two times weeding was done at an interval of 30 days. Ear thing up was executed after planting. The treatment details given below.

T <sub>1</sub>	:	First spray with mancozeb @ 0.25% followed by cymoxanil + mancozeb @ 0.3% and one more spray with mancozeb @ 0.25%.
T <sub>2</sub>	:	First spray with mancozeb @ 0.25% followed by ametoctradin + dimethomorph (0.2%) followed by one more spray with mancozeb.
T <sub>3</sub>	:	First spray with mancozeb @ 0.25% followed by azoxystrobin + tebuconazole (0.1%) followed by one more spray with mancozeb
T <sub>4</sub>	:	Control

The first spraying of fungicides was done immediately after the first appearance of a few symptoms of the disease on the leaves and was repeated thrice at an interval of ten days according to the treatment schedule.

Percent disease intensity (PDI) was recorded at 7 days intervals after each spray. The yield of potato tubers (t/ha) for different treatments was recorded at harvest.

The percent disease intensity (PDI) of late blight of potato was recorded from the randomly selected 5 plants per plot based on 0-9 scale (Mayee and Datar, 1986) <sup>[5]</sup>. Disease intensity was monitored one day before each spray and calculated by using formula.

$$\text{Percent disease intensity} = \frac{\text{Sum of all rating given to plants}}{\text{Total no. of plants observed} \times \text{Maximum rating}} \times 100$$

Data on yield of potato and percentage of disease index was statistically analyzed (Panse and Sukhatme, 1985) <sup>[9]</sup>.

### Results and Discussion

Perusal of data recorded during *Rabi* season of 2020-21, 2021-22 and 2022-23 was pooled and presented in the Table 1 showed that all treatments recorded significantly lowest disease intensity of late blight as compared to control at every interval. Treatment T<sub>1</sub> *i.e.* First spray of mancozeb (75% WP) @ 0.25% followed by cymoxanil (8%) + mancozeb (64%) @ 0.3% and one more spray with mancozeb (75%) @ 0.25% at 10 days interval gave 60.25 percent reduction of disease over the control in field condition at 35<sup>th</sup> days after first spray in pooled data. The significantly minimum intensity of 8.44%, 15.55%, 16.19% and 13.39% respectively was recorded during 2020-21, 2021-22, 2022-23 and pooled data in treatment T<sub>1</sub> *i.e.* First spray of mancozeb (75% WP) @ 0.25% followed by cymoxanil (8%) + mancozeb (64%) @ 0.3% and one more spray with mancozeb (75%) @ 0.25% at 35 days after first appearance of disease followed by treatment T<sub>2</sub> *i.e.* First spray with mancozeb @ 0.25% followed by ametoctradin (27%) + dimethomorph (20.27% SC) @ (0.2%)

followed by one more spray with mancozeb at 10 days interval.

Whereas, significantly higher disease intensity (33.69%) was observed in unsprayed control at 35 DAS. The intensity of disease was increased gradually over the period of experiment in all treatments including unsprayed control. The highest tuber yield of 17.18 t/ha, 16.87 t/ha, 18.14 t/ha and 17.40 t/ha was recorded in treatment T<sub>1</sub> during 2020-21, 2021-22, 2022-23 and pooled data respectively, which was followed by treatment T<sub>2</sub>.

Later it was observed that at 7<sup>th</sup>, 14<sup>th</sup>, 21<sup>st</sup>, 28<sup>th</sup> and 35<sup>th</sup> DAS, the treatments differ significantly over the unsprayed control. Sharma and Saikia (2013) <sup>[10]</sup> evaluated chemicals for the management of late blight of potato and reported that cymoxanil and mancozeb was found effective in reducing disease severity.

The data regarding economics of different treatments are presented in Table 2. Among the all treatments, the highest additional yield (5.70 t/ha) and income (Rs. 44692) over control was observed in the treatment T<sub>1</sub> (First spray with mancozeb @ 0.25% followed by cymoxanil + mancozeb @ 0.3% and one more spray with mancozeb @ 0.25%) followed by in the treatment T<sub>2</sub> (3.83 t/ha and Rs. 27178).

The net monetary return was maximum in treatment T<sub>1</sub> (Rs. 181680) which was followed by T<sub>2</sub> (Rs. 162282). Maximum benefit cost ratio (1.74) was observed in treatment T<sub>1</sub>.

All the treatments showed significantly better disease controlled as well as tuber yield over non- treated control. The results of this study were consistent with previous studies and indicated that the application of protective fungicides could reduce foliar late blight to acceptable levels (Fontem, 2001; Kassa and Buyene, 2001; Ojiambo *et al.*, 2001) <sup>[3, 4, 8]</sup>.

The results of the present investigation indicate that the sequential fungicidal treatment (T<sub>1</sub>) significantly reduced disease severity and increased yield over control. This is in accordance with the findings of Mhatre *et al.* (2020) <sup>[7]</sup> who claimed that the best control of potato late blight was achieved by spray with mancozeb @ 0.25% followed by cymoxanil + mancozeb @ 0.3% and one more spray with mancozeb @ 0.25% at field condition. Further they reported

that treatment was also the most cost effective and gave the highest yields. All these findings are in agreement with the present findings of study. Considering findings of the present investigation it may be concluded that Prophylactic spray with

mancozeb @ 0.25% followed by cymoxanil + mancozeb @ 0.3% and one more spray with mancozeb @ 0.25% at 10 days interval can be used as alternative for management of late blight of potato.

**Table 1:** Disease intensity of late blight at different interval (Pooled of 2020-21 to 2022-23)

Treatment	Disease severity (%)											
	7 <sup>th</sup>				14 <sup>th</sup>				21 <sup>st</sup>			
	2020-21	2021-22	2022-23	Pooled	2020-21	2021-22	2022-23	Pooled	2020-21	2021-22	2022-23	Pooled
Mancozeb FB cymoxanil + mancozeb FB mancozeb	0.30 (2.79)	3.71 (10.94)	3.49 (10.59)	2.50 (8.11)	1.33 (6.61)	5.71 (13.68)	6.66 (14.89)	4.57 (11.73)	3.04 (9.97)	9.94 (18.07)	9.84 (18.21)	7.61 (15.42)
Mancozeb FB ametocitradin + dimethomorph FB mancozeb	0.15 (1.40)	4.35 (12.02)	5.39 (13.39)	3.30 (8.94)	1.11 (6.02)	7.30 (15.62)	8.88 (17.32)	5.77 (12.99)	3.93 (11.41)	11.75 (19.94)	12.41 (20.58)	9.35 (17.51)
Mancozeb FB azoxystrobin + tebuconazole FB mancozeb	0.30 (2.79)	5.51 (13.46)	6.66 (14.90)	4.16 (10.38)	1.70 (7.33)	8.57 (16.97)	10.79 (19.09)	7.02 (14.47)	4.30 (11.90)	13.33 (21.33)	16.82 (24.21)	11.48 (19.15)
Control	1.11 (6.02)	7.30 (15.57)	9.21 (17.63)	5.87 (13.08)	5.41 (13.43)	13.33 (21.40)	16.19 (23.70)	11.64 (19.52)	11.93 (20.20)	22.53 (28.32)	24.44 (29.62)	19.66 (26.07)
SE(m) ±	0.53	0.75	0.77	0.42	0.35	0.68	0.56	0.33	0.40	1.04	0.66	0.44
C.D. @ 0.05	1.55	2.33	2.38	1.20	1.03	2.11	1.76	0.94	1.19	3.23	2.03	1.26
C.V. (%)	36.19	12.87	12.22	16.21	9.40	8.94	6.73	8.72	6.75	10.59	6.36	8.83

**Table 1:** Continued

Treatment	Disease severity (%)								Yield (t/ha)			
	28 <sup>th</sup>				35 <sup>th</sup>							
	2020-21	2021-22	2022-23	Pooled	2020-21	2021-22	2022-23	Pooled	2020-21	2021-22	2022-23	Pooled
Mancozeb FB cymoxanil + mancozeb FB mancozeb	6.07 (14.25)	12.38 (20.57)	14.60 (22.45)	11.02 (19.09)	8.44 (16.86)	15.55 (23.20)	16.19 (23.71)	13.39 (21.26)	17.18	16.87	18.14	17.40
Mancozeb FB ametocitradin + dimethomorph FB mancozeb	8.74 (17.15)	15.23 (22.94)	17.77 (24.93)	13.92 (21.68)	10.15 (18.53)	19.99 (26.55)	21.90 (27.89)	17.35 (24.33)	15.27	14.86	16.47	15.53
Mancozeb FB azoxystrobin + tebuconazole FB mancozeb	9.56 (17.99)	19.36 (26.09)	20.95 (27.23)	16.62 (23.77)	11.11 (19.40)	22.85 (28.52)	23.49 (28.98)	19.15 (25.64)	14.88	13.75	14.48	14.37
Control	20.52 (26.91)	30.16 (33.29)	32.71 (34.88)	27.79 (31.70)	24.22 (29.46)	37.45 (37.72)	39.36 (38.86)	33.69 (35.35)	10.95	10.69	13.47	11.71
SE(m) ±	0.46	0.58	0.37	0.30	0.51	0.40	0.42	0.29	0.37	0.44	0.47	0.48
C.D. @ 0.05	1.35	1.81	1.14	0.86	1.49	1.25	1.27	0.82	1.08	1.37	1.44	0.96
C.V. (%)	5.35	5.04	3.03	4.86	5.38	3.09	3.08	4.21	9.35	7.03	6.69	8.89

**Table 2:** Economics (Pooled of 2020-21 to 2022-23)

Tr. No.	Treatments	Yield (t/ha)	Additional yield over control (t/ha)	Total Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net Income (Rs/ha)	Additional income over control (Rs/ha)	B: C Ratio
1	Mancozeb FB cymoxanil + mancozeb FB mancozeb	17.40	5.70	104224.00	181680.00	77456.00	44692.00	1.74
2	Mancozeb FB ametocitradin+ dimethomorph FB mancozeb	15.53	3.83	102340.00	162282.00	59942.00	27178.00	1.58
3	Mancozeb FB azoxystrobin + tebuconazole FB mancozeb	14.37	2.67	98468.00	149826.00	51359.00	18595.00	1.52
4	Control	11.70	--	89811.00	122575.00	32764.00	--	1.36
	SE ±	0.48		--	--	--		--
	CD @ 0.05	0.96		--	--	--		--
	CV (%)	8.89		--	--	--		--

**Conclusion**

Perusal of data recorded revealed that all the treatments showed significantly better disease controlled as well as tuber yield over non- treated control. The treatment T<sub>1</sub> i.e. first spray of mancozeb (75% WP) @ 0.25% followed by cymoxanil (8%) + mancozeb (64%) @ 0.3% and one more spray with mancozeb (75%) @ 0.25% was found significantly superior in controlling the late blight disease of potato and also recorded significant highest yield (t/ha) also the net monetary return was maximum in treatment T<sub>1</sub> (Rs. 181680) which was followed by T<sub>2</sub> (Rs. 162282). Maximum benefit cost ratio (1.74) was observed in treatment T<sub>1</sub> compared to other treatments. Hence the treatment mancozeb (75% WP) @ 0.25% followed by cymoxanil (8%) + mancozeb (64%) @ 0.3% and one more spray with mancozeb (75%) @ 0.25% is

recommended for the management of late blight disease of potato in plateau region of Maharashtra.

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