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Management of late blight of potato (*Solanum tuberosum* L.) through chemical under field conditions Allahabad Uttar Pradesh, India

Praveen Kumar, HS Singh, Abhilasha A Lal and Sunil Zacharia

Abstract
An experiment was conducted for the Management of late blight of potato (*Solanum tuberosum* L.) by selected systemic and contact fungicides in the research field of Department of Plant Pathology, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad during *Rabi* Season of 2013-2014. Seven treatments including control with three replications were taken up using RBD. Treatments comparing of foliar spray of Indofil M-45 (mancozeb 75%), Companion (carbendazim 12% + mancozeb 63%), Ridomil MZ-72 (metalaxyl 8% + mancozeb 64%), Moximate (cymoxanil 8%+ mancozeb 64%), Avtar (hexaconazole 4% + zineb 68%), Lurit (dimethomorph 50%), and control (spray of plane water) were applied at the onset of disease symptoms at 60 DAS. Observations for percent disease intensity were recorded at 10 and 20 days after spray. Minimum Percent disease intensity was recorded in (cymoxanil 8% + mancozeb 64%) at 10 days and 20 days after the spray (10.67% and 13.67%, respectively), followed by dimethomorph 50% (11.67% and 16.00%), as compared to control which recorded maximum percent disease intensity (41.00% and 62.00%, respectively). Maximum yield (q/ha) was recorded in cymoxanil 8% + mancozeb 64% (135.67), followed by dimethomorph 50% (128.33), as compared to control T_0 - (67.00, respectively). The highest cost benefit ratio was recorded in T_4– cymoxanil 8% + mancozeb 64% (1:1.91), followed by T_6 - dimethomorph 50% (1:1.80), as compared to control T_0- (1:0.99, respectively).

Keywords: Potato, *Phytophthora infestans*, *Rabi*, chemical, management

Introduction
Potato (*Solanum tuberosum* L.) is the third most important food crop in world after rice and wheat. It belongs to family solanaceae. It's well known as the king of vegetables. It's planted in 18.2 million ha and total yield reached 314.1 million tons (FAO, 2010) [3]. It is grown in more than 125 countries and consumed almost daily by more than a billion of people (Verma, 1992) [11]. It is used for a variety of purposes as a fresh vegetable for cooking at home, as raw material for processing into food products, food ingredients, starch and alcohol, as feed for animals, and as seed tubers for growing the next season's crop. It is a rich food in carbohydrate, protein, vitamins C, B_1, B_6, folic acid, potassium, magnesium, zinc and copper (Livestrong, 2013) [7].

Potato crop is vulnerable to infection by bacterial, viral, nematode and fungal disease. Among the fungal disease late blight of potato caused by *Phytophthora infestans* is the worst damaging one and cause reduction in quantity and quality of the potato crop. Late blight of potato is identified by brown/black lesions on leaves and stems that may be small at first and appear water-soaked or have chlorotic borders, but soon expand rapidly and become necrotic. In humid conditions, *P. infestans* produces sporangium and sporangiophores on the surface of infected tissue. This sporulation results in a visible white growth at the leading edge of lesions on abaxial (lower) surfaces of leaves. As many lesions accumulate, the entire plant can be destroyed in only a few days after the first lesions are observed (Schumann and Arcy, 2000). The mycelium of *P. infestans* containing cellulose and glucans, is endophytic, having hyaline, much branched, coenocytic hyphae. The mycelium produces branched sporangiophores that produce lemon-shaped sporangium at their tips. Sporangium germinate almost entirely by releasing three to eight zoospores at temperature up to 12 or 15 °C, where as above 15 °C sporangium may germinate directly by producing a germ tube (Agrios, 2005) [2]. The famous famine in Irelad between 1845 and 1847 was due largely to the failure of potato crop and migration of millions of people (Sharma, 2001) [8]. Late blight of potato is traditionally suggested to be managed by fungicidal application. Selection of proper fungicides and testing of their efficacy are essential aspects of this management strategy. Several researchers had reported the effective control of the disease with the application of fungicides and also the use

of chemicals is economical for farmers. Present study was aimed to determine the efficacies of different doses of fungicides against late blight of potato under Allahabad Agro climatic condition as this disease causes enormous losses.

Materials and Methods

The research was carried out during 2013-14 at the field of Department of Plant Pathology, Sam Higginbottom Institute of Agriculture, Technology & Sciences (deemed - to - be university) Allahabad, Uttar Pradesh, India. The soil of the research field was sandy loam with pH 5.6. The research 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 and 20 cm, respectively. The soil was raised and drains were made to remove excess water. The symptoms appeared at 60 days after sowing.

A B C D

Fig 1: Symptoms of Late Blight on (A) Stem, (B) Leaves of Potato (C) sporangium and (D) sporangiophore of *Phytophthora infestans* (40 X)

On the basis of symptoms, sporangium and sporangiophore characteristics (figure 1) of the fungus were identified as *Phytophthora infestans* causative agent of late blight of potato. The treatments comprised of application of mancozeb 75%, (carbendazim 12% + mancozeb 63%), (metalaxyl 8% + mancozeb 64%), (cymoxanil 8% + mancozeb 64%), (hexaconazole 4% + zineb 68%), (dimethomorph 50%) and Untreated (control). The crop was sprayed three times at 60, 70, and 80 DAS. The disease intensity 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. Each disease was identified on the basis of following symptoms (Table 1).

Table 1: Disease rating scale

Grade	Percent disease severity with description
0	No symptoms on leaves
1	Small blight on leaves covering 1% or less leaf area
3	Blight lesions on leaves small, scattered, covering 1-10% of leaf area
5	Blight lesions bigger, covering 11-25% of leaf area
7	Blight lesions bigger coalescing covering 26-50% of leaf area.
9	Blight growth covering 51% or more of leaf area.

Percent disease index (PDI) was calculated by using following formula (Wheeler, 1969).

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

Results and Discussion

The results obtained during the present investigation are presented under appropriate headings with the observations concerning various aspects of disease intensity and yield attributes of potato.

Effect of Fungicides on the percent Disease Intensity of Late Blight of Potato

Fungicides differed in respect of late blight disease intensity (%) at different growth stages (Table 2). At 60 DAS, the lowest (8.00%) disease intensity was recorded with (cymoxanil 8% + mancozeb 64%), followed by (dimethomorph 50%) (9.67%). The highest disease incidence was recorded in control (30.67%), followed by (mancozeb 75%) (11.67%), (metalaxyl 8% + mancozeb 64%) (12.67%), (carbendazim 12% + mancozeb 63%) (14.67) and (hexaconazole 4% + zineb 68%) (15.33%, respectively). At 70 DAS, the lowest (10.67%) disease intensity was recorded in (cymoxanil 8% + mancozeb 64%), while the highest (41.00%, respectively) was recorded in control plot. At 80 DAS, the lowest (13.67%) disease intensity was recorded in (cymoxanil 8% + mancozeb 64%), followed by (dimethomorph 50%) (16.00%, respectively). On the other hand, the highest (62.00%) disease intensity was recorded in control plot. Among the fungicides (cymoxanil 8% + mancozeb 64%) performed better than other fungicides to reduce disease intensity of the late blight disease (Table 2).

Table 2: Effect of Foliar Spray of Fungicides on Percent Disease Intensity against Late Blight of Potato.

Treatments	PDI			Yield (q/ha)	C:B Ratio
	60 DAS	70 DAS	80 DAS		
T_{0}- Control	30.67	41.00	62.00	67.00	1:0.99
T_{1}- Indofil M 45 (mancozeb 75%)	11.67	14.00	19.00	122.00	1:1.78
T_{2}- Companion (carbendazim 12% + mancozeb 63%)	14.67	17.67	24.00	109.00	1:1.58
T_{3}- Ridomil MZ 72 (metalaxyl 8% + mancozeb 64%)	12.67	16.67	21.33	116.00	1:1.64
T_{4}- Moximate (cymoxanil 8% + mancozeb 64%)	8.00	10.67	13.67	135.00	1:1.91
T_{5}- Avtar (hexaconazole 4% + zineb 68%)	15.33	19.67	27.67	102.00	1:1.45
T_{6}- Lurit (dimethomorph 50%)	9.67	11.67	16.00	128.00	1:1.80
S Ed. (±)	1.51	1.70	1.44	1.71	-
C. D. (P = 0.05)	3.29	3.71	3.14	3.73	-

PDI= Percent disease intensity
DAS= Date after sowing
C: B= Cost Benefit ratio

Effect of Fungicides on the Yield (q/ha) of Late Blight of Potato

The investigation on effect of fungicides on disease intensity and yield obtained from all fungicidal treated plants significantly differed from untreated control. Maximum yield of 135.67 q/ha was recorded from (cymoxanil 8% + mancozeb 64%) treated plot which was on par with (dimethomorph 50%) (128.33 q/ha), as against the yield in control plots of just 67 q/ha. When the economic analysis of different fungicidal spray schedules was worked out, three sprays of (cymoxanil 8% + mancozeb 64%) not only reduced the disease intensity but also gave the higher cost benefit ratio (1:1.91), followed by (dimethomorph 50%) (1:1.80) treated plots.

In the present study, the minimum disease intensity of late blight and maximum yield was found when (cymoxanil 8% + mancozeb 64%) was used as foliar spray. The probable reason for such finding may be that, (cymoxanil 8% + mancozeb 64%) 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 in plant. 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. Similar trends were reported by Sharma & Saikia (2013) [9], Abdul *et al.* (2014) [1] and Johnson *et al.*, (2000) [5]. They also reported that (cymoxanil 8% + mancozeb 64%) was the most effective fungicide recorded minimum disease intensity against late blight of potato. This was also supported by the findings of Grayson *et al.*, (1995) [4] and Johnson *et al.*, (1997) [6] against late blight of Potato.

Conclusion

Moximate (cymoxanil 8% + mancozeb 64%) was the most effective fungicides in managing the disease intensity of late blight on potato caused by *Phytophthora infestans*. This fungicide also gave higher yield (135.67 q/ha) and was the most economical with 1:1.91. In the present research have proved their potential and can be used in future for the management of late blight of potato.

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