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Effect of Certain Fungicides and Botanicals against Late Blight of Potato (*Phytophthora infestans*)

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Potato (*Solanum tuberosum* L.), an important cash crop of India, is prone to many diseases and amongst these, late blight [*Phytophthora infestans* (Mont) de-Bary] is one of the highly destructive diseases and a major constraint in the profitable cultivation of potato. After realizing the significance of controlling the devastating disease for the sustainability in potato production and thus ensuring more profitability, the present investigation has been conducted with an objective to select the most effective fungicides and botanicals for the management of the disease. The present study was done by KVK, Saharsa during rabi season for consecutive two years (2015-16 and 2016-17) as On-Farm Trial mode at farmers fields of an adopted village of Saharsa district in Bihar. In each trial, there were four treatments including one control i.e. farmers' practice. The study concludes that the best treatment option to combat late blight disease is Seed treatment with *Trichoderma viride* @ 5g per kg of seed and spray of Ridomil @ 2g per litre of water starting from 30 DAP alternating with Dimethomorph 1g + ridomil 2g per litre of water at 10 days intervals. The results of economic analysis reveal that highest net return as well as benefit-cost ratio was also highest in Seed treatment with *Trichoderma viride* @ 5g per kg of seed and spray of Ridomil @ 2g per litre of water starting from 30 DAP alternating with Dimethomorph 1g + ridomil 2g per litre of water at 10 days intervals.

Keywords: Late blight; potato; chemicals; Trichoderma; yield and economics.

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1. INTRODUCTION

Late blight of potato caused by *Phytophthora infestans* (Mont.) de Bary, is one of the most important and devastating diseases affecting potato crops (*Solanum tuberosum* L.) around the world [1,2]. The disease has results in destructive consequences and the most documented event in Ireland (1845) when almost half of the potato crop was destroyed [1]. If the late blight disease is not controlled, losses can reach 100% [3] and even with low infection levels, the crop may be unsuitable for storage [1]. Almost one million people died in the great famine and several had to emigrate to the United State and other regions [4,1]. The use of systemic and protectant fungicides has perhaps been the most studied aspect in temperate countries [5]. Preventive fungicides principally inhibit spore germination and penetration, but after the pathogen enters into the leaves, these fungicides become ineffective.

The wet conditions are favoured by this disease with high humidity (>90%), but this fungus has great ability to adapt to a differential environments [6]. It is found in temperate as well as in subtropical regions. During moist weather, whole plants may be destructed in a short period of time [7] and rapidly spread if kept unchecked [8]. Management of late blight needs aggressive measures which include combined use of cultural, sanitation, scouting, and the combination of host plant resistance with fungicides application [9,10,2].

The infected tissue shows brown spots on the leaves often surrounded by a halo of chlorotic (yellowed) tissue, later on, covered the entire foliage with cottony white fungal growth and great impact when the stem is infected because all tissue above this point will be in mortal stage [11].

This study aimed to test the efficacies of common fungicides for management of late blight and establish the appropriate spray interval for control of late blight on potato under natural conditions.

2. MATERIALS AND METHODS

The experiment was conducted at the farmers' field of Saharsa district, Bihar as 'On Farm Trial' mode for two years during 2015-16 and 2016-17 in *Rabi* season when there was the severe incidence of this late blight disease. The planting was done during the 2nd week of November and the variety *Kufri Pukhraj* is used for this experiment. The experiment was conducted in a Randomized Block Design with 3 replication and 4 treatments with recommended agronomic practices. The plot size of each treatment was 5m x 5m and spacing was maintained 60cm x 20cm each for the row to row and plant to plant. The crop was harvested during last week of February. The details of technologies assessment/refinement, farming situation, area of intervention and technology option was presented in Table 1.

Table 1. Technology option assessed during 2015-16 and 2016-17

Problem area	**Important cause**	**Production system**	**Micro-farming situation**
Low productivity of Potato	High infestation of late blight	Rice-based	Irrigated medium land with clay to sandy clay loam soil
Intervention plan			
Farmers' practice-I	Spray of Mancozeb @ 2.5 gram per litre of water starting from onset of the disease		
Technology option – II	Spray of Copper oxychloride @ 3 gram per litre of water starting from 30 DAP alternating with Metalaxyl-Mancozeb @ 2.5g gram per litre of water at 10 days intervals		
Technology option – III	Seed treatment with Carbendazim @ 3g per kg of seed and spray of Carbendazim @ 3g per litre of water starting from 30 DAP alternating with Cymoxanil- Carbendazim 3g per litre of water at 10 days intervals.		
Technology option – IV	Seed treatment with *Trichoderma viride* @ 5g per kg of seed and spray of ridomil @ 2g per litre of water starting from 30 DAP alternating with Dimethomorph 1g + ridomil 2g per litre of water at 10 days intervals		

To record the late blight incidence, ten plants per plot were randomly selected and disease scoring was done with the help of disease scoring scale (0-9 scale) [12].

$$PDI = \frac{Sum\ of\ all\ numerical\ ratings}{Total\ no.\ of\ plant\ examined\ x\ maximum\ rating\ scale}\ x\ 100$$

Percent Increase in Yield (PIY) over control was calculated based on the following formula

$$PIY = \frac{Treatment\ yield\ -\ Control\ yield}{Control\ yield}\ x\ 100$$

Yield obtained was recorded plot-wise and incremental C: B ratio of different treatment was worked out by dividing the net returns from the total cost of fungicides.

3. RESULTS AND DISCUSSION

3.1 Effect of Different Fungicides on Disease Severity (PDI)

Application of different plant protection chemicals used in the experiment had a significant effect. The crop practised by farmers own choice suffered severely. The results (Table 2) indicated that the lowest percent disease index (19.28%) was recorded in Technology options –IV these findings are also similar to El-Naggar et al. [13]; Chowdappa et al. [14]; Wilson et al. [15] throughout the crop season. Seed treatment plays a vital role for preventing the initial appearance of the disease. These findings are also in line with earlier observation [16 and 17]. While the maximum percent disease index (93.78%) was found in Farmers' Practice followed by Technology options-II (42.20%) and Technology options-III (24.60%). The results is in accordance with the findings of Wilson et al. [15].

3.2 Effect of Different Fungicides on the Yield of Potato

All the treatment of fungicides proved significantly superior in increasing the yield of potato (Table 2) by effectively controlling the late blight disease in comparison to Farmers' Practice. The highest yield of potato was recorded in Technology option – IV (323.5 q/ha) which is 55.38% more than Farmers' practice (208 q/ha) followed by Technology option – III (306.0 q/ha) and Technology option –I (239.0 q/ha). These results are in agreement with the findings of Shikha and Harsha [18]; Yuan-Hang et al. [19]; Harman et al. [20]. The significant increase in yield in Technology option –II might be due to effective control of late blight disease starting from seed treatment with Mancozeb preventing the pathogen attack at the initial stage. Later alternate spray schedule of two fungicides can check the spread of the disease by suppressing the growth and sporulation of the pathogen [21].

3.3 Economics and Incremental Cost-Benefit (C: B) Ratio of Different Treatments

The Cost-Benefit ratio was worked out by dividing the net returns from the total cost of cultivation (Table 2). The highest net return was recorded from the treatment of Technology option –IV Rs. 2,85,200 per ha followed by Technology option –III Rs. 2,63,400 per ha. The lowest gross return was obtained in Farmers' Practice plot Rs. 1,68,600 per ha. The incremental C:B ratio of different treatments showed that maximum C:B ratio of 3.13 was obtained from the Technology option-IV and Technology option- III 15.73. Thus looking to the economics of different treatments it can be concluded that the severe late blight disease can effectively controlled by adopting proper fungicides with prophylactic measures like Seed

Table 2. PDI, Yield, Net profit and benefit-cost (B:C) ratio under different treatments

Treatments	PDI %	Yield		Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
		(q/ha)	% increase over control				
T_1	93.78	208.0	-	75000	243600	168600	2.25
T_2	42.20	239.0	14.80	87000	298800	211800	2.43
T_3	24.60	306.0	47.11	93000	356400	263400	2.83
T_4	19.28	323.5	55.38	91000	376200	285200	3.13
SEm+	0.63	0.49					
CD(P=0.05)	1.86	1.15					

treatment with *Trichoderma viride* @ 5g per kg of seed and spray of ridomil @ 2g per litre of water starting from 30 DAP alternating with Dimethomorph 1g + ridomil 2g per litre of water at 10 days intervals (Technology option-IV) recorded low disease severity, higher yield, net return and incremental C:B ratio.

4. CONCLUSION

The present study resulted from On Farm Trials, it can be concluded that Seed treatment with *Trichoderma viride* @ 5g per kg of seed and spray of Ridomil @ 2g per litre of water starting from 30 DAP alternating with Dimethomorph 1g + ridomil 2g per litre of water at 10 days intervals was more feasible and economically viable and superior over farmers practice. It can be also recommended that such a participatory approach involving extension works and farmers in a demonstration of research emanated proven technology might be a potentiality to evaluate the curtail losses due to pest /disease incidences.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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