



Bioefficacy of Fungicides Against *Phytophthora infestans* Causing Late Blight of Potato under Laboratory Condition

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Authors' contributions

This work was carried out in collaboration with all authors. Author BM designed the study, performed the statistical analysis and wrote the protocol. Author SI wrote the first draft of the manuscript. Authors BM and SI managed the analyses of the study. Authors SI and RM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted in laboratory in aqueous environment to evaluate bioefficacy of fungicides against *Phytophthora infestans* (Mont.) de Bary causing late blight of potato (*Solanum tuberosum* L.) during February, 2015. Infected leaves of potato var. Kufri Jyoti were collected from field in morning hours, cut into small pieces (1.0cm x 0.5cm), and were placed in petriplates containing fungicides suspension (0.1, 0.05 and 0.025%) and sterile filtered tap water. The plates were incubated at room temperature for 48 h and observed under microscope. Derosal (carbendazim) and Shine-35 (metalaxyl) showed very negligible or little effect. However, metalaxyl when associated with mancozeb (Matco) inhibited mycelial growth and sporangia formation. Blitox (copper oxychloride), Avtar (hexaconazole + zineb) and Vitavax Power (Carboxin + Thiram) inhibited mycelial growth only at higher concentration. Adequate inhibition of mycelial growth and sporangia formation was recorded in Indofil Z-78 (zineb), Indofil M-45 (mancozeb), Mirador (azoxystrobin), Acrobat (dimethomorph) and Melody Duo (Iprovalicarb + Propineb). Highest inhibition of both mycelial growth and sporangia formation were evidenced in Ethaboxam (a thiazole

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carboxamide fungicide) followed by FolioGold (Chlorothalonil + Metalaxyl) and Kavach (Chlorothalonil). This rapid laboratory evaluation method is truly useful to select effective fungicide(s) against late blight of potato quickly within 48-72 h.

Keywords: Late blight; potato; *Phytophthora infestans*; fungicide; management.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important cash crop throughout the world, used as staple food in many developing countries. It is the world's fourth-largest food crops ranks after maize, wheat and rice. At present, India is the world's second largest potato producing nation after china. Potato is easily digestible and highly nutritious which containing carbohydrates, proteins, minerals, vitamins and high quality dietary fiber [1]. It is most widely grown vegetable crop in the country with a share of 21.9 per cent area. The area under potato cultivation is 2060 thousand ha with total production of 44893 thousand MT with 21.8 MT/ha productivity. Uttar Pradesh is the leading potato growing state in the country with a production of 14315 thousand MT followed by West Bengal (10200.30 thousand MT and productivity 21.68 MT/ha) and Bihar [2].

The crop is affected by numbers of fungal, bacterial, viral and phytoplasma diseases [3,4]. Among them, Late blight is most serious biotic stress of potato caused by oomycete pathogen *Phytophthora infestans* (Mont.) de Bary. The disease is threatening potato production throughout the world and causing havoc losses in every year [5,6]. Cool and wet weather condition is more favorable for *Phytophthora infestans*. The pathogen can affect all the parts of plant during its growing season. There is no true resistance source in the country for late blight at present. Every year new fungicides and bio-molecules are introducing in the country against this destructive fungal disease whose efficacy needs to be determined. Screening of fungicides in field condition is time taking. So, the quick screening method developed by Mondal et al. [7] was followed for the experiment that can be incorporated indispensably into Integrated Disease Management (IDM) programme.

2. METHODOLOGY

Fifteen fungicides including protective, systemic fungicides and combination products were selected for the study (Table 1). One non-target fungicides (carbendazim) was included for comparison. Aqueous suspension of commercial preparation was used for evaluation. Diseased leaves containing white mycelial growth

underside (Fig B) were collected from infested field (situated at Benuria under Sub-humid Lateritic Red and Undulating Agro-climatic Zones of West Bengal at an average altitude of 58.9 meter above msl and 23°39'N latitude and 87°42'E longitude) in morning hours. Leaf bits were prepared measuring nearly 1.0cm x 0.5cm containing both diseased and healthy tissue. Three such bits were placed in a petriplate containing fungicide suspension or sterile filtered tap water (Aquaguard™ Classic-a complete 3-stage water purification system). Initially fungicide suspension/water was agitated for better contact with the leaf bits and the process was repeated after three hour. There were three replications for each treatment. The plates were incubated at room temperature for 48 h and then observed under microscope (Compound light microscope, 10X objective lens) to record the extent of mycelial growth and sporangia formation in fungicide suspension or water [7]. The experiment was conducted during February, 2015 at the Department of Plant Protection, Palli-Siksha Bhavana (Institute of Agriculture), Visva-Bharati. A rating scale was also prepared to record the extent of mycelial growth and sporangia formation [7].

3. RESULTS AND DISCUSSION

Good variation was recorded (Table 1) in respect to effect of different fungicides on mycelial growth and sporangia formation (Fig C and D). Among the fungicides used Derosal (carbendazim) showed very negligible effect on *Phytophthora infestans*. More or less similar effect was recorded in case of Shine-35 (metalaxyl). However, metalaxyl when associated with mancozeb (Matco) inhibited mycelial growth and sporangia formation. Blitox (copper oxychloride), Avtar (hexaconazole + zineb) and Vitavax Power (Carboxin + Thiram) inhibited mycelial growth only at higher concentration. Adequate inhibition of mycelial growth and sporangia production was observed in Indofil Z-78 (zineb), Indofil M-45 (mancozeb), Mirador (azoxystrobin), Acrobat (dimethomorph) and a combination product, Melody Duo (Iprovalicarb 5.5% + Propineb 61.25% WP). But, highest inhibition of both mycelial growth and sporangia production were recorded in

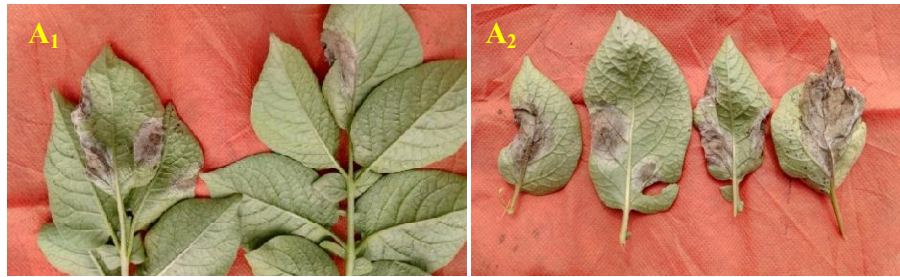


Fig. A. Late blight infested leaf brought to the laboratory for laboratory experiment

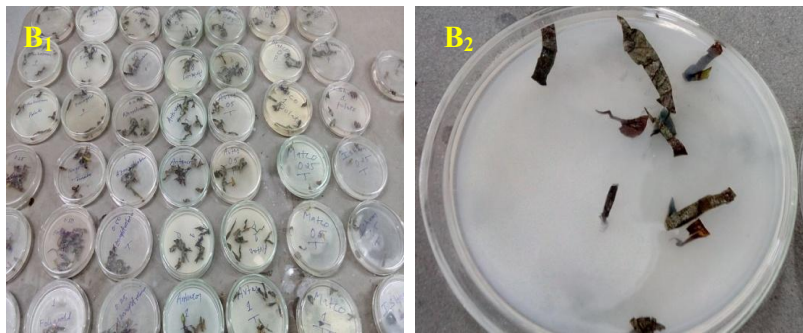


Fig. B. Infected leaf bits in fungicide suspension



Fig. C. Mycelial growth along with sporangial germination



Fig. D. Mycelial growth along with sporangial germination

Where, *D*₁: Control treatment, *D*₂: FolioGold treatment, *D*₃: Ethaboxam treatment

Ethaboxam (Fig. *D*₃) followed by FolioGold (chlorothalonil + metalaxyl) (Fig. *D*₂) and Kavach (Chlorothalonil 75% WP). It can be concluded from the

study that ethaboxam is more efficacious against late blight disease followed by FolioGold and Kavach than other fungicides used

Table 1. Efficacy of fungicides against *Phytophthora infestans* in aqueous medium

Fungicides	Active ingredient and formulation	Extent of mycelial growth			Extent of sporangia formation		
		% concentration of fungicide formulation			% concentration of fungicide formulation		
		0.1	0.05	0.025	0.1	0.05	0.025
Kavach (<i>Syngenta</i> India Ltd.)	(Chlorothalonil 75% WP)	Nil	Scanty	Scanty	Nil	Nil	Very few
Indofil M-45 (Indofil Industries Ltd.)	Mancozeb 75% WP	Very scanty	Medium	Medium	Nil	Medium	Medium
Indofil Z-78 (Indofil Industries Ltd.)	Zineb 75% WP	Scanty	Medium	Medium	Nil	Very few	Very few
Ishaan (Rallis A Tata Enterprise)	Chlorothalonil 75% WP	Very scanty	Scanty	Scanty	Nil	Nil	Nil
Shine 35 (Fil Industries Ltd.)	Metalaxyl 35% WS	Medium	Profuse	Profuse	Nil	Medium	Medium
Mirador (SDS Ramcides CropSci. Pvt. Ltd.)	Azoxystrobin 23% SC	Very scanty	Scanty	Medium	Very few	Few	Few
Acrobat (BASF India Ltd.)	Dimethomorph 50% WP	Scanty	Medium	Medium	Nil	Nil	Very few
Derosal (Bayer Crop Science)	Carbendazim 50% WP	Profuse	Profuse	Profuse	Medium	Huge	Huge
Ethaboxam (Sumitomo Chemical India Ltd.)	Ethaboxam 40% SC	Nil	Nil	Very scanty	Nil	Nil	Very few
Matco (Indofil Industries Ltd.)	Metalaxyl 8% + Mancozeb 64% WP	Nil	Scanty	Medium	Nil	Very few	Few
Melody Duo (Bayer Crop Science)	Iprovalicarb 5.5% + Propineb 61.25% WP	Scanty	Medium	Medium	Nil	Medium	Medium
Vitavax Power (Dhanuka Agritech Ltd.)	Carboxin 37.5% + Thiram 37.5% WS	Scanty	Profuse	Profuse	Few	Medium	Huge
FolioGold (<i>Syngenta</i> India Ltd.)	Chlorothalonil 33% + Metalaxyl 3.3% SC	Nil	Very scanty	Scanty	Nil	Nil	Very few
Blitox (Rallis India Limited)	Copper oxychloride 50% WP	Scanty	Medium	Profuse	Very few	Few	Medium
Avtar (Indofil Industries Ltd.)	Hexaconazole 4% + Zineb 68% WP	Scanty	Medium	Profuse	Very few	Few	Medium
Water	Sterile filtered tap water	Profuse	Profuse	Profuse	Huge	Huge	Huge

Where, Nil= absent of branched/unbranched hyphae or sporangia around the leaf tissue, Very scanty/very few=10 or <10 short branched/unbranched hyphae or sporangia around the leaf tissue, Scanty/few=>10 to 25 branched/unbranched hyphae or sporangia around the leaf tissue, Medium=>25 to 60 branched/unbranched hyphae or sporangia around the leaf tissue, Profuse/huge=>60 branched/unbranched hyphae or sporangia around the leaf tissue

for the experiment (Table 1). Mirador, Acrobat and Melody Duo was effective too. So, these fungicides can be used to manage the disease in field condition. The method is truly useful to select effective fungicides/chemicals against late blight of potato quickly within 48-72 h. Earlier, similar method was utilized successfully in selecting fungicides for management of fruit and vine rot of pointed gourd caused by *Phytophthora melonis* [8]. In this case infected fruit tissue was used. Khatua et al. [9] tested performance of the fungicides against *Phytophthora infestans* in aqueous environment using mycelial disc from agar medium as inoculum. The results supported the earlier records of rapid laboratory evaluation method of fungicides against *Phytophthora infestans* in aqueous environment causing late blight of potato [7].

5. CONCLUSION

Late blight disease of potato is a serious problem throughout the world. The whole crop can be damaged within a few days under favourable environment, if proper management practices are not taken. The method followed for the experiment is very much effective to manage the disease in field condition. Because, effective fungicides can be selected quickly within 48-72 h in laboratory condition using this technique. The results of the study (Ethaboxam > FolioGold > Kavach > Mirador > Acrobat > Melody Duo) may be recommended to the farming community for management of the devastating disease of economically important crop.

COMPETING INTERESTS

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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