JOURNAL OF PURE AND APPLIED MICROBIOLOGY, March 2017. Vol. **11**(1), p. 599-603

Efficacy of New Fungicides against Late Blight of Potato in Subtropical Plains of India

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http://dx.doi.org/10.22207/JPAM.11.1.78

(Received: 29 January 2017; accepted: 05 March 2017)

The field efficacy of metiram 55%+pyraclostrobin 5% WG, iprovaliadacarb 5.5%+propineb 61.25% WP, dimethmorph 50% WP, dimethmorph 50% WP+ mancozeb 75%, WP, famoxadone16.6+cymoxanil22.1% SC along with existing standard fungicides were evaluated for management of late blight during 2012-15. The results revealed that treatment mancozeb 75% WP (0.2%- before appearance) followed by two more spray with mancozeb 75% WP (0.2%) +dimethomorph 50% WP (0.2%) at 7-10 days intervals showed less terminal disease severity (24.55%) with highest disease controlled (74.45%), which was at statistically par with treatment mancozeb75% WP (0.2%, before appearance) followed by cymoxanil 8+mancozeb 64 % WP (0.3%) with two more spray at 7-10 days intervals, with 27.56% terminal disease severity along with disease controlled 71.29%. The highest tuber yield (28.74t/ha) was observed with mancozeb75% WP (0.2% before appearance) followed by two more spray with dimethomorph 50% WP (0.2) at 7-10 days intervals with followed by 28.12 t/ha with mancozeb 75% WP (0.2%- before appearance) followed by two more spray with mancozeb 75% WP (0.2%) +dimethomorph 50% WP (0.2%) at 7-10 days intervals. One spray of mancozeb (contact fungicides: before appearance) and latter two sprays of translaminar/systemic+contact fungicides at 7-10 days interval give better results for management of late blight of potato.

Keywords: Late blight, Potato, Fungicides, *Phytophthora infestans*.

Late blight of potato (*Solanum tuberosum*) caused by a fungus like organism, *Phytophthora infestans* (Mont.) de Bary is one of the major cause for affecting yields in the world wherever potato crop is grown. A study report that economic impacts of late blight to US potato growers (cost of spraying plus losses from disease) averaged more than US $500/ha (Guenthner et al., 2001), making late blight one of the most economically important disease of potato. The cost of Phytopthora to the potato alone amounted to US $6.7 billion annually (USA Blight, 2012). In India, it caused up to 10-20% yield loss during 2013-14 (Lal *et al*., 2016). In Indo-Gangetic plains, disease occur in mild to moderate form but assumes a serious proportion if congenial weather develops early in the crop season (Sharma *et al*., 2015). The key to pathogenic oomycetes' success resides in their capacity to adapt to overcome host resistance and occasionally jump to new hosts (Derevnina *et al*., 2016). *P. infestans* infects potato and tomato plants, causing late blight disease. It is not only serious disease of potato but also cause significant loss in tomato crop. The host resistance is best option for management of this disease. However, due to very divers' virulence nature of *P. infestans;* the resistance of the varieties is wiped out within a

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decade. Therefore the next best option is leftover use of fungicides. Several fungicides including contact, systemic and translaminar have been evaluated from time to time; however, the pathogen has shown a remarkable capacity for change with respect to host genotype and fungicides. As a result, disease control requires regular application of fungicides at high rates and short intervals throughout the growing season (Lal *et al*., 2015a). A survey in Peru found that farmers on average sprayed six times with fungicides (Nelson *et al*., 2001) However, latter publications indicate that farmers in Peru often spray more than ten times (Bustamante *et al*., 2008; Perez *et al*., 2009). The number of sprays depends on the various factors, viz, nature of fungicides being used, climatic conditions, disease pressure, timing of the disease appearance and duration of varieties. In Indian condition, generally more number of sprays is required in hilly and plateau regions than the plains regions. However, it is not true in all case of plains due to erratic rain fall during crop period, which necessitates more number of sprays than normal. The systemic fungicides possess better persistence on the host surface and are being used as mixture with contact fungicides against potato late blight so as to avoid development of resistance in pathogen (Davidse *et al*., 1989). Fungicide mixtures, containing two or more fungicides with different modes of action, have been developed with the twin objectives of broadening the activity spectrum against diverse plant diseases and to check the development of resistance in the target pathogens (Thind, 2012). The new fungicides with unique chemistry are being developed for management of late blight of potato. Therefore, an experiment was planned to evaluate new fungicides along with existing fungicides with proper schedule of spray for management of late blight of potato.

MATERIALS AND METHODS

The experiments was conducted at ICAR-CPRIC farm, Modipuram Meerut (29.1° N, 77.92° E, 300 msl) during rabi season of 2012-2013, 2013-14 and 2014-15. The variety K. Bahar were planted in randomize block design, plot size of 3x3 m^2 keeping 60×20 cm row-plant distances. The crop was sown in second week of November each year and was raised following the standard agronomic practices of the regions including proper fertilizers requirements. Nine treatments consist of a total three spray of each treatment, one spray of contact fungicides (preventive) and two sprays of systemic + contact fungicides. These treatments are as follows:

T1: Mancozeb 75% WP (0.2%,before appearance) followed by two more spray with mancozeb 75% WP (0.2%) +dimethomorph 50% WP (0.2%) at 7-10 days intervals.

T2: Metiram 55%+pyraclostrobin 5% WG (0.2%, before appearance) followed by two more spray at 7-10 days intervals.

T3: Mancozeb 75% WP (0.2%, before appearance) followed by two more spray with iprovaliadacarb 5.5%+propineb 61.25 % WP (0.3%) at 7-10 days intervals.

T4:Mancozeb75% WP (0.2%, before appearance) followed by two more spray with metalaxyl 8% +mancozeb 64 % WP (0.25%) at 7-10 days intervals.

T5: Mancozeb75% WP (0.2%, before appearance) followed by two more spray with cymoxanil 8+mancozeb 64 % WP (0.3%) at 7-10 days intervals.

T6: Mancozeb 75% WP (0.2% before appearance) followed by with two more spray at 7-10 days intervals.

T7:Mancozeb75%WP (0.2% before appearance) followed by two more spray with dimethomorph 50% WP (0.2) at 7-10 days intervals.

T8: Mancozeb 75% WP (0.2 before appearance) followed by two more spray with famoxadone 16.6+cymoxanil22.1% SC (0.2%) at 7-10 days intervals.

T9: Control.

Disease severity was recorded before each spray and last reading was taken after 10 days of final spray. Disease severity was recorded following the method of Henfling (1987). The data on percentage disease control and tuber yield were also recorded at the time of harvest.

Statistical analysis

The experimental data were analyzed with help of IRRISTAT software (version 4.4.20030719).

RESULTS AND DISCUSSION

The field efficacy of Metiram 55%+pyraclostrobin 5% WG, iprovaliadacarb 5.5%+propineb 61.25 % WP, dimethmorph 50% WP, mancozeb 75% WP (0.2%) +dimethomorph 50%

Table 1. Evalation of different fungicides for management of late blight of potato during 2012-13, 2013-14 and 2014-15

Treatments	2012-13			2013-14			2014-15			Mean		
	Terminal disease severity (%)	Disease controlled (%)	Yield (T/ha)	Terminal disease severity (%)	Disease controlled (%)	Yield (T/ha)	Terminal disease	Disease controlled severity (%)	Yield (T/ha) (%)	Terminal disease	Disease controlled severity (%)	Yield (T/ha) (%)
Mancozeb 75% WP (0.2) - mancozeb 75% WP (0.2%) + dimethomorph 50% WP (0.2%) - mancozeb 75% WP (0.2%) +dimethomorph 50% WP (0.2%): 3 spray	28.33	71.19	29.45	21.00	77.50	24.05	24.33	74.65	30.87	24.55	74.45	28.12
Metiram 55%+pyraclostrobin 5% WG (0.2%): 3 spray	45.00	54.24	26.50	36.67	60.71	21.57	43.33	54.86	24.26	41.67	56.60	24.11
Mancozeb 75% WP (0.2)- iprovaliadacarb 5.5%+propineb 61.25% WP (0.3%) - iprovaliadacarb 5.5%+ propineb 61.25 %WP (0.3%):3 spray	30.00	69.49	27.07	26.67	71.43	22.81	36.00	62.50	27.59	30.89	67.81	25.82
Mancozeb 75% WP (0.2)- metalaxyl 8% +mancozeb 64 % (0.25%) - metalaxyl 8% +mancozeb 64 % (0.25%):3 spray	31.67	67.80	28.01	28.33	69.64	23.68	40.67	57.64	25.89	33.56	65.03	25.86
Mancozeb 75% WP (0.2)- cymoxanil8+ mancozeb 64% WP (0.3%)- cymoxanil8+ mancozeb 64% WP (0.3%): 3 spray	28.33	71.19	28.23	24.67	73.57	23.19	29.67	69.10	25.54	27.56	71.29	25.65
Mancozeb 75% WP (0.2) :3 spray	41.67	57.63	28.11	35.00	62.50	21.90	46.00	52.08	28.78	40.89	57.40	26.26
Mancozeb 75% WP (0.2) –dimethmorph 50%WP (0.2) – dimethmorph 50%WP (0.2) :3 spray	35.00	64.41	33.50	25.33	72.86	23.90	27.67	71.18	28.81	29.33	69.48	28.74
Mancozeb 75% WP (0.2) – famoxadone 16.6+cymoxanil22.1%SC(0.2%)- famoxadone16.6+cymoxanil22.1%SC (0.2%): 3 spray	31.67	67.80	30.63	28.33	69.64	24.27	29.33	69.44	27.07	29.78	68.96	27.32
Control	98.33		24.63	93.33		19.70	96.00		23.74	95.89		22.69
CD (0.05)	14.24		5.68	9.66		3.35	5.74		6.42	6.97		3.73

WP, famoxadone16.6+cymoxanil 22.1% SC along with mancozeb 75%, cymoxanil8+mancozeb 64% WP, and metalaxy8+mancozeb 64% WP were evaluated for late blight management. It was observed that all treatments on mean basis (56.60-74.45% disease controlled) found effective against control 95.89% disease severity. The results revealed that treatment mancozeb 75% WP (0.2%,before appearance) followed by two more spray with mancozeb 75% WP (0.2%) +dimethomorph 50% WP (0.2%) at 7-10 days intervals showed less terminal disease severity (24.55%) with highest disease controlled (74.45%).The second best treatment was mancozeb75% WP (0.2%, before appearance) followed by two more spray with cymoxanil 8+mancozeb 64 % WP (0.3%) at 7-10 days intervals, with 27.56% terminal disease severity along with disease controlled 71.29%. The next best treatment was mancozeb75% WP (0.2% before appearance) followed by two more spray with dimethomorph 50% WP (0.2) at 7-10 days intervals with 29.33% terminal disease severity and disease controlled 69.48%. Although, these three treatments were statistically at par with remaining other treatment like mancozeb 75% WP (0.2 before appearance) followed by two more spray with famoxadone16.6+cymoxanil22.1% SC (0.2%) at 7-10 days intervals with 29.78% terminal disease severity and mancozeb 75% WP (0.2%, before appearance) followed by two more spray with iprovaliadacarb 5.5%+propineb 61.25% WP (0.3%) at 7-10 days intervals with 30.89% terminal disease severity (Table 1). The lowest efficacy (56.60% disease controlled) was observed with metiram 55%+pyraclostrobin 5% WG (0.2%- before appearance) followed by two more spray at 7-10 days intervals; followed by 57.40% with mancozeb 75% WP (0.2% before appearance) followed by with two more spray at 7-10 days. Regarding yield parameters, all treatments gave higher yield in comparison to control treatment. The highest tuber yield (28.74t/ha) was observed with mancozeb75% WP (0.2% before appearance) followed by two more spray with dimethomorph 50% WP (0.2) at 7-10 days intervals with followed by 28.12 t/ha with mancozeb 75% WP (0.2%- before appearance) followed by two more spray with mancozeb 75% WP (0.2%) +dimethomorph 50% WP (0.2%) at 7-10 days intervals. The yields of both the treatments were statically at par. The lowest yield (24.11t/ha) was observed with metiram 55%+pyraclostrobin 5% WG (0.2%- before appearance) followed by two more spray at 7-10 days intervals against control (22.69 t/ha). Lal *et al*. (2015b) reported that the mancozeb showed more disease severity as compared to other fungicides tested and similar finding also found in the present investigation. Chakraborty and Mazumdar (2012) reported that the severe late blight can be effectively managed with prophylactic spray of mancozeb @ 0.25% followed by cymoxanil+mancozeb or dimethomorph+mancozeb @ 0.3% at the onset of disease and one more spray of mancozeb @ 0.25% seven days after application of systemic fungicides. Both the chemicals (Cymoxanil and dimethmorph) found effective in the present study also, but here, contact fungicides used only as preventive and after appearance of the disease systemic/translmianar fungicides applied. The efficacy of contact fungicides at/after appearance of the disease was not as good as the efficacy systemic fungicides. Dimethmorph and fenamidon+mancozeb showed less disease against late blight of potato (Khadka *et al*., 2016). It is observed that treatment consisted with Iprovaliadacarb 5.5%+propineb 61.25% WP, Dimethmorph 50% WP and famoxadone16.6+cymoxanil22.1% SC can be integrated at farmer practices as new combination for management of late blight. Iprovalicarb is a protective, curative and antisporulant fungicide with translaminar and acropetal mode of action. It gets distributed evenly in plants. It is an inhibitor of phospholipid biosynthesis and cell wall synthesis. Propineb is a non-specific, multi-site fungicide with protective action against germinating conidia. It works as a good curative and anti-sporulant on disease causing pathogens (https://www.bayer.in/product). The excellent residual activity of famoxadone, combined with the strong curative attributes of cymoxanil is likely to contribute to the high level of performance if both of these fungicides are used together in the field (Bassi *et al*., 1999). Dimethomorph is moderate amount of translminar and acropetal systemicity and disrupts all stage of asexual life cycle of *P.infestans* (Cohen et al., 1995).

REFERENCES

1. Bassi, A., Sbriscia, C., Cagnieul, P., The control of potato late blight in Southern Europe with a Famoxatet-based mixture. Proceedings of the 14th Triennial Conference of the European Association for Potato Research, 1999; pp. 351-352.
2. Bustamante, N., Pérez, W., Aragón, L. Control químico del tizón tardío (*Phytopthora infestans*) de la papa "Canchán" en Huasahuasi, Junín. *Fitopatología*, 2008; **43**(1): 32-40.
3. Chakraborty, A., Mazumdar, D. Development of effective spray schedule for the management of late blight of potato in plains of west Bengal. *Potato J*., 2012; **39**(1): 92-94.
4. Cohen, Y., Balder, A. Cohen, B.H. Dimethomorph activity against oomycete fungal plant pathogens. *Phytopathol.*, 1995; **85**: 1500-1506.
5. Davidse, L.C., Henken, J., VanDalen, A., Jaspers, A.P.K. Mantel, B.C. Nine years of practical experience with phenylamide resistance in (*Phytophthora infestans* (Mont.) De Bary). *Boletin-Tecnico* – INTA, 1989; **96**:11.
6. Derevnina, Lida., Petre, Benjamin., Kellner, Ronny., Dagdas, Yasin F., Sarowar, M N., Giannakopoulou, A., la Concepcion,Juan Carlos De., Chaparro-Garcia, A., Pennington, H.G., van West,P. and Kamoun, S. Emerging oomycete threats to plants and animals. *Phil. Trans. R. Soc. B,* 2016; **371**:20150459.
7. Guenthner, J., Michael, K. and Nolte, P. The economic impact of potato late blight on US growers. *Potato Res.*, 2001; **44**:121-125.
8. Henfling, J.W. Late blight of potato: *Phytophthora infestans.* Technical Information Bulletin 4 (second edition revised) CIP, Lima Peru: 1987; 22p.
9. https://www.bayer.in/product.
10. Lal M., Yadav S., Chand S., Kaushik S.K., Singh B.P., Sharma S. Evaluation of fungicides against late blight (*Phytophthora infestans*) on susceptible and moderately resistant potato cultivars. *Indian Phytopath.,*2015a; **68**(3): 345-347.
11. Lal M., Lal C., Yadav S., Gunjan, Singh B.P., Kaushik S.K., Sharma S. Biological characterization, mt haplotyping, and chemical management of *Phytophthora infestans* causing late blight of potato. *Int. J. Agricult. Stat. Sci.,* 2015b; **11**(1): 259-266.
12. Lal M., Arora R.K., Maheshwari U., Rawal, S., Yadav S. Impact of late blight occurrence on potato productivity during 2013-14. *Int. J. Agricult. Stat. Sci*., 2016; **12**(1): 187-192.
13. Nelson, R.J., Orrego, R., Ortiz, O., Tenorio, J., Mundt, C.C., Fredrix, M., and Vien, N.V. Working with resource-poor farmers to manage plant diseases. *Plant Disease,*2001; **85**: 684-695.
14. Perez, W., Lara, J. and Forbes, G.A. Resistance to metalxyl-M and cymoxanil in a dominant clonal lineage of *Phytopthora infestans* in Huanuco,Peru,an area of countinous prodiction. *Eu J. of Plant Pathology*, 2009; **125**: 87-95.
15. Khadka, R.B., Rawal, R., Marasaini, M., Shrestha, G.K., Chapagain, T., Gautam, I.P., and Khatri, B.B. Evaluation of Different Fungicides and Clones against Potato Late Blight (Phytophthora Infestans) In Western Nepal.5th International Conference on Agriculture, Environment and Biological Sciences (ICAEBS-16) April 28-29, 2016; Pattaya (Thailand).
16. Sharma S., Sundaresha S., Singh B.P. Late blight of potato. In: A Manual on Diseases and Pests of Potato (Singh B, Nagesh M, Sharma S, Sagar V, Jeevalatha A and Sridhar J Eds.). Technical Bulletin No. 101, 2015; ICAR-Central Potato Research Institute, Shimla pp 1-7.
17. Thind, S. Fungicides in crop health security– the road ahead. *Indian Phytopath.,* 2012; **165** (2): 10.
18. USA Blight. USA Blight: a national project on late blight of tomato and potato in the United States. United States Department of Agriculture (USDA). 2012; available at www.usablight.org.