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Research article

MANAGEMENT OF LATE BLIGHT, SEVERE MOSAIC AND PLRV OF POTATO

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ABSTRACT: Experiments were conducted at Binuria under Bolpur-Sriniketan block of West Bengal (India) during 2012-13 to evaluate the efficacy of some fungicides including a few bio-enriched molecules for management of late blight and viral diseases of potato (*Solanum tuberosum* L.). Management of late blight using *Rakhwala* (liquid organic fungicide) proved well but it gave best result when applied along with Mancozeb. Among the other formulation of fungicides, Melody Duo (Iprovalicarb + Propineb) found effective in reducing the disease severity. Increased yield and improved tuber quality was also recorded in these treatments. Repeated application of *Green Spot* (a natural pathogen related protein synthesizer) considerably improved the plants health by keeping the viral infection (Severe mosaic and PLRV) at lower level that resulted in increase of tuber yield. This information may be helpful for sustainable production of disease free seed tubers as well as quality potato tubers.
Key words: Fungicide, late blight, management, PLRV, potato, severe mosaic

INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important solanaceous cash crop, used as staple food in many developing countries. The crop is suffering from different biotic and abiotic factors. Among the biotic cause, the insect pests like aphid (*Myzus persicae, Aphis gossypii*), cut worm (*Agrotis ipsilon*), potato tuber moth (*Phthorimoea operculella*) and mole cricket (*Grylotalpa* spp.) are very common. Some of them act as vector of viral diseases of potato. Incidence of late blight (*Phytophthora infestans*), early blight (*Alternaria solani*), scab (*Streptomyces scabies*), wire stem (*Rhizoctonia solani*) and bacterial wilt (*Ralstonia solanacearum*) are most common and serious diseases causing huge yield loss every year. Indiscriminate use of systemic fungicides especially metalaxyl (Ridomil) provides chance to develop resistant strain of the fungus [1, 2, 3].

Myzus persicae and *Aphis gossypii* are mainly responsible for spreading viral diseases of potato. Potato viruses like mild mosaic (PVX, PVS and PVA), severe mosaic (PVY), leaf roll (PLRV), rugose mosaic (PVY + PVX) and crinkle (PVX + PVA) are quite common in West Bengal. Incidence of mild mosaic, severe mosaic and leaf roll vary from 2.0 to 15.0%, 1.5 to 18.5% and 2.0 to 19.8%, respectively (De, 2004). A significant positive correlation between vector's pressure and spread of PVY and PLRV diseases in the field has been reported by Biswas *et al.* [4]. The disease incidence increased with the increment of vector pressure. *Myzus persicae* (main vector) and *Aphis gossypii* were jointly responsible for 63.9-80.0% spreading of PLRV and 47.6-96.0% spreading of PVY diseases in the field. Pattern of spread of PVX, PVY and PLRV diseases in the field indicated that spread of PVX was found in the adjoining plants of the initially infected plant.

A huge amount of yield loss occurs due to late blight and viral diseases depending on degree of susceptibility of the cultivar, time of appearance, age of plant infection and other epidemiological factors. At present no true resistant source of the potato is available in the country. Moreover, new fungicides and other molecules are introducing in the country every year against fungal and viral diseases whose efficacy needs to be ascertained.

As no true resistant cultivars are available at this moment, hence, chemical control is indispensable for alternative approach to manage these diseases. But indiscriminate use of chemical pesticides hampered ecological equilibrium, invites resurgence problems, develop resistance strains, destroy earth worms and other micro biota etc. Therefore, the present study was undertaken to find out suitable bio-enriched molecules and comparatively safer pesticides to combat these diseases.

METERIALS AND METHODS

Field experiments on potato (cv. Kufri Jyoti) were conducted at the farmer's field that was adjacent to the Agricultural Farm of Palli-Siksha Bhavana (Institute of Agriculture), Visva- Bharati, Sriniketan, West Bengal (India) during *Rabi* season, 2012-13 to study the field efficacy of different fungicides against late blight disease of potato. The experimental farm was situated at 23°39′ N latitude and 87°42′ E longitude with an average altitude of 58.9 m above the mean sea level under red and lateritic agro-climatic zone of West Bengal. The soil of the experimental plot was sandy loam in texture, low in available nitrogen (156 kg/ha), medium in available phosphorus (12.5 kg/ha) and available potassium (165.5 kg/ha).

Normal recommended agronomic practices were adopted to grow the crop successfully in respect to earthing- up, application of fertilizer and irrigation. Two hand weeding was done at an interval of 25 days. Proper control measures were taken minimizing cut worm, mole cricket and aphid infestation. Soil application of Bifenthrin 10 EC (1875ml/ha) was done mixing with rice husk for controlling of cut worm, mole cricket and termite in both fungal and viral disease management trials whereas Imidacloprid 17.8% SL (0.2ml/l) was sprayed to manage aphid and other sucking insects in case of fungicidal trial.

Experimental details in field condition for late blight of potato

Seven fungicides were evaluated to determine their effectiveness against late blight. The seed tuber of potato was planted during last week of December, 2012 with a spacing of 25cm × 60cm. There were seven treatments including one control with three replicates. A total of twenty one numbers of plots having 3m × 4m of size/plot were there. Fungicidal solutions were prepared by dissolving definite amount of the chemicals in definite quantity of plain water. Spray was initiated just after detection of the late blight symptoms in the experimental field and repeated thrice at an interval of 12 days. During spraying care was taken for both upper and lower surface of leaves as well as stems. Sprayer was thoroughly washed before spraying of each fungicidal solution. The following treatments were taken for this study. T_1= Mancozeb @ 2g/l water (Mancozeb 75% WP; Source: Indo Gulf Fertilizers), T_2= *Rakhwala* @ 1ml/l water (Soluble liquid type organic fungicide, containing natural alkaloid and other natural ingredients, organic catalyst etc.; Source: Grace Bio-Care Pvt. Ltd.), T_3= Pack-up @ 4g/l water (Metiram 70% WG; Source: Krishi Rasayan Exports Pvt. Ltd.), T_4= Melody Duo @ 1.5g/l water (Iprovalicarb 5.5% + Propineb 61.25%; Source: Bayer Crop Science), T_5= Blitox @ 4g/l water (Copper oxy-chloride 50% WP; Sourcr: Rallis India Limited), T_6= Mancozeb + *Rakhwala* @ 2g + 1g/l water, T_7= Untreated control.

Data were taken on foliage infection starting from the first appearance of the disease, disease severity (0-9 scale), PDI (Percent Disease Index) and yield. Per cent tuber infection was recorded after harvesting. Tuber yield per hectare was computed based on total tuber yield per plot. Glossiness of the tubers was also recorded on harvested tubers. Observing the colour and luster of freshly harvested tubers a gradation was done viz. more glossy, glossy, less glossy and non-glossy. Only outer surface of the tubers were taken into account. For estimation of disease severity, 0-9 scale was used (Table 1) with slight modification of the scale described by Rahman *et al.* [5].

Table 1: Disease severity scale

Score	Description
0	No spot/lesion on the leaflets.
1	1-10%
3	11-30%
5	31-50%
7	51-70%
9	71% and above

PDI (Per cent Disease Index) was estimated by selecting 25 plants randomly from each plot using following formula:

$$PDI = \frac{\text{Class frequency}}{\text{No. plants assessed x Highest score of scale}} \times 100$$

PTI (Per cent Tuber Infection) was estimated by selecting 25 plants randomly from each plot followed by counting of total numbers of tubers and numbers of infected tubers.

$$PTI = \frac{\text{Numbers of infected tubers}}{\text{Total numbers of tubers}} \times 100$$

Whenever necessary, data were transformed. Treatment means (field data) was compared following Duncan's Multiple Range Test (DMRT) according to Gomez and Gomez [6].

Experimental details in field condition for viral disease management

Green Spot - a natural P. R. protein synthesizer that retards virus multiplication (claimed by M/s grace Bio-care Pvt. Ltd.) was evaluated to determine its effectiveness against rugose mosaic (PVY + PVX) and leaf roll virus disease of potato (PLRV). There were only two treatments including untreated control with thirty replicates. Size of the sample was 30plants/replication. Randomized Block Design was followed for the experiment. There were total sixty plots having 3m × 4m of size/plot. The seed tubers of potato were planted during last week of December, 2012 with a spacing of 25cm × 60cm. *Green Spot* was diluted dissolving 4ml of the same in one litre of plain water. Three spraying were done carefully to cover all the above ground parts of the plants at an interval of 15 days starting from 22 days after planting. Only fresh water was sprayed over the control plots. The following treatments were taken for this study. T_1= *Green Spot* (Natural P. R. Protein Synthesizer @ 4ml/l; Source: Grace Bio-Care Pvt. Ltd.), T_2= Untreated control (Fresh water).

Data were taken on foliage infection starting from the first appearance of the disease, its subsequent development and yield. Tuber yield per hectare was computed based on total tuber yield per plot. Remission of the symptoms of viral diseases after three spraying was observed minutely. Per cent Disease Incidence was estimated by selecting 30 plants randomly from each plot followed by counting of total numbers of infected and uninfected plants.

$$PDI = \frac{\text{Numbers of infected plant}}{\text{Total numbers of plant}} \times 100$$

Data were transformed whenever necessary. Statistical analysis was made following Gomez and Gomez [6].

RESULTS AND DISCUSSION

Efficacy of Rakhwala and other fungicides against late blight of potato

All the fungicides significantly reduced the per cent disease index (PDI), per cent tuber infection (PTI) and increased yield over control. The PDI due to application of different treatments ranged from 8.97 to 77.44 where the lowest and highest PDI were recorded from T_6 (Mancozeb + *Rakhwala*) and T_7 (untreated control), respectively. Although, combination of Mancozeb + *Rakhwala* gave the minimum PDI (8.97) numerically amongst the treated fungicides but it was statistically at par with Melody Duo (15.28). Melody Duo ranked second position followed by *Rakhwala* (17.81), Blitox (20.06), Mancozeb (22.04) and Pack-up (24.14). Except Pack-up and untreated control, Melody Duo (T_4) was statistically similar with *Rakhwala* (T_2), Blitox (T_5), Mancozeb (T_1). It was revealed from the study that, *Rakhwala* and Mancozeb when applied alone was not as effective as combination of Mancozeb + *Rakhwala*.

Regarding PDC (Per cent disease control), Mancozeb + *Rakhwala* appeared highest (88.43) and it differed significantly from all other treatments followed by Melody Duo (80.36), *Rakhwala* (76.49), Blitox (74.22), Mancozeb (71.70) and Pack-up (68.07). There was no significant difference from Melody Duo to *Rakhwala*, Blitox and Mancozeb except Pack-up. All the treatments significantly reduced PDI of late blight over control.

The per cent tuber infection due to application of different fungicides ranged from 1.0 to 6.0. The highest PTI were recorded in untreated control (6.0) whereas lowest of that were observed in Mancozeb + *Rakhwala* (1.0) and Melody Duo (1.0) treated plots. Superiority of all the treatments was observed than the untreated control where maximum percentage of tuber infection was recorded. There was no significant difference amongst the treatments Mancozeb + *Rakhwala* (1.0), Melody Duo (1.0) and *Rakhwala* (1.33) whereas *Rakhwala* (1.33) and Blitox (1.5) revealed statistically similar in respect of PTI.

Table 1. Efficacy of different fungicides against late blight of potato

Treatments	PDI	PDC	PTI	Yield (t/ha)	Glossiness of tuber
T_1 - Mancozeb	22.04 (27.92)[#]	71.70 (57.89)	2.0 (8.13)	19.05	Less glossy
T_2 – *Rakhwala*	17.81 (24.86)	76.49 (61.20)	1.33 (6.65)	19.33	Glossy
T_3 - Pack-up	24.14 (29.30)	68.07 (55.83)	2.5 (9.10)	16.60	Non-glossy
T_4 - Melody Duo	15.28 (22.91)	80.36 (63.76)	1.0 (5.74)	22.08	Glossy
T_5 – Blitox	20.06 (26.55)	74.22 (59.51)	1.5 (7.04)	19.13	Non-glossy
T_6 - Mancozeb + *Rakhwala*	8.97 (17.36)	88.43 (70.16)	1.0 (5.74)	22.52	More glossy
T_7 - Untreated Control	77.44 (61.90)	-	6.0 (14.18)	12.34	Non-glossy
SEm (±)	2.05	2.16	0.31	0.89	-
CD (*p*=0.5)	6.32	6.81	0.96	2.71	-

PDI= Per cent Disease Index, PDC= Per cent Disease Control, PTI= Per cent Tuber Infection, [#]Figures in parentheses are angular transformed values

Glossiness of the tuber was measured on harvested tubers observing its colour and luster, and graded as more glossy, glossy, less glossy and non-glossy. It was depicted from the study that when *Rakhwala* applied with Mancozeb (T_6) produced more glossy tubers while Melody Duo (T_4) and *Rakhwala* (T_2) alone produced glossy tubers. Less glossy tubers producing treatment was Mancozeb (T_1) but the treatments Blitox (T_5), Pack-up (T_3) and untreated control (T_7) produced non-glossy tubers. Glossyness of the tubers is an important factor in respect of consumer choice and market price. More glossy and Glossy tubers fetch more market price and highly acceptable to the consumers than the less glossy and non-glossy tubers. Tuber yield (t/ha) was varied from 12.34 to 22.52 in different treatments. Lowest yield was obtained in untreated control (12.34) and highest of that in Mancozeb + *Rakhwala* (22.52) treated plot. Significantly higher yield was recorded in all the treatments from untreated control. There was no significant statistical difference between the treatments Mancozeb + *Rakhwala* (22.52) and Melody Duo (22.08). Though Mancozeb (19.05), *Rakhwala* (19.33) and Blitox (19.13) were produced similar moderate yield without sowing any significant difference, Pack up (16.60) produced comparatively lower yield.

Efficacy of Green Spot against viral diseases (severe mosaic and PLRV) of potato

The experiment was conducted to compare the mean per cent viral infection in treated population with untreated population of the crop. For this, 30 samples were drawn from each population during each observation at 15 days intervals. Each sample was consisting of 30 plants which were chosen randomly. Finally, the observed data were subjected to t-test for two independent samples for testing the equality of means.

Table 2: Observation on Severe mosaic in *Green Spot* treated and untreated plot

Parameters	Sample size	Mean population (%)	Std. Dev.	t-test for equality of means	
				t_{cal}	Significant
Treated	30	4.77	4.90	-2.208	p=0.031
Untreated	30	10.44	4.44		

Table 3: Observation on PLRV in *Green Spot* treated and untreated plot

Parameters	Sample size	Mean population (%)	Std. Dev.	t-test for equality of means	
				t_{cal}	Significant
Treated	30	9.15	6.71	-2.919	p=0.045
Untreated	30	20.55	7.97		

Perusal of Table 2 revealed that in treated plot mean per cent of severe mosaic (4.77) was significantly lower as compared to untreated population (10.44) at a probability level of 0.03 which indicated that application of the *Green Spot* was beneficial in reducing the viral infection. Similar results (Table 3) were also found in PLRV infection in the plots where application of *Green Spot* always gave better result (9.15) than the untreated one (20.55). Apart from these, the leaves of viral infected plants were observed spreaded out from curly state after three applications of *Green Spot*. Interestingly, level of mosaic in infected leaves was also remitted.

Table 4: Observation on tuber yield in *Green Spot* treated and untreated plot (Severe mosaic)

Parameters	Sample size	Mean wt. of tuber (g/plant)	% reduction of yield/plant	t-test for equality of means
Treated	30	333.07	-	p=0.015*
Untreated	30	282.83	15.08	

Table 5: Observation on tuber yield in *Green Spot* treated and untreated plot (PLRV)

Parameters	Sample size	Mean wt. of tuber (g/plant)	% reduction of yield/plant	t-test for equality of means
Treated	30	343.83	-	p=0.118*
Untreated	30	320.13	6.89	

It revealed from the experiment that in treated plot, mean yield per plant (333.07g) was significantly higher as compared to yield in untreated plot (282.83g) at a probability level of 0.015, which indicated that application of the *Green Spot* was beneficial in reducing the severe mosaic infection resulting in significant increase in tuber yield. Per cent reduction of yield/plant over treated plot was recorded 15.08 (Table 4). Experimental findings regarding PLRV revealed that mean yield per plant (343.83g) also proved better in treated plot as compared to untreated plot (320.13g) at a probability level of 0.118 indicating 6.89% yield loss per plant in untreated plot (Table 5). Potato viruses like mild mosaic (PVX, PVS and PVA), severe mosaic (PVY), leaf roll (PLRV), rugose mosaic (PVY + PVX) and crinkle (PVX + PVA) are reported to be quite common in West Bengal. Incidence of mild mosaic, severe mosaic and leaf roll varied from 2.0 to 15.0%, 1.5 to 18.5% and 2.0 to 19.8% whereas yield reduction recorded due to PVX, PVY and PLRV ranging between 25.9-48.6%, 59.6-77.9% and 50.2-68.7%, respectively [7].

CONCLUSION

Management of late blight of potato using *Rakhwala* proved well but it gave best result when applied along with Mancozeb whereas among the other formulation of fungicides Melody Duo also effective in reducing the disease as well as yield and quality of tuber. Experiment on viral diseases revealed that after repeated application of *Green Spot* considerably improved the plants health by keeping the viral infection (Severe mosaic and PLRV) at lower level, which resulted in increase of tuber yield. Therefore, it can be concluded that both *Rakhwala* and *Green Spot* may be incorporated for sustainable production of potato. More experiments are needed to know the mode of action of these biomolecules.

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