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EFFECTIVENESS OF SOME FUNGICIDES AGAINST LATE BLIGHT OF POTATO CAUSED BY *PHYTOPHTHORA INFESTANS*

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ABSTRACT

An investigation was carried out at Potato Research Station Sialkot during 2014-15 and 2015-16 crop season to find out suitable fungicides to combat the late blight disease of potato. Six fungicides viz. Ridomil Gold, Defeater Plus, Puslan, Success, Aleitte and Dithane M-45 were tested against the disease in two consecutive seasons. All the fungicides reduced the late blight disease incidence of potato over control. Among the fungicides, alternate spray of Ridomil Gold and Dithane M-45 was found highly effective to minimize the late blight and to increase the yield of potato.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important tuberous crop cultivated for uses as vegetable, food and several other processed products. Potato plays an important role in supplying vegetable throughout the year and solves the nutritional problems to a great extent for lower income community. The area under this crop is increasing and the potato growers are gradually adopting it as a cash crop. Potato production is only 19.34 t/ha in the country which is lower as compared to China and India with potato yields of 95.99 and 45.34 t/ha respectively (Shabbir et al., 2016). The major constraint in potato production has been the infestation of wide range of pests and diseases. Among diseases, late blight of potato caused by *phytophthora infestans* (Mont) Debary is the most devastating, destructive and caused potato yield losses of 50-70% (Abd-El-Khair and Haggag, 2007; Rahman et al., 2008). This notoriously known disease caused Irish devastation in the 1840 causing starvation which resulted in death of one million people and mass migration from Ireland to the USA and other European countries (Zadoks, 2008). Devastations such as the great Irish potato famine are less likely to reoccur because of the profound use of fungicides. One of the most important and reliable technique used for late blight control is the application of chemical substances termed as fungicides (Majeed et al., 2014) but indiscriminate use of systemic fungicides especially metalaxyl (Ridomil) provides chance to develop resistance strain of the fungus has been reported (Ali and Dey, 1999; Rasheed and Khan, 2008; Singh, 2000). Epidemiological studies indicate that the disease is devastating at 12- 25°C with relative humidity more than 85%. At present no resistant source of the potato is available in the country. Moreover, new fungicides are being introducing in the country every year against late blight whose efficacy needs to be ascertained.

So the present study was carried out to find out the most effective fungicides to combat the late blight (*Phytophthora infestans* L.) of potato.

MATERIALS AND METHODS

The experiment was conducted at Potato Research Station Sahowali, Sialkot (PRSSS) during 2014-15 and 2015-16. The experimental plot was well ploughed. Recommended doses of fertilizers were used. In both the seasons well sprouted seed of potato variety SH-5 (developed at this station-2005) susceptible to late blight infection was planted with spacing of row to row (within plot) and tuber to tuber (within row) 75 cm and 20 cm respectively in a randomized complete block design (RCBD) with three replications. Each plot had four rows and in each row 30 seed tubers were sown. Post emergence weedicide (Metribuzin 250 g/acre) was applied to control the weeds. Earthing up was executed. Four irrigations were applied throughout the entire growing period. Proper control measures were taken to control insect pests. Six fungicides were included to determine their effectiveness against late blight. There were six treatments in both the cropping seasons consisting of six fungicides and one control in both the seasons. The treatments were as followed:

T_1 = An alternate spray of Ridomil Gold and Dithane M-45
T_2 = An alternate spray of Defeater Plus and Dithane M-45
T_3 = An alternate spray of Puslan and Dithane M-45
T_4= An alternate spray of Success and Dithane M-45
T_5 = An alternate spray of Aleitte and Dithane M-45
T_6 = Control

All the fungicides were used @ 2g/liter of water. In control, no fungicidal spray was applied. Fungicidal solution was prepared by dissolving prescribed amount of the chemicals in definite quantity of plain water. Spray was initiated just after the observation of late blight symptoms in the experimental area and repeated four times at an interval of 7 days. Care was taken during spray of both upper and lower surface of leaves as well as stem were well covered by fungicidal solution. Spray tank was thoroughly washed before filling the fungicidal solution materials. The data on disease severity were recorded using 0-9 disease rating scale of Wang et al. (2007) as shown in Table 1 on day before spray and at weekly intervals after sprayings. The percent disease incidence was calculated by the following formula:

$$Disease\ Incidnce = \frac{No.of\ infected\ Plants}{Total\ No.of\ Plants} \times 100$$

Data analysis: The crop was harvested during March 2015 and March 2016 respectively. The data were subjected to analysis of variance and DMR test at 5% level of significance for comparing the difference among treatment means (Steel et al., 1981).

Table 1. Rating scale for the assessment of late blight severity on potato leaves.

Rating Scale	Disease incidence%	Level of resistance/Susceptibility
0	No disease	
1	10%	Small lesion on the inoculated point with the lesion area Less than 10% of the whole leaflet
3	10% and 20%	Lesion area between 10% and 20% of the whole leaflet
5	20% and 30%	Lesion area between 20% and 30% of the whole leaflet, the Waterish area less than 50% of the whole leaflet
7	30% and 60%	Lesion area between 30% and 60%
9	over 60%	Lesion area over 60% of the whole leaflet

RESULTS AND DISCUSSION

Results obtained from 2014-15 season indicated that all the treatments, Ridomil Gold and Dithane M-45 (T_1), Defeater plus and Dithane M-45 (T_2), Puslan and Dithane-45 (T_3), Success and Dithane M-45 (T_4), Alliete and Dithane M-45 (T_5) except Control (no fungicide applied (T_6) significantly reduced the foliage infection and increased the yield over control (Table 2). The mean disease percent ranged from 6.66 to 100 where the lowest and the highest mean disease percent were recorded from (T_1) and control. Although (T_1) showed the minimum mean disease percent 6.66 numerically among all the treatments but it expressed statistically similar to (T_2) and (T_3) with their values 7.33 and 9.00 respectively. T_4 ranked next in reducing 15.00 mean disease percent.

Although T_5 appeared least effective as compared to other test fungicides but it reduced foliage infection by 78.34% over control. Significantly higher yield was recorded with T_1 29.07 t/ha which was statistically similar with T_2

which gave the second highest yield of 8.33 t/ha followed by T_3, T_4, T_5 with their values of 27. 40, 26.66 and 25.92 tons per hectare respectively. The lowest yield of 24.99 t/ha was observed in control.

Table 2. Effectiveness of test fungicides against late blight of potato during 2014-15.

Sr. No.	Treatments	Disease percent	Percent Decrease	Yield t/ha
T_1	An alternate spray of Ridomil Gold and Dithane M-45	6.66 a	93.34	29.07 a
T_2	An alternate spray of Defeater plus and Dithane M-45	7.33 a	92.67	28.3 ab
T_3	An alternate spray of Puslan and Dithane M-45	9.00 a	91.00	27.40abc
T_4	An alternate spray of Success and Dithane M-45	15.00 b	85.00	26.66bcd
T_5	An alternate spray of Alliete and Dithane M-45	21.66 c	78.34	25.92 cd
T_6	Control (no fungicide applied)	100 d	00.00	24.99 d
LSD	5%	2.7		2.1

Results obtained during 2015-16 season revealed that all the tested fungicides significantly reduced the late blight of potato and increased the yield over control. The foliage infection due to disease ranged from 8.33 to 100% minimum and maximum respectively recorded with T_1 and control Table 3.

The ascending order of the effectiveness of treatments were arranged as T_1, T_2, T_3, T_4, T_5 and control. T_1 and T_2 were equally effective in minimizing the disease incidence of 8.33 and 10.66 respectively and they were statistically similar but differed significantly with rest of the treatments. Percent decrease over control due to fungicidal application in descending order of was 91.67, 89.34, and 83.67, 77.69 and 74.67 respectively in T_1, T_2, T_3, T_4 and T_5. Regarding yield, significantly higher yield was obtained in descending order of 30.41, 29.31, 28.38, 27.03, 25.98 tons per hectare in all the treatments respectively. The lowest yield of 24.58 t/ha was recorded in control.

Table 3. Effectiveness of test fungicides against late blight of potato during 2015-16.

Sr. No.	Treatments	Disease percent	Percent Decrease	Yield t/ha
T_1	An alternate spray of Ridomil Gold and Dithane M-45	8.33 a	91.67	30.41 a
T_2	An alternate spray of Defeater Plus and Dithane M-45	10.66 a	89.34	29.31 ab
T_3	An alternate spray of Puslan and Dithane M-45	16.33 b	83.67	28.38 abc
T_4	An alternate spray of Success and Dithane M-45	22.33 c	77.69	27.03 bcd
T_5	An alternate spray of Alliete and Dithane M-45	25.33 d	74.67	25.98 cd
T_6	Control (no fungicide applied)	100 e	00.00	24.58 cd
LSD	5%	2.2		2.9

Results on the effectiveness of fungicides to minimize the disease incidence of late blight under two years field trials 2014-15 and 2015-16 indicated that all the fungicidal treatments (T_1, T_2, T_3, T_4, and T_5) reduced the disease incidence and increased yield over control. More or less both the systemic and contact fungicides were equally effective against late blight. The performance of Metalaxyl in controlling late blight under present investigation has been supported by the findings of many researchers throughout the world (Islam et al., 2002; Singh and Shekhawat, 1999; Singh et al., 2001; Tsakiris et al., 2002). Among the used fungicides Dithane M-45 showed better performance in reducing disease parameters.

Tsakiris et al. (2002) suggested that integration of host resistance and Dithane M-45 application reduced the late blight severity by more than 50% and resulted in yield gains of more than 30% which clearly supports the present investigation. De and Mohsin (1999) stated that Dithane M-45 gave the lowest disease incidence, highest yield and greatest net benefit against late blight. Bradshaw (1992) stated that Metalaxyl+Dithane M-45 delayed disease progress more efficiently when Dithane M-45 alone was in accordance with our present study. To overcome this notorious disease, mixture or alternate use of Ridomil Gold and Dithane M-45 has also been supported by (Singh et al., 1994; Wang et al., 2007).

It is being concluded that among all the treatments, alternate use of Ridomil Gold and Dithane M-45 proved

highly effective to minimize late blight and to increase yield of potato. So, this may be recommended to control late blight of potato.

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