



Efficacy of Foliar Spray with Seven Fungicides and a Botanical to Control Scab (*Elsinoe fawcettii*) and Dieback (*Colletotrichum gloeosporioides*) Diseases of Lemon

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Abstract

An investigation was conducted in a six year old lemon (*Citrus limon*) garden during March to September 2007 to find out the effect of foliar spray with seven fungicides and a botanical on the severity of citrus scab (*Elsinoe fawcettii*) and dieback (*Colletotrichum gloeosporioides*) of the crop. The tested fungicides were Dinthane M 45 (0.30%), Rovral 50 WP (0.10%), Bavistin 50 WP (0.10%), Champion 77 WP (0.20%), Cupravit 50 WP (0.20%), Tilt 250 EC (0.25%), Proud 250 EC (0.25%) and the botanical allamanda (*Allamanda cathartica*) leaf extract (1:4). The results showed that the fungicides and allamanda leaf extract are effective to achieve significant reduction in severity of scab and dieback diseases, and to increase fruit yield of lemon. The reduction of Percent Disease Index (PDI) of scab on leaf and fruit, and that of dieback ranged 26.45-83.87, 49.01-60.20 and 35.22-58.01%, respectively after six months of first spray. The relationship of increase in fruit yield was directly and linearly correlated with percentage of reduction in severity of dieback diseases. Based on reduction of disease severity and increase of fruit yield, Allamanda leaf extract was noted as most effective material followed by Bavistin 50 WP, Tilt 250 EC, Cupravit 50 WP and Dithane M-45.

Keywords: Citrus, scab, dieback, lemon, fungicide, botanical, control

1. Introduction

Limon (*Citrus limon* L.) is a popular fruit throughout the world due to its attractive flavor, appealing taste and nutritive value, especially as a potential source of vitamins C and minerals (Reuther *et al.*, 1967). In Bangladesh, eight species of citrus are cultivated in about 15.0 ha of land producing 31.750 metric tons of fruits per annum (BBS, 2005). The production of citrus is severely affected by different diseases. Of them scab caused by *Elsinoe fawcettii* and dieback caused by *Colletotrichum gloeosporioides* are considered as major diseases of the crop in the country (Alam, 2003). Citrus scab attacks the young shoots and causes dropping of fruitlets up to 65.9-71.29% (Huang, 1999). Dieback breaks out widely and has become limiting factor of citrus cultivation in many countries including Bangladesh (Talukdar, 1974; Rawal and Saxana, 1997; Alam, 2003). In Bangladesh, the

prevalence of dieback on Elachi lemon and Kagzi lime was up to 89.9 and 100%, respectively (Miah and Fakir, 1987).

A few works have been done on the control of citrus scab and dieback with plant extracts (Thakore *et al.*, 1994; Das *et al.*, 1998; Yesmin, 2004; Fang *et al.*, 2004; Xu *et al.*, 2004 and Alam, 2006). Alam (2006) conducted a research work on standing citrus plant using bio-agent, plant extracts and fungicides for controlling scab and die-back of citrus. The highest reduction of scab severity (percent disease index) was performed by Champion 77 WP (72.72% leaf scab and 83.98% fruit scab) followed by Bishkatali extract (67.54 & 79.99%), Bordeaux mixture (66.26 & 72.01%) and *Trichoderma harzianum* T₂₂ (62.36 & 63.34%), respectively. The highest reduction of dieback severity (percent disease index) over control was resulted

by Dithane M 45 (73.46%) followed by Neem extract (67.34%), Bordeaux mixture (59.19%) and *Trichoderma harzianum* T₂₂ (57.67%). Though fungicides may cause environmental pollution, in absence of suitable alternatives, necessity of fungicides to control plant diseases can not be ignored. Conclusive reports on the management of the diseases with fungicides are scanty. Use of botanicals is an important alternative of chemicals and also an ecofriendly approach that reduces the management cost of diseases. Allamanda leaf extract have antifungal activity but do not evaluated against scab and dieback disease of citrus (Islam, 2004; Meah, 2003 and Khan, 1999).

In view of the above facts, the present study was undertaken to evaluate the efficacy of foliar spray with seven fungicides and a botanical to control scab and die-back of citrus.

2. Materials and Methods

The tested fungicides in the study were Rovral 50 WP (Iprodione) @ 0.1%, Champion 77 WP (Copper hydroxide) @ 0.2%, Dithane M 45 (Mancozeb) @ 0.3%, Cupravit 50 WP (Copper Oxychloride) @ 0.1%, Tilt 250 EC (Propiconazole) @ 0.25%, Proud 250 EC (Propiconazole) @ 0.25%, Bavistin 50 WP (Carbendazim) @ 0.1%, and the botanical allamanda (*Allamanda catliartica*) leaf extract @ 1:4 were used as treatments in the present study. Another treatment was maintained in the study where plain water was sprayed, which served as Control. Suspensions of all materials were prepared with water.

The experiment was conducted in a well established lemon garden at Sher-e-Bangla Agricultural University campus, Dhaka during March to September, 2007 following complete randomized block design with three replications (plants). Twenty seven plants of 6 years old were selected from the garden, which were considered as experimental units. Before initiation of the experiment, weeding, irrigation, application of fertilizer, manure and insecticides were done at recommended rates (Singh, 1988). All treatments were applied as foliar spray for 6 times at an interval of 15 days starting from 15 May, 2007.

Data on the incidence of both scab and dieback were recorded after 2, 4 and 6 sprays from 5 randomly selected twigs of each plant. First spray was done in 15 May, 2007. The plants were sprayed 7 times at 15 days intervals. Number of total as well as scab infected leaves and fruits of selected twigs, and number of dieback infected twigs were recorded. The incidence of scab on leaves and fruits, and that of dieback on twigs were expressed in percentage based of total number of observations. The severity of scab on leaf or fruit was recorded following a 0-5 scale, where 0=No infection, 1=Less than 5%, 2=5-10%, 3=11-20%, 4=21-30% and 5= more than 30% areas of leaf or fruit are infected (Gonzalez *et al.*, 1993). The dieback severity was also recorded following a 0-5 scale as described by Rahman and Hossain (1988) with slight modifications, where 0=No infection, 1=Up to 10%, 2=11-20%, 3=21-30%, 4=31-50% and 5= more than 50% twigs are infected. The percent disease index (PDI) of the diseases was calculated using a standard formula (Abedin and Chowdhury, 1982).

$$PDI = \frac{\text{Total sum of numerical rating}}{\text{No. of obs.} \times \text{Maximum grade in rating scale}} \times 100$$

The data on various parameters were analyzed and means of treatments were tested by Duncan's Multiple Range Tests (DMRT) using MSTAT-C package.

3. Results and Discussion

3.1. Severity of scab on leaf

After two sprays (one month), the severity of scab on leaf, in terms of percent disease index (PDI) was recorded 18.29 in plants at control, whereas the values were 7.30-13.53 in plants to treated with the fungicides and the botanical. The significant reduction of disease severity due to spraying of fungicides and botanical compared to control was monitored. The lowest PDI was found in plants sprayed with Rovral 50 WP followed by Bavistin 50 WP, Allamanda leaf extracts, Tilt 250 EC, and Cupravit 50 WP. The efficacy of the five treatments to reduce the PDI was statistically similar but significantly higher compared to other three treatments, which also showed statistically similar effect on PDI. After

four sprays (two months), the highest PDI of 21.81 was found in plants at control treatment. All treatments gave significant reduction in the disease severity over control. The lowest PDI of 4.12 was recorded from plants sprayed with Allamanda leaf extract, which was statistically similar to Rovral 50 WP, Champion 77 WP and Tilt 250 EC. After six sprays (three months), the PDI was 15.31 at control. It was reduced to 2.23-11.26 due to spray with the fungicides as well as the botanical. The highest reduction was achieved with Champion 77 WP followed by Rovral 50 WP, Allamanda leaf extract, Tilt 250 EC and Bavistin 50 WP. Efficacy of five fungicides was not significantly different. The least effective fungicide was Proud 250 EC followed by Cupravit 50 WP. The severity of scab on leaf was decreased by 24.82-60.01, 43.00-82.03 and 26.45-85.43% over control after 2, 4 and 6 sprays, respectively (Table 1).

3.2. Severity of scab on fruit

After two sprays (one month), the highest PDI of 24.55 was found in fruits at control. The PDI was reduced to 12.40- 17.30 due to spray of the materials. The reduction under all treatments was significant compared to control. The lowest disease severity (PDI) was recorded in fruits sprayed with Cupravit 50 WP. The second lowest PDI was

achieved with Dithane M 45, which was statistically similar to Rovral 50 WP and Bavistin 50 WP. The least effective fungicide was Tilt 250 EC. Its efficacy was not significantly different from that of Champion 77 WP and Proud 250 EC. The effectiveness of Allamanda leaf extract to reduce PDI was better than the latter three fungicides.

After four sprays (two months), all treatments gave significant decrease in PDI on fruits compared to control. The PDI recorded from the fruits sprayed with Dithane M 45, Cupravit 50 WP and Tilt 250 EC was statistically similar and significantly lower compared to other materials. The PDI under the treatments with Rovral 50 WP, Bavistin 50 WP and Allamanda leaf extract was also statistically similar and significantly lower compared to Proud 250 EC and Champion 77 WP. After six sprays (three months), significantly the lowest PDI was recorded with Champion 77 WP, whereas the highest PDI was observed at control. The PDI recorded from fruits sprayed with Dithane M 45, Proud 250 EC and Allamanda leaf extract was statistically similar and significantly lower compared to Cupravit 50 WP, Tilt 250 WP and Bavistin 50 WP. The PDI of scab on fruit was reduced by 24.64-49.49, 39.40-54.98 and 49.01-80.12% over control after 2, 4 and 6 sprays, respectively (Table 2).

Table 1. Effect of foliar spray with seven fungicides and one botanical on percent disease index (PDI) of scab (*Elsinoe fawcettii*) on leaves of lemon

Treatments	After two sprays		After four sprays		After six sprays	
	PDI	Decrease of PDI over control (%)	PDI	Decrease of PDI over control (%)	PDI	Decrease of PDI over control (%)
Rovral 50 WP (0.10%)	7.30 c	60.01	4.97e	78.32	2.47 e	83.87
Champion 77 WP (0.20%)	13.41 b	26.68	4.79e	79.11	2.23 e	85.43
Dithane M 45 (0.30%)	13.53 b	26.02	12.39 c	45.96	4.82 d	68.51
Cupravit 50 WP (0.10%)	10.00 c	45.32	12.78 c	44.26	7.25 c	52.64
Tilt 250 EC (0.25%)	9.30 c	49.15	6.56 de	71.39	3.35 de	78.11
Proud 250 EC (0.25%)	13.75 b	24.82	13.07 b	43.00	11.26 b	26.45
Bavistin 50 WP (0.10%)	8.19 c	55.22	7.56 d	67.03	3.51 de	77.07
Allamanda leaf extract (1:4)	8.87 c	51.50	4.12 e	82.03	2.72 e	82.23
Control (Plain water)	18.29 a	----	22.93 a	----	15.31 a	----

Values within the same column having a common letter(s) do not differ significantly ($P \leq 0.05$)

Table 2. Effect of foliar spray with seven fungicides and one botanical on percent disease index (PDI) of scab (*Elsinoe fawcettii*) on fruit of lemon

Treatments	After two sprays		After four sprays		After six sprays	
	PDI	Decrease of PDI over control (%)	PDI	Decrease of PDI over control (%)	PDI	Decrease of PDI over control (%)
Rovral 50 WP (0.10%)	13.5 d	45.01	13.00de	48.61	12.21 cd	54.45
Champion 77 WP (0.20%)	17.3 b	29.53	14.35 c	43.28	5.33 f	80.12
Dithane M 45 (0.30%)	13.3 de	45.82	11.39 f	54.98	10.67 e	60.20
Cupravit 50 WP (0.10%)	12.4 e	49.49	13.90 f	45.05	13.15 b	50.59
Tilt 250 EC (0.25%)	18.5 b	24.64	13.90 f	45.05	13.67 b	49.01
Proud 250 EC (0.25%)	17.5 b	28.71	15.33b	39.4	11.34 de	57.70
Bavistin 50 WP (0.10%)	13.5 d	45.01	13.2 de	47.82	12.96 bc	51.65
Allamanda leaf extract (1:4)	15.0 c	38.90	12.35 e	51.38	9.06 e	66.20
Control (Plain water)	24.55 a	----	25.30a	----	26.81a	----

Values within the same column having a common letter(s) do not differ significantly ($P \leq 0.05$)

3.3. Severity of dieback

Effect of different treatments on the severity of dieback, in terms of PDI, is presented in Table 3. The PDI was 23.20, 21.30 and 17.07 at control after 2, 4 and 6 sprays, respectively with fungicides and the botanical. The lowest PDI was recorded from fruits sprayed with Champion 77 WP, which was statistically similar to Cupravit 50 WP, Tilt 250 EC, Bavistin 50 WP and Allamanda leaf extract. The materials reduced the PDI to 21.05-21.30 and the reduction was significant compared to control. After six sprays, all treatments gave significant reduction in PDI over control. The PDI under the treatments with Dithane M 45, Champion 77 WP, Tilt 250 EC, Bavistin 50 WP and Allamanda leaf extract was statistically similar and significantly lower compared to only Rovral 50 WP. Due to different treatments, the PDI was reduced by 12.32-28.78, 35.79-47.11 and 35.22-58.01% over control after 2, 4, and 6 sprays, respectively.

3.4. Fruit yield

Number of lemon at control was 13.33/plant. Foliar spray with all materials gave significant increase in fruit yield over control producing 24.33-53.00 fruits/plant. The percent increase of fruit yield was 82.52-297.60 over control. The highest fruit number was obtained with Allamanda leaf extract. Its efficacy to increase fruit yield was statistically similar to Bavistin 50 WP, Tilt 250 EC, Cupravit 50 WP and Dithane M 45. Fruit number was recorded from plants sprayed with Rovral 50 WP, Champion 77 WP and Proud 250 EC was statistically similar and significantly lower compared to other spraying materials (Table 4). The percentage of increase in fruit yield and decrease in PDI of dieback severity were positively and linearly correlated. Their relationship could be expressed by the regression equation $Y=8.9775x-247.88$. The correlation coefficient ($r=0.785^{**}$) was significant (Fig. 1).

Table 3. Effect of foliar spray with seven fungicides and one botanical on percent disease index (PDI) of dieback (*Colletotrichum gloeosporioides*) of lemon

Treatments	After two sprays		After four sprays		After six sprays	
	PDI	Decrease of PDI over control (%)	PDI	Decrease of PDI over control (%)	PDI	Decrease of PDI over control (%)
Rovral 50 WP (0.10%)	26.10ab	12.32	25.27 b	59.39	24.42 b	35.22
Champion 77 (0.20%)	21.05 b	29.29	19.47 d	45.81	18.65 cde	50.53
Dithane M 45 (0.30%)	25.10ab	15.68	23.03 bc	35.90	15.83e	58.01
Cupravit 50 WP (0.10%)	21.30 b	28.45	19.00 d	47.11	19.53cd	48.19
Tilt 250 EC (0.25%)	22.90 b	23.07	21.20 cd	40.99	18.63 cde	50.58
Proud 250 EC (0.25%)	24.70ab	17.03	23.00 bc	35.79	20.47 c	45.70
Bavistin 50 WP (0.10%)	21.20 b	28.78	19.73 d	45.08	16.40 de	56.49
Allamanda leaf extract (1:4)	23.20 b	22.06	21.30 cd	40.71	17.07 cde	54.72
Control (Plain water)	29.77 a	----	35.93 a	----	37.70 a	----

Values within the same column having a common letter(s) do not differ significantly ($P \leq 0.05$)

Table 4. Effect of foliar spray with seven fungicides and one botanical against scab (*Elsinoe fawcettii*) and die back (*Colletotrichum gloeosporioides*) of fruits yield of lemon

Treatments	Fruits per plant	% Increase in fruit yield over control
Rovral 50 WP (0.10%)	24.33b	82.52
Champion 77 (0.20%)	31.33b	135.03
Dithane M 45 (0.30%)	42.66a	220.03
Cupravit 50 WP (0.10%)	44.00a	230.08
Tilt 250 EC (0.25%)	45.00a	237.58
Proud 250 EC (0.25%)	27.33b	105.03
Bavistin 50 WP (0.10%)	52.66a	295.05
Allamanda leaf extract (1:4)	53.00a	297.60
Control (Plain water)	13.33c	----

Values within the same column having a common letter(s) do not differ significantly ($P \leq 0.05$)

The results of the present study showed that foliar spray with fungicides as well as Allamanda leaf extract was effective to reduce severity of scab and dieback diseases and to increase fruit yield of lemon. Considering the reduction of disease severity and increase of fruit yield, Allamanda leaf extract was noted as the most effective treatment followed by Bavistin 50 WP, Tilt 250 EC, Cupravit 50 WP and Dithane M 45. After final spray, the reduction of PDI of scab on

leaf and fruit, and that of dieback ranged 26.45-83.87, 49.01-66.20 and 35.22-58.01%, respectively. The relationship of increase in fruit yield was directly and linearly correlated with percentage of reduction in severity of dieback disease. The findings of the present investigation agreed with the findings of other investigators (Rahman and Hossain, 1988; Harsh *et al.*, 1992; Hossain, 1993; Thakore *et al.*, 1994; Li *et al.*, 1997; Singh *et al.*, 2000).

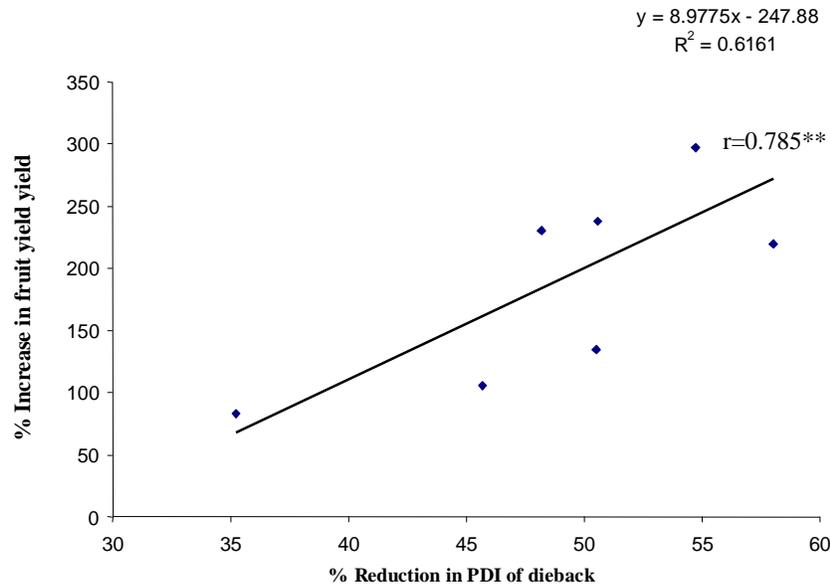


Fig. 1. Relationship of increase in fruit yield with reduction in percent disease index (PDI) of dieback (*Colletotrichum gloeosporioides*) of lemon

Singh *et al.* (2000) reported that copper fungicides controlled citrus scab of 81.1% applied as foliar spray. Li *et al.* (1997) found that Pujunk (Copper hydroxide) controlled citrus scab effectively. Thakore *et al.* (1994) found that the best control of dieback of citrus was achieved with Dithane M-45 at 2000 ppm. Literature on the efficacy Allamanda leaf extract against *E. fawcettii* and *C. gloeosporioides* is not available. However, the evidence of inhibitory effect of many botanicals on plant pathogens is available (Meah, 2003; Islam, 2004).

4. Conclusions

Based on findings of the present investigation, Bavistin 50 WP, Cupravit 50 WP, Champion 77 WP, Dithane M-45 and Allamanda leaf extract may be applied to control scab and dieback diseases and to increase fruit yield of lemon. However, before final recommendation further test is necessary for 3-4 consecutive years.

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