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Original Research

Evaluation of Various Chemicals Against Citrus Canker on Grapefruit cv. Shamber

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ABSTRACT

A good quality fruit fetches a high market value. Citrus canker disease badly affects quality of citrus fruits including grapefruit. The present study was conducted to find out suitable chemicals, alone or incombination, for the control of citrus canker. The experiment was conducted on 15-year-old disease-affected grapefruit cv. Shamber plants in the orchard of Horticultural Research Station, Sahiwal to control the disease for better quality fruit production. Therefore, four sprays of Aliette (300 g 100 L^{-1} of water), Bordeaux mixture (1:1:100), Flare (100 g 100 L^{-1} of water) or Bordeaux mixture + Flare were applied; two in the month of March and other two in the month of August with fifteen days interval along with control (no chemical). Combined application of Bordeaux mixture and Flare reduced the attack of citrus canker on leaves and fruits. Comparatively lower values of affected leaves (1.27%), lesions per leaf (0.40), affected fruits (0.25 %) and lesions per fruit (0.22) were observed in the treatment in which a combination of Bordeaux mixture and Flare was sprayed on the plants. The disease percentage was high on leaves and fruits of unsprayed (control) plants, while other thee treatment were in the middle in their efficacy to control the disease.

Keywords: *Bordeaux mixture, bacterial disease, Citrus paradisi, fosetyl-Al, streptomycin, Xanthomonas spp.*

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INTRODUCTION

Citrus is the most important commercial fruit of Pakistan. It is a rich source of vitamin C, folic acid and dietary fiber as well as antioxidants (Iqbal et al., 2016). Due to its pronounced characters being good for health, it is highly appreciated all over the world. In Pakistan it shares 29.55% of the total orchards under citrus fruit cultivation (Ahmad and Mustafa, 2006). Total cultivated area of citrus in Pakistan is 183,849 ha and its production is 2.35 million tons (Anonymous, 2019). Among the citus varieties the grapefruit shares less than 2% in production (Iqbal et al., 2016). Grapefruit cultivars are highly appreciated due to their high medicinal importance.

A great reason of low production and poor fruit quality is the attack of pests and diseases. Citrus canker is one of the most devastating diseases that affect the crop adversely (Das, 2003). It is caused by *Xanthomonas* bacterium and is one of the largest reasons of deterioration of fruit quality and production. Two common strains of the bacterium attacking citrus plants are *Xanthomonas axonopodis* pv. *citri* and *Xanthomonas axonopodis* pv. *aurantifolii. The host plants of the bacterium include* numerous species, cultivars, and hybrids of citrus and its relatives like orange, mandarin, tangerine, grapefruit, pummelo, lemon, lime, tangelo, clementine, kumquat, sour orange, rough lemon and trifoliate orange. Previous studies show that in the whole citrus group, some of the grapefruit cultivars are more susceptible to citrus canker (Raza et al., 2016). The diseases can be identified by eruptive lesions on leaves, stems and fruits (Lakshmi et al., 2014). The severe symptoms of the disease can be seen in form of defoliation, fruit drop, twig dieback, general tree decline and badly blemished fruits (Hall et al., 2010). The major contributing factors in spreading citrus canker are unskilled workers, disease infested scion wood, tools, equipment and wind driven rains (Gottwald et al., 2001). Good management practices are beneficial but once the disease appears, it cannot be controlled completely or eradicated by even chemicals (Hussain et al., 2014). Disease impact and low production kept grapefruit away to emerge as a major crop. However, now with the good management practices, this crop is getting a step forward and area under its cultivation is increasing (Ishfaq et al., 2007).

As citrus canker badly affects health of the trees and reduces yield and quality of fruits, the present study was conducted to evaluate some chemicals against the disease-affected plants of grapefruit cv. Shamber. It was aimed to find out the most suitable chemicals, alone and in-combination, to control the disease for better tree health and quality fruit production.

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MATERIALS OF METHODS

Grapefruit (*Citrus paradisi* Macf.) cv Shamber plants, aged 15 years, grown in the orchard of Horticultural Research Station, Sahiwal were sprayed with different chemicals to control the prevailing citrus canker disease. The experimental area lies between 30°39'52.16" N latitude and 73°6'30.54"E longitude with an altitude of 152.5 m. The average maximum and minimum temperatures of the rea are 32-35 °C and 10-15 °C, respectively with an average rainfall of 349 mm per year. The treatments applied as foliar sprays were; Aliette @ 300 g 100 L^{-1} of water, Bordeaux mixture (1:1:100), Flare @ 100 g 100 L^{-1} of water, and a combination of Bordeaux mixture and Flare along with control (Table 1).

Aliette® (Bayer Crop Science) is a fungicide containing Fosetyl as aluminium salt (80%). It is effective against various fungal diseases and also against citrus canker. Flare® (Kanzo-Evyol Group) containing streptomycin (80%) is a bactericidal. Bordeaux mixture is very effective against various fungal and some bacterial diseases. It was prepared by soaking 1 kg limestone ($CaCO_3$) and 1 kg copper sulphate ($CuSO_4$) in water separately in the evening and next day in the morning before spray, these were mixed and volume of the solution was made up to 100 liters by adding water.

A total of four sprays were applied during a year; two in the month of March and the other two in the month of August with fifteen days interval. Each treatment was applied on five plants following the randomized complete block design (RCBD) with three replications. The first experiment was conducted during the year 2013 and then repeated during next two consecutive years (2014 and 2015). The data were recorded after one month of the last spray. The data on affected leaves, lesions per leaf, affected twigs, lesions per twig, affected fruits and lesions per fruit were recorded from at least ten leaves, twigs and fruits, respectively from each tree.

Statistical analysis

The data collected were subjected to square root transformation as it was in percentages, then analyzed statistically using analysis of variance (ANOVA) technique and the treatment means were separated by applying least significant difference (LSD) test at p <0.05. The analysis was conducted through the statistical software package STATISTIX 8.1.

RESULTS

The minimum percentage of affected leaves (1.27) was recorded in the treatment where combination of Bordeaux mixture and Flare was sprayed on the plants. This was followed by 1.36% affected leaves in Aliette sprayed plants. However, these two treatments were statistically similar. The maximum value of affected leaves (6.45%) was found in untreated control plants, which significantly differed from other treatments (Table 2). Regarding disease symptoms on leaves, the minimum number of lesions per leaf (0.40) was counted when Bordeaux mixture and Flare was sprayed in combination, followed by when Bordeaux mixture and Aliette were sprayed alone. The three treatments stood statistically at par with each other. The maximum number of lesions per leaf (0.85) was counted in unsprayed (control) plants, being significantly different from all other treatments (Table 2). No twig was found affected by the disease in any treatment including control, thus no lesions were noticed on the twigs (Table 2).

Significantly lower percentage of affected fruits (0.25) was recorded as a result of combined application of Bordeaux mixture and Flare, while significantly higher percentage of affected fruits (1.17) was noted when no spray was applied to the plants. These two treatments significantly differed from each other and also from rest of the treatments (Table 2). As for as the disease symptoms on fruits are concerned, the minimum lesions per fruits (0.22) were counted due to combined application of Bordeaux mixture and Flare as foliar sprays, followed by Bordeaux mixture sprays. These two treatments were

Table 1: Detail of different treatments applied to control citrus canker disease.

Treatments (chemical brand names)	Active ingredient	Concentration (in 100 L of water)	Mode of application
Control (no chemical)	-	-	-
Aliette	Fosetyl-Al (80 WP)	300 g	Foliar spray
Bordeaux mixture	Copper sulphate and limestone	1000 g of each	Foliar spray
Flare	Streptomycin (80%)	100 g	Foliar spray
Bordeaux mixture + Flare	Copper sulphate, limestone and Streptomycin (80%)	1000 + 1000 + 100 g	Foliar spray

Table 2: Effect of different chemicals as alone or in combination to control citrus canker disease.

Treatments	Affected leaves (%)	Lesions per leaf	Affected twigs (%)	Lesions per twig	Affected fruits (%)	Lesions per fruit
Control (no chemical)	6.45 a	0.85 a	-	-	1.17 a	0.80 a
Aliette (300 g 100 L^{-1})	1.36 d	0.58 bc	-	-	0.72 b	0.59 b
Bordeaux mixture (1:1:100)	3.80 c	0.41 c	-	-	0.55 b	0.34 c
Flare (100 g 100 L^{-1})	4.54 b	0.61 b	-	-	1.06 a	0.65 ab
Bordeaux mixture + Flare	1.27 d	0.40 c	-	-	0.25 c	0.22 c

Means followed by the same letter(s) are not significantly different at p <0.05 (LSD test).

statistically alike. The maximum lesions per fruits (0.80) were recorded when no spray was applied to the plants, followed by Flare sprays alone; these two treatments were also statistically similar (Table 2).

DISCUSSION

In citrus canker disease, the bacterium *Xanthomonas axonopodis* causes lesions on the leaves, twigs and fruits (Raza et al., 2016). If the disease is not controlled properly, it adversely affects the plants. The infections typically become active in early spring; the highest risk for new infections is during emergence of fresh shoots and buds. The disease incidence is optimum in warm temperature and at its peak during the periods of high rainfall, humidity and strong winds. The canker lesions ooze bacteria when wet, the bacteria get spread by wind driven rains, air currant, insects, birds, human movements or through spray irrigation systems over short distances (Hall et al., 2010). Present study showed that a combination of antifungal and antibacterial chemicals i.e. Bordeaux mixture and Flare gave comparatively good results to control citrus canker. Researches have shown that the disease affects the production of citrus and for ultimate eradication of the disease, the role of chemicals is important (Ashraf et al., 2014). Therefore, combinations of different chemicals are used to improve their efficiency against the disease. In citrus, usually Bordeaux mixture is one of the cheaper and reliable fungicides to control the diseases for the farmers. It is copper-based and considered more important against most of the diseases in fruit plants. In the present research, the Bordeaux mixture (a fungicide) proved to be effective when it was combined with Flare (bactericidal) to control citrus canker disease. These two may have synergistic effect, thus overall enhanced the efficacy to reduce the affected leaves and fruit percentage. These results are in accordance with the effect of copper-based fungicides as discussed by Vitanovic (2012). Flare contains streptomycin in its composition, and it acts as strong antibacterial agent. Streptomycin in combination with copper-based fungicides is more effective to control the citrus canker and the same idea was explained by Graham et al. (2010). In the absence of a fungicide, Flare (antibacterial) alone was not much effective to control the disease as in the present study and explained by Ashraf et al. (2014).

CONCLUSION

Flare (streptomycin) alone is not much effective to control citrus canker disease in grapefruit cv. Shamber. However, due to synergistic effect, its efficacy was increased when applied in combination with Bordeaux mixture (1:1:100).

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