

PREVALENCE OF CITRUS DECLINE IN DISTRICT SARGODHA

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Citrus occupies a prominent position in fruit industry all over the world. In Pakistan, it ranks first in terms of area, production and export among other fruits. The quality fruit production is under serious threat due to a number of diseases and disorders. Among diseases, citrus decline is of significant importance. As no systematic information is available on the prevalence of this disease, therefore, surveys were conducted to observe disease incidence, severity and percent disease index of citrus decline in six tehsils of district Sargodha. Maximum mean disease incidence was recorded in tehsil Sargodha (94.06%) followed by tehsil Shahpur (93.33%) while it was the minimum in tehsil Sillanwali (35.73%). Similarly, mean disease severity was found to be the maximum in tehsil Sargodha (1.47) followed by tehsil Bhalwal and was the minimum in Sillanwali (0.64). As regards disease index, it was recorded to the maximum in tehsil Sargodha (29.41%) followed by tehsil Shahpur (26.75%). On the other hand, minimum disease index was again observed in tehsil Sillanwali (10.36%). It is, therefore, concluded that decline is widely prevalent in citrus orchards in district Sargodha and warrants strict control measures to abate yield losses.

Keywords: Citrus diseases, disease incidence, disease severity, disease index, low yield.

INTRODUCTION

Citrus is an important fruit of the family Rutaceae and is grown throughout the world on both sides of equator. The quality of citrus fruit varies in different regions based on the climate and variety (Mahmood and Akhtar, 1996). In Pakistan, citrus ranks first among other fruits and is grown on an area of 0.193 million hectares with a total production of 2.396 million tons (GOP, 2016). Almost 95% of citrus in Pakistan is grown in Punjab province and the most famous variety is 'Kinnow mandarin'.

Citrus has high medicinal as well as nutritional value. It is a rich source of vitamin C, sugar, organic acids, amino acids and minerals like calcium and magnesium. Citrus is prone to a number of diseases and disorders. Most common diseases are anthracnose, citrus greening, citrus tristeza virus (CTV), melanose, slow decline and sudden death of citrus. Soil borne fungi have also been found involved (Iqbal and Mukhtar, 2014; Iqbal *et al.*, 2014). Disorders include chimera, frost, growth regulator injury, hail damage, mesophyll collapse, mineral deficiencies, toxicities, phytotoxicity, sunburn and wind damage (Burney *et al.*, 2007).

Among diseases citrus decline is known to occur in all citrus growing areas of Pakistan. It is a disease of crowns and structural roots and associated with poorly aerated and/or poorly drained soils. Its symptoms include rapid wilting and declining, sometimes with fruit still on the tree. Decline affected trees grow poorly and become unthrifty prior to

mortality. Major structural changes occur in the roots in the form of blackened or dead roots, brown lesions extend into and across the tree and stop at the bud union. A characteristic feature of citrus decline is that the affected wood gives rancid coconut oil odour, especially when it is heated. There is no gummosis or pitting of the rootstock (Berkley, 2004).

Citrus decline is a global problem in citrus growing areas. The disease has killed more than 1 million trees in Brazil (Roman *et al.*, 2004). The first symptoms appear only on adult trees entering their 4-6th year. The disease generally affects only bearing trees. Once a tree is affected, it does not recover. Twig blight causes a general decline of the tree canopy and result in poor growth of flushes. Symptoms may be confined to one part of the canopy and can be confused with those of other diseases, like greening in South Africa; tristeza or spreading decline caused by burrowing nematodes (*Radopholus citrophilus*) in Florida (EPPO/CABI, 1996a,b,c). The leaves of decline affected citrus trees often show zinc deficiency symptoms, zinc accumulates in the bark and outer xylem of the trunk, usually prior to visible symptom development. The significance of these high levels of zinc is not known but its analysis can be useful for diagnosis (Young and Albrigo, 1980a, b).

Citrus decline is rapidly spreading in district Sargodha and almost all the orchards are suffering from this disease. As no systematic and detailed information is available on this issue, therefore, the present studies were done to assess the disease severity, incidence and prevalence of this disease in the

district so that control measures may be adopted to minimize yield losses.

MATERIALS AND METHODS

The studies were carried out during the years 2014 and 2015 to determine incidence, severity and prevalence of citrus decline in district Sargodha. For the estimation of incidence and severity of the disease, a total of 1320 trees from 264 citrus orchards were surveyed in 88 randomly selected locations of the district. In each orchard, 5 trees were randomly observed for the presence or absence of the disease. The disease incidence in each orchard was calculated by using the formula described below by Rehman *et al.* (2011).

$$\text{Disease Incidence} = \frac{\text{Number of plants declined}}{\text{Total number of plants}} \times 100$$

The disease severity was recorded using 0-5 visual rating scale by Kazmi *et al.* (2005). Where 0=Healthy Plants; 1=1-10% decline; 2=11-20%; 3=21-30%, 4=31-50% 5=More than 50%

Disease Index in each orchard was determined by the formula given below (Kazmi *et al.*, 2005).

$$\text{Disease index} = \frac{0(n1) + 1(n2) + 2(n3) + 3(n4) + 4(n5) + 5(n6)}{N} \times \frac{100}{5}$$

Where, n1=No. of trees in 0 rating, n2 =No. of trees in 1 rating, n3 =No. of trees in 2 rating, n4 =No. of trees in 3 rating, n5 =No. of trees in 4 rating, n6 =No. of trees in 5 rating, N = Total Number of Trees

RESULTS AND DISCUSSION

Disease incidence, severity and disease index were found to be variable in district Sargodha. Maximum mean disease incidence was recorded in tehsil Sargodha (94.06%) followed by tehsil Shahpur (93.33%) and Sahiwal (73.33%) while it was the minimum in tehsil Sillanwali (35.73%). Similarly, mean disease severity was the maximum in tehsil Sargodha (1.47) followed by tehsils of Bhalwal (1.38) and Shahpur (1.25), however, the minimum disease severity of 0.64 was observed in tehsil Sillanwali. Likewise, maximum disease index was observed in tehsil Sargodha (29.41%) followed by tehsil Shahpur (26.75%) and Bhalwal (23.77%). On the other hand minimum disease index (10.36%) was found in tehsil Sillanwali as shown in Table 1.

In tehsil Bhalwal of Sargodha almost 54% of the locations had 100% disease incidence. Similarly, 61.5% locations fell into disease severity rating of "2" which was maximum rating observed in any location of tehsil Bhalwal (Table 2).

In tehsil Kot Momin 27% of the locations showed 100% disease incidence, while, 80% locations had disease severity rating of "1", which was maximum rating observed in any of locations in tehsil Kot Momin. Disease index ranged from 12-28% as shown in Table 3.

Table 1. Mean disease incidence, severity and disease index in different tehsils of district Sargodha.

Tehsil	Disease severity (0-5)	Disease incidence (%)	Disease index (%)
Bhalwal	1.38	72.85	23.77
Kot Momin	0.80	64.87	15.80
Sargodha	1.47	94.06	29.41
Sahiwal	0.89	73.33	19.28
Shahpur	1.25	93.33	26.75
Sillanwali	0.64	35.73	10.36

Table 2. Mean disease incidence, severity and disease index in different locations of tehsil Bhalwal of district Sargodha.

Location	Disease severity(0-5)	Disease incidence (%)	Disease index (%)
Chak No. 4 SB	2	100	31
Chak No. 7 ML	2	100	32
Chak No. 7 SB	2	100	40
Chak No. 7 ASB	2	100	37
Chak No. 8 NB	2	100	33
Chak No. 9 NB	1	67	15
Chak No 9 Lokri	2	100	36
Chak No. 10 NB	0	0	0
Chak No. 13 NB	2	93	31
Chak No. 18 NB	2	100	37
Chak No. 22 NB	0	0	0
Chak No. 23 NB	1	87	17
Chak No. 26 NB	0	0	0

Table 3. Mean disease incidence, severity and disease index in different locations of tehsil Kot Momin of district Sargodha.

Location	Disease severity(0-5)	Disease incidence (%)	Disease index (%)
Chak No. 9 SB	0	0	0
19 SB	0	0	0
20 SB	1	60	12
21 SB	1	80	19
65 SB	1	73	16
66 SB	1	87	23
Rawan	0	0	0
Dera Thoye Wala	1	100	24
Ghulapur Bangla	1	100	29
Jalla Makhdum	1	80	16
Takht Hazara	1	60	12
Naseerpur Kalan	1	73	17
Mateela	1	100	25
Dodha	1	100	28
Midh Road	1	60	16

In tehsil Sargodha 71% of the locations observed had 100% disease incidence and in 47% locations, the maximum recorded disease severity rating was "2" in any of locations of tehsil Sargodha. Disease index ranged from 20-40% (Table 4). In tehsil Sahiwal 61% locations observed had 100% disease incidence; 11% locations showed disease severity rating "2" (maximum) in any of locations of tehsil Sahiwal. Disease index ranged from 12-32% as shown in Table 5.

Table 4. Mean disease incidence, severity and disease index in different locations of tehsil Sargodha of district Sargodha.

Location	Disease severity(0-5)	Disease incidence (%)	Disease index (%)
Chak No. 24 SB	1	80	20
Chak No 27 SB	2	100	37
Chak No 28 SB	1	73	20
Chak No 30 NB	1	100	27
Chak No 48 NB	1	100	29
Chak No 53 SB	2	100	31
Chak No 56 NB	1	100	27
Chak No 90 NB	2	100	32
Chak No 91 NB	1	73	24
Chak No 93 SB	2	100	40
Chak No 94 NB	2	100	37
Chak No 95 NB	2	100	33
Chak No 95SB	2	100	32
Chak No 101 SB	1	73	24
Chak No 112 NB	1	100	29
Chak No 115 SB	2	100	31
Chak No 122 SB	1	100	27

Table 5. Mean disease incidence, severity and disease index in different locations of tehsil Sahiwal of district Sargodha.

Location	Disease severity(0-5)	Disease incidence (%)	Disease index (%)
Kot Pehalwan	1	100	28
Biral Sharif	1	93	25
Nawabpur	1	100	24
Vijh	1	100	28
Nehang	0	0	0
Chohal	1	100	23
Tirkhanwala	0	0	0
Haveli Majuka	2	100	32
Pindi Wala	1	100	24
Sial Sharif	2	100	31
Sangoraka	1	60	12
Farooka	1	67	16
Sial Dholka	1	100	23
Muhammad Wala	1	100	24
Jahane Wala	0	0	0
Dherowal	1	100	28
Chatror	1	100	29
Radhan	0	0	0

In Shahpur tehsil, 58% locations had 100% disease incidence and 25% locations showed maximum disease severity rating "2" while disease index ranged from 19-35% (Table 6). Similarly, in Sillanwali only one location had 100% disease incidence where maximum disease severity rating was "2". Disease index however, ranged from 4-32% (Table 7).

Table 6. Mean disease incidence, severity and disease index in different locations of tehsil Shahpur of district Sargodha.

Location	Disease severity(0-5)	Disease incidence (%)	Disease index (%)
Malakwal	1	67	19
Wadhi	2	87	35
Kot Maghrib	1	93	20
Shahpur Saddar	1	100	27
Noor Kallu	1	100	27
Kandaan Kalan	2	100	31
Jhavarian	1	100	28
Hussain Shah	1	80	25
Kudyana	1	93	23
Allahdad Wala	1	100	25
Chachar Sharf	1	100	28
Chak 128 NB	2	100	33

Table 7. Mean disease incidence, severity and disease index in different locations of tehsil Sillanwali of district Sargodha.

Location	Disease severity(0-5)	Disease incidence (%)	Disease index (%)
Chak No.118 NB	1	33	15
Chak No.119 SB	1	73	24
Chak No.120SB	0	0	0
Chak No.122 NB	1	53	12
Chak No.123 SB	2	100	32
Chak No.124 SB	0	0	0
Chak No.127 SB	0	20	4
Chak No.127 NB	1	67	15
Chak No.137 SB	0	0	0
Chak No.147 NB	0	0	0
Chak No.148 NB	1	47	12

The overall results indicate that decline is widely prevalent and wreaking havoc with citrus orchards in citrus growing areas of district Sargodha. Legions of factors both biotic and abiotic are involved in decline. Most of the scientists were in opinion that it was citrus tristeza causing citrus decline (Arif *et al.*, 2005). Others were in view that phytoplasma and bacteria are involved in citrus decline (Burney *et al.*, 2007). Some considered bacteria e.g. *Xanthomonas compestris* as the cause of citrus decline. Fungal involvement in citrus decline was studied in Oman, Iran and Pakistan. A list of fungi has

been reported to cause decline symptoms. e.g. *Lasiodiplodia hormozganensis*, *L. theobromae*, *Fusarium solani*, *Phytophthora* sp., *Neoscytalidium dimidiatum* and *Nattrassia mangiferae* being the most common (Al Sadi *et al.*, 2014; Safdar *et al.*, 2010).

Besides these biotic factors the human manipulations regarding orchard management as well as intercropping are aggravating the situation in existing citrus growing areas. Most of the orchards in Sargodha, Bhalwal and Shahpur had old citrus plantations and intercropping of wheat, berseem and barley is practiced. No dead wood removal and less frequent pruning gave the orchards a form of forest. The traditional method of flood irrigation instead of supporting tree vigor added to disease spread. However, better situation was found in terms of orchard management in Kot Momin and Sillanwali tehsils where the growers are following integrated orchard management approaches.

Generally, disease index of more than 15% of any disease at any location or any commodity is considered alarming. However, in district Sargodha overall disease index ranged from minimum of 10.36 to maximum 29.41% which is a real panic for the growers as well as entire citrus industry and requires immediate attention of the scientists and other stakeholders. There is lack of value chain and supply chain studies and training of the growers' at large scale based on the best available integrated approaches. Nominal quarantine measures in the country has also aggravated the disease situation which renders the growers to either change their crops or they sell their properties to land mafia for housing societies.

It is concluded that the situation of citrus decline is alarming in district Sargodha and almost every orchard faced the problem. The situation is alarming and warrants strict control strategies for its management. Moreover, the quarantine measures at tehsil level can protect the disease free areas. It is also emphasized that the farming community be trained for integrated production technology of citrus as well as harvest and postharvest handling. Most of the times orchards are given on contract when they bear fruit and the contractors are least concerned with the health of trees. Therefore, the farmer may sign MoUs with contractors to look after their orchards during the time of fruit development, maturity and at harvest.

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