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RESEARCH ARTICLE

Investigation of Citrus Melanose Disease in Silanwali, Sargodha (Pakistan)

[a]Muhammad U. Hassan, [a]Muhammad A. Zeshan*, [a]Yasir Iftikhar, [b,c]Muhammad U. Ghani, [a]Muhammad A. Shabbir, [a]Sonum Bashir, [a]Suleman Saleem, [a]Komal Ambreen
[a] *Department of Plant Pathology, College of Agriculture, University of Sargodha, Sargodha. Pakistan.*
[b] *Institute of Soil and Environmental Sciences, University of Agriculture Faisalabad. Pakistan.*
[c] *National-Regional Joint Research Center for Soil Pollution Control and Remediation in South China, Guangdong Key Laboratory of Integrated Agro-environmental Pollution Control and Management, Institute of Eco-Environmental and Soil Sciences, Guangdong Academy of Sciences, 808 Tianyuan Road, Tianhe District, Guangzhou, Guangdong, China.*

Corresponding Author:
Muhammad A. Zeshan, Email: Muhammad.ahmad@uos.edu.pk

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A B S T R A C T

Citrus melanose deteriorates the marketable quality of citrus fruits; impacting the country's economy to a considerable level. Sargodha is the citrus hub of the country where growers suffer from huge economic losses incited by citrus melanose. Assessment of factors affecting the citrus mealnose development in Silanwali would be effective to devise durable management practices for sustaining citrus industry in the region. The main objective of the survey is to explore the health status of citrus orchards regarding melanose disease. This study provides an area-specific survey for factor affecting mealnose and probable management tactics. A comprehensive survey was completed in Silanwali, Sargodha, to inspect citrus melanose regarding age of the orchard, type of irrigation (canal/tube well), intercropping, pruning practices, and weed infestation. The survey was based upon symptomology followed by laboratory analysis and farmer's interviews regarding history and management options being practiced. The diseased samples were processed for fungal isolation and microscopic identification for confirmation before final data recording. The results indicated that the older orchards (25-35 years old) had a high disease incidence (30.1%), while in middle-aged (15-25 years old) and young orchards (5-15years old), about 20% and 15.4%, respectively. Tube well irrigation system data showed a 3.3% higher disease incidence over canal irrigation. A 1.6% rise in disease incidence was observed due to intercropping, weeds provide around 3.4% more incidence than incidence rate of intercropping does while pruning reduced up to 8% of the incidence of disease. PCA elucidated that weed, tube well irrigation, and intercropping was positively associated with diseases incidence while pruning and canal irrigation were negatively related, showing significant effects in reducing the diseases. The findings highlight the specific management options for mitigation of melanose. It could be concluded that sanitation, pruning and irrigation management are alternate options apart from fungicidal application to control melanose.

Keywords: Citrus melanose, *Diaporthe citri*; citrus disease; orchard management; irrigation; pruning; intercropping

INTRODUCTION

Citrus is the most precious fruit of tropical and sub-tropical areas which is rich in vitamin C and has good contents for the absorption of iron, zinc, and other important nutrients to fulfill daily nourishment (Safdar *et al..,* 2010; Rymbai, 2024; Ahmad *et al..,* 2024). Climatic conditions and fertile land in Pakistan are favorable for producing citrus where kinnow and mosambi are the most widely grown crops. Citrus cultivation stands at a

vital position in Pakistan's agriculture while Sargodha is the main region for its production and is known as California of Pakistan (Bhatti *et al..,* 2024). Citrus melanose is the most prevalent disease in areas with high temperature and relative humidity (Zhou *et al..,* 2025). It is caused by a fungal pathogen (*Diaporthe citri*) (*Phomoposis citri*), that usually affects young leaves and fruits under prolonged rainy or humid weather conditions (Anwar *et al..,* 2021; Zhou *et al..,* 2024). It is present in 80 citrus producing countries where blemishes on fruit rind deteriorate its market value. This disease is characterized by sores shaped like teardrops, blemishes, cakes, and scabs (Pu *et al..,* 2024). The first symptoms are observed as very minute water spots, mostly translucent and yellowish in color like a halo and which usually disappear (Ateeq *et al..,* 2023). The conidia produced are particularly resistant to drying and very viable for some time in water. The teleomorph consists of perithecia that are spherical, borne on the twigs, and carrying ascospores sexually produced (Feng *et al..,* 2024).

Melanose affects all citrus species, but lemons and grapefruits appear to be more susceptible to the disease (Goyal and Lakhwani, 2025). Several fungicides have been tested for their efficacy against melanose. Basic copper sulfate, chlorothalonil, dithianon, and captafol were curative post-bloom applications. Benomyl gave no protection for melanose but was effective in reducing the production of inoculum on dead twigs. Research has shown that copper fungicides increase the control of melanose on citrus species grown in Florida (Liu *et al..,* 2023).

There is a huge potential to work on citrus melanose in Pakistan. The study was initiated with the objectives to monitor and calculate the disease incidence in Silanwali tehsil so there was need for the current survey on citrus melanose. This extreme importance of disease in fruit production, coupled with significant losses in quality, makes it even more necessary that this disease be managed for the economic sustainability of citrus growers.

This research addresses a major challenge faced by citrus growers, aiming to ensure the sustainability and profitability of the citrus industry in the region. Moreover, it contributes to the broader field of plant pathology, highlighting the interplay between pathogens, environmental factors, and agricultural practices in disease management.

MATERIALS AND METHODS

The survey for citrus melanose disease incidence was conducted in Silanwali (Tehsil of District Sargodha). Overall 36 survey points were selected from 7 Union Councils based upon age of the orchard, cultural practices and irrigation.

Study Timelines & survey criteria: The survey period lasted from April 2024 to October 2024; each survey was conducted weekly. The selected orchards were divided into newly planted, middle aged and older orchards in all union councils. Further, the selected orchards were based upon intercropped and non-intercropped; orchards with weeds and without weeds; irrigation with canal and tube well water, more or less irrigations, pruned and un pruned orchards.

Collection of samples and data recording: Based on characteristic symptoms, diseased samples were collected from the aerial portion, middle and bottom of trees including leaves and fruits during the surveys of citrus orchards and incidence was recorded on salient features i.e. tear stain, mudcake and sandpaper on leaves, twigs, and fruits. The data of disease incidence was recorded according to the following formula; and was evaluated by using Table 1.

$$\text{Disease incidence} = \frac{\text{symptomatic leaves}}{\text{total leaves}} \times 100$$

Table 1. Disease severity scale

Scale	Response
0	No melanose
1	Mild melanose
2	Suitable for fresh market
3	Moderate speck melanose, suitable only for processing
4	Severe speck melanose
5	Severe tearstain or mudcake melanose

Confirmation of pathogen in laboratory: Prepare potato dextrose agar (PDA medium) according to the standard composition: 200 g of skinned potatoes, 20 g of dextrose, and 15 g of agar (Usman *et al..,* 2024; Atiq *et al..,* 2024). The pathogen *Diaporthe citri* causing citrus melanose was isolated from an infected tissue and maintained on PDA medium at 40C. Working cultures were prepared regularly and stored at 250C. Later, the pathogen was confirmed based on cultural and morphological characters: colony color and spore identification. Pure culture plate has greyish color as in paper. Pathogensity test is performed by inoculating *Diaporthe citri* on the 60 days grown citrus plants in control conditions.

Linear regression to determine the relationship between melanoses and independent variables:

Linear regression model was used to determine the relationship between disease incidence and predictors i.e. age of orchard, intercropping, irrigation system, weeds, pruning etc. Independent variables were ranked as older, young etc. while dependent variables consisted of numerical values. Residuals were tested using at 5% probability, slope quantified the direction. The statistical analyses were performed using Statistic 8.1 software.

RESULTS

A thorough summary of survey conducted for citrus melanoses in 36 orchards is presented in Table 2. This has been elaborated Union Councils wise with details of orchard ID, irrigation method and frequency, orchards age etc. It is evident from the data that disease incidence and severity levels are varied with orchard age, irrigation methods, number of irrigations at each surveyed unit.

Table 2. Citrus melanoses disease incidence and severity across surveyed units

Sr. #	Union Council	Orchard ID	Age	Irrigation System	Dominant Situation	% Incidence	Severity Level
1	UC 121	C1213	New	Canal	More irrigations	15	3
2	UC 148	C14802	New	Canal	Inter cropping	14.5	4
3	UC Shamsabad	CS1O3	New	Canal	More irrigations	12	4
4	UC 121	C121O1	New	Canal	Less irrigations	12	3
5	UC 148	C147O2	New	Canal	Weed	16	1
6	UC 121	C121O2	New	Canal	Inter cropping	11.5	4
7	UC Chanab Nagar	CCn2O1	New	Tube well	Less irrigations	13	1
8	UC 148	C14801	New	Tube well	Weed	21.5	5
9	UC 118	C11803	New	Tube well	More irrigations	17.5	2
10	UC 148	C147O3	New	Tube well	Inter cropping	16.5	5
11	UC 118	C11901	New	Tube well	Pruning	11	1
12	UC 121	C1212	New	Tube well	Inter cropping	20	1
13	UC 111	C111O1	Middle	Canal	More irrigations	22	4
14	UC 111	C107O2	Middle	Canal	Inter cropping	23	4
15	UC Shamsabad	CS2O3	Middle	Canal	Pruning	14	5
16	UC 148	C147O1	Middle	Canal	Less irrigations	20.5	4
17	UC chanab nagar	CCN1O2	Middle	Canal	Inter cropping	23	1
18	UC 111	C107O3	Middle	Canal	Weed	24.5	1
19	UC 118	C11903	Middle	Tube well	Weed	29.5	3
20	UC 111	C111O2	Middle	Tube well	Less irrigations	22.5	4
21	UC Shamsabad	CS1O1	Middle	Tube well	Inter cropping	24	2
22	UC 111	C111O3	Middle	Tube well	More irrigations	24.5	4
23	UC 121	C1211	Middle	Tube well	Inter cropping	22	5
24	UC 111	C107O1	Middle	Tube well	Pruning	16	2
25	UC 121	C121o3	Old	Canal	More irrigations	31.5	4
26	UC Chanab nagar	Ccn2o3	Old	Canal	Pruning	18	4
27	UC Shamsabad	Cs2o1	Old	Canal	Weed	32.5	3
28	UC 118	C11902	Old	Canal	Inter cropping	29	4
29	UC Chanab nagar	Ccn2o2	Old	Canal	Inter cropping	28.5	4
30	UC Chanab nagar	Ccn1o1	Old	Canal	Less irrigations	25.5	4
31	UC Shamsabad	Cs1o2	Old	Tube well	Inter cropping	36	2
32	UC 118	C11801	Old	Tube well	Pruning	23.5	5
33	UC Chanab nagar	Ccn1o3	Old	Tube well	Inter cropping	33.5	3
34	UC 118	C11802	Old	Tube well	More irrigations	33	5
35	UC 148	C14803	Old	Tube well	Weed	35.5	2
36	UC Shamsabad	Cs2o2	Old	Tube well	Less irrigations	32.5	4

*UC= Union Council

The melanose disease incidence has been categorized according to age i.e. newly planted orchards, orchard with middle age and very old orchards (Figure 1). Melanose disease incidence tends to be increased with increase in orchards age. There was high disease incidence (>30%) in older orchards; indicating a directly proportional relationship between disease and age. The bar graph depicted a decreasing trend for disease

incidence in middle aged and newly planted orchards. The trend line showed a negative relationship between orchard age and plant health. It is evident that older orchards have provided favorable environment for the pathogen growth and disease incidence.

The effect of irrigation water from canal and tube well was compared in citrus orchards of different ages for the disease incidence (Figure 2). It was noted that disease incidence was more in orchards irrigated with tube well water in all ages. The orchards where intercropping was done showed more incidence of melanose as compared to non-intercropped areas (Figure 3). Pruning has inversely proportional relationship with melanose disease incidence; orchards where pruning was regularly completed, showed less disease incidence (Figure 4). There was more melanose incidence in orchards where weeding was not performed as compared with other orchards (Figure 5). In UC wise comparison of disease incidence, maximum disease incidence was recorded from UC "Shaheenabad" and minimum from UC "121". (Figure 6).

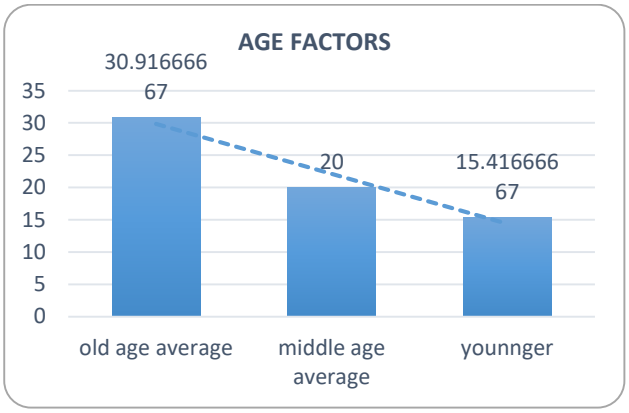

Figure 1. Effect of orchard age on the melanose disease incidence

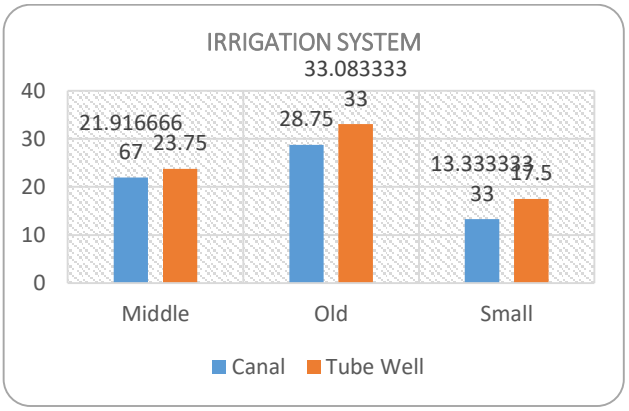

Figure 2. Effect of irrigation system on the melanose disease incidence

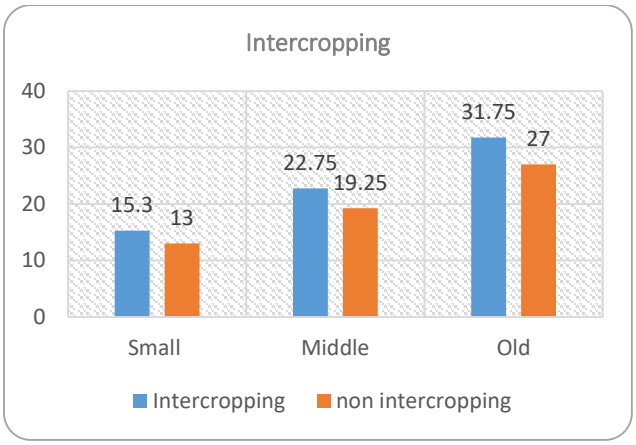

Figure 3. Effect of intercropping on melanose disease incidence

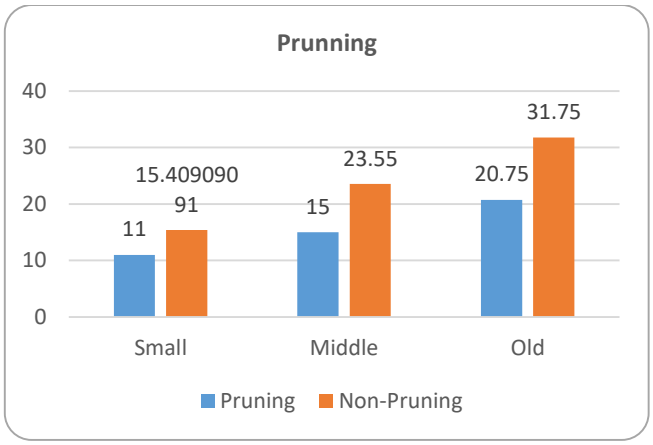

Figure 4. Effect of pruning on melanose disease incidence

DISCUSSIONS

Melanose disease incidence increased as the orchards are aged in the current experiment. The orchards with more age have high affinity for fungal inoculum in their canopies on dead wood (Moyo *et al..,* 2025). The abundance of inoculum is directly proportional to the chances for disease incidence. The reason for low incidence in orchards with less age is the presence of less dead wood in their canopies which provide reduced opportunities for fungal proliferation (Rehman *et al..,* 2020). The outcomes of the present study infer that aged orchards have more favorable disease development conditions which is supported by previous findings that melanose is more pronounced where dead material serve as inoculum. It has been observed during a survey that melanose incidence was less in newly planted orchards (Chaisiri *et al..,* 2022). The results necessitate the removal of dead branches from the orchards to

minimize the source of inoculum as an effective management strategy (Martino *et al..,* 2024). It is also inferred from the outcomes that older orchards are more likely to be considered for cultural operations in order to get rid from inoculum reservoirs. An effective management strategy is the replantation of aged orchards so that fungal reservoirs can be reduced. Farmers can save their produce from qualitative destruction by considering the factors exacerbating the melanose disease (Ateeq *et al..,* 2023).

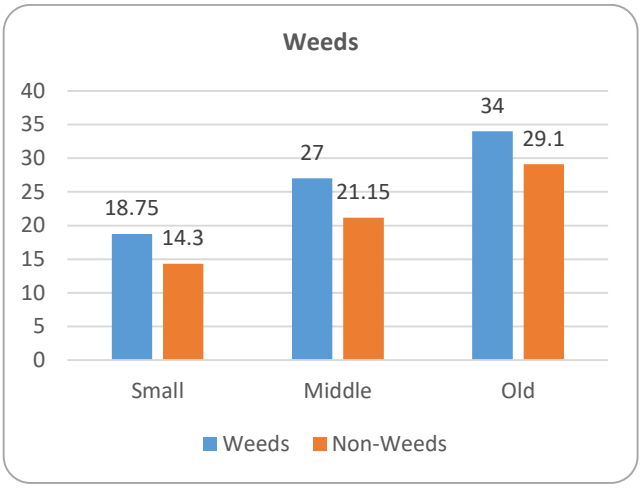

Figure 5. Effect of weeds density on disease incidence in citrus orchards

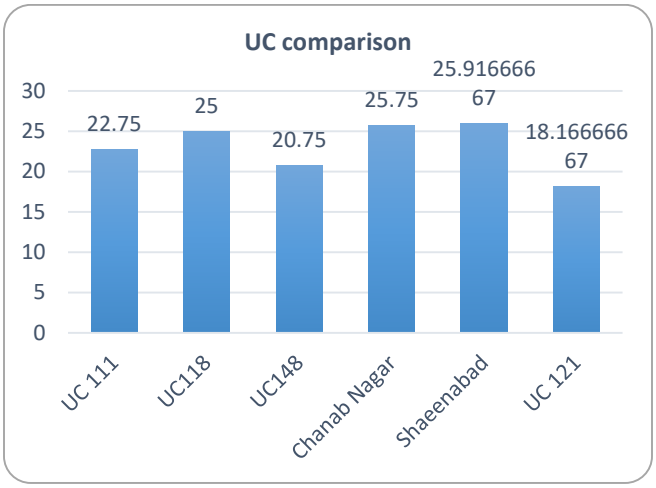

Figure 6. Union Council wise comparison of disease incidence in citrus orchards

In current experiment, primary focus was to identify the correlation between tree age and disease incidence while other factors like weather conditions and genetic potential of the cultivars was not considered which could provide valuable outputs about disease management. The shortcomings of the present research work develop a way forward for more insights regarding environmental factors and breeding for resistance to devise a sustainable management plan for melanose disease.

There was more melanose incidence in orchards where irrigation was applied through tube well than canal water. It has been recorded that tube well water contains more minerals and impurities that favor the growth melanose fungus *D. citri*. The canal water has less quantity of impurities and minerals; ultimately creating less favorable conditions for fungal growth (Kalal *et al..,* 2023). These results are in line with many previous studies suggesting that quality of water has significant impact on the host pathogen interaction by influencing their favorable conditions. The careful monitoring the quality of water may be the effective cultural tool in disease management; low quality water should be treated before irrigation (Ziogas *et al..,* 2021).

Orchards having intercropping exhibited more disease incidence than non-intercropped orchards (Ur Rehman *et al..,* 2024). It was further analyzed that melanose was more pronounced in newly planted orchards having intercropping. This could be attributed to the creation more humid conditions and less air circulation in orchards due to more than one crops; humidity favors the growth of *D. citri* and melanose disease (Liu *et al..,* 2024). Newly planted orchards need more resources and uncompetitive environment for their growth; due to intercropping these young plants are stressed and become predisposed to fungal attack (Mir *et al..,* 2022).

The disease incidence was recorded from pruned and un-pruned orchards with the findings that it was more in later. The researchers found that there were more dead wood in un-pruned orchards that serve as breeding sites for the pathogen resulting in more disease incidence (Lai *et al..,* 2024). Un-pruned orchards are denser with less air circulation producing more humidity that favors pathogen growth and ultimately disease is enhanced (Matias *et al..,* 2023).

During survey, another factor regarding orchard sanitation was considered with the outcome that more incidence was recorded from orchards where abundant weeds were present than orchards where proper and regular weeding was accomplished. Weeds preserve moisture creating more humid conditions favoring the fungal pathogen; secondly weeds also serve as alternate hosts for the pathogen (Ferro *et al..,* 2024; Usman *et al..,* 2025). The weeds also compete with plants for nutrient

resources and create hindrances in the application of fungicides that disturbing the management (Lei *et al..,* 2024).

CONCLUSION

The existing study focused on the significant relationship between several variables of orchard practices and disease occurrence statistically against the prevalence of Citrus Melanose in Silawali, Sargodha. It has, thus, been demonstrated that orchards with an age range from 25 to 35 years most frequently harbor this disease, with an average incidence of 30.1%. On the other hand, the lowest incidence could be related back to very young orchards, which were 5 to 15 years old, with 15.4%. PCA elucidated that weed, tube well irrigation, and intercropping were positively associated with diseases incidence while pruning and canal irrigation were negatively related, showing significant effects in reducing the diseases. Disease incidence through tubewell irrigation source was reported to be 3.3% higher than the canal-irrigated orchards. In this context, excessive diseases increased by 2.5% incidence due to over-irrigation, coming as Pruning reduced it by 8%. Right from the present analysis, it thus seriously reflects the need for immense improvement in very important variables of orchard management. Older orchards should be monitored more carefully to avoid from melanose disease incidence and sanitation including weeding and pruning are the pre-requisites for melanose management.

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Contribution of Authors:

Muhammad U. Hassan	:	Grabbed idea and Conducted research
Muhammad A. Zeshan	:	Supervised research
Yasir Iftikhar	:	Review and Co-supervision
Muhammad U. Ghani	:	Improved discussion
Muhammad A. Shabbir	:	Data Analysis
Sonum Bashir	:	Helped in Lab analysis
Suleman Saleem	:	Coordination in data recording
Komal Ambreen	:	Editing