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Survey on the prevalence of fungal diseases and it's impact on the cultivation of fig (*Ficus carica* L.) in Purandar region of Maharashtra

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ABSTRACT

The study evaluated the frequency of fungal infections in fig and their economic implications across 100 orchards in the Purandar region, Maharashtra. Rust-related pathogens (*Cerotelium fici or Phakopsora sp.*) were the most common disease, appearing in 75% of assessed farms, with 25% reporting concomitant infections such as leaf blight and mite infestations. Economic analysis indicated that 50% of farms suffered substantial income loss, with an average market disruption score of 3.25 on a 5-point scale. According to regression analysis, yield was more strongly predicted by farm size (β = 2.517) than by years of expertise (β = 0.228). The research underscores the pressing necessity for rust-resistant cultivars, comprehensive disease management, and focused extension initiatives to guarantee the enduring viability of fig farming in the Purandar region.

Introduction

Fig (*Ficus carica* L.), a deciduous tree in the Moraceae family, is one of the oldest cultivated fruit crops, originally from Southwest Asia and currently grown in tropical and subtropical climates around the world. This crop is particularly well-suited to dry and semi-arid agro-climatic zones due to its ability to thrive in water-scarce environments and poor soils. It provides both nutritional value and commercial potential with minimal resource inputs (Singh *et al.*, 2023; Tripathi *et al.*, 2025). As of 2021, India's fig cultivation area was 5,912 hectares, with an annual production of 14,695.56 tonnes. Maharashtra is India's biggest producer, accounting for around 2,705 MT from 947 hectares, surpassing Karnataka and Uttar Pradesh. Purandar tehsil in Pune district is the state's most notable fig-growing zone, spanning 1,332 hectares throughout Purandar and Bhor tehsils, with Purandar taluka accounting for 45.92% of the cultivated area (Daundkar *et al.*, 2016). The Adriatic Common type, which bears fruit without pollination, was granted Geographic Indication (GI) status in 2016, highlighting its agricultural and economic importance for smallholder farmers' livelihoods in semi-arid Maharashtra.

Despite the economic significance, fig farming faces serious and escalating risks from pathogenic fungal infections. According to reports, 94% of fig farmers in Purandar suffer from extensive fungal infections, which result in considerable crop losses. Fig rust, caused by *Cerotelium fici or Phakopsora sp.*, is the most common and devastating fungal disease in *F. carica* worldwide, causing red-orange pustules on leaf undersides, necrosis and defoliation, and a significant reduction in fruit yield and marketability (Avasthi *et al.*, 2023; Khot *et al.*, 2024). Beyond rust, phytopathogenic fungi collectively account for approximately 20% of global crop production loss (Davies *et al.*, 2021), whereas fungal infections in horticulture cause 40-60% of seasonal crop losses, including 15-20% in the field and another 15-20% during packing, storage, and transport (Tripathi *et al.*, 2024). These losses incur major economic consequences, including increased fungicide spending, lower fruit quality and lower market pricing, with smallholder farmers being especially vulnerable.

Despite the increasing economic importance of fig production in India, rigorous field-level assessments of disease prevalence, economic effect, and farmer management strategies are limited. This study fills that gap by quantifying the prevalence and severity of fungal diseases in fig orchards in the Purandar region, assessing the associated economic losses, documenting farmers' existing management practices, and identifying knowledge gaps to inform targeted, sustainable disease management strategies applicable to semi-arid fig-producing regions across India.

Material and Methods

Study area and population

The survey was executed in prominent fig-producing villages within the Purandar, Daund, and Khedshivapur regions from August 2022 to August 2025, utilizing a standardized questionnaire in both English and Marathi. The regions constitute a significant fig cultivation zone distinguished by varied agricultural methods and various farmer populations. A survey of 100 orchards growing figs was conducted to evaluate the economic implications, yield, and prevalence of the disease.

Survey Design and Data Collection

A standardized questionnaire was conducted via direct interviews with farmers, focusing on cultivation traits, disease prevalence, yield efficacy, and market performance. The data variables encompass years of agricultural experience, farm size (in acres), total yield (in tonnes), types of diseases observed, frequency of field inspections, and dependence on expert consultation. Additionally, farmers used a five-point Likert scale to score the perceived price effect (1 being no effect and 5 being a severe impact). Disease presence was classified as rust-related, multiple (rust combined with blight or mite infestations) or absent. Management practices were documented based on the principal disease-control strategy employed: chemical pesticide application, traditional remedies, or no treatment.

Classification of groups

Farms were classified into three categories according to the stated economic impact of disease. Such as severely impacted, slightly impacted, and unaffected. These groups were utilized to evaluate yield characteristics, price effect scores and management techniques.

Statistical analysis

Descriptive statistics were calculated to summarize yield, area, and price-related variables. The variability in farmer experience and farm size was evaluated by standard deviation metrics. Correlation analysis (Pearson's r) was utilized to investigate the correlations among experience, yield, price effect and farm area. A one-way ANOVA assessed yield disparities across farms impacted by single versus multiple disease outbreaks, with a significance threshold established at $p < 0.05$. A multiple linear regression analysis was performed to assess the impact of farming experience and cultivated area on total production, utilizing the following model:

$$\text{Yield} = -10.91 + 0.228(\text{Years}) + 2.517(\text{Area})$$

Regression coefficients were analyzed to ascertain the relative impacts of farm size and experience on productivity.

Evaluation of spatial productivity

Productivity at the village level was assessed by compiling farm-specific data to ascertain total and per-acre yields for each site. A comparative analysis revealed high-efficiency and low-efficiency clusters to emphasize geographical diversity in cultivation results.

Results and Discussion

The survey of 100 fig orchards in the Purandar region indicated significant variability in farm features as well as widespread disease-induced economic disruption. Rust-related infections were the most common disease issue, impacting 75% of examined farms. This significant prevalence supports previous epidemiological evaluations that showed extensive fig rust occurrence in Maharashtra (Parthasarathy *et al.*, 2020; Avasthi *et al.*, 2023). An additional 25% of farms showed co-occurring diseases such as leaf blight and red spider mite infestations, demonstrating the complicated disease dynamics found in semi-arid orchard systems (Habib *et al.*, 2025). The average market disruption score was 3.25 on a 5-point scale, showing significant economic pressure due to disease prevalence (Table 2, Fig. 1).

Inspection frequency data revealed primarily proactive management behaviour: 50% of farmers monitored weekly, 25% monitored daily, and the remaining 25% followed alternative schedules (Fig. 1). Expert consultation was evenly distributed across four categories: agricultural extension agencies, pesticide dealers, undefined guidance, and no consultation, with each accounting for 25% of respondents. This homogeneous distribution reveals a substantial need for structured, science-based extension support for fig producers in the region.

According to the economic impact assessment, 87% of farms saw a major income reduction, 8% were mildly impacted, and 5% indicated no obvious effect (Table 3). Quantitative investigation revealed that severely afflicted farms produced an average output of 1.19 tonnes/ acre, compared to 0.97 tonnes/ acre on unaffected farms. A prevalent local market price of ₹ 50,000 per tonne results in an estimated yearly loss of ₹ 11,000 per acre for badly impacted orchards. The projected yearly income loss for seriously afflicted farms was ₹ 47,300 per farm (95% CI: ₹ 42,100-₹ 52,500), based on an average farm size of 4.29 acres. This represents a gross income decrease of nearly 23% from disease-free baseline yields. Disease severity had a significant negative connection with yield per acre ($r = -0.847$, $p < 0.001$; Table 3), indicating that fungal pathogenicity is the principal cause of productivity reduction. These findings are consistent with global evidence that major fungal infections cause 10-30% crop losses each year, with considerable downstream market implications (Savary *et al.*, 2019; Davies *et al.*, 2021).

The correlation study indicated significant correlations between significant farm variables. A negative association ($r = -0.881$) between farmer experience and perceived price effect suggests that experienced farmers are better equipped to handle market shocks. The negative association between experience and farm area ($r = -0.971$) indicates that newer entrants tend to manage larger holdings, presumably reflecting recent agricultural investments in the region. The positive correlation between yield and price effect ($r = 0.951$) is most likely due to premium or volume-based market dynamics, in which high-yielding farms use pricing arrangements to enhance the economic impact of disease-related production changes.

A one-way ANOVA revealed non-significant difference in yield between farms with single or multiple disease infections ($F = 0.807$, $p = 0.534$). This non-significant finding implies that active chemical control may somewhat mitigate the compounding impact of co-occurring pathogens, lowering the additive yield penalty that would otherwise be expected due to concurrent disease loads.

Multiple linear regression confirmed the predicted model: Yield = -10.91 + 0.228 (Years) + 2.517 (Area). The area coefficient (2.517) outperformed the experience coefficient (0.228), indicating that farm size is a far better predictor of total yield than farming experience. This conclusion suggests that economies of scale play a significant role in the current production system, which has practical consequences for extension programme design. Land consolidation techniques may produce bigger productivity gains than experience-based farmer training programmes alone.

The majority of farmers (61%) used chemical pesticides as their primary disease management method, with only a small percentage using traditional medicines or no treatment (Fig. 2). While chemical pesticides provide effective short-term management, over-reliance creates long-term hazards, such as pesticide residual issues in fruits destined for premium and export markets. Sustainably addressing rust disease necessitates a concerted move toward creating rust-tolerant cultivars and deploying regionally customized Integrated Pest Management (IPM) packages.

A village-level productivity analysis found significant spatial variability across the Purandar region. Sonori and Dive had the highest total production (126.2 tonnes from 22 farms; 0.89 tonnes/ acre), while Singapur (Lawande Vasti) had the highest per-acre efficiency (3.0 tonnes/ acre). Khor achieved a volume-efficiency balance (1.95 tonnes/ acre), indicating that the local conditions were optimal. High-efficiency villages like Singapur and Khor can serve as model sites for farmer-to-farmer knowledge transfer, resulting in targeted and replicable productivity gains across the region.

Table 1. Production statistics of fig worldwide from 2017-2021

S.No.	Year	Area harvested (ha)	Production (tonnes)	Yield (t/ ha)
1.	2017	5667	14462.78	2.55
2.	2018	5791	14882.73	2.57
3.	2019	5822	14566.58	2.50
4.	2020	5867	14637.37	2.49
5.	2021	5912	14695.56	2.49

Table 2. Economic impact of fungal diseases on fig

Economic Impact	Farms	Avg. yield (tonnes)	Avg. area (acres)	Yield per Acre (tonnes)	Avg. price effect
Severe impact	87	4.5	4.29	1.19	4.14
Slightly impacted	8	7.09	8.88	0.76	2.13
No effect	5	3.33	3	0.97	1

Table 3. Economic impact on average market price and average yield

Economic Impact	Farms	Avg. price effect	Avg. yield (tonnes)	Avg. area (acres)	Avg. yield/ acre
Decreased significantly	87	4.14	4.5	4.29	1.19
Slightly impacted	8	2.13	7.09	8.88	0.76
No noticeable effect	5	1	3.33	3	0.97

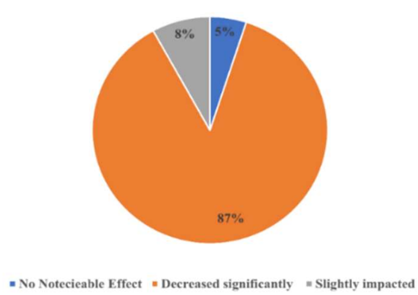

Fig. 1. Economic impact of fungal diseases on fig farms

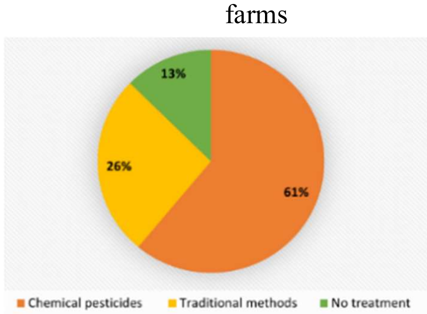

Fig. 2. Management practices and effectiveness at farmer's field

Conclusion

This research provides critical evidence-based insights for developing targeted interventions to improve the sustainability and profitability of fig cultivation. The findings back up urgent priorities such as developing rust-resistant varieties, expanding targeted extension services, implementing location-specific management strategies, and launching land consolidation projects. The long-term viability of fig cultivation as an economic option for smallholder farmers is crucial for addressing the complex issues identified by this thorough survey study, which requires coordinated efforts across research, extension, and policy domains.

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Conflict of Interest

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are included in the manuscript.

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