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Pest and disease management in grapes: Adoption rates and usage constraints

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Abstract
This study investigates the adoption of pest and disease management technologies and constraints among grape growers in Chikkaballapura district, Karnataka, a prominent grape-growing region. Two taluks, Chikkaballapura and Sidlaghatta, were chosen due to their intensive use of plant protection chemicals. A total of 60 grape growers were selected using simple random sampling from 12 villages. Data was collected from the grape growers using a structured schedule. The collected data was analysed using Sengupta's (1967) scale, frequencies, and percentages to determine adoption levels. The study revealed that nearly half (46.66%) of grape growers had low adoption of pest and disease management practices, with only 33.34% showing high adoption and 20% at a medium level. While practices like pruning infected branches and using recommended chemicals were widely adopted, bio-control methods were largely ignored by 88.34% of growers. Farmers faced several challenges, with the high cost of chemicals being the most significant (58.33%). Many also struggled with understanding labels and the toxicity of chemicals (45%), and found spraying difficult (31.66%). Other issues included improper dosage and timing of chemical applications, and a lack of awareness about climate and disease forecasting. The frequent need for chemical sprays to manage diseases effectively added to the financial burden on growers. These findings highlight the need for more affordable and accessible pest management solutions, better education on chemical use, and support for adopting bio-control methods. Addressing these challenges can help improve the sustainability and profitability of grape cultivation in the region, ultimately benefiting the growers and the broader agricultural community.

Keywords: Grapes, adoption, constraints, pest management, bio-control and sustainability

Introduction
Grape (*Vitis vinifera* L.) is one of the most significant commercial crops globally, valued not only for its delicious taste but also for its nutritional benefits. Grapes are a rich source of essential minerals such as calcium, phosphorus, and iron, and vitamins like B1 and B2. The juice of grapes is known for its mild laxative properties and its ability to stimulate kidney function, making it a popular choice for both dietary and medicinal purposes. In India, grapes are cherished as a table fruit and have successfully adapted to the diverse agro-climatic conditions of the subcontinent, thriving in temperate, subtropical, and tropical regions.

In India, grape cultivation is spread across three distinct regions: the temperate region, the subtropical region, and the tropical region. Karnataka, particularly the districts of Bangalore and Chikkaballapura, falls under the mild tropical area, which is conducive to grape cultivation. Additionally, the north interior Karnataka region, including districts like Vijayapura, Bagalkot, Gulbarga, and Belgaum, is also known for its grape production. According to the Agricultural and Processed Food Products Export Development Authority (APEDA), India's grape production in 2023 is estimated to be around 3 million tonnes, reflecting a slight increase due to favourable growing conditions and good rainfall (Anonymous, 2023) [3].

Over the years, crop production and protection technologies in India have made significant strides, leading to increased agricultural productivity. The application of agrochemicals has become more prevalent, reflecting a shift from cereal and millet-based agriculture to a horticulture-based economy. Despite the standardization of grape crop production and protection

technologies, there remains a gap in awareness and adoption among farmers. This gap underscores the need for enhanced education and extension services to ensure that farmers can fully benefit from these advancements.

Plant protection chemicals play a crucial role in safeguarding crops from insect pests, diseases, and weeds, which can appear at various stages of crop growth. The extent of crop loss depends on the severity and virulence of pest and disease attacks. Efficient management of inputs such as virus-free seedlings, irrigation, fertilizers, and crop protection chemicals is essential to meet the growing demand for food and fodder. In India, the annual loss of agricultural production due to pests and diseases is estimated to be around Rs. 90,000 crores (Anonymous[1], 2023) [2]. Even salvaging 50% of this potential loss could significantly reduce agricultural losses and improve food security.

Farmers today are more informed about the availability and efficacy of different brands of plant protection chemicals. Brand preference and loyalty are becoming more pronounced as farmers seek products that offer reliable performance and satisfaction. This trend highlights the importance of effective marketing and education strategies to help farmers make informed decisions about the products they use. The present study was undertaken with the overall objective of examining the extent of adoption of pest and disease management practices among grape growers in Chikkaballapura district and documenting the constraints they face in using different plant protection chemicals. This study aims to provide insights into the current practices and challenges faced by grape growers, thereby informing strategies to enhance the adoption of effective pest and disease management practices and improve overall grape production in the region.

Methodology

The study was conducted in Chikkaballapura district, a prominent grape-growing region in Karnataka. This district was chosen deliberately to explore the adoption of pest and disease management technologies among grape growers and their constraints in adoption of the adoption of plant protection chemicals. Within the district, two taluks Chikkaballapura and Sidlaghatta were selected due to their intensive use of plant protection chemicals in fruit and vegetable cultivation. From each taluk, six villages were randomly chosen, and from each village, five grape growers were selected using simple random sampling, resulting in a total sample size of 60 grape growers. Data was collected from the primary sources using a structured schedule. Primary data was gathered from farmers regarding their adoption of pest and disease management practices for grapes, and the constraints faced in their adoption.

Adoption refers to the extent to which respondents use pest and disease management practices in grape cultivation. The scale developed by Sengupta (1967) was employed to measure this adoption level. During personal interviews, grape growers responded to 15 questions covering pest and disease management practices on a three-point continuum scale: “no adoption” (0), “partially adopted” (1), and “fully adopted” (2). The responses were recorded for each practice. To assess the overall level of adoption, respondents were categorized based on the mean and standard deviation (SD). Those with scores less than the mean minus half the standard deviation were classified as having low adoption. Respondents with scores within the range of the mean plus or minus half the standard deviation were categorized as having medium adoption. Finally, those with scores greater than the mean plus half the standard deviation were classified as having high adoption. The collected information from grape growers was analysed using frequency, percentages to ascertain the extent of adoption of pest and disease management technologies and the constraints faced by grape growers in using different plant protection chemicals.

Results and Discussion

Extent of adoption of pest and disease management technologies by grape growers

The study aimed to assess the adoption levels of pest and disease management practices among grape growers. The findings indicate a varied adoption level among the 60 grape growers surveyed. A significant portion of the grape growers, 46.66%, fell into the low adoption category. This suggests that nearly half of the growers are not fully utilizing pest and disease management practices, which could be due to various constraints such as lack of knowledge, resources, or access to appropriate technologies. About 20% of the growers were categorized under medium adoption, indicating that these growers are somewhat aware and practicing pest and disease management but may not be doing so comprehensively. The remaining 33.34% of the growers exhibited high adoption levels, likely indicating that these growers are more informed and equipped with the necessary tools and knowledge to effectively manage pests and diseases in their vineyards. The mean adoption score was 30.38 with a standard deviation of 4.68, indicating a moderate level of adoption overall but with considerable variability among the growers.

The results highlight a critical need for targeted interventions to enhance the adoption of pest and disease management practices among grape growers. The low adoption rate observed in nearly half of the respondents underscores the necessity for improved extension services and educational programs. According to Rogers’ Diffusion of Innovations theory, the adoption of new practices is influenced by factors such as relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003) [9]. In this context, several factors could be influencing the adoption levels. Firstly, growers with low adoption levels may lack sufficient knowledge about the benefits and methods of pest and disease management. Extension services need to focus on increasing awareness and providing practical demonstrations to bridge this knowledge gap (Feder, Just, & Zilberman, 1985) [6]. Secondly, the availability of resources such as quality pesticides, disease-resistant grape varieties, and financial support plays a crucial role. Growers with limited access to these resources are less likely to adopt comprehensive management practices (Ankushkumar *et al*., 2019) [1]. Thirdly, the cost of implementing pest and disease management practices can be prohibitive for some growers. Financial incentives or subsidies could encourage higher adoption rates. Additionally, growers’ perceptions of the effectiveness of pest and disease management practices influence their adoption. Demonstrating the tangible benefits through case studies and success stories can enhance adoption rates. Lastly, peer influence and community norms also impact adoption. Growers are more likely to adopt practices that are widely accepted and practiced within their community (Chigadolli et. al., 2019) [5]. In deduction, the study reveals a significant variation in the adoption levels of pest and disease management practices among grape growers. To improve adoption rates, it is essential to address the identified constraints through targeted educational programs, resource provision, and financial support. By enhancing the knowledge, resources, and economic feasibility of these practices (Lohar *et al*., 2019) [7], grape growers can be better equipped to manage pests and

diseases effectively, leading to improved productivity and sustainability in viticulture.

Table 1: Overall adoption level of pest and disease management practices among grape growers (n=60)

Sl. No.	Over all adoption level	Frequency	Percentage to total
1.	Low (<28.03)	28	46.66
2.	Medium (28.03-32.72)	12	20.00
3.	High (>32.72)	20	33.34
Total		60	100.00

Mean = 30.38; SD= 4.68

The study aimed to assess the extent of adoption of pest and disease management practices among grape growers. The findings, summarized in Table 2, reveal a diverse range of adoption levels among the 60 grape growers surveyed.

Field Sanitation and Roughing: Field sanitation and roughing were fully adopted by 66.67% of the growers, while 33.33% did not adopt this practice. This high level of adoption indicates a strong awareness among growers about the importance of maintaining clean fields to prevent pest and disease outbreaks. Field sanitation involves removing diseased plants and debris, which can harbor pests and pathogens, thus reducing the risk of future infestations (Feder, Just, & Zilberman, 1985) [6].

Pruning Time: Pruning time was categorized into summer (April) and winter (September). Both periods saw partial adoption by 58.34% of the growers, with 41.66% fully adopting the practice. The uniformity in adoption rates for both periods suggests that growers recognize the importance of timely pruning in managing grapevine health. Pruning helps in removing diseased or dead wood, improving air circulation, and promoting healthy growth, which are essential for disease management.

Removing Infected Branches/Fruits and Loose Bark: This practice was fully adopted by all growers (100%), indicating a unanimous understanding of its critical role in preventing the spread of diseases. Removing infected parts of the plant helps in reducing the inoculum load and prevents the spread of pathogens to healthy parts of the plant.

Application of Bordeaux Paste: Similarly, the application of Bordeaux paste to cutting ends after pruning was fully adopted by 100% of the growers. This practice is essential for protecting pruning wounds from infections. Bordeaux paste, a mixture of copper sulfate and lime, acts as a protective barrier against fungal infections.

Providing Proper Ventilation: Proper ventilation was fully adopted by 58.34% of the growers, while 41.66% did not adopt this practice. Adequate ventilation is crucial for reducing humidity levels, which can help prevent fungal diseases. Good air circulation helps in drying out the foliage and reducing the conditions favourable for fungal growth.

Bio-control: Bio-control methods were the least adopted, with only 11.66% of the growers partially adopting these practices, and 88.34% not adopting them at all. This low adoption rate may be due to a lack of awareness or confidence in the effectiveness of bio-control methods. Bio-control involves using natural predators or antagonists to manage pest populations, which can be an effective and environmentally friendly approach.

Neem Cake Application: Neem cake application was fully adopted by 8.34% of the growers, partially adopted by 31.66%, and not adopted by 60%. The moderate adoption rate suggests that while some growers recognize the benefits of neem cake, others may be deterred by its cost or availability. Neem cake, a by-product of neem oil extraction, has pesticidal properties and can improve soil health.

Disease Management: For disease management, the adoption of recommended chemicals and dosages varied:

Downy Mildew: All growers (100%) used the recommended chemicals, but only 23.34% fully adopted the recommended dosages, with 76.66% partially adopting them. This indicates a high level of chemical use but a lack of adherence to precise dosages. Downy mildew is a common grape disease, and using the correct dosage of fungicides is crucial for effective control.

Powdery Mildew: Similar to downy mildew, 100% of the growers used the recommended chemicals, but only 40% fully adopted the recommended dosages. Powdery mildew can significantly affect grape yield and quality, and proper fungicide application is essential.

Anthracnose and Blight: All growers used the recommended chemicals, but only 26.67% fully adopted the recommended dosages. Anthracnose and blight are serious diseases that require precise chemical management for effective control.

Insect Pest Control: The adoption of insect pest control practices also varied:

Flea Beetle Management: All growers used the recommended chemicals, but only 35% fully adopted the recommended dosages. Flea beetles can cause significant damage to grapevines, and proper chemical management is necessary.

Thrips and Mealybugs Management: Similar to flea beetle management, 100% of the growers used the recommended chemicals, but only 35% fully adopted the recommended dosages. Thrips and mealybugs are common pests that can affect grape quality and yield.

Leaf Eating Caterpillar Management: This practice saw a lower adoption rate, with 36.67% fully adopting the recommended chemicals and dosages. Leaf-eating caterpillars can defoliate grapevines, reducing photosynthesis and overall plant health.

Stem Borer Management: Only 43.34% of the growers fully adopted the recommended chemicals and dosages. Stem borers can cause significant damage to grapevines by boring into the stems and disrupting nutrient flow.

Mites Management: This practice had the lowest adoption rate, with only 36.67% fully adopting the recommended chemicals and dosages. Mites can cause significant damage to grapevines by feeding on the leaves and reducing photosynthetic capacity.

The high adoption rates for practices such as field sanitation, pruning, and the use of Bordeaux paste indicate that grape growers are well aware of the basic practices required for maintaining vineyard health. However, the lower adoption rates for bio-control methods and precise chemical dosages suggest areas where further education and support are needed.

The low adoption of bio-control methods could be attributed to several factors, including a lack of knowledge about these methods, scepticism about their effectiveness, or difficulties in accessing bio-control agents. Extension services and agricultural support programs should focus on educating growers about the benefits and application of bio-control methods to increase their adoption. Bio-control methods can provide sustainable and environmentally friendly alternatives to chemical pesticides, reducing the risk of pesticide resistance and environmental contamination (Rogers, 2003) [9].

The partial adoption of recommended chemical dosages highlights a critical area for improvement. Growers may be using chemicals but not adhering to the recommended dosages, which can lead to ineffective pest and disease control and potential resistance development. Training programs should emphasize the importance of following recommended dosages to ensure effective management and sustainability. Proper dosage ensures that the chemicals are effective in controlling pests and diseases while minimizing the risk of resistance development and environmental harm (Mutteppa *et al*., 2021) [8].

In conclusion, while grape growers have adopted several key pest and disease management practices, there is a need for increased education and support to improve the adoption of bio-control methods and precise chemical dosages. By addressing these gaps, it is possible to enhance the overall effectiveness of pest and disease management in grape cultivation. Improved adoption of these practices can lead to better pest and disease control, higher yields, and more sustainable grape production.

Table 2: Extent of adoption of pest and disease management practices among grape growers (n=60)

Sl. No.	Management practices	Full adoption		Partial adoption		Non- adoption	
		F	%	F	%	F	%
1.	Field sanitation and roughing	40	66.67	0.00	0.00	20	33.33
2.	Pruning time						
	Summer – April	25	41.66	35	58.34	0	0.00
	Winter – September	25	41.66	35	58.34	0	0.00
3.	Removing infected branches/fruits and loose bark at the time of pruning	60	100	0	0.00	0	0.00
4.	bordeaux paste to cutting ends after pruning	60	100	0	0.00	0	0.00
5.	Providing proper ventilation	35	58.34	0	0.00	25	41.66
6.	Bio-control	0	0.00	7	11.66	53	88.34
7.	Neem cake application	5	8.34	19	31.66	36	60.00
8.	**Disease control – chemicals and concentration used**						
a)	Downy mildew						
	Recommended chemicals used	60	100	0	0.00	0	0.00
	Recommended dosage	14	23.34	46	76.66	0	0.00
	2 g Mancozeb 75 WP or						
	2 g Metalaxyl MZ 72 WP or						
	1.5 ml Difenoconazole or						
	1 g Carbendazim 50 WP						
b)	Powdery mildew						
	Recommended chemicals used	60	100	0	0.00	0	0.00
	Recommended dosage	24	40.00	36	60.00	0	0.00
	0.5 g Myclobutanil or						
	1 g Carbendazim 50 WP or 0.3 Dinocap						
c)	Anthracnose and blight Recommended chemicals used Recommended dosage 2 g Metalaxyl MZ 72 WP or 2.5 Amister or 1 g Propineb or 2 g Mancozeb + Fenamidone or 2 g Copper oxychloride	 60 16	 100 26.67	 0 44	 0.00 73.33	 0 0	 0.00 0.00
9.	**Insect pest control – chemicals and concentration used**						
a)	Flea beetle management Recommended chemicals used Recommended dosage 2 ml Chlorpyrifos 20 EC 2 ml Quinalphos 25 EC	 60 21	 100 35.00	 0 39	 0.00 65.00	 0 0	 0.00 0.00
b)	Thrips and Mealybugs management Recommended chemicals used Recommended dosage 1.7 ml Dimethiate 30 EC 1 ml Dichlorophos 76 EC 0.3 g Imidachloprid 17.8 SL	 60 21	 100 35.00	 0 39	 0.00 65.00	 0 0	 0.00 0.00
c)	Leaf eating caterpillar management Recommended chemicals used Recommended dosage 2 ml Quinalphos 25 EC	22 7	36.67 11.67	0 15	0.00 25.00	38 38	63.33 63.33
d)	Stem borer management Recommended chemicals used Recommended dosage 0.5 ml Dichlorophos 76 EC	26 7	43.34 11.67	0 9	0.00 15.00	34 34	56.66 56.66
e)	Mites management Recommended chemicals used Recommended dosage 2.5 Dicofol 18.5 EC	22 7	36.67 11.67	0 15	0.00 25.00	38 38	63.33 63.33

Constraints faced by grape growers in using different plant protection chemicals

The study identified several constraints faced by grape growers in using plant protection chemicals, as summarized in Table 3. The most significant constraint reported by 58.33% of the growers was the high cost of chemicals. This high cost is likely due to the frequent need for chemical applications, with grape crops requiring 20-26 sprays per season to manage diseases effectively. The financial burden of purchasing a large number of chemicals and the necessity for repeated applications can be overwhelming for many growers, particularly those with limited financial resources. Another major constraint was the lack of knowledge on label checking and the toxicity of chemicals, each reported by 45% of the growers. This indicates a significant gap in the education and training of farmers regarding the safe and effective use of plant protection chemicals. Without proper knowledge, farmers may misuse chemicals, leading to ineffective pest control and potential health risks. This

underscores the need for comprehensive training programs that educate farmers on reading labels, understanding chemical toxicity, and implementing safe handling practices. The lack of knowledge regarding plant protection measures and the proper dosage or recommended concentration of chemicals, reported by 36.66% of the growers, further emphasizes the need for targeted extension services that provide practical guidance on the correct application of pesticides and fungicides.

The difficulty of spraying in grape orchards, reported by 31.66% of the growers, suggests that physical challenges also play a role in the adoption of pest management practices. Grape orchards can be challenging environments for spraying due to the dense foliage and the need for precise application techniques. This could be addressed by promoting the use of more efficient spraying equipment or techniques that are easier to manage in vineyard conditions. Additionally, 25% of the growers expressed concerns about the side effects after spraying, indicating that the adverse effects of chemicals on human health and the environment are significant issues. This highlights the importance of promoting safer alternatives and integrated pest management (IPM) practices that minimize the reliance on chemical inputs. Lack of awareness on climate and disease forecasting was reported by 18.33% of the growers. Climate and disease forecasting are crucial for timely and effective pest management, as they help farmers anticipate and prepare for pest outbreaks. Enhancing farmers' access to weather and disease forecasting tools can help them make more informed decisions about pest control measures. The non-availability of labour for spraying and plant protection equipment in nearby places, each reported by 15% of the growers, points to logistical challenges that can hinder effective pest management. Addressing these issues may involve improving the supply chain for agricultural inputs and providing better access to labour resources.

The study reveals that grape growers face multiple constraints in adopting plant protection chemicals, ranging from financial and educational barriers to logistical and health concerns. Addressing these constraints through targeted interventions, such as financial support, education and training programs, and improved access to resources, can enhance the adoption of effective pest and disease management practices. By doing so, grape growers can achieve better crop health and productivity, contributing to the overall sustainability of grape cultivation.

Table 3: Constraints faced by grape growers in using different plant protection chemicals (n=60)

Sl. No.	Constraints	Frequency	Percentage
1.	High cost of the chemical	35	58.33
2.	Lack of knowledge on label checking	27	45.00
3.	Lack of knowledge on toxicity of chemicals	27	45.00
4.	Lack of knowledge regarding plant protection measures	22	36.66
5.	Proper dosage/recommended concentration	22	36.66
6.	Too difficult to spray in grape orchards	19	31.66
7.	Side effects after spray	15	25.00
8.	Lack of awareness on climate and disease forecasting	11	18.33
9.	Non-availability of labours for spraying	9	15.00
10.	Non-availability of plant protection equipment's nearby places	9	15.00

Note: Multiple responses were given by the single farmer

Conclusion

This study sheds light on the challenge's grape growers in Chikkaballapura district face in adopting pest and disease management technologies. While some growers have successfully implemented key practices, many still struggle, especially with bio-control methods. The high cost of chemicals, lack of knowledge, and practical difficulties in application are significant hurdles. To boost the sustainability and profitability of grape farming, it's essential to provide more affordable pest management options, enhance education on chemical use, and support the adoption of bio-control methods. Addressing these issues will not only benefit the grape growers but also strengthen the agricultural community in the region.

Conflict of Interest: The authors declare no conflict of interest.

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