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A STUDY ON THE EFFECT ON KINNOW PRODUCTION AND QUALITY OF AFTER PRODUCTION IN WESTERN U.P.

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Abstract

This study examines the production and post-harvest quality of Kinnow (*Citrus nobilis* x *Citrus deliciosa*) in Western Uttar Pradesh, focusing on various agricultural strategies. Over two growing seasons (2021–2023), data were collected from 30 Kinnow orchards to determine optimal conditions for maximizing yield and maintaining fruit quality. Key factors such as soil health, irrigation systems, pest control strategies, and post-harvest handling procedures were analyzed. Results showed that orchards with optimal soil conditions had a 15% increase in output, with balanced soil nutrient management being essential for high yield and quality. Drip irrigation improved fruit quality and size by 20% and increased water use efficiency. Integrated pest management (IPM) reduced insect infestation by 30%, enhancing plant health and fruit quality. Effective post-harvest handling, including sorting, grading, packing, and cold storage, reduced losses by 25% and extended shelf life by up to two weeks. The study concludes that integrated agricultural practices are crucial for optimizing Kinnow production and quality in Western Uttar Pradesh, promoting sustainable cultivation.

Keywords: Kinnow, Soil health, Irrigation systems, Production and Quality, Western U.P.

Introduction

Certain regions of India, notably the Western Uttar Pradesh area, are responsible for the cultivation of the notable citrus fruit known as Kinnow, which is a mandarin hybrid with a high yield. Kinnow is a crop that is well recognized for its high nutritional value and economic significance, and it makes a significant contribution to the agricultural economy. This research is to investigate the impact of agricultural techniques on the production of Kinnow as well as the quality of the product after harvest, with the goal of solving the problems that farmers in the area are now facing. Kinnow is a hybrid citrus fruit that is recognized for its juicy, tangy taste as well as its high nutritional content. It is a product of the cross between Citrus nobilis and Citrus deliciosa. When it comes to the agricultural economy, this fruit is a big contributor in many parts of India, notably in the area of Western Uttar Pradesh. The climatic conditions and rich alluvial soil of this region are ideal for the growth of kinnow, which is why it is the most popular option among the farmers in this area. Over the course of the last several years, it has been more apparent that improving agricultural techniques in order to improve both the product's output and its quality has become

increasingly important. In light of the growing demand for high-quality fruits in both local and international markets, there is an urgent need to concentrate on methods that not only bring about an increase in output but also ensure that the quality of the fruits after harvest is preserved. The purpose of this research is to evaluate the impact of different agricultural techniques on these characteristics, with the goal of generating insights that may assist farmers in improving their production systems.

Objectives

The primary objectives of this study are:

1. To evaluate the impact of soil health on Kinnow production and quality.
2. To compare the efficiency of different irrigation practices.
3. To assess the effectiveness of various pest control methods, with a particular focus on integrated pest management (IPM).
4. To examine the influence of post-harvest handling techniques on fruit quality and shelf life.

Importance of Soil Health

Establishing and maintaining healthy soil is essential to the cultivation of Kinnow. It is important to note that the development and yield of citrus trees are highly impacted by the physical, chemical, and biological characteristics of the soil. There are a number of important soil factors that play a significant influence in determining the health and production of Kinnow orchards. These parameters include pH, nutrient content (particularly nitrogen, phosphorus, and potassium), and organic matter. Previous studies have shown that ensuring that the pH of the soil remains at its ideal range (between 6.0 and 7.0) and that enough amounts of necessary nutrients are present may considerably improve the quality of citrus fruits and improve their output. For example, nitrogen is essential for the growth of the plant's vegetative tissue, phosphorus is necessary for the development of the plant's roots and the fruiting process, and potassium is essential for the general health of the plant and the quality of the fruit. Within the scope of this research, we will investigate the unique soil needs for Kinnow, as well as the ways in which departures from these ideal circumstances impact the results of production.

Irrigation Practices

A further essential component of kinnow farming is the control of water management. For the purpose of maximizing water use, it is vital to implement irrigation techniques that are efficient, particularly in areas where water resources are limited. Traditional flood irrigation techniques, despite their widespread use, often constitute a large amount of water waste and have the potential to result in problems such as waterlogging and nutrient leaching. Drip irrigation systems, on the other hand, have been shown to improve water usage efficiency by delivering water directly to the root zone and so minimizing the amount of water that is lost due to evaporation. This strategy not only helps to save water but also enhances the development of plants and the amount of fruit they produce. This research endeavors to discover which of these two irrigation methods is the most efficient method of water management for Kinnow orchards located in Western Uttar Pradesh by comparing and contrasting the two methods.

Pest Control Methods

The production of Kinnow has significant problems from pests and illnesses, which have an impact on both the output and the quality of the fruit. IPM, which stands for integrated pest management, is a holistic strategy that integrates biological, cultural, mechanical, and chemical means to control pests in a way that is both ecologically and economically sustainable. It is possible to drastically decrease pest populations and limit damage to crops by the use of integrated pest management (IPM) measures. These activities include the utilization of biological control agents (for example, predatory insects and neem oil), cultural practices (for example, crop rotation and sanitation), and the targeting of

chemical pesticides. When it comes to the management of insect-related difficulties in Kinnow orchards, this research will evaluate the efficiency of integrated pest management (IPM) in comparison to standard chemical control approaches.

Post-Harvest Handling

To ensure that the quality of Kinnow fruits is preserved and that they have a longer shelf life, post-harvest treatment methods are very necessary. Keeping the nutritional content and taste intact, preventing physical damage, and reducing the amount of spoilage may be accomplished by proper sorting, grading, packing, and storage conditions. Handling that is not done correctly during and after harvesting may result in large post-harvest losses, which in turn reduces the economic benefits that farmers get. It is possible to retain the quality of fruit by using methods such as utilizing ventilated crates, ensuring that storage temperatures are kept at a low level, and reducing handling. During the course of this research project, we will investigate the influence that various post-harvest handling procedures have on the quality and marketability of Kinnow fruits.

Review of the Literature

Citrus production benefits from maintaining healthy soil, efficient irrigation, pest control, and proper post-harvest management. Nutrient and pH levels in soil are crucial for fruit quality, as highlighted by Ahmed and Ahmad (2019), who found that balanced nutrient management significantly improves citrus yield and quality. Drip irrigation, compared to flood irrigation, enhances water use efficiency and fruit quality, with Choudhary and Sharma (2020) reporting a 20% increase in output. Integrated pest management (IPM), which includes biological agents and selective chemical pesticides, reduces pest damage and promotes sustainable orchard health, as shown by Gupta and Singh (2018).

Post-harvest handling, such as using ventilated crates and cold storage, minimizes losses and extends shelf life, according to Patel and Kumar (2021). Economic analyses by Singh and Verma (2017) indicate that despite higher initial costs, practices like drip irrigation and IPM offer significant long-term economic benefits due to increased yields and reduced losses. Kumar and Dubey (2020) emphasized the limitations of chemical pest control and the benefits of IPM for sustainable pest management.

Reddy and Singh (2018) demonstrated that incorporating organic matter into soil improves structure, nutrient availability, and microbial activity, leading to better plant health and fruit quality. These integrated agricultural practices are essential for sustainable citrus production, enhancing both yield and quality while promoting environmental responsibility.

Methodology

Data will be collected from thirty Kinnow orchards located throughout the Western Uttar Pradesh area throughout the course of two growing seasons (2021-2022 and 2022-2023) in order to accomplish the goals of the study. For the purpose of gathering complete information on soil health, irrigation practices, pest control measures, and post-harvest handling procedures, field experiments and surveys will be carried out. A pH test, a nutrient content analysis, and an organic matter analysis will be performed on soil samples. A comparison will be made between the effectiveness of drip irrigation systems and the more conventional flood irrigation systems. For the purpose of determining the influence that post-harvest handling procedures have on fruit quality and shelf life, an evaluation will be conducted to determine how successful integrated pest management tactics are.

Study Area

Specifically, the research was carried out in the Western Uttar Pradesh area, which is distinguished by its subtropical temperature and excellent alluvial soil, making it a suitable location for the growth of Kinnow.

Data Collection

Over the course of two growth seasons (2021-2022 and 2022-2023), data was collected from thirty different Kinnow orchards located around the area. For the purpose of gathering information on soil health, irrigation practices, pest control measures, and post-harvest handling procedures, field experiments and surveys as well as other approaches were utilized. Samples of soil were examined to determine their pH, nutrient content (nitrogen, phosphorus, and potassium), and organic matter content.

Irrigation Methods

The research compared the effectiveness of drip irrigation systems to the more conventional flood irrigation method in terms of the amount of water used and the effect it had on the amount of fruit produced.

Pest Control Methods

It was determined whether or not the techniques of integrated pest management (IPM), which include cultural practices, chemical pesticides, and biological control, were effective.

Post-Harvest Handling

Various post-harvest handling practices, including as sorting, grading, packing, and storage conditions, were evaluated to determine the extent to which they influenced the quality of the fruit.

Results

To get a good yield and quality of Kinnow, it is essential to have optimal soil health, which includes a pH range of 6.0 to 7.0 and suitable quantities of nitrogen, phosphate, and potassium. The importance of maintaining ideal soil conditions for effective citrus agriculture is shown by the fact that orchards that used balanced nutrient management strategies reported a 15% increase in output in comparison to those that had nutrient shortages. It has been discovered that drip irrigation is substantially more effective than the more conventional flood irrigation method when it comes to irrigation techniques. The efficiency with which water was used was enhanced, and as a result, the amount of fruit produced increased by twenty percent. Additionally, drip irrigation was a preferable form of watering for Kinnow orchards since it helped to the production of fruits that were of a greater quality and of a larger size.

A thirty percent reduction in the number of pest infestations was seen when Integrated Pest Management (IPM) strategies were added into pest control approaches. This was in comparison to the use of chemical treatment alone. This resulted to plants that were healthier and fruits that were of greater grade. Biological control agents, such as Trichogramma and neem oil, were particularly efficient in controlling pest populations at manageable levels without the detrimental effects that are associated with chemical pesticides. These agents played a significant role in the process. However, post-harvest management practices were shown to have considerable influence on the quality of Kinnow fruit as well as its marketability. Post-harvest losses were cut by twenty-five percent thanks to the utilization of vented crates and cold storage, which also helped to preserve the quality of the fruit and prolong its shelf life by as much as two weeks. Growers will ultimately benefit from improved economic returns as a result of these methods, which are vital for avoiding losses and ensuring that fruits continue to be fresh and appealing to customers for extended periods of time.

Table 1: Soil Health Analysis

Parameter	Optimal Range	Average Value (Sample A)	Average Value (Sample B)	% Deviation from Optimal
Ph	6.0-7.0	6.8	5.9	+13.3%, -1.7%
Nitrogen (N)	50-100 mg/kg	85 mg/kg	40 mg/kg	+15%, -20%
Phosphorus (P)	15-30 mg/kg	25 mg/kg	10 mg/kg	+16.7%, -33.3%
Potassium (K)	100-200 mg/kg	150 mg/kg	80 mg/kg	+25%, -20%
Organic Matter	>3%	3.5%	2.5%	+16.7%, -16.7%

The soil health study that is shown in Table 1 offers essential insights into the circumstances that are impacting the cultivation of kinnow in Western Uttar Pradesh. Since pH levels are a fundamental indication of soil acidity, they are extremely important since they have an effect on the availability of nutrients and the overall health of plants. Sample A, which has a pH of 6.8, is located comfortably within the ideal range of 6.0-7.0, which indicates that the conditions under which Kinnow can flourish are good. In comparison, Sample B has a pH of 5.9, which is somewhat lower than the range that is considered to be ideal. It is possible that the plants' ability to absorb nutrients would be hindered by this minor acidity, which will have an effect on their development and overall output.

In citrus trees, the levels of nitrogen (N) in the soil are very necessary for the development of both the vegetative and fruiting stages. When compared to the specified range of 50-100 mg/kg, Sample A has a nitrogen level of 85 mg/kg, which falls within the acceptable range. This suggests that there is sufficient availability of nutrients to enable the growth of healthy foliage and fruiting. In contrast, Sample B achieves a nitrogen concentration of 40 mg/kg, which is lower than the range that is considered to be ideal. It is possible that this deficit will result in lower yields and stunted development if it is not supplied in the suitable manner.

Phosphorus (P) is an essential element for the development of citrus trees' roots and the production of their fruits. The ideal range for phosphorus level is between 15 to 30 mg/kg, and Sample A has a phosphorus content of 25 mg/kg, which is sufficient to sustain vigorous root development and blooming. In comparison, Sample B had a phosphorus level of 10 mg/kg, which is much lower than the range that is considered to be ideal. Due to this deficit, root growth and general plant vigor may be hindered, which may have an impact on both the quantity and the quality of the fruit.

Potassium (K) is essential for the general health of plants, including their resistance to disease and the quality of their fruits. A potassium concentration of 150 mg/kg is found in Sample A, which is within the acceptable range of 100-200 mg/kg for potassium content. The presence of this sufficient potassium supply helps to maintain a robust plant metabolism and improves the quality of the fruit. The potassium concentration in Sample B is 80 mg/kg, which is slightly below the ideal range. This might potentially compromise the health of the plant as well as the growth of the fruit.

The amount of organic matter present in the soil is necessary for the structure of the soil, the retention of water, and the cycling of nutrients. Sample A has a level of organic matter that is 3.5%, which is somewhat more than the threshold of 3% that is considered ideal. Because of this larger organic matter content, soil fertility and microbial activity are increased, which in turn supports the development of crops in a sustainable manner. In comparison, Sample B has a composition of organic matter that is 2.5%, which is lower than the threshold that is considered optimum. Because of this decreased organic matter content, the fertility of the soil and the availability of nutrients may decrease over time, which is why organic amendments are required to improve the health of the soil.

Table 2: Comparison of Irrigation Practices

Practice	Water Use Efficiency (L/Tree/Season)	Average Yield (kg/Tree)	Fruit Size (cm)	Fruit Quality Rating (1-10)
Flood Irrigation	1000	50	7.0	7
Drip Irrigation	700	60	8.0	8

When it comes to the production of Kinnow, the comparison between flood irrigation and drip irrigation indicates substantial variations in terms of water usage efficiency, yield, fruit size, and fruit quality rating. The use of flood irrigation, which requires one thousand liters of water per tree every season, results in an average output of fifty kilograms per tree, with fruits measuring seven centimeters in diameter and a quality rating of seven. On the other hand, drip irrigation uses 700 liters of water per tree every season, but it results in a 20% greater output of 60 kilograms per tree rather than the traditional method of watering. Furthermore, fruits that are produced with drip irrigation are noticeably bigger, measuring 8.0 centimeters in diameter, and have a better quality rating of 8. This illustrates that drip irrigation not only helps to conserve water but also improves productivity and fruit quality, making it a more efficient and effective technique of irrigation for Kinnow orchards as it increases both output and fruit quality.

Table 3: Effectiveness of Pest Control Methods

Method	Pest Infestation Reduction (%)	Average Yield (kg/Tree)	Fruit Quality Rating (1-10)
Chemical Control	20	50	6
Integrated Pest Management (IPM)	30	55	8
Biological Control	25	52	7

In Kinnow orchards, the effectiveness of various pest management approaches, including chemical control, Integrated Pest Management (IPM), and biological control, demonstrates variable influences on the infestation of pests, productivity, and the quality of the fruit. The application of chemical management leads to a reduction in pest infestation by twenty percent, which in turn results in an average yield of fifty kilograms per tree and a fruit quality rating of six. In contrast, integrated pest management (IPM) and biological control strategies are more successful, producing decreases in pest infestation of thirty percent and twenty-five percent, respectively. When compared to biological treatment, this results in considerably higher fruit quality ratings of 8 and 7, respectively, and higher average yields of 55 kg and 52 kg per tree for integrated pest management and biological control, respectively. The findings highlight the benefits of using integrated and biological pest control measures in order to decrease the damage caused by pests during the cultivation of Kinnow fruits while preserving their excellent quality.

Table 4: Post-Harvest Handling Techniques

Technique	Post-Harvest Losses (%)	Shelf Life (Days)	Average Fruit Weight (g)	Fruit Quality Rating (1-10)
Traditional Handling	20	10	150	6
Ventilated Crates	15	12	160	7
Cool Storage	10	14	165	8

The examination of post-harvest handling strategies, including vented boxes, cold storage, and traditional handling, indicates the influence that these procedures have on post-harvest losses, shelf life, average fruit weight, and fruit quality rating for Kinnow fruits. The traditional method of handling resulted in post-harvest losses of twenty percent, a shelf life of

ten days, an average weight of one hundred fifty grams for the fruit, and a quality grade of six for the fruit. The post-harvest losses are reduced by fifteen percent, the shelf life is extended to twelve days, the average weight of the fruit is increased to one hundred sixty grams, and the quality of the fruit is improved to a rating of seven. The quality of these measurements is further improved by the use of cool storage, which reduces losses to ten percent, extends the shelf life to fourteen days, increases the average weight of the fruit to 165 grams, and achieves the maximum possible quality rating of eight. These results show the need of implementing modern post-harvest handling practices such as vented crates and cold storage in order to reduce losses and retain better fruit quality. This will ultimately result in increased marketability and economic returns for farmers of Kinnow.

Table 5: Economic Analysis of Agricultural Practices

Practice	Initial Cost (INR/ha)	Annual Return (INR/ha)	Cost-Benefit Ratio
Traditional Practices	20,000	50,000	2.5
Drip Irrigation	40,000	70,000	1.75
Integrated Pest Management (IPM)	30,000	65,000	2.17
Improved Post-Harvest Handling	25,000	60,000	2.4

A comparison of the starting costs, yearly returns, and cost-benefit ratios of various agricultural approaches for the production of kinnow is made in the economic analysis. The figures are expressed in Indian Rupees per hectare. Due to the fact that traditional procedures demand an initial investment of 20,000 Indian Rupees (INR), but provide an annual return of 50,000 INR, the cost-benefit ratio for these activities is 2.5. Although drip irrigation and integrated pest management (IPM) have greater starting expenses of 40,000 INR and 30,000 INR, respectively, as well as higher annual returns of 70,000 INR and 65,000 INR, respectively, the cost-benefit ratios for these two methods are 1.75 and 2.17, respectively. With an initial expenditure of 25,000 Indian Rupees, improved post-harvest processing not only delivers a high yearly return of 60,000 Indian Rupees but also has a cost-benefit ratio of 2.4.

This results in economic losses of ten thousand Indian rupees per hectare. Citrus canker, which has a prevalence of twenty percent, is reduced by forty percent with chemical control and by sixty percent through integrated pest management, resulting in losses of eight thousand Indian rupees. Fruit flies, which are widespread at a rate of 25%, are handled with an effectiveness of 60% through chemical control and 80% with integrated pest management, resulting in losses of 12,000 Indian Rupees. The relevance of integrated pest control measures in avoiding economic losses and maintaining the health of Kinnow orchards is highlighted by these findings.

Table 6: Challenges in Pest Management

Pest Type	Prevalence (%)	Chemical Control Effectiveness (%)	IPM Effectiveness (%)	Economic Loss (INR/ha)
Aphids	30	50	70	10,000
Citrus Canker	20	40	60	8,000
Fruit Flies	25	60	80	12,000

Aphids, citrus canker, and fruit flies are the most common pests that are found in Kinnow agriculture. The table provides information regarding the efficiency of chemical control and integrated pest management techniques in managing these pests, as well as the economic losses that have been suffered. Aphids have a prevalence rate of thirty percent, and

chemical treatment may successfully reduce infestations by fifty percent and integrated pest management by seventy percent.

Table 7: Role of Organic Matter in Soil Health

Parameter	Without Organic Matter	With Organic Matter	% Improvement
Soil pH	5.8	6.5	12.1%
Nitrogen (N) (mg/kg)	45	90	100%
Phosphorus (P) (mg/kg)	12	25	108.3%
Potassium (K) (mg/kg)	70	140	100%
Organic Matter (%)	2.0	3.5	75%

This table provides an analysis of the influence that organic matter has on a variety of soil health metrics that are essential for the production of kinnow. In the absence of organic matter, the pH of the soil is 5.8, the levels of nitrogen are 45 mg/kg, the levels of phosphorus are 12 mg/kg, the levels of potassium are 70 mg/kg, and the organic matter content is 2.0%. After the incorporation of organic matter, the pH of the soil rises to 6.5, the levels of nitrogen rise to 90 mg/kg, the levels of phosphorus rise to 25 mg/kg, the levels of potassium rise to 140 mg/kg, and the organic matter content rises to 3.5%. Consequently, this results in a 12.1% increase in pH, a 100% increase in nitrogen, 108.3% increase in phosphorus, 100% increase in potassium, and 75% increase in the amount of organic matter. Organic matter has been shown to greatly improve soil fertility, nutrient availability, and general soil health, which in turn contributes to enhanced Kinnow growth, yield, and fruit quality. This is demonstrated by the statistics. When it comes to achieving sustainable soil management and improving agricultural production in Kinnow orchards, the incorporation of organic amendments is very necessary.

Discussion

The study provides a comprehensive analysis of the factors affecting Kinnow citrus cultivation in Western Uttar Pradesh, detailed across seven key tables. Table 1 underscores the importance of maintaining optimal pH and nutrient levels for maximizing crop yield and quality. Sample A's balanced soil conditions highlight the ideal environment for robust orchard growth, while Sample B's variations indicate potential productivity constraints, emphasizing the need for precise soil management strategies to ensure sustainable citrus production. Tables 2 through 4 offer critical insights into irrigation strategies, pest control measures, and post-harvest handling techniques. Drip irrigation, as shown in Table 2, outperforms flood irrigation with greater water use efficiency, higher yields, larger fruit sizes, and improved quality. Table 3 demonstrates that Integrated Pest Management (IPM) and biological controls are more effective than conventional chemical treatments in reducing pests and maintaining fruit quality. Table 4 highlights that advanced post-harvest handling techniques, such as vented boxes and cold storage, significantly reduce losses, extend shelf life, and enhance fruit quality, boosting market readiness and economic returns. Overall, the findings advocate for the adoption of integrated agricultural practices in Kinnow farming. Effective irrigation, balanced fertilization, proper pest control, and advanced post-harvest handling can markedly improve both production and fruit quality. Implementing these methods could lead to better economic outcomes and increased sustainability for Kinnow producers in the region.

Conclusion

This study highlights the necessity of integrated agricultural methods for maximizing Kinnow production and maintaining high post-harvest quality in Western Uttar Pradesh. By evaluating soil health, irrigation practices, pest management methods, and post-harvest handling procedures, the research provides comprehensive insights into enhancing both yield and fruit quality. The findings reveal that drip irrigation is more effective than traditional

flood systems, improving water use efficiency and positively impacting production and fruit characteristics. Integrated Pest Management (IPM) and biological control strategies are shown to be more effective than chemical treatments in reducing insect infestations and preserving fruit quality. Post-harvest techniques, such as using vented crates and cold storage, significantly reduce losses and extend shelf life, thus enhancing the marketability and economic value of Kinnow fruits. Despite higher initial costs, economic analysis supports the adoption of modern techniques due to their superior long-term returns and sustainability. The study underscores the importance of balanced soil nutrients and organic matter for maintaining soil health and promoting sustainable crop growth. Future research should focus on the long-term effects of these practices and explore additional strategies to enhance the sustainability of Kinnow farming. The study aims to provide actionable recommendations to help local farmers achieve better economic outcomes and contribute to the overall sustainability of the agricultural sector. This ensures that Kinnow cultivation remains viable and productive despite environmental and economic challenges.

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