

Disease Management in Conventionally and High-Density Planted Kinnow

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Abstract

Kinnow is the leading citrus fruit with 55.47 thousand ha in terms of area and 1312.4 million tons in terms of production during 2019-20 in the state among citrus crops. The study was conducted in the sub-mountainous zone of Punjab and a total of 120 Kinnow growers were selected for the study. The study revealed that higher returns in high density due to various factors such as faster returns on investment, better spray coverage at lower cost and easier harvesting etc. as compared to the conventional spacing system was ranked first by the respondents as the reason behind preferring high-density planting kinnow cultivation with a mean score of 0.94. Further, it was also found that 10.8 per cent of the respondents applied recommended plant protection measures in high-density planting orchards to control citrus canker while For control of Gummosis/foot rot, in high density planting 14.2 percent of respondents administered recommended pesticides. Among cultural practices, it was found that the training and pruning method was followed by a majority (90.8%) of the respondents in densely planted orchards whereas in conventional planting method, it was adopted by all respondents

Keywords: Kinnow growers, Plant protection measures, Disease management

JEL Classification: Q10, Q15, Q55

Introduction

Fruits are a gift given by nature to humanity. Nutritionally fruits and vegetables have great importance as they are a prime source of nutrients like protein, minerals, carbohydrates (CHO), and vitamins, all of which are essential for human health. Amongst fruits, citrus crop is cultivated throughout the world and has properties like anti-tumor, anti-cancerous and anti-inflammatory due to phytochemicals and major nutrients present in them. Kinnow is the most dominant citrus fruit among these citrus crops in India. High-density planting comprises of densely planting small trees while controlling their vegetative growth through dwarfing rootstocks, bioregulators, or other horticultural techniques like pruning, channeling much of the plant's energy to the productive sections (Goswami *et al* 2014). The prevalent fruit crops cultivated in Punjab are citrus, guava, mango, litchi, peach, pear and ber. The total area under fruit cultivation in Punjab was 90.42 thousand ha with production of 19.72 lakh ton in 2019-20. Among these citrus crops, Kinnow is the leading citrus fruit with 55.47 thousand hectares in terms of the area and 13.29 lakh ton in terms of production during 2019-20 in the state (Anonymous 2020a).

The ever-increasing population in our country demands more production of fruits to fill the gap between the per capita availability and consumption. Diversification in intake habits and consumption patterns is noticed in India from the last few years. Changes in consumption patterns led to changes in cropping patterns. The economy of the country is moving from a supply-driven economy to demand-driven economy. According to Engel's law income of the people increases day by day, due to this economic growth food intake habits also shift from simple and stable food to -value food products. Consumption of milk products, fruits and vegetables increases at the highest rate day by day. To revive agriculture in our state, diversification in agriculture towards HVCs (High-value commodities) is the most encouraging and promoting strategy (Kumar 2012).

The diverse group of citrus fruits includes oranges, grapefruits, trifoliate orange, mandarins, pummelo, citranges, lemons etc which acts as the primary source of vitamins and mineral elements in addition to sugar thereby helping in metabolism as well as the building process of human bodies. Citrus crop is susceptible to many destructive diseases and pests which are continuously emerging and can severely hinder or completely decline the entire production. The most common diseases are Citrus Greening, Citrus Canker, Gummosis, Sooty Mould, Pink Disease, Powdery

Mildew, Citrus, Scab, Sooty Mould etc. Thyagarajan and Prabu (2005) reported that high cost of labour, wide price fluctuations, lack of knowledge about pests and diseases, lack of credit, insufficient water supply, exploitation by middlemen by charging a high rate of commission and brokerage were some of the major issues faced by the farmers.

Chetri *et al* 2019 reported that high-density planting can also help in countering citrus greening disease and Kumar (2003) suggested that education should be provided to respondents about inputs, identification of diseases and insect pests with training courses. Keeping this in mind the present study was planned with the objective to study plant protection measures followed for disease management in Kinnow cultivation.

Data Sources and Methodology

The study was conducted in the sub-mountainous zone of Punjab state. A list of Kinnow growers who were practicing high-density planting as well as conventional planting of Kinnow in the sub-mountainous zone of Punjab comprised of districts Hoshiarpur, Ropar, Nawanshahr, Gurdaspur, SAS Nagar, Mohali and Pathankot was obtained from the concerned Horticulture Development Officer of Department of Horticulture, Punjab. A compiled list of 795 Kinnow growers from all six districts of the sub-mountainous zone was obtained. A total of 127 Kinnow growers were selected from this list based on a probability proportionate to the number of Kinnow growers. Age of the orchard pertaining to selected respondents varied between 6-30 years in case of high-density planted (HDP) Kinnow and 4-22 years in the case of conventional planting. The data were personally

interviewing the respondents with the help of interview schedule in year 2020. Proper precautions were taken to avoid unbiased responses. Further data were analysed with the help of frequency and percentages.

Results and Discussion

Reasons Behind Preferring High Density Planting Over Conventional Planting System

As far as the reason behind preferring high-density planting over conventional planting system in Kinnow cultivation was concerned, the data depicted in Table 1 revealed that higher returns in high density due to various factors such as faster returns on investment, better spray coverage at lower cost and easier harvesting, etc. as compared to the conventional spacing system was ranked first by the respondents as the reason behind preferring high-density planting Kinnow cultivation with a mean score of 0.94, these findings were in line with the observations carried out by Phillips (1978), Nawajet *al* (2007), Pandey *et al* (2015) and Singh *et al* (2023). It was succeeded by higher yield per unit area which was obtained by accumulating more plants per unit area that lead to more overall yield per acre in the densely planted orchards with a mean score of 0.87 was ranked second and these findings were supported by Ram *et al* (2001) and Braret *al* (2009). Subsequently, better utilization of land and resources as compared to the conventional method was ranked third by the respondents with a mean score of 0.85. Jackson (1989) and Zekri (2000) also indicated that by planting more number of plants per acre, farmers gets comparatively more income during initial years in high density than traditional planting and early economic returns

Table 1: Distribution of the respondents according to the reasons behind the adoption of high-density planting over conventional planting system

S. No	Reasons	Number	%	Mean score	Rank
1.	Higher yield	104	86.6	0.87	2
2.	Induced precocity	61	50.8	0.51	7
3.	Early economic returns	100	83.3	0.83	4
4.	Lesser overall production cost	16	13.3	0.13	9
5.	Lesser labour requirement	7	5.8	0.6	13
6.	Ease of harvesting	74	61.6	0.62	6
7.	Easy to manage	81	67.5	0.67	5
8.	Better utilization of land and resources	102	85	0.85	3
9.	Higher returns	113	94.2	0.94	1
10.	Less incidences of diseases and pests	11	9.2	0.9	11
11.	Better fruit quality	13	10.8	0.11	10
12.	System automation	36	30	0.30	8
13.	Better utilization of sunlight	8	6.6	0.7	12

*Multiple response

were cited as the fourth major reason behind the adoption of high-density planting system by the respondents in this study with the mean score of 0.83. The Fifth major reason behind choosing high-density planting over conventional planting was ease to manage the orchard due to the small tree size as compared with a conventional method with a mean score of 0.67 similar findings were also reported by Lal *et al* (1996) and Pandey *et al* (2015). It was succeeded by the ease of harvesting with the mean score of 0.62 because trees are comparatively smaller in this method than in the traditional method of planting Kinnow.

The other reasons behind the adoption of Kinnow cultivation in descending order of importance were induced precocity in fruit bearing of Kinnow over the conventional method, system automation of various farm operations such as irrigation and fertigation or mechanical pruning in comparison to the conventional method and lesser Overall production cost in the densely planted orchard than conventional method were ranked seventh, eighth and ninth with a mean score of 0.51, 0.30 and 0.13 respectively. These results were mostly in conformity with the findings of Wheaton *et al* (1989), Dalviet *et al* (2010) and Dogaret *et al* (2017)

On the other hand, lesser labour requirement in densely planted Kinnow orchards over the conventional planting method was ranked last by the respondents with the mean score of only 0.6. While better utilization of sunlight and increased photosynthetic efficiency of plant was ranked second last by the respondents with the mean score of 0.7 and these results were in track with the findings of Braret *et al* (2009). Better fruit quality in high-density planting was ranked 10th with the mean score of 0.11 followed by fewer incidences of diseases and pests in HDP as compared to the conventional method with the mean score of 0.9 almost

similar trends were presented by Singh *et al* (2004) and Pandey *et al* (2015). It was concluded from this paragraph that because trees are planted at a close spacing in high-density planting method, due to which very less amount of sunlight reaches the various parts of plants, which ultimately leads to lesser aeration in the orchard, low photosynthesis and respiration in plants which further leads to the low quality of fruit in the densely planted orchard as compared to the widely spaced orchard in which tree vigour is better due to the wider spacing between trees. Trees planted at closer spacing also become more vulnerable to insect pests and disease

Plant Protection Measures Followed for Disease Management in Kinnow Cultivation

Majority of the respondents (7.5%) applied plant protection measures at the recommended time and only 5 percent of the respondents applied recommended doses followed by 4.2 percent of respondents who applied less than recommended doses and 1.7 percent applied more than recommended doses. Whereas in the conventional planting, it was reported by 42.9 percent of the respondents out of which 28.6 percent of respondents administered the suggested insecticides and all of the respondents administered recommended doses of insecticides. The results were supported by the findings of Hakim (1999), Kumar and Kumar (2020).

Infestation of Gummosis/Foot rot was observed by 19.2 percentage respondents in high density and by 14.3 percent in conventional planting Kinnow orchards. All conventional planting respondents applied recommended plant protection measures and 14.2 percent of respondents from high-density planting orchards administered suggested fungicides.

All the respondents followed the recommended time of

Table 2. Distribution of the respondents according to use of insecticides for disease management

Insect	f (%)		Recommended TOA		Dose							
	n=120		n=7		f (%)		HDP f (%)			CP f (%)		
	HDP	CP	HDP	CP	LR	R	MR	LR	R	MR		
1. Citrus Canker												
Recommended insecticide	13 (10.8)	2 (28.6)	9 (7.5)	2 (28.6)	5 (4.2)	6 (5)	2 (1.7)	-	2 (28.6)	-		
Non-recommended insecticide	7 (5.8)	1 (14.3)	-	-	-	-	-	-	-	-		
2. Gummosis/Foot Rot												
Recommended insecticide	17 (14.2)	1 (14.3)	15 (12.5)	1 (14.3)	-	17 (14.2)	-	-	1 (14.3)	-		
Non-recommended insecticide	6 (5)	-	-	-	-	-	-	-	-	-		

*TOA=Time of application, HDP:high density planting, CP=Conventional planting, LR=Less than recommended, R=Recommended, MR=More than recommended

application in conventional planting but in the densely planted orchards it was followed by 12.5 percent of respondents. Recommended doses of fungicides were exerted by all the respondents in both planting methods.

Dose of Recommended Pesticide Used for Disease Management

It can be noticed from Table 3 indicate that 10.8 percent of respondents in high-density planting applied the recommended fungicide to control Citrus canker *i.e.*, Streptocycline+Copper sulphate and Boudreaux mixture. For Streptocycline+Copper sulphate application about 4.2 percent of the respondents applied the dose as less than recommended followed by 2.5 percent and 1.6 percent of the respondents who applied recommended and more than recommended dose respectively. For Boudreaux mixture application about 2.5 percent of the respondents applied the dose as recommended. While in traditional planting 28.6 percent of the respondents applied the recommended fungicide to control Citrus canker *i.e.*, Streptocycline+Copper sulphate and all the respondents used less than recommended doses.

For control of Gummosis/foot rot, in high-density planting, 14.2 percent of respondents administered recommended pesticides *i.e.* Ridomil gold 68 WP, Alliet 80 WP, Sodium hypochlorite 5% and Bordeaux mixture. For Ridomil Gold 68 WP application 2.5 percent of the respondents applied recommended dose followed by 0.8 percent of the respondents who applied less than the recommended dose. For Alliet 80 WP application all the respondents followed recommended dose. For Sodium hypochlorite application all the respondents followed recommended dose. For the Bordeaux mixture application, all of the respondents followed recommended dose. Whereas in traditional planting, For control of Gummosis/foot rot,

only 14.3 respondents applied recommended pesticides *i.e.* Alliet 80 WP and also exerted the recommended doses for the control of gummosis.

Cultural Practices Followed in Kinnow Cultivation

A close examination of data in Table 4 affirmed that the training and pruning method was followed by the majority (90.8%) of the respondents in densely planted orchards whereas in the conventional planting method it was adopted by all respondents. All of the respondents who adhered to the training and pruning also followed the recommended time for training and pruning in both planting methods of Kinnow cultivation which was in the month of February and March.

Regarding harvesting method of Kinnow majority (58.3% in HDP and 71.4% in conventional planting) of the respondents used Kinnow clippers which is the recommended tools for the harvesting of Kinnow. Where 41.6 per cent in high density and 28.5 percent of respondents in traditional planting used secateurs, although secateurs are not recommended tools for harvesting of Kinnow. The results were compatible with the findings of Singh (2000).

Conclusion and Policy Implications

The higher and early economic returns, higher yield, better utilization of disease and resources from high-density planting in kinnow over conventional planting systems were the major reasons for its adoption. It was observed that citrus canker and gummosis/ foot rot are common diseases in Kinnow and to control these, most of the respondents administered recommended fungicide with the recommended dose. Most of the respondents applied recommended pesticides in high-density planting while for control of Gummosis/foot rot, few respondents applied recommended pesticides. Both high density and conventional plantation adopters did the training and pruning at recommended time and most of them used clippers and secateurs for harvesting. To summarize it

Table 3. Distribution of the respondents according to the dose of PAU recommended pesticides for disease management

Name of disease and pesticide used	Dose used	f (%)	
		HDP n=120	CP n=7
1. Citrus canker	Less than recommended (30-40g+25g/500L)	5(4.2)	2(28.6)
a. Streptocycline+Copper sulphate	Recommended (50g+25g/500L)	3(2.5)	-
	More than recommended (60-70g+ 25-30g/500L)	2(1.6)	-
b. Bordeaux mixture	Recommended (2:2:250)	3(2.5)	-
2. Gummosis/Foot rot	Less than recommended (10-20g/10L per plant)	1(0.8)	-
a. Ridomil Gold 68 WP	Recommended (25g/10L per plant)	3(2.5)	-
b. Alliet 80 WP	Recommended (2.5g/L)	2(1.6)	1(14.3)
c. Sodium Hypochlorite 5%	Recommended (50ml/10L per plant)	7(5.8)	-
d. Bordeaux mixture	Recommended (2:2:250)	4(3.3)	-

*HDP: high density planting, CP=Conventional planting,

Table 4. Distribution of the respondents according to the time and method for training and pruning

Training and pruning		High Density n=120		Conventional n=7	
		f	%	f	%
1	Followed	109	90.8	7	100
	Recommended time of training and pruning	109	90.8	7	100
Harvesting method					
1	Use of clippers (recommended)	70	58.3	5	71.4
2	Use of secateurs	50	41.6	2	28.5

can be said that farmers are preferring high density plantation of kinnow and managing the diseases using recommended practices. Further studies to validate the economic returns of high density plantation over conventional planting system should be conducted and high density plantation should be popularized among the kinnow growers using the appropriate extension strategies viz. success stories, field days, training programmes and exposure visits etc.

References

- Anonymous . 2020. *Package of practices for cultivation of fruits*. Pp. 1, 13-14. Punjab Agricultural University, Ludhiana. <https://www.pau.edu/publications>
- Brar J S and Singh S P 2009. Radiant energy distribution in guava (*Psidium Guajava*) plants at different spacings. *Journal of Agro meteorology* **11**: 135-39. <http://dx.doi.org/10.54386/jam.v11i2.1239>
- Chetri L B and Kandel B P 2019. Intensive fruit cultivation technology of citrus fruits: High density planting. *Journal of Agricultural Studies* **7**:63-74. <http://dx.doi.org/10.5296/jas.v7i1.14865>.
- Dalvi N V, Salvi B R, Chavan S A and Kandalkar M P 2010. High density planting in mango cv. Alphonso. *Journal of Horticultural Science* **5**: 117. <https://jhs.iahr.res.in/index.php/jhs/article/view/457>.
- Dogar W A, Khan A A, Ahmed S, Tariq S, Ahmad M, Imran M and Khan N 2017. Study to determine the effects of high density plantation on growth and yield of citrus. *SAR Journal of Agriculture* **33**: 315-19. <http://dx.doi.org/10.17582/journal.sja/2017/33.2.315.319>
- Goswami A K, Prakash J and Singh A K 2014. High density planting systems in tropical fruits. *HortFlora Research Spectrum* **3**:298-300. <https://hortflorajournal.com/AbstractInfo.aspx?ContentId=124>
- Jackson J E 1989. World-wide development of high density planting in research and practice. *Acta Horticulturae* **243**:17-27. <https://doi.org/10.17660/ActaHortic.1989.243.1>
- Jaouad M, Moinina A, Ezrari S, Lahlali R 2020. Key pests and diseases of citrus trees with emphasis on root rot diseases: An overview. *Moroccan Journal of Agricultural Science* **1**:149-60. https://www.researchgate.net/publication/340515634_The_key_pests_and_diseases_of_citrus_trees_with_emphasis_on_root_rot_diseases-An_overview/citations
- Kaur S, Kaur P and Kumar P 2020. Farmers' Knowledge of Soil Health Card and Constraints in its Use. *Indian Journal of Extension Education*. **56**:28-32. <https://acspublisher.com/journals/index.php/ijee/article/view/4484>
- Kumar R 2003. Adoption of cultivation practices by Kinnow growers of Sub-Mountainous Hoshiarpur district of Punjab. M.Sc. Thesis. Punjab Agricultural University, Ludhiana, India.
- Kumar P 2012. Impact study of the National Horticulture Mission scheme in Karnataka. Research report. Agricultural Development and Rural Transformation Centre Institute for Social and Economic change. Bangalore. Pp 1-20. <http://www.isec.ac.in/NHMS-Karnataka.pdf>
- Kumar A and Kumar P (2020) Chemical Control Measures Adopted by Kinnow Growers in Punjab. *Indian Journal of Extension Education*. **16**:489-95. DOI: <https://doi.org/10.35716/tsoed-2020/NS20-063>
- Nawaz M A, Ahmed W A Q A R, Iqbal M A and Khan M M 2007. Effect of different rootstocks on plant nutrient status and yield in Kinnow mandarin (*Citrus reticulata Blanco*). *Pakistan Journal of Botany* **39**:1779-86. [https://www.pakbs.org/pjbot/PDFs/39\(5\)/PJB39\(5\)1779.pdf](https://www.pakbs.org/pjbot/PDFs/39(5)/PJB39(5)1779.pdf)
- Oviasogie FE, Ogofure AG, Beshiru A, Ode JN, Omeje FI 2015. Assessment of fungal pathogens associated with orange spoilage. *African Journal of Microbiology Research* **1758-63**. <http://dx.doi.org/10.5897/AJMR2014.7246>
- Pandey S D, Kumar A, Patel R K, Rai R R and Nath V 2015. Influence of planting densities on plant growth, yield and quality of litchi cv. Shahi. *Ecoscan* **8**:397- 401. <https://www.semanticscholar.org/paper/INFLUENCE-OF-PLANTING-DENSITIES-ON-PLANT-GROWTH%2C-OF-Pandey-Kumar/db182e514c8e88732bb289b225429cc5ec4df7ad>
- Phillips R L 1978. Citrus tree spacing and size control. *Proceedings International Society of Citriculture* **1**:319-24. <https://ci.nii.ac.jp/naid/10019679483/>
- Ram S, Singh C P and Shukla P 2001. Effect of different planting densities on growth and yield of mango. *Indian Journal of*

- Horticulture* **58**:191-95. <https://www.indianjournals.com/ijor.aspx?target=ijor:ijh&volume=58&issue=3&article=001>
- Singh B 2000. Adoption of recommended practices by the peach growers of Amritsar district. M.Sc Thesis. Punjab Agricultural University, Ludhiana, India.
- Singh A and Dhaliwal G S 2004. Influence of radiation interception and canopy temperature on fruit quality of Sardar guava at different planting distances. *Indian Journal of Horticulture* **61**: 118-21. <https://www.indianjournals.com/ijor.aspx?target=ijor:ijh&volume=61&issue=2&article=004>
- Thyagarajan S and Prabu R 2005. Recommended technologies adopted by tomato growers. *Agricultural Extension Review* **17**: 26-30. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Thyagarajan+S+and+Prabu+R+%282005%29+Recommended+technologies+adopted+by+tomato+growers.+Agric+Ext+Rev+17%3A+26-30.&btnG=
- Zekri M 2000. Evaluation of orange trees budded on several rootstocks and planted at high density on flat woods soil. *Proceedings of Florida State Horticultural Society*. **113**:119-23. <https://journals.flvc.org/fshs/article/download/86366/83282>

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