



Plant Archives

Journal homepage: <http://www.plantarchives.org>DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.124>

EFFECTIVENESS OF DISEASE-FREE PLANTING MATERIALS OF CITRUS IN IMPROVING YIELD AND FARMERS' INCOME IN VIDARBHA REGION OF MAHARASHTRA, INDIA

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(Date of Receiving-08-01-2025; Date of Acceptance-10-03-2025)

ABSTRACT

While establishing a citrus orchard, the most crucial factor which should be taken into consideration is purchasing good quality, healthy, disease-free planting material. Often farmers tend to ignore this factor and then suffer economic loss. The study conducted with 300 farmers of Vidarbha region of Maharashtra, attempts to determine the significance of purchase of planting materials from certified nurseries which practice containerized disease-free planting material production technology like ICAR- ICAR- Central Citrus Research Institute, Nagpur which is a national pioneer in this aspect. The stepwise regression analysis of probable factors affecting citrus yield also revealed the source of purchase (X_2) as a significant contributing factor ($F=35.36$, $p<.0001$). The other significant factors were educational qualification (X_1) of the farmers ($F=26.34$, $p<.0001$), timely application of recommended doses of inputs (X_4 = $F=28.84$, $p<.0001$), contact with extension professional (X_3 = $F=10.53$, $p=0.0015$) and removal of dropped fruits from orchards (X_5 = $F=4.06$, $p=0.04$). An increase of Rs. 2,35,423.71/ha/yr in Nagpur mandarin, Rs. 40,000/ha/yr in sweet orange and Rs. 45,000/ha/yr was reported in 5-year period by farmers who purchased planting materials from CCRI. Overall, 85% farmers benefitted from the disease-free plants of the institute

Key words: Citrus, disease-free planting materials, yield, average annual income, Vidarbha, ICAR-CCRI

Introduction

As our country continues her march towards *Viksit Bharat*, the agenda of *Viksit Krishi* has a mammoth role to play in an agrarian developing economy like India. About 65% of our population are directly involved in agriculture and allied activities while 55% of the country's total workforce is engaged in this sector (PIB, 2023). Hence, increasing farmers' income is the prime goal of *Viksit Krishi* and this would be possible only through improved yield and productivity. In this context, India's horticulture sector has proven to be more profitable and productive than the agricultural sector and has emerged as a rapidly growing industry. Horticulture is considered more profitable than traditional agriculture in India as it contributes a significant portion of the agricultural GDP

while utilizing a smaller land area, making it a more lucrative option for farmers. Horticulture contributes around 30.4% to the Gross Domestic Product (GDP) while using only 13.1% of the gross cropped area. India ranks second in fruits and vegetable production in the world after China (Economic Times, 2023). The country's advantage lies in being a low-cost producer of fruits and vegetables because of a combination of factors such as favorable agro-climatic conditions, availability of labour and low input costs. As a result, fruits and vegetables account for almost 90% of the total horticulture production in the country (Economic Times, 2023). Amongst this, citrus is a widely cultivated fruit crop which has presence in almost all states of India. Starting from mandarins, sweet oranges, limes and lemons to grapefruits and

pummelos; citrus species present a nutritious and refreshing fruit platter to Indians throughout the year through its wide biodiversity.

Citrus cultivation in India spans across 11.00 lakh hectares, making it the third most cultivated fruit after mango and banana. The annual production of citrus is 14.65 million tons (MoAg & FW, GoI, 2023). Citrus is a perennial fruit crop and once planted, generally take 3-5 years to bear fruits. The productive age of citrus plants is approximately 20 years but with good care and management the plants have potential to bear fruits for 25 years and beyond. However, the key to a healthy long lasting citrus orchard is selection and plantation of good quality planting material.

The persistent problem of citrus growers of Vidarbha region of Maharashtra is lack of availability of good quality, or in other words, disease-free planting materials which has time and again emerged in field surveys and case studies (Bhattacharyya *et al.*, 2023). Farmers often end up purchasing from planting materials at low costs from private nurseries which often end up to be spurious and of low quality. These when planted grow into orchards of low productivity and remain susceptible to diseases and pests and decline at an early age. As a result, the farmers suffer economic loss. Citrus being a perennial crop, the damage is irreversible after plantation of low-quality plants. In this context, since 2001, ICAR- Central Citrus Research Institute, Nagpur is actively involved in sale of containerized disease-free planting materials of citrus at a rather no-profit no-loss basis to farmers throughout the country by establishing mother block and undertaking rigorous indexing and screening of virus and other pathogens in the planting materials developed. ICAR-CCRI nursery has been awarded “5 star” rating by National Horticulture Board. Till date the institute has distributed more than 50 lakh plants across the country wide and generated revenue of more than 15 crores. Orchards encompassing more than 18050 ha have been planted by disease-free plants of ICAR-CCRI. The institute has commercialized this technology by licensing it with 9 private nurseries.

Hence, a study was formulated at ICAR-CCRI to determine the degree of contribution of quality of planting materials towards yield of citrus. To validate results of this study, a trend analysis was done of the farmers who had purchased disease-free planting materials of citrus (Nagpur mandarin, sweet orange and acid lime cultivars) from ICAR-CCRI, Nagpur.

Material and Methods

Locale of Study

Nagpur, Amravati and Wardha districts which are

the popular citrus belts of Vidarbha region of Maharashtra were purposively selected for the study. These districts account for most of Nagpur mandarin production in the country by virtue of which Nagpur mandarin (*Citrus reticulata* Blanco) even received the GI tag in 2014. The Amravati and Nagpur districts of Maharashtra contribute about 80 per cent of the total area under mandarin orchards in Maharashtra state sharing 48.88 per cent and 31.45 per cent, respectively (Wankhede *et al.*, 2017).

Sampling Plan and Data Collection

A sample of 100 citrus growers was selected as respondents for the study through stratified random sampling method from each of the 3 districts thus making a total sample size of 300 farmers. The research design followed was *ex post facto*. Semi structured interview schedule was developed and data was collected through personal interview method.

Degree of contribution of quality of planting materials towards yield of citrus

For analyzing the degree of contribution of quality of planting materials towards yield of citrus, a list of independent variables like educational qualification of the farmers (X_1), source of planting material (X_2), contact with extension professional (X_3), timely application of recommended doses of inputs (fertilizer, water, insecticides and pesticides- X_4) and removal of dropped fruits (X_5) were selected after review of literature and pilot study. The dependent variable Y was productivity (kg/ha) of citrus. Here, the assumption was that source of purchase or the type of nursery was a determining factor that the planting material will be disease free or not. For example, ICAR-CCRI nursery which is NHB certified practices containerized nursery technology and viral, bacterial, fungal indexing which ensures the disease-free character before sale to farmers. Likewise other government nurseries and good private nurseries who are practicing containerized method are less likely to have diseased plants in their nursery. Hence, source of planting material was considered to be the litmus test for the quality of planting materials because in field survey there is no other option to determine quality of plants other than rigorous lab testings which are not feasible in social science studies.

Stepwise regression analysis was conducted in SAS 9.3 version in order to determine the variables (factors) that contributed significantly to citrus productivity (response variable). The stepwise regression analysis is an improvement of the forward selection procedure because it re-examines at every stage of the regression

Table 1: Summary of Stepwise Regression.

Step	Variable Entered	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	X2 (source of planting material)	1	0.1928	0.1928	78.2618	35.36	<.0001
2	X1 (educational qualification of the farmers)	2	0.1227	0.3155	46.1814	26.34	<.0001
3	X4 (timely application of recommended doses of inputs)	3	0.1129	0.4284	16.8116	28.84	<.0001
4	X3 (contact with extension professional)	4	0.0387	0.4671	8.0569	10.53	0.0015
5	X5 (removal of dropped fruits from orchards)	5	0.0146	0.4817	6.0000	4.06	0.0459

analysis of the variable introduced into the model in previous stages. This is to make sure that the variable that was the best previously is being determined whether it is still useful or not to the model with the introduction of other variables. The partial F criterion for each variable in the regression at any stage of calculation is evaluated and compared with a pre-selected percentage point of the appropriate F distribution. This provides a judgment on the contribution made by each variable as though it has been the most recent variable entered irrespective of its actual point of entry in the model. Any variable which provides a non-significant contribution is removed from the model (Udokang, 2020)

The stepwise regression procedures are as stated below:

- **Step I:** Compute the simple correlation of the independent variable X_k with response variable Y and select the independent variable that is highly correlated with the response variable. This is equivalent to the one with the largest F ratio.
- **Step II:** Test for the significant of the selected variable in the model. If it is significant then proceed to Step III.
- **Step III:** Compute the partial correlation of the variable not selected with response variable given that the selected variable is in the model and select the one with the largest partial correlation. This is the same thing as computing the partial F ratio and selecting the variable that has the largest partial F ratio value.
- **Step IV:** Test for significance of the model.
- **Step V:** Test for the significance of each of the variable in the model.
- **Step VI:** The process is repeated till when no variable can be removed and the best variable cannot be significant.

Trend in annual income based on source of planting materials

To supplement results of regression analysis, trends in citrus production and income generated from citrus cultivation were compared of farmers who had purchased

planting materials from CCRI with those who had purchased from private uncertified nurseries. The trend was mapped by comparing the average annual income of 300 farmers from citrus production in year 2018 (5 years ago) and year 2020 (3 years ago) as reported by the farmers growing Nagpur mandarin, sweet orange (*Citrus sinensis* (L.) Osbeck) and acid lime (*Citrus aurantifolia* L.).

Review of Farmers of ICAR-CCRI Planting Materials

The change in production and income of farmers who purchased disease-free planting materials from CCRI were reported through bar graphs using descriptive statistics of percentage. A positive change in production and income was considered to be a benefit, a zero change as no benefit and a negative change as loss after cultivation with ICAR-CCRI planting materials.

Results and Discussion

Contribution of source of planting materials and other factors to citrus production

Source of planting material (X_2) contributed most significantly to the yield of citrus (Table 1) which was evident through its largest F value (35.36) and the model was found to be significant at 1% level ($p < .0001$). This shows that the technology being used in nurseries in raising the plants plays an important role in determining the susceptibility of citrus plants to diseases and hence affects yield. Farmers who purchased plants from ICAR-CCRI and other certified government and private nurseries reported better yield than those who purchased from non-certified nurseries. The second significant factor was educational qualification of the farmers (X_1) which had F value of 26.34 and $p < .0001$. The educational backgrounds of farmers determined their awareness and adoption of new technologies through increased social participation. Timely application of recommended doses of inputs (X_4 = F value 28.84, $p < .0001$) and contact with extension professional (X_3 = F value 10.53, $p = 0.0015$) were other significant factors affecting yield. Also, removal of dropped fruits from orchards (X_5) though had the lowest F value (4.06) but still was significant at 5% level. Removal of dropped fruits reduces the spread of diseases and incidences of insect attack.

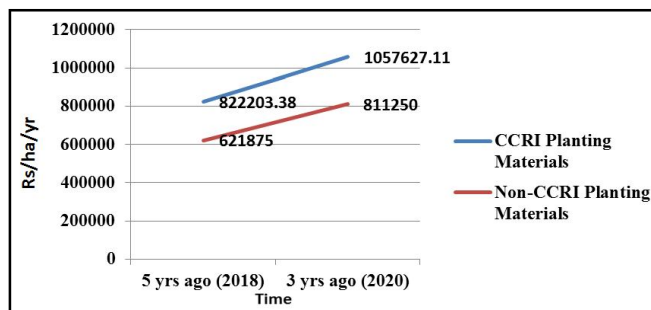


Fig. 1: Comparative trend in annual income generated from Nagpur mandarin orchards having CCRI and Non-CCRI planting materials over the past 5 years.

Trend in annual income based on source of planting materials

As already evident from Table 1 that purchase of planting material from certified nurseries play a significant role in determining the production of citrus, the disease-free planting materials of ICAR-CCRI had a major contribution to the containerized nursery technology popularization in India. Hence to supplement the results of regression analysis, the trend in annual income of citrus farmers who purchased plants from CCRI were mapped. The farmers who had purchased CCRI planting materials of Nagpur mandarin reported to obtain an average annual income of Rs. 8,22,203.39/ha/yr, 5 years ago which increased to Rs. 10,57,627.1/ha/yr, 3 years ago from the year of study. Those with non-CCRI planting materials reported a lesser average annual income of Rs. 62,1875/ha/yr, 5 years ago which increased to Rs. 81,1250/ha/yr, 3 years ago. So an increase of Rs. 2,35,423.71/ha/yr and Rs. 1,89,375/ha/yr was reported among both categories of farmers (Fig. 1).

The farmers who had purchased CCRI planting materials of sweet orange reported to obtain an average annual income of Rs. 1,60,000/ha/yr, 5 years ago which increased to Rs. 2,00,000/ha/yr, 3 years ago from the year of study. Though there was a decrease in production but due to rise in market prices of sweet orange, farmers

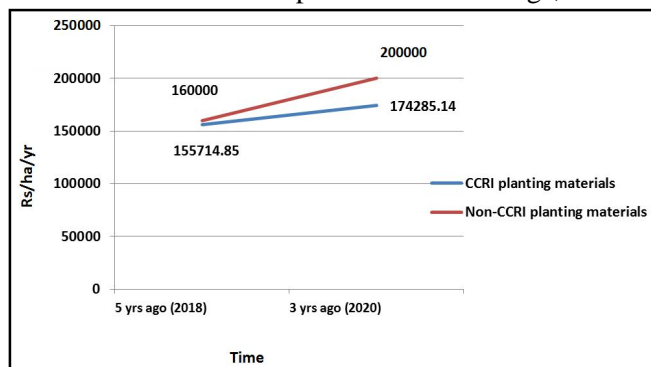


Fig. 2: Comparative trend in annual income generated from sweet orange orchards having CCRI and Non-CCRI planting materials over the past 5 years.

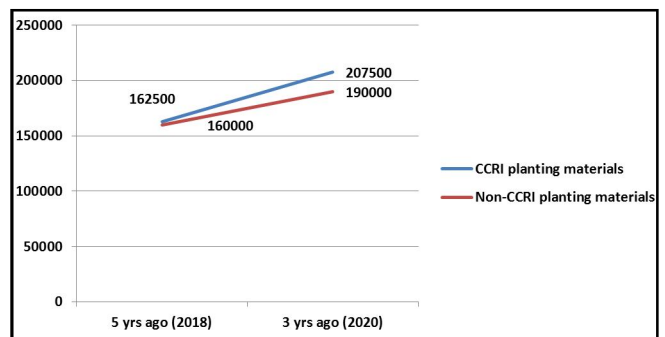


Fig. 3: Comparative trend in annual income generated from acid lime orchards having CCRI and Non-CCRI planting materials over the past 5 years.

had an increase in income. Those with non-CCRI planting materials reported a lesser average annual income of Rs. 1,55,714.85/ha/yr, 5 years ago which increased to Rs. 1,74,285.14/ha/yr, 3 years ago. So an increase of Rs. 40,000/ha/yr and Rs. 18,570.29/ha/yr was reported among both categories of farmers (Fig. 2). Hence it was revealed that CCRI sweet oranges due to better quality, lesser cost of cultivation involved in lesser incidence of pest and diseases, gave farmers better remuneration than those having non-CCRI plants.

The farmers who had purchased CCRI planting materials of acid lime reported to obtain an average annual income of Rs. 1,62,500/ha/yr, 5 years ago which increased to Rs. 2,07,500/ha/yr, 3 years ago from the year of study. Those with non-CCRI planting materials reported a lesser average annual income of Rs. 1,60,000/ha/yr, 5 years ago which increased to Rs. 1,90,000/ha/yr, 3 years ago. So an increase of Rs. 45,000/ha/yr and Rs. 3,00,000/ha/yr was reported among both categories of farmers (Fig. 3).

Review of farmers after using CCRI planting materials of various citrus cultivars

The farmers who had purchased CCRI planting materials of Nagpur mandarin, sweet orange and acid lime reported their reviews after planting the materials in their orchards. 85% of mandarin farmers reported that they benefitted in terms of production and income after

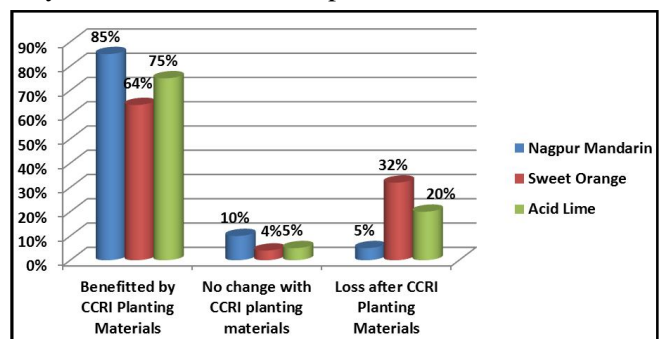


Fig. 4: Review of farmers after using CCRI planting materials of various citrus cultivars.

cultivating CCRI planting materials while 10% reported they experienced no change and 5% suffered loss. In case of sweet orange, 64% reported increase in production and income after cultivating CCRI plants but 4% experienced no change and 32% had suffered losses. In case of acid lime the beneficiaries were 75%, 5% with no change and 20% had reported losses (Fig. 4). The loss maybe due to several factors like not timely planting the saplings or improper management of the tender plants, drying or destruction of root system plants while travelling because farmers often travel by road from far off places to CCRI to purchase the plants.

Conclusion

While establishing a citrus orchard, the most crucial factor which should be taken into consideration is purchasing good quality, healthy, disease-free planting material. Often farmers tend to ignore this factor and enthusiastically venture into the cultivation. Once planted, the low bearing quality of plants is visible only after 5 years of planting and the irreversible damage has already been done as the crop is perennial. Hence, it is extremely crucial to purchase good quality planting materials from certified nurseries using containerized nursery technology. The productivity of disease-free plants purchased from ICAR-CCRI is 15t/ha as compared to plants of other uncertified nurseries and have an enhanced orchard life of 20-25 years as against the local nursery plants which last hardly 10-12 years (Bhattacharyya *et al.*, 2023). This technology is a boon to citrus growers who suffer from lack of availability of good quality planting materials. In this direction, Government of India launched the Atmanirbhar Clean Plant Programme (CPP) in the 2023-24 Union Budget which seeks to produce disease-free and superior planting material for esteemed horticultural crops with citrus being one. The programme proposed to start 10 "Clean Plant Centres" across India with ICAR-CCRI having one centre. Total budget allocation is Rs. 2,200 crores spread over a period of 7 years for the CPP (Kar, 2024). These centres will actively participate in research, diagnostics, and therapies, consequently enhancing the accessibility of certified planting material and diminishing the duration of quarantine periods. CPP

has the potential to enhance India's position in global horticultural industry through the improvement of quality and production of horticultural crops.

Acknowledgements

The authors acknowledge the physical and logistic support provided by ICAR-CCRI during data collection.

Conflict of Interest: The authors declare no conflict of interests

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