Evaluation of the certified citrus commercial seedlings distribution program for citrus fruit supply stability

L Mufidah*, A Sugiyatno, L Zamzami

1Indonesian Citrus and Subtropical Fruits Research Institute (ICSFRI), Raya Tlekung Street No.1, Batu, Indonesia

*E-mail: lyli.mufidah@gmail.com

Abstract. Nurseries belong to the upstream hierarchy in the production chain hence, play an integral role in sustainable food production. The Indonesian Citrus and Subtropical Fruits Research Institute (ICSFRI) between 2018 and 2020, distributed 296,297 certified citrus commercial seedlings for East and Central Java provinces. Meanwhile, an evaluation of the program showed that it is applicable as a reference to improve and forecast stability in citrus fruit supply. This study was conducted using descriptive and inferential statistics, meanwhile, a total of twenty citrus varieties were distributed. The main variety distributed in East and Central Java were tangerine cv Pontianak and mandarin cv Batu55 respectively, while three regencies in East Java and two in Central Java were sampled as the study locations, thereafter, a total of 73 beneficiary farmers were selected as respondents. The result showed that the death rate for distributed seedlings was relatively low, with the tangerine cv Pontianak indicating the highest death compared to mandarin cv Madura. This implies that the supply of tangerine and mandarin is expected to increase approximately by three thousand tons within the next two to three years. Besides this amount is predicted to constitute 3% of import in 2019. However, to actualize this, improvement in water availability, weather forecast, as well as farmer empowerment need to be considered to meet up with citrus supply, both in quantity and quality.

Keywords: certified citrus commercial seedlings, distribution program, empowerment programs, mapping, variety preferences

1. Background of the study

Citrus are the third most consumed fruit by Indonesians, with a per capita consumption of 3.60 kg/capita in 2016 [1]. Pusdatin (2016) projected that the demand for citrus is expected to rise by 3.73% in 2020, due to the increasing citrus production. Besides, previous data have shown that the main factor responsible for this growth is the expansion of land area. Notwithstanding, productivity is still developing at a slow pace [3]. A key element which affects citrus plant productivity is the provision of high-quality seeds. This is achieved by providing certified commercial citrus seedlings which have proven to possess high resistance to five systemic pathogens including CVPD (Citrus Vein Pl oem Degeneration), CTV (Citrus Tristeca Virus), CVEV (Vitrus Vein Enation Virus), CEV (Citrus Exocortis Viroid) and CPsV (Citrus Psorosis Virus) [4,5]. Moreover, high-quality seeds is crucial, especially during this pandemic period, to provide nutritious food that fulfills food safety standards [6,7].
The Indonesian Citrus and Subtropical Fruits Research Institute (ICSFRI) between 2018 and 2020, distributed 296,297 certified citrus commercial seedlings to East and Central Java provinces. One of the objectives was to mitigate the distribution of uncertified seeds which have proven to be the major cause of CVPD spread [8]. Therefore, an evaluation is required in these two areas, to ascertain variety diversity, seedlings performance, obstacles encountered, and empowerment programs. This evaluation is expected to serve as a reference for improving and forecasting the stability of citrus fruit supply in line with citrus production centers in the future.

2. Research Methods

2.1. Time and Place
This was a survey study, conducted from March to December 2019 at the recipient locations of the ICSFRI citrus seedlings program namely Tuban, Pacitan, Pamekasan in East Java, as well as Klaten and Pati in Central Java.

2.2. Data Collection
The convenient sampling technique was used for the respondents, meanwhile, the data used include primary such as, (1) ICSFRI data on the citrus seedlings’ distribution in East and Central Java, (2) Interview data obtained from 73 beneficiary farmers located in five regencies, namely Klaten, Pati, Tuban, Pacitan, and Pamekasan.

2.3. Data Analysis
Data analysis was performed using descriptive statistics and inferential tests (Mann Whitney and Kruskal-Wallis). The Mann Whitney and Kruskal-Wallis tests were selected after observing the normality of data distribution. Furthermore, the normality test was performed to examine whether the residual variable was normally distributed as indicated by a diagonal line with kolmogorov-smirnov (K-S). A significance level above 0.05 shows that the data is normally distributed, and vice versa.

The non-parametric inferential analysis with Mann-Whitney U-test was used to quantify variety differences, empowerment program, and plant age at the two locations. There was a significant difference when sig. < 0.05, and vice versa [9].

Also, the Kruskal-Wallis test, used for three or more sample data groups showed that k sample was from the same population [9]. Furthermore, sig. < 0.05 indicate significant differences and vice versa [10]. The statistical hypothesis was as follows:

\[ H = \frac{12}{N(N+1)} \left( \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1) \right) \]

Where:
\( K \) = population \( n_i \)
\( n_i \) = sample size i
\( I = 1,2,\ldots,k \)
\( N = n_1 + \ldots + n_k = \sum_{i=1}^{k} n_i \)
\( R_i \) = rank number for sample of i population
\( t \) = number of the same observation at certain rank
3. Results and Discussion

3.1. Diversity of variety

Based on the normality tests (Kolmogorov Smirnov) the citrus varieties at each point were not the same. The data for seedlings varieties at each distribution point in East Java were not normally distributed, whereas in Central Java, data were normally distributed. Due to the diversity between data group, the Mann-Whitney test was used to test the difference.

The test between seedlings varieties distributed at East and Central Java showed that there was a significant difference, where the mean rank value for Central Java was greater compared to East Java (Table 1). This implies that variety diversity at each distribution point was higher in Central Java. Each location in Central Java received an average of 3 varieties, while East Java received 2 different varieties.

Table 1. The Mann-Whitney test results for varieties distribution at each point in East and Central Java

| Number of varieties distribution at each location | N   | Mean Rank | Sum of Ranks |
|--------------------------------------------------|-----|-----------|--------------|
| East Java                                        | 75  | 43.37     | 3252.50      |
| Central Java                                     | 16  | 58.34     | 933.50       |

Parameter

\[ P \text{ value} = 0.031 \]

\[ \alpha = 0.05 \]

Out of the 23 citrus varieties distributed by ICSFRI, only 20 were distributed in East Java. The distribution is presented on a bar chart (Figure 1). Based the results, the most widely distributed citrus seed variety in East Java was tangerine cv. Pontianak, which amounted to 75.6 thousand seedlings, followed by mandarin cv. Batu 55 as well as mandarin cv. Madura. Whereas, in Central Java, ICSFRI distributed 17 varieties (Figure 1). Based on Figure 4 and 5, the most widely distributed seedling variety in this province was mandarin cv Batu 55, which amounted to 16.2 thousand seedlings, followed by tangerine cv Pontianak and orange cv Pacitan.

![Distribution of citrus seedlings in East and Central Java by variety](image)

**Figure 1.** Distribution of citrus seedlings in East and Central Java by variety
The result indicates that mandarin / tangerine usually for fresh consumption, are also a priority for cultivation by farmers in East (90%) and Central Java (85%). Whereas cultivations of other citrus groups were relatively small with orange 4%, lemon 1%, as well as pummelo 5% for East Java, and 14%, 0.2%, and 0.8% respectively for Central Java. This is reasonable given that the demand for this type was quite high, as observed in the import demand. In 2019, about 103.5 thousand tons of mandarin/tangerine were imported with a value of US$ 174 million (Central Bureau of Statistics, 2020). Furthermore, the result also showed that lime and kaffir lime were less desirable due to the lack of demand from these two areas. This situation requires a follow-up by introducing the potential of the existing citrus varieties, including lime and kaffir lime [11,12]. Moreover, Kaffir lime is usually exported to five European countries by exporters from Indonesia (Java Fresh).

3.2. *The performance of the seedlings*

From the evaluation results, 82% of the farmers stated that the quality of citrus seedlings received was good. This was indicated by the small percentage of dead seedlings (12%). In addition, the variety received were in accordance with the farmers' expectations (84.9%). Tangerine and mandarin were received by the 73 beneficiary farmers. Descriptively, tangerine cv Pontianak, mandarin cv Terigas, Batu 55, Tejakula, and tangerine cv Madu, had the highest number of dead seedlings while the lowest number of dead seedlings was of mandarin cv Madura (Table.2).

The age for the citrus plants in East and Central Java were not significantly different, meanwhile, the average age was 7 months. This is recommended as the reference for the local government in preparing marketing strategies in the next two to four years, as the citrus trees are matured enough to produce fruits at this point. Meanwhile, the price stability requires consideration during peak harvest season. Major citrus groups such as mandarin and tangerine with a total distribution of 263.4 thousand plants and average dead seedlings of 12%, had an initial production of 13 kg per tree in the first year, meanwhile, this value is estimated to hit three thousand tons and equal to 3% import value in 2019.

| Varieties                  | Dead Seedlings | N  | Mean Rank |
|----------------------------|----------------|----|-----------|
| Tangerine cv Pontianak     | 12             | 60.71 |
| Mandarin cv Terigas        | 31             | 42.58 |
| Mandarin cv Batu 55        | 1              | 39.50 |
| Mandarin cv Tejakula       | 10             | 26.45 |
| Tangerine cv Madu          | 15             | 18.83 |
| Mandarin cv Madura         | 4              | 16.50 |

Parameter

| Chi-Square = 37,660   |
| P value = 0.000       |
| α = 0.05             |

3.3. *Constraints faced by beneficiary farmers*

Sixty percent of the farmers experienced few difficulties in cultivating citrus, mainly in terms of water availability (52%), pest and disease (30%) as well as unpredictable weather (11%). Small percentages in terms of the correct way for cultivation (2%) and seedlings condition (1%). In Indonesia, water availability
in citrus cultivation was related to the weather, given that most of the farmers rely on water supply from rainfall. This culminated to farming practices such as proper irrigation management [13–16].

3.4. Empowerment programs
The citrus farmer group empowerment program in East Java was distinctive compared to that of Central Java which require optimization in form of assistance, institutions, and technological guidance by the local government (Table 3). Although, East Java has proven to be one of the citrus centers in Indonesia, however, both East and Central Java still needs improvement in terms of farmer empowerment [17,18]. Furthermore, technological assistance and adoption are often linked to field extension officers. It is undeniable that this extension agents are potentially positioned as a bridge for technology adoption [19–22]. Also, the empowerment of farmers and access to financial institutions promotes cultivation, considering that agriculture requires a lot of initial capital [22,23].

| Table 3. The Mann-Whitney test result for empowerment program in East and Central Java |
|-------------------------------------------------|-----------------|-----------------|
| Empowerment Programs                            | N    | Mean Rank | Sum of Ranks |
| East Java                                       | 45   | 42.88     | 1929.50       |
| Central Java                                    | 28   | 27.55     | 771.50        |

Parameter
P value = 0.000
α = 0.05

4. Conclusion
The citrus seedlings distribution program in East and Central Java is expected to meet the needs of farmers, and mitigate the circulation of uncertified citrus seedlings which has shown to be the major factor in the spread of CV PD/ Huanglongbing disease in Indonesia. Based on the results, variety diversity at each distribution location was higher in Central Java meanwhile, the two regions prioritized the cultivation of mandarin varieties. Furthermore, the quality of seedlings was consistent with the farmers expectations, both in terms of variety and the seedling mortality (12%). The empowerment program still needs to be improved, especially at Central Java as the farmers still face several obstacles in cultivating tangerine/mandarin due to the lack of water. The results imply that tangerine and mandarin supply is expected to increase to three thousand tons within the next two to three years and constitute 3% of import in 2019. However, water availability, weather forecast, as well as farmer empowerment needs to be improvement, to maintain citrus supply both in quantity and quality in line with the prediction.

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