
PAPER 4:

CITRUS VARIETY IMPROVEMENT PROGRAM IN INDONESIA : VARIETIES, PRODUCTION AND DISTRIBUTION VIRUSES FREE OF CITRUS NURSERY STOCKS

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ABSTRACT

Indonesia is rich in local citrus varieties that are mainly grouped into mandarin, tangerine, pummelo and other groups. The citrus variety improvement program was initiated in 1987 to produce virus-free propagation materials especially for the Huanglongbing (HLB), Citrus Tristeza Virus (CTV) and the Citrus Vein Enation Virus (CVeV). Activities consisted of the selection of mother trees, shoot-tip grafting and indexing, and technology improvement in production systems, distribution process and seed certification regulation; all with the ultimate aim of producing virus free citrus stocks. A typical process for the distribution of virus-free citrus propagation material in Indonesia can be described as follows: (i) Foundation Blocks where individual pots are planted in an insect proof screen house; (ii) Multiplication Blocks consist of densely planted bud-produced plants in an insect proof screen house; and (iii) Commercial Nursery Blocks produce labelled citrus nursery stocks in the fields. Despite the technical and regulatory issues faced in implementation, at present citrus Foundation Blocks have been established in 19 provinces, while Multiplication Blocks have been built at 29 provinces out of the total 34 provinces in Indonesia. Most nurserymen in Indonesia produce budded citrus trees in the field, while some new nurserymen have started to produce labelled citrus nursery stock in polybags. Good management practices combined with synchronized production of rootstock seedlings, and timely pruning at Multiplication Blocks are key for producing good quality citrus budsticks at the most appropriate time for budding. These strategies enable nurserymen to produce citrus stocks within one year. So far more than 10 million virus-free citrus stocks have been produced under this program.

Keywords: *Citrus* sp, variety, Huanglongbing (HLB), shoot-tip grafting (STG), foundation, block, multiplication blocks, certification program

INTRODUCTION

The citrus growing areas in Indonesia amounts to almost 70,000 ha, and production has been estimated to be around 1,500,000 tons. Harvesting seasons fall during the periods of January-April (19% of total national production); May-August (56% of total national production) and September-December (25% of total national production). Indonesia imports a lot of citrus especially mandarins from citrus producing countries such as China, Pakistan, Thailand, USA and at times from Argentina and South Africa. These imports reach less than 10 % of the national production.

In the 1980s, most citrus plantations in Indonesia were infected by the Huanglongbing (HLB), also known as the Citrus Vein Phloem Degeneration (CVPD) disease, which is caused by the *Liberibacter asiaticum* (Jagoueix et al.,1994) and transmitted by a vector known as the *Diaphorina citri* Kuw. The disease also infected material for propagation, reducing productivity to approximately 10tonnes/ha and significantly denting the citrus agribusiness in Indonesia. Despite the bleak outlook for the citrus industry due to the widespread effect of the disease,

citrus growers were eager to continue planting citrus trees because for economic reasons. Efforts to curb the spread of the disease in the past yielded unsatisfactory results. In 1987, the Indonesian Citrus Rehabilitation Program for production of virus-free citrus nursery stocks was initiated (Supriyanto & Whittle, 1992). By 1992, the program was successful in producing and distributing HLB and other virus-free citrus stocks in several places, notably in North Bali. The success of the program was then strengthened with the initiation of the Indonesian citrus certification program.

At present time, the Multiplication Blocks which serve as the primary source of scions for nurserymen have been established at 29 provinces out of the total 34 provinces of Indonesia. The establishment of country-wide Multiplication Blocks signify potential for the production of virus-free citrus stocks or labeled citrus stocks almost anywhere in Indonesia. Based on this system, more than 10 million virus-free citrus stocks have been produced in Indonesia, although the production of certified nursery stocks are still not enough to fulfill the national demands because of various reasons. Although the program was successful, the performance of citrus plantations again fluctuated due to the recommended technology was not implemented by citrus growers properly

Citrus agribusiness in Indonesia is located in more than 25 provinces mainly in the provinces of East Java, North Sumatera, West Kalimantan, West Sumatera and Bali. The citrus plantations are spread throughout varied agro-climatic conditions such as lowlands and highlands, dry and humid areas, and sometimes in swampy area. These areas host a wide range of varieties, and various forms of cultivation are often times practiced.

CITRUS VARIETIES

Indonesia is rich in local citrus varieties that can be grouped into mandarin, tangerine, pummelo and others including lime, lemon, *Citrus hystrix*. Almost 80% of the citrus production area at lowland were planted with tangerine cultivars Siam Pontianak, Banjar, Madu, Gunung Omeh and Kintamani. Those varieties have narrow different in morphological site except the rind color will be green and yellowish when planted at lowland while in the high land the color became yellow-orange. Mandarin group varieties were planted at high land area mainly with local variety e.g. Keprok Batu 55 are being become Indonesia mandarin because they are going to be planted in most provinces in this country. Gayo mandarin from Aceh with smooth texture of the flesh and the best mandarin of Soe come from West Timor-NTT (Figure 1) which have rind color of deeply orange-red because while during ripening at the area the temperature amplitude is relatively high caused by cool wind breezed from Australia continental. These mandarin of Tejakula, Madura and Borneo Prima have yellow-orange rind color although planted at lowland area. Pummelo such cultivar Nambangan grow well at lowland while planted at highland, the bitter taste will be appeared. Borneo lime were planted by citrus growers at the lowland area and even in East Kalimantan, growers planted the seedless lime at swampy area.



Figure 1. The Gayo or SoE mandarin, has been touted as the best mandarin variety in Indonesia from East Nusa Tenggara. The variety is commonly found in traditional markets

For the purpose of improving the citrus fruit quality in Indonesia and fulfilling the demand for seedless citrus fruits, a hybridization research program has been conducted through conventional breeding, irradiated gamma ray and fusion protoplasm at the Indonesian Citrus and Subtropical Fruits Research Institute (ICSFRI). A notable achievement of this research was the production of a seedless pummelo variety (Pamindo or Pamel Indonesia), and a mandarin variety (SoEIndo or SoE Indonesia) induced via gamma irradiation. Research in finding a citrus variety tolerant to HLB is still ongoing.



Figure 2. Pamindo (Pummelo of Indonesia) : A seedless new variety of pummelo induced by gamma ray irradiation

PRODUCTION OF VIRUSES FREE OF CITRUS MOTHER TREES

The rich citrus diversity in Indonesia and the increasing market demand for local citrus varieties create a necessity for all varieties that are distributed to citrus growers to follow a certification program. A labeled citrus nursery stock ensures that the citrus stocks are free from viruses, with true-to-type scions and rootstocks, and are in good condition to be delivered to citrus growers. Once a single desirable citrus tree is located in a particular area and identified as a new potential citrus variety, it is then sent to the Indonesian Citrus and Subtropical Fruit Research Institute (ICSFRI). The option of hybridization is also considered for the production of the new prior variety.

The plant materials of new prior of citrus varieties are cleaned from viruses such HLB, CTV, CVEV, CEC and CPsV by Shoot-tip Grafting (STG) based on protocols described by past studies (Murashige et al., 1972, Navaro et al., 1975; Triatminingsih et al., 1992 & Devy et al., 2015). For promotion of STG plantlet regrowth, re-grafting is performed onto 4-6 month old rootstock seedlings which are grown in an insect proof screen. After three to five months, the grafted plants are ready to be indexed. The absence or presence of pathogens are verified through indexing conducted using PCR, Elisa kit and citrus indicator plants for comparison (Muharam and Whittle, 1992; Devy et al., 2015).

Based on the research and experiences thus far, there is still need for improvement in several aspects in order to produce virus-free citrus mother trees. For shoot-tip grafting, the percentage of successful grafts varied depending on the varieties, with averages of 40-60% reached. Pummelo faces a high difficulty level in STG results due to the presence of trichome at its apical dome. However when successful, re-grafting percentages reached 60-90% for pumelo. A negative indexing result meant the plant is free from viruses or systemic pathogens. Subsequently, the plants are vegetatively propagated and maintained in an insect proof screen house as a mother plant source and indexed periodically.

DISTRIBUTION OF VIRUSES FREE OF CITRUS PROPAGATION MATERIAL

The distribution of virus-free citrus propagation materials from mother trees in ICSFRI to the citrus growers follows the path described (Supriyanto et al., 1992): Foundation Blocks – Multiplication Blocks – Citrus Nursery Blocks (Nurserymen) - Citrus Growers. This is then ensued by a certification program. Foundation Blocks house plants from mother trees in ICSFRI. The plants are grown in individual pots under insect proof screen house with indexing and true to type checks performed periodically in order to remove mutation sprouts. Multiplication Blocks

are where plants are grown in a high planting density of 50cm x 25 cm, under insect proof screen houses, and harvesting is done after 3-5 years. At the Citrus Nursery Blocks, plants are produced on the field or in the polybags following the regulations of the certification program. Once the process is complete, plants are ready for citrus growers who are entitled to receive premium certified nursery stocks, with specific varieties during the planting season.

Table 1 shows the distribution of viruses free of citrus propagation material via Foundation Blocks and Multiplication Blocks through nurserymen to the citrus growers in Indonesia. Foundation Blocks so far have been established in 19 provinces while Multiplication Blocks have been built at 29 provinces of 34 provinces existing in Indonesia. From those more than 10 million of viruses free of citrus nursery stocks has been distributed to the citrus growers in this country

Table 1. Distribution of viruses free of propagation planting material to Foundation Blocks and Multiplication blocks in Indonesia

Mark	Foundation Blocks	Multiplication Blocks
Number of provinces	19	29
Number of plants	786	43.713
Number of varieties :		
Mandarin	12	21
Tangerine	4	6
Pummelo	1	5
Others : lime, lemon	2	5

TECHNOLOGY RECOMMENDED

The mission to produce virus-free citrus nursery stocks or labeled citrus nursery stocks within one year (Hardiyanto et al., 2011; Supriyanto et al., 2017) is a priority of the institute, with daily activities being undertaken at the Experiment Garden of Punten – ICSFRI towards this. Research has been conducted to improve the technology for producing citrus budded trees. Polybags measuring in diameter x height of 10 cm x 30 cm, filled with sand as a big portion of mixed media are used. For monitoring purposes, it is of importance to remove yellow leaves from seedlings of 'Japansche citroen' rootstock and curving roots of seedlings. Most importantly is for the selection of nucellar seedlings, leaving out off – types (Andriani et al., 2013). This is usually conducted before transplanting of seedling to the polybags. Budding height is 20-25 cm above media surface. The key for the success in producing labeled citrus nursery stock within one year is synchronizing the scion harvesting time with the time when seedlings are ready to be budded. This recommended technology has been implemented in several provinces and widely adopted in East Nusa Tenggara (Supriyanto et al., 2015). Based on the experiences of the research team, the improved quality of the nursery stocks planted by citrus growers has led to better fruit quality especially in terms of fruit homogeneity (Supriyanto & Zamzami, 2014).

Once virus-free citrus stocks are planted in the field, the risk of being re-exposed and re-infected by vectors especially the HLB and CTV diseases increases. For maintaining the health and vigor of the new plants, citrus growers are advised to implement the Integrated Management for Citrus Healthy Orchard (IMCHO) technology package which consist of the following components: (1) Using virus-free citrus nursery stocks; (2) Vector control; (3) Eradication of infected trees; (4) An optimum maintenance; and (5) Consolidation of orchard management between growers in the Citrus Grower Group, and among Citrus Grower Groups under the Citrus Association in the area of citrus agribusiness (Supriyanto, 1996; Supriyanto et al., 2001; 2012).

ISSUES AND RECOMMENDATIONS

Twenty years of experience in producing virus-free citrus mother trees and distribution of the material propagation to almost all provinces in Indonesia have revealed various observations and issues that have to be addressed.

Issues include: (1) Existing Multiplication Blocks are not well maintained, leading to the insufficient number of scions produced. (2) It is a common complaint among Citrus nurserymen that they are unable to obtain the bud sticks during the budding period in a timely manner. The current practice is for bud sticks to be harvested in Multiplication Blocks selectively, instead of pruning all simultaneously. This creates an uncertain pattern in growth flush, reducing the production of bud sticks or scions. (3) Broken screens are not promptly repaired, leaving Multiplication Blocks in deplorable conditions, and causing healthy plants in the screen house to be infected by viruses through the introduction of vectors. (4) The limited number of bud sticks has led nurserymen to look elsewhere for another sources of scions of which the health status is unknown. (5) Many nurserymen still prefer prolonging the lifespan of plants grown in Multiplication Blocks under insect proof screen houses for 5 years instead of 3 years. (6) Many small-scale citrus nurserymen are finding it difficult to implement management practices recommended by citrus certification program.

Observations and recommendations include: (1) The success using the STG protocol is species and variety-specific, with each citrus species exhibiting different levels in success, hence protocols should be tailor-made accordingly; (2) The method of indexing has to be consistently improved; (3) Five years has been recommended as the optimal time to produce bud woods in multiplication blocks, instead of the current three years as suggested; (4) In order to increase the bud stick production from Multiplication Blocks, some form of training has to be conducted. Areas of training include Multiplication Block management, and enforcement of implementing the certification regulation program; and (5) Establishing an 'Indonesian Citrus Nursery Information System' to ensure all the activities of citrus nurserymen in this country are well coordinated.

CONCLUSION

Twenty years after the Citrus Variety Improvement Program started in Indonesia, more than 10 million virus-free citrus stocks have been produced and delivered to citrus growers throughout the whole country. Future research and activities are geared towards the improvement in management of Foundation Blocks and Multiplication Blocks; technology improvement to produce labeled citrus nursery stocks within one year; enforcement for the better implementation of the citrus certification program; as well as establishing the National Citrus Nursery Information System.

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