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Improving Productivity and Quality of Indonesian Mangosteen

R. Poerwanto, D. Efendi, Sobir and R. Suhartanto
Center for Tropical Fruit Studies
Bogor Agricultural University
Jl Pajajaran, Bogor 16143
Indonesia

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Abstract

Indonesia has numerous edible fruit species found over the archipelago. Some of fruit species have become commercial, but they have not been cultivated optimally; among of them is mangosteen (*Garcinia mangostana* L.). Mangosteen found in Indonesia over the archipelago, grows in compound garden and agro forestry-like garden, at lowland to up to 800 m above sea level. The production center of mangosteen is in western of Indonesia, including Sumatra, Java, Bali and West Nusa Tenggara. Mangosteen fruits are harvested all year long through archipelago. However, main harvesting season is September to April. Mangosteen production fluctuates from 30,000 to 70,000 tons a year, and high quality fruits are mostly exported. The fruits are exported to Taiwan, Singapore, Hong Kong, Malaysia, United Arab Emirate, Saudi Arabia, and Netherlands. The demand of mangosteen in world market has increased markedly. To meet the export demand, improvement of existing trees and development of new orchard should be conducted. Center for Tropical Fruit Studies of Bogor Agricultural University has been developing several approaches to improve existing trees and technology package to establish mangosteen orchard, which consists of (a) introducing new mangosteen clone 'Wanayasa', (b) improvement rooting system using *mycorhyza* and *Agrobacterium rhyzogenes*, (c) enhancement of tree growth using double-rootstock system, (d) cropping system, (e) irrigation and fertilization system, (f) trees husbandry, and (g) harvest and post-harvest technology. We are also conducting several researches on genetics variability identification and development, studies on cause of gamboges and methods to overcome the gamboges problem on fruits, developing non-destructive technology for detection of gamboges, and improving technique for prolonging shelf-life of fruits.

INTRODUCTION

Mangosteen, one of the best of tropical fruits, became Indonesian mainstay fruit with increasing international demands. Export of Indonesian mangosteen has been continuously increased from only 425 tons in 1991, 4,868,528 tons in 2001, and 9,304,511 tons in 2003 (Department of Agriculture, 2005). At present, mangosteen is regarded as the top fresh fruit export. Indonesian mangosteen is exported to Europe, Middle East and to traditional markets such as Taiwan, Hong Kong, and Singapore. However, increases in export have not been supported by increases in production and quality. Till this year, Indonesia is relying on backyard mangosteen or small holder grove without technological input for export increase. Investment on mangosteen orchard has not been made extensively, probably due to the long juvenility period of 8 to 15 years, low productivity, and gamboges problem of the fruit. Low productivity is mostly due to poor flowering and fruit set. Developing technology to improve productivity of the mangosteen orchard and the quality of the fruits are important for export increases as well as for domestic market with better quality fruits.

IMPROVEMENT OF EXISTING TREES

In Indonesia, mangosteen is cultivated in compound gardens in back yard and agroforestry-like gardens by small holder farmers. Productivity and fruit quality of this

garden are low. Converting 'Mangosteen Forest' to be 'Mangosteen Orchard' could increase productivity and percentage of export quality fruits. The first experiment and field trial was conducted on mangosteen orchards in Leuwiliang district of Bogor. Productivity of the tree has been increased from 5-20 kg/tree to 45-80 kg/tree and export quality fruit increased from 5% to 40%. The mangosteen forest conversion system has been adopted by Department of Agriculture for applying on other center of mangosteen production.

TECHNOLOGY FOR ORCHARD ESTABLISHMENT

A series of studies were conducted to improve technology for mangosteen orchard establishment. The studies consist of grafting technique, packaging of seedling distribution, improving root growth of young mangosteen, fertilization, shading, pruning, harvesting methods, and gamboges studies.

Improvement of Grafting Technique

The growth of grafted mangosteen is slow due to a problem in graft union. Anatomy difference between rootstock and scion cause the problem. The rootstock trunk is round with thin bark while scion twig is cylindrical with thick bark. Thus, when they are grafted, the cambium tissues of the rootstock and scion are not closely fused (Tirtawinata, 2003). To overcome this problem, our study found that grafting mangosteen on node is better than on internode. The trees grafted on node growth better than the trees grafted on internode (Sofiandi, 2006).

We found a new technique to improve the root system of mangosteen and enhance growth using a nursery stock plant technique. Giving an additional nursery stock plant to the mangosteen seedling provides the tree with a double root system. Nursery stock plant of *G. dulcis* and *G. fructicosa* on non-grafted seedlings enhanced seedling growth as much as twice compared to the seedlings without a nursery stock plant. Other experiments using mangosteen as the nursery stock plant of three types of seedling (non-grafted, grafted with juvenile scion, grafted with mature scion) showed that seedlings with a nursery stock plant grew better than seedlings without a nursery stock plant (Poerwanto, 2002).

Packaging for Seedling Distribution

Improved packaging for seedling distribution is needed to protect the seedlings, to make shipment easier, and to control seedling quality. Two main points needed to pay attention on distribution are growth medium and seedling transpiration. The best medium for seedling transportation is mix of soil:paddy hask charcoal:manure (Hutasoit, 2006). The research will continue to find lighter media and better anti-transpiration and to find technology for soil less seedling transportation. Applying chitosan and anti-transpiration before seedling transportation seem promising.

Improving Root Growth

Poor root system is one of causes for poor growth and long juvenile phase of mangosteen. Improvement of root system is very important to overcome these problems. *Agrobacterium rhizogenes* is a gram negative bacterium from family Rhizobiaceae that can induce growth of adventitious roots as well as hairy roots. Interaction of *Agrobacterium rhizogenes* 07-2001 into mangosteen genome improves mangosteen growth. Inoculation of *A. rhizogenes* strain TISTR-509, ATCC-15834, R1000, 07-2001, and strain A4 into in vitro mangosteen plantlets induced formation of better root systems by 20, 15, 10, 5 and 5%, respectively.

Fertilizer Study

Another problem on Indonesian mangosteen production is less or no fertilizer application. There is no standard of optimum fertilizer dosages for mangosteen yet. On the other hand, research showed that mangosteen was highly responsive to fertilizer applications. Application of NPK fertilizer at 50:10:20 ppm onto young mangosteen

improved the growth of the tree. Our recent work found excessive, optimum, and deficient ranges of nitrogen, potassium and phosphorus in mangosteen leaves. Optimum range of nitrogen is narrow; and excessive nitrogen level in the leaves may result in severe burn symptom in the leaves.

Shading

Young mangosteen needs shading and the growth of the trees are hampered without proper shading. Use of banana or papaya as shading plants is proven to be technically and economically promising because both plants appear to prefer the same agro-ecological zone with mangosteen, both plants could be easily pulled out when the mangosteen trees grow up, and both plants produce fruit much earlier than mangosteen, thus providing additional income for the farmers.

Effect of Harvesting Methods on Postharvest Flush

There are two methods of mangosteen harvesting in Indonesia, harvesting with and without pair of leaves. These two methods have different effect on harvested mangosteen quality and on the subsequent mangosteen tree growth. Harvesting with leaves can function as postharvest prunning and could increase the number of postharvest flush compared to other methods. It also retain green color of the petal of the fruits. Purple rind of mangosteen fruit with green petal is preferable for export to China.

Gamboges Studies

Gamboges or yellow latex is one of important problems on mangosteen that severely deteriorate the quality of mangosteen fruits. The edible part of mangosteen become bitter and the rind become hard and difficult to open due to this disease. Yellow latex on mangosteen aril is due to cracking of endocarp. Longitudinal and transversal section of mangosteen pericarp showed laticifer of yellow latex. Based on our preliminary research, we found 8 bacterial isolates that were associated with gamboges. Four of these isolates were pathogenic causing necrosis on tobacco leaves.

POSTHARVEST HANDLING

Development a Model for Non-Destructive Fruit Evaluation

The research goal is to measure internal quality of fruit based on non-destructive methods, and to predict maturity level and shelf-life of the fruit. There is difference in ultrasonic wave between young and mature mangosteen fruit. Ultrasonic wave can be used to differentiate between mangosteens with different maturity level. The research also showed that mangosteen with internal breakdown had a faster ultrasonic wave spreading compared to good internal quality mangosteen fruit. The more mature the fruit or the longer the fruit on storage, the fruit flesh tend to be soften, so the ultrasonic wave is more difficult to spread and the speed of the wave will be slower on those fruits. The ultrasonic wave will spread faster on young fruits compared to mature fruits (Nasution, 2006).

Study to Improve Shelf-Life

Shelf-life of mangosteen fruits is short. At room temperature, mangosteen fruits become hard and difficult to be opened after 20 d. Our study found technology to prolong the shelf-life of mangosteen fruits up to 40 d by coating the fruit with chitosan, wrapping it with plastic PE film, and storing the fruits at 15°C.

GENETIC STUDY AND CROP IMPROVEMENTS

Mangosteen is an apomictic plant, of which seed does not originate from hybridization because the stamen does not developed properly and the pollens become aborted before anthesis (Rai, 2005). However, we found morphological variability in characters among mangosteen population in Java Island (Sobir et al., 2003). Molecular

confirmation by mean RAPD analysis to mangosteen from Java and Sumatra Island has successfully detected genetics variability among mangosteen population at 0.27 of dissimilarity level (Mansyah et al., 2003).

Elucidation of genetical variability in mangosteen population to improve mangosteen could be conducted through direct selection from the field population. Our selection on mangosteen population in Purwakarta Regency provided one potential clone, and released as new variety named Wanayasa (Center for Tropical Fruits Studies, 2004). Subsequently, due to pollination handicap for hybridization in mangosteen, we conducted several experiments for genetical variability improvement, such as Gamma ray irradiation on seed, callus and cell culture (Harahap, 2005; Qosim, 2005).

Gamma ray irradiation on directly on seed resulted several mutants that indicated better growth at seedling stages. Subsequently irradiation treatment on mangosteen seed in in vitro medium affected plantlet growth, morphological performance, and several leaf anatomical structure, and increasing genetics variability up to 0.60 dissimilarity level. Cluster analysis revealed that clustering pattern may not be associated to gamma ray irradiation dose, indicating the effect of the treatments to genetical variability was randomly occurring (Harahap, 2005; Qosim, 2005).

CONCLUSIONS

Center for Tropical Fruit Studies of Bogor Agricultural University has made several efforts for improving productivity and quality of Indonesian Mangosteen, through

a. Improvement existing trees by converting mangosteen forest to an orchard,
b. Establishment of new orchard technology,
c. Harvest and post-harvest technology consisting of: off season production technology, shelf-life improvement, non-destructive fruit evaluation, and
d. Genetics improvement trough genetic variability analysis and mutation breeding.

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