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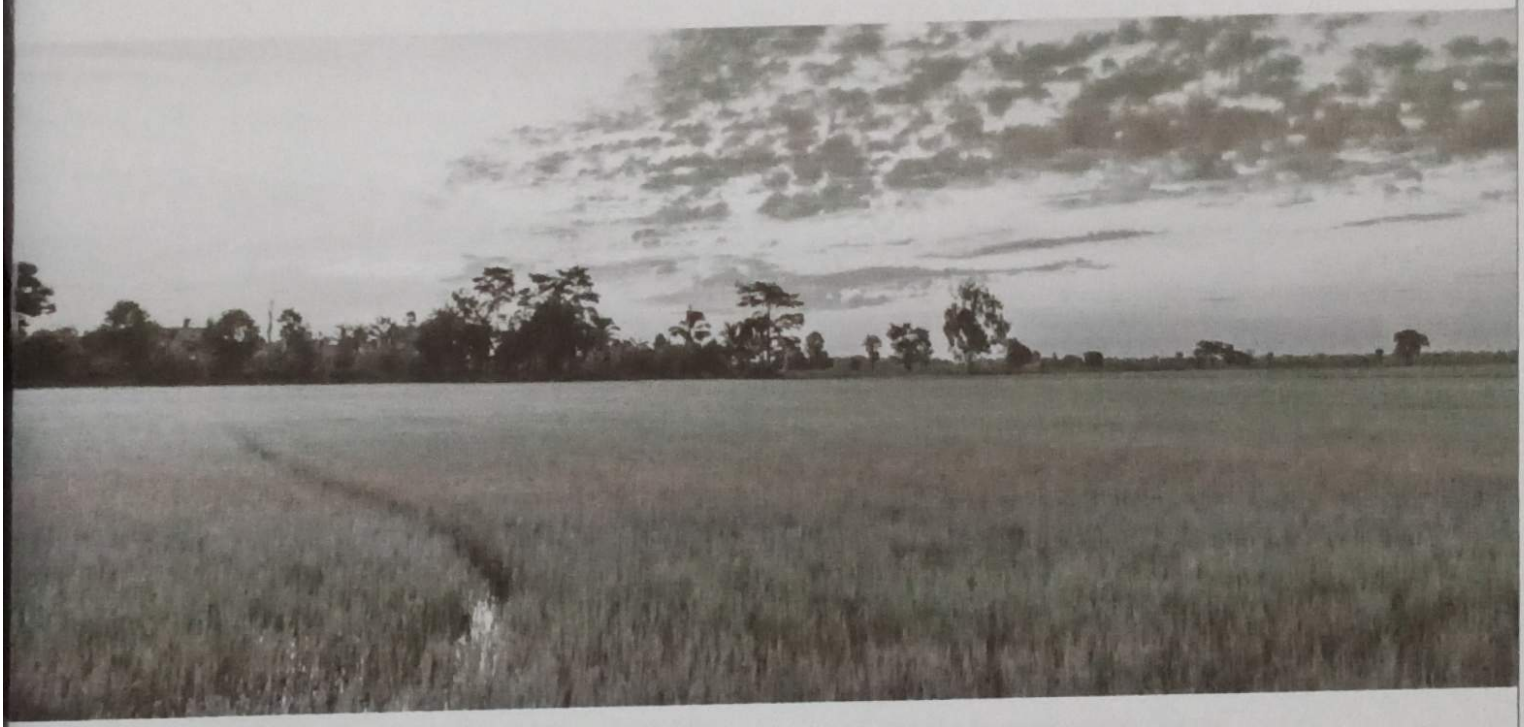

Editors :

Dr. Afandi
Prof. Dr. Ken Hiramatsu

DECEMBER 3-4, 2018

at FACULTY OF AGRICULTURE, LAMPUNG UNIVERSITY
BANDAR LAMPUNG, INDONESIA

LEMBAR PENGESAHAN

Judul	:	**Roles of Plant Tissue Culture on Agricultural Productivity**
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13/P/B/5/FP/20
Prosiding

PROGRAM

Date : December 3rd,2018
Venue : Hall of Faculty of Agriculture, Lampung University (UNILA),
Plenary Session

Start		Speaker/Chair Person	Title
8:00	Registratio		
8:30	Session 1	Chair: Cicih Sugianti & Auliana Afandi	Welcoming and Introductory Session
8:30		Prof. Dr. RA Bustomi Rosadi,	Committee Report
		Prof. Dr. Irwan S.Banuwa, Dean of Faculty of Agriculture,	Welcome Address
		Prof. Dr. Hasriadi Mat Akin, Rector of UNILA	Welcome Address
		Prof. Masateru SENGE Dean of UGSAS, GU	Declaration of Opening
9:00	Photo Session & Welcome Ceremony		
9:15	Coffee Break		
9:30	Session 2	Chair: Prof. Chihara E., GU	
9:30		Dr. Dwi Hapsoro, Faculty of Agriculture, UNILA	Roles of Plant Tissue Culture on Agricultural Productivity
10:00		Assoc. Prof. Teruaki Shimazu , GU	Airflow resistance of insect screen and evaporative cooling for natural ventilated greenhouse in humid temperate/ tropical climate region
10:30		Supriyono Loekito PT.GGP	Sustainable agriculture, a strategy to maintain the business sustainability of PT. Great Giant Pineapple under Global Climate Change
11:00	Q & A		
11:45	Lunch break		
12:45	Session 3-Paralell at Post Graduate Building, Fac. of Agriculture, Lampung University		
15:15	Coffee Break		
15:35	Session 4	Chair: Dr. Tumiar K Manik	
15:35		Assis. Prof. Tanaka, T., GU	Applications of Structural Equation Modeling in Crop Yield Variability of the Farmers' Fields
15:55		Agustini (Agric.Service, Bandar Lampung City)	Potential of yard Utilization for Supporting the Fulfillment of Food Security in Bandar Lampung City, Indonesia
15:15		Assis. Prof. Noda, K., GU	GIS analysis for vulnerability assessment of salt damage on Taro Patch in Palau
16:45		Prof. K. Hiramatsu, Vice Dean of UGSAS, GU	Closing
18:30		MC: Dr. Afandi UNILA	Banquet , at Bandar Lampung' s mayor house

Study Excursion/field trip, at December 4, to PT.GGP, Central Lampung
Start : 06.30 from Faculty of Agriculture, Lampung University.

Parallel Session

Venue : Post Graduate Building, Faculty of Agriculture, Lampung University

Room 1

Start	Speaker/Chair Person	Title
12:45	Chair: Assis. Prof. Noda,	*Influence of Climate Change on Crop Production*
12:45	T.K.Manik	Predicting Cassava Suitability as Impacted by Climate Change in Indonesia
12:55	Afandi	Tracking the fate of organic matter residue using soil dispersion ratio under intensive farming in red acid soil of Lampung, Indonesia
13:10	WARJI	Multi-layered Microcapsules of Biopesticides to Support Sustainable Agriculture
13:20	Irwan S. Banuwa	Effect of Ridges and Organic Fertilizer on Erosion and Nutrients Loss
13:35	Q&A	
13:45	Coffee break	
13:55	Priyo Cahyono	Effects of Waterlogging on Pineapple Growth and Soil Properties on Red Acid Soils of Lampung, Indonesia
14:10	Rusdi EVIZAL	Potential Yield of Replanted Trees of Cocoa Clones Introduced in Lampung
14:25	Dudy Arfian (PT GGP)	Effects of aluminum stress on shoot growth, root growth and nutrient uptake of three pineapple smooth cayenne clone [*Ananas comosus* (L.) Merr.]
14:40	Didin Wiharso	The effect of long-term cassava cultivation on organic carbon content and soil physical properties in Central Lampung
14:55	Q & A	
15:15	Coffee break	

Room 2

Start time	Speaker/Chair Person	Title
12:45	Chair: Diding	*Cash Crop productivity and its constraint*
12:45	Siti Nur Rohmah	Corn Yield and Soil Properties under long term conservation tillage in clayey soil tropical upland of Lampung, Indonesia
13:55	Lestari Wibowo	The role of refugia in the wetland paddy ecosystem
13:10	Dwi Oktaria	Soil organic carbon in soil fraction and corn yield under long-term tillage system and nitrogen fertilization
13:20	Ahmad Tusi	Ventilation Flow Rate and Photosynthesis Prediction based on Water Vapor Balance under Ventilated Greenhouse
13: 35	Q & A	
13:50	Coffee break	

14:00	M. A. Fauzan	Aggregate Stability and Root Biomass Affected by Soil Tillage and Mulching in the Gedung Meneng Soil Planting Green Nut (*Vigna radiata* L.) of the Long Term Experiment
14:15	Ayu Wulan Septitasari	Application of induced compost of cellulolitic (*aspergillus fumigatus*) and ligninolitic (*geotrichum* sp.) inoculum on the vegetative growth of red chili (*Capsicum annuum* L.)
14:30	Yogi Irawan	Soil Compaction, Water Content, Bulk Density and Soil Root Biomass Affected by Tillage and Fertilizer on Gedung Meneng Soil under Green Bean Growth
14:45	Tubagus Hasanuddin	Perceptions of farmers, Effectiveness of Farmers Group, and Diffusion of Innovation of Organic Farming System in Lampung Province
15:00	Q & A	
15:15	Coffee break	

Room 3

Start time	Speaker/Chair Person	Title
12:45	Chair: Prof. K. Hiramatsu, GU	*Annual Crop productivity and technology for supporting*
12:45	Novita Desri Wanti	Production and harvested nutrient of cassava (*manihot esculenta l.*) affected by compost and its combination with NPK inorganic fertilizer for the 5th planting period
12:55	Debby N.A	Simulation of Cavendish Banana Transporation
13:10	Cicih Sugianti	The application of hot water treatment in mango cv arumanis
13:20	Maria Viva Rini	The Diversity of Arbuscular Mycorrhiza Fungi at Rhizosphere of Cassava of Thailand Clone Cultivated in Lampung Timur and Tulang Bawang Barat
13:35	QA	
13:50	Coffee break	
14:00	Adinda Kusuma Dewi	Harvested nutrient and production of cassava (*manihot esculenta*) affected by tillage and herbicide in the 4th planting period in Gedung Meneng soil Bandar lampung
14:10	Nurhidayat	Production and Harvested Nutrients of Sugarcane 1st Ratoon (*Saccharum officinarum* L.) Affected by Organic and Inorganic Fertilizer
14:25	Agus HARYANTO	Biogas Production From Oil Palm Empty Fruit Bunches through Dry Fermentation Process: Preliminary Results
14:40	Diding	The Current Status of Authentication of Indonesian Specialty Coffees Using UV-Visible Spectroscopy and Chemometrics
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15:15	Coffee break	

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Roles of Plant Tissue Culture on Agricultural Productivity

Dwi Hapsoro
(Faculty of Agriculture, Lampung University, Indonesia)

Introduction

As human population grows, its need for food increases. It was estimated that by the year of 2050, human population would be 9.1 billion, which is about 34% higher than the world's population now (Salokhe, 2016). Therefore, increasing agricultural production has become never-ending effort to catch up the population growth to sufficiently meet its demand.

Rising agricultural production could be achieved by intensification and extensification. Intensification is carried out mainly by increasing the technological level, or by employing more modern one, while extensification is done mainly by increasing land area. For a large company, the two strategies are often executed simultaneously, in order to meet increasing product demand. Plant tissue culture technology has been very advantegous for supporting both intensification and extensification.

This paper aims to put forwad roles plant tissue culture for supporting agricultural productivity.

Plant Tissue Culture and Its Role on Agricultural Productivity

Plant tissue culture could be defined as aseptically culturing in vitro small parts of plants (protoplast, cell, tissue, organ) on a spesific medium containing a complete mineral nutrients and plant growth regulators under controlled environmental condition in order that the plant parts grow, proliferate and develop into complete plants or just grow and proliferate for special purpose. Based on the definition, the end goal is not always complete plants, but it could be other forms, for example proliferating calli, roots, or shoots. Based on the definition, plant tissue culture has five important characteristics i.e in vitro, aseptic, complete mineral nutrients, plant growth regulators, and controlled environmental conditions.

In relation to agricultural productivity, plant tissue culture has been applied for (1) rapid clonal propagation of plants with novel characters, (2) production of disease-free plants, (3) seed germination, especially for orchids, (4) embryo rescue, (5) induction of desirable, heritable trait through somaclonal variation, (6) production of homozigous, pure lines of plants for hybrid variety production, and (7) providing facility for mutation breeding and plant genetic engineering. Basically plant tissue culture could be applied for rapid clonal propagation and for facilitating plant breeding, both being supportive for plant productivity.

Rapid clonal propagation by tissue culture for supporting productivity. Planting materials are vital to productivity. They should be genetically, physiologically, and physically superior. The plants being mass propagated are always those considered to have novel, heritable characters. Environmental condition of plant tissue culture system, which is aseptic and supplied with optimal amount of nutrients, enables the production of planting materials which are physiologically and pysically superior and free of disease, especially caused by pathogenic bacteria and fungi. Virus-free planting materials could also be produced, i.e. by culturing a very small part of meristem tips.

Plant tissue culture has been used to clonally mass propagate various species of plants for commercial purpose and for community development. Plant tissue culture has been applied to propagate many herbaceous plants and floricultural plants. This technology has long been used to propagate banana of Cavendish type. It is almost impossible to use suckers as planting materials for growing banana in a large area (on the scale of thousand plants) because one mother plant could only produce more or less five suckers with variable sizes. This means they have variable ontogenetic ages, which could most likely result in variable harvesting time.

Recently, some oil palm plantation companies have been using plant tissue culture to clonally mass-propagate superior mother plants to produce a large number of planting materials. Traditionally, the planting materials are hybrid seeds from hybridization of progenitors *dura*

type and *pisifera* type. The hybrid planting materials, which are called *tenera* (D x P) type, are of high variability genetically, which in turn will result in variable productivity. If the superior *tenera* (D x P) type is selected, and clonally mass-propagated, superior uniform planting meterials will be produced and productivity will increase. It was reported that productivity of oil palm using clonal tenera plants was 30% higher than that using (D x P) seeds (Ng et al., 2003). Similar results were also reported by Alwee et al.(2010), when comparing productivity of oil palm plants derived from clonal propagation and those derived from (D x P) seeds.

Tissue culture-facilitated plant breeding for supporting productivity. The use of plant tissue culture for facilitating plant breeding includes embryo rescue, production of homozigous, pure lines of plants for hybrid variety production; induction of desirable, heritable trait through somaclonal variation; mutation breeding and plant genetic engineering.

Embryo rescue could be conducted by tissue culture by culturing the embryos, unless otherwise they will undergo abortion. The embryos being rescued are usually resulted from hybridization of distantly related plants. For example, rice varieties called NERICAs (New Rices for Africa) are derived from hybridization between *Oryza glaberrima*, an African species, and *Oryza sativa*, an Asian species. *Oryza glaberrima* are local variety which is well adapted to local agroclimate conditon (Africa) but has low productivity (yield of about 1 ton per hectar), while *Oryza sativa* is not adapted to African agroclimate condition but shows relatively high productivity (yield of about 5 tons per hectar). The resulting NERICAs show characteristics of the African and Asian rice varieties. The characteristics of Africal rice varieties include tolerant to drought stress, poor nutrient condition and mineral toxicity, and local pest and disease; grow well on upland condition, and perform early vigorous growth. The characteristics of Asian rice varieties include producing more erect leaves and full panicles of grain and showing earlier harvesting time i.e 90-100 days after planting, which is 30-50 days earlier than local varieties. The NERICAs has higher yield (around 4 tons per hectar) compared to the African varieties (approximately 1 ton per hectar).

Plant tissue culture can be applied for producing homozigous, pure lines of plants for hybrid variety production. This is done by culturing haploid cells such as those from anthers and pollen grains of plants derived from the hybridization of two or more progenitors with desired characters, allowing them to proliferate as calli, which expectedly consist of haploid cells. Chromosome doubling could occur spontaneously or by applying a chromosome-doubling agence such as colchicines, causing the cells in the calli to become diploid. Each individual diploid cells are by theory completely homozygous, meaning that the genes at each locus are homozygous. The calli are then regenerated into population of plants which were then selected for novel characters. The selected plants could be propagated to become varieties or become parental lines for producing hybrid varieties. One example of producing homozygous plant of rice using plant tissue culture were reported by Dewi and Purwoko (2016).

Plant tissue culture could be used to induce somaclonal variations. Somaclonal variations could be defined as genetic variations in somatic cells resulted from in vitro culture of plants (tissue culture of plants). Inducing somaclonal variations could be used as a means to produce new varieties with desired characters. Somaclonal variations usually result from induction and proliferation of callus in a tissue culture system. The rapid induction and proliferation of callus may lead to changes in genes which in turn cause changes in heritable characters. In a breeding program for certain novel characters, the proliferating calli are subjected to a selection pressure which is related to the desired characters. In this case, the proliferating calli are cultured on the media containing selection pressure materials, and the survived cells are then selected and regenerated into plants. Some researchers used polyethylene glycol (PEG) as a selection pressure to obtain plants with drought tolerance. Some also used sodium chloride as a selection pressure material to obtain plants with both tolerance to drought and high salinity stress. The selection pressure materials could also be those to mimic biotic stresses. For example, some researchers used toxins as a selection pressure material to produce plant varieties with tolerance to patogens that release the toxins.

Plant tissue culture could facilitate mutation breeding and plant genetic engineering. In this case, certain concentration (LD_{50}) of mutagenic chemical agence such

as EMS (ethyl methanesulfonate) could be put into culture of proliferating callus or shoots. The lethal dosage (LD_{50}) of EMS should be determined an experiment. The survived callus or shoots are then regenerated into plants and the plants are selected for desired characters. The mutagenic agence could be physical, such as gamma ray. As with the chemical mutagenic agence, LD_{50} of physical mutagenic agence should be determined before being applied (Hapsoro et al., 2018)

Basically, plant tissue culture is not theoretical requirement for plant genetic engineering. However, almost all genetic engineering practices has used plant tissue culture system. Plant genetic engineering is a biotechnology to modify character (s) of a plant by directly inserting a gene (s) of interest into its genome. What it means by "directly" is that the sexual hybridization does not occur. The process of gene insertion uses plant tissue culture system, usually in the form of callus culture and shoot culture.

Conclusion and future prospects

Roles of plant tissue culture for supporting agricultural productivity are on the area of rapid clonal propagation and facilitating plant breeding. Rapid clonal propagation is intended mainly to provide high quality planting materials, in term of genetics, physiology, and physical appearance. Facilitating plant breeding is done by induction of genetic variability due to somaclonal variations, mutation breeding, and genetic engineering. In practice, the application of plant tissue culture technology find limitations especially in many developing contries such as Indonesia. The technology is still considered expensive. Therefore, low-cost plant tissue culture operation should be formulated. Since each plant species need special "recepie", it is necessary in the future to find more general recepie by deciphering mechanism of plant regeneration in vitro. Research in molecular biology and plant physiology on regeneration aspects of plant tissue culture will expectedly solve the problem.

References

[1]Alwee SSRS, SH Roowi, AK Teng, AZ Othman. 2010. Progress of oil palm tissue culture in FELDA and its challenges. Paper presented in International Seminar of Advances in Oil Palm Tissue Culture. International Society of Oil Palm Breeders. Yogyakarta, 2010.

[2] Dewi I.S. and BS Purwoko, 2016. Role of polyamines in inhibition of ethylene biosynthesis and their effects on rice anther culture development. Indonesian Journal of Agricultural Science, 9(2): 60-67.

[3] Hapsoro D., T Inayah and Yusnita. 2018. Plant regeneration of Sugarcane (*Saccharum officinarum* L.) calli in vitro and its response gamma irradiation. J. ISSAAS 24 (1): 58-66.

[4] Ng SK, TK Cheong, KC Haw, HSH Oii, LK Yee, P. Karayoganam, H von Uexkull, R Hardter. 2003. Clonal Oil Palm: Production, yield performance and nutritional . In: Oil Palm, Management for Large and Sustainable yields. H.von Uexkull and Hardter (Eds). Internasional Potash Institute. Kassel. Germany, p:99-114.

[5] Salokhe, S. 2016. A Boon for Agriculture. 5th International Conference on Agriculture & Horticulture. Cape Town, South Africa. June 27-29, 2016.