January 2022

THE SECOND INTERNATIONAL CONFERENCE ON GENETIC RESOURCES AND BIOTECHNOLOGY: Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture

Committees: The Second International Conference on Genetic Resources and Biotechnology

Cite as: AIP Conference Proceedings **2462**, 010002 (2022); https://doi.org/10.1063/12.0008934
Published Online: 19 January 2022

Steering, Scientific and Organizing Committees

Steering Committee

Chair:

Dr. Ir. Fadjry Djufry, M.Si , *Director General of Indonesian Agency for Agricultural Research and Development (IAARD), Ministry of Agriculture, Indonesia*

Vice Chair:

Ir. Mastur Ph.D, *Director of Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Dr. Siswa Setyahadi, *Head of Indonesian Biotechnology Consortium, Indonesia*

Secretary:

Dr. Sustiprijatno, *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Scientific Committee

Prof. Dr. M. Sabran, *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Prof. Dr. Bahagiawati A., *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Prof. Endang Gati Lestari, *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Associate Prof. Endang Septiningsih, *Texas A & M University, USA*

Dr. Prakit Somta, *Kasetsart University, Thailand*

Dr. Laosatit Kularb, *Kasetsart University, Thailand*

Dr. Back Ki Kim, *Seoul National University, South Korea*

Dr. Iswari Saraswati Dewi, *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Dr. Puji Lestari, *Indonesian Center for Rice Research, IAARD, Ministry of Agriculture, Indonesia*

Dr. Dani Satyawan, *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Dr. Alina Akhdiya, *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Ir. Tri Puji Priyatno, PhD, *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Dr. Ir. Ragapadmi Purnamaningsih, *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

Dr. Nurul Hidayatun, *Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Ministry of Agriculture, Indonesia*

The Second International Conference on Genetic Resources and Biotechnology
AIP Conf. Proc. 2462, 010002-1–010002-3; https://doi.org/10.1063/12.0008934
Published by AIP Publishing. 978-0-7354-4172-9/$30.00

Organizing Committee

Chair	:	Dr. Toto Hadiarto
Vice Chair	:	Dr. Dani Satyawan
Secretary	:	Dr. Wening Enggarini
		Rerenstradika Tizar Terryana, M.Si
Treasurer	:	Dra. Sih Parmiyatni
		Ma'sumah, S.Si
Publication and documentation:		
		Dr. Hakim Kurniawan
		Endo Kristiyono, M.T.I.
		Andika Bakti, S.I.Kom
		Ansori
Logistic	:	Wawan, M.Si.
		M. Hasni Zulfikar

Preface: The Second International Conference on Genetic Resources and Biotechnology

Cite as: AIP Conference Proceedings **2462**, 010001 (2022); https://doi.org/10.1063/12.0006897
Published Online: 19 January 2022

Preface: The Second International Conference on Genetic Resources and Biotechnology

The Second International Conference on Genetic Resources and Biotechnology, which is the continuation of the first event held in 2018, focuses on topics related to advances in biotechnology to create more opportunities for effective conservation and sustainable utilization of genetic resources for food and agriculture. This year conference's theme is Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture. The conference was organized by Indonesian Agency for Agricultural Research and Development (IAARD), Ministry of Agriculture, Indonesia, in collaboration with Indonesian Biotechnology Consortium and held on 24th-25th of May 2021virtually due to the pandemic of COVID-19.

The conference aims to share and exchange current scientific information and technological developments on biotechnology and their applications for conservation and sustainable use of genetic, to encourage and promote quality, efficiency, and modernization of management and utilization of genetic resources, and to facilitate national and international collaboration among participants. There are five scopes discussed in this conference. They are effective management of conservation and sustainable use of genetic resources for food and agriculture, application of genomics and molecular markers for genetic resource conservation and crop adaptation to climate change, application of innovative crop improvement techniques for conservation and sustainable use of plant genetic resources for food and agriculture, plant cell and tissue culture for conservation and effective utilization of genetic resources, and the use of microbial genetic resources as biological control agents of agricultural pests and diseases, and for soil bioremediation.

Five speakers from the United States of America, Japan, India and Indonesia were invited to discuss about their expertise and knowledge on relevant subjects in the plenary sessions. This conference was attended by more than 100 participants including 75 presenters and 44 listeners worldwide. They came from diverse governmental, private, or academic institutions and also scientific communities. The presented materials have undergone peer review processes and only qualified papers were selected. Furthermore, all papers were subjected to double blind peer-review and expected to meet the scientific criteria of significance and academic excellence to be published in a conference proceedings indexed in a well-known, reputable service.

We would like to express our sincere gratitude to our speakers, presenters and all participants for their contributions in this conference. We would also like to express our appreciation for the generosity of our sponsors that support this conference: PT CropLife, PT ITS Science Indonesia, PT Fajar Mas Murni and PT Prima Instrument Analitika. Lastly, special thanks to all committee members for their exceptional work and contributions in the conference and publication.

Chair of Organizing Committee

Dr. Toto Hadiarto

The Second International Conference on Genetic Resources and Biotechnology
AIP Conf. Proc. 2462, 010001-1–010001-1; https://doi.org/10.1063/12.0006897
Published by AIP Publishing. 978-0-7354-4172-9/$30.00

Table of Contents

THE SECOND INTERNATIONAL CONFERENCE ON GENETIC RESOURCES AND BIOTECHNOLOGY: Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture

PREV

Conference date: 24–25 May 2021
Location: Bogor, Indonesia
ISBN: 978-0-7354-4172-9
Editors:
I Made Tasma, Dwinita Winkan Utami, Ika Roostika, Yadi Suryadi, Chaerani, Eny Ida Riyanti, Puji Lestari, Toto Hadiarto, Reflinur, Joko Prasetyono, Fatimah, Surya Diantina, Tru Puji Priyanto, Kusumawaty Kusumanegara, Wening Enggarini, Rerenstradika Tizar Terryana and Dani Satyawan
Volume number: 2462
Published: Jan 19, 2022
DISPLAY :

- 20
- 50
- 100
- all

PRELIMINARY

FreeJanuary 2022

Preface: The Second International Conference on Genetic Resources and Biotechnology

AIP Conference Proceedings **2462**, 010001 (2022); https://doi.org/10.1063/12.0006897

- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Committees: The Second International Conference on Genetic Resources and Biotechnology

AIP Conference Proceedings **2462**, 010002 (2022); https://doi.org/10.1063/12.0008934

- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

EFFECTIVE MANAGEMENT OF CONSERVATION AND SUSTAINABLE USE OF GENETIC RESOURCES FOR FOOD AND AGRICULTURE

FreeJanuary 2022

Harnessing plant genetic resources through biotechnology for food security in Indonesia

Mastur, Reflinur, Nurul Hidayatun, Sustiprijatno, Fatimah, Tri Puji Priyatno and Puji Lestari
AIP Conference Proceedings **2462**, 020001 (2022); https://doi.org/10.1063/5.0075671

- SHOW ABSTRACT
- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

DNA barcoding of *Vatica bantamensis*, a critically endangered tree endemic to Banten, Indonesia

Muhammad Rifqi Hariri, Iyan Robiansyah, Dipta Sumeru Rinandio, Dodo, Desi Siti Sundari, Cecep H. Sukmawan and Bayuntoro Ardi
AIP Conference Proceedings **2462**, 020002 (2022); https://doi.org/10.1063/5.0075529

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Genetic parameters of agronomic traits in soybean (*Glycine max* [L.] Merrill) genotypes tolerant to drought

Made J. Mejaya, Suhartina, Purwantoro, Novita Nugrahaeni and Titik Sundari
AIP Conference Proceedings **2462**, 020003 (2022); https://doi.org/10.1063/5.0075159

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Yield stability performance of soybean (*Glycine max* [L.] Merrill) lines tolerant to drought

Suhartina, Purwantoro, Novita Nugrahaeni, Abdullah Taufiq and Made Jana Mejaya
AIP Conference Proceedings **2462**, 020004 (2022); https://doi.org/10.1063/5.0075158

- SHOW ABSTRACT
-
  - PDF
  - E-READER

- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Polymorphisms and associations of the *RACK1* genes with antibody response to Newcastle disease in KUB chickens

Ifa Manzila, Puji Lestari, Tike Sartika, Tri Puji Priyatno, Risa Indriani, Kristianto Nugroho and Rerenstradika Tizar Terryana
AIP Conference Proceedings **2462**, 020005 (2022); https://doi.org/10.1063/5.0075622

- SHOW ABSTRACT
-
- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Rice grain quality evaluation of promising lines of rice under irrigation and for salinity tolerance

Dody D. Handoko, Nafisah, Aris Hairmansis, Trias Sitaresmi, Heni Safitri, Satoto, Ali Imamuddin, Cucu Gunarsih and Untung Susanto
AIP Conference Proceedings **2462**, 020006 (2022); https://doi.org/10.1063/5.0075956

- SHOW ABSTRACT
-
- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Existing diversity profile for kernel characteristics of maize germplasm in IAARD-ICABIOGRAD gene bank

Andari Risliawati, Sobir, Trikoesoemaningtyas, Willy B. Suwarno and Puji Lestari
AIP Conference Proceedings **2462**, 020007 (2022); https://doi.org/10.1063/5.0075178

Characterization of Japansche citroen rootstock somaclones and *in vitro* selection for aluminium tolerance

Deden Sukmadjaja, Mia Kosmiatin and Tiwi Wati
AIP Conference Proceedings **2462**, 020008 (2022); https://doi.org/10.1063/5.0077888

Resistance to brown planthoppers (*Nilaparvata lugens* Stål) in rice accessions originated from Sumatra Island, Indonesia

Dodin Koswanudin, Nurul Hidayatun and Muhamad Ace Suhendar
AIP Conference Proceedings **2462**, 020009 (2022); https://doi.org/10.1063/5.0075680

Morphological identification of underutilized local fruits in Kutai Barat Regency to support their conservation and sustainable use

Fitri Handayani, Nurbani and Asep Pebriandi
AIP Conference Proceedings **2462**, 020010 (2022); https://doi.org/10.1063/5.0075594

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Genetic resources of adlay (*Coix lacryma-jobi* L.) in East Kalimantan as source of functional food

Fitri Handayani, Muhammad Amin and Muhammad Taufiq Ratule
AIP Conference Proceedings **2462**, 020011 (2022); https://doi.org/10.1063/5.0075593

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Screening of soybean genotypes resistance to rust disease (*Phakopsora pachyrhizi*)

Sumartini and Kurnia Paramita Sari
AIP Conference Proceedings **2462**, 020012 (2022); https://doi.org/10.1063/5.0075674

- SHOW ABSTRACT

-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Identification of soybean promising lines resistant to pod-sucking bug, *Riptortus linearis* (Fabricius)

M. Muchlish Adie, Titik Sundari, Kurnia Paramita Sari and Ayda Krisnawati
AIP Conference Proceedings **2462**, 020013 (2022); https://doi.org/10.1063/5.0075343

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Variation in pod shattering resistance among black soybean genotypes associated with agronomic traits

Ayda Krisnawati, Titik Sundari and M. Muchlish Adie
AIP Conference Proceedings **2462**, 020014 (2022); https://doi.org/10.1063/5.0075338

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Preliminary characterization and identification of genetic integrity of velvet bean germplasm in IAARD-ICABIOGRAD gene bank

Nurwita Dewi, Andari Risliawati and Nurul Hidayatun
AIP Conference Proceedings **2462**, 020015 (2022); https://doi.org/10.1063/5.0076355

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Plant parasitic nematodes infesting three minor legumes (velvet bean, lablab bean, and jack bean)

Chaerani, Try Zulchi P. Hariyadi and Nurwita Dewi
AIP Conference Proceedings **2462**, 020016 (2022); https://doi.org/10.1063/5.0075204

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Proactive management approach of seed PGRFA conservation during the pandemic of coronavirus disease (COVID-19) in Indonesia

Nurul Hidayatun, Andari Risliawati, Nurwita Dewi, Lina Herlina and Dodin Koswanudin
AIP Conference Proceedings **2462**, 020017 (2022); https://doi.org/10.1063/5.0075531

- SHOW ABSTRACT

-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Evaluation of mung bean accessions in saline soil based on quantitative morphological characters

Trustinah, Ratri Tri Hapsari, Rudi Iswanto and Rudy Soehendi
AIP Conference Proceedings **2462**, 020018 (2022); https://doi.org/10.1063/5.0075324

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Screening and evaluation of 100 upland rice accessions for developing high-yielding upland rice varieties tolerant against acid soil

Lina Herlina and Yusi N. Andarini
AIP Conference Proceedings **2462**, 020019 (2022); https://doi.org/10.1063/5.0075550

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Morphological characters of sugarcane mutant (*Saccharum officinarum* L.) from *in vitro* selection for drought stress

Rr. Sri Hartati, Sri Suhesti and Nurya Yuniyati
AIP Conference Proceedings **2462**, 020020 (2022); https://doi.org/10.1063/5.0075656

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Identifying potential seedless citrus accessions through floral structure and pollen performance

Baiq Dina Mariana, Anis Andrini and Sri Andayani
AIP Conference Proceedings **2462**, 020021 (2022); https://doi.org/10.1063/5.0076922

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Secondary characters based selection of Indonesian kenaf (*Hibiscus cannabinus* L.) germplasm for developing superior varieties

Taufiq Hidayat R. S., Marjani, Nurindah, Muhammad Rasyidur Ridho, Cynthia Lestari Hertianti and Widya Fatriasari
AIP Conference Proceedings **2462**, 020022 (2022); https://doi.org/10.1063/5.0075716

- SHOW ABSTRACT

-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Genetic relationship of pigmented rice (*Oryza sativa* L.) collected from Eastern Indonesia based on morpho-agronomical traits and SSR markers

Yusi Nurmalita Andarini, Willy Bayuardi Suwarno, Hajrial Aswidinnoor and Hakim Kurniawan
AIP Conference Proceedings **2462**, 020023 (2022); https://doi.org/10.1063/5.0075706

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Rejuvenation and morphological characterization of local rice from the province of Yogyakarta

Setyorini Widyayanti, Sutarno, Endang Wisnu Wiranti and Kristamtini
AIP Conference Proceedings **2462**, 020024 (2022); https://doi.org/10.1063/5.0075721

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Characterization of plant architecture and yield trait of castor (*Ricinus communis* L.) germplasm suitable for mechanical harvesting

Tantri Dyah Ayu Anggraeni and Rully Dyah Purwati
AIP Conference Proceedings **2462**, 020025 (2022); https://doi.org/10.1063/5.0075155

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Characterization and interrelationships of the number of vessel bundles with yield components in various genotypes of soybean (*Glycine max* [L.] Merrill)

Anna S. Karyawati and Dyah P. Fitrawantio
AIP Conference Proceedings **2462**, 020026 (2022); https://doi.org/10.1063/5.0075693

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Tuber starch content of edible canna (*Canna indica* L.) from different geographical origins

Surya Diantina, Randy Sanjaya, Kristina Dwi Atmini, Ace Suhendar and Dodin Koswanudin
AIP Conference Proceedings **2462**, 020027 (2022); https://doi.org/10.1063/5.0075922

- SHOW ABSTRACT

-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

The diversity of morpho-agronomic characters and identification of early maturity cassava (*Manihot esculenta* Crantz.) germplasm

Tinuk Sri Wahyuni, Kartika Noerwijati and Made J. Mejaya
AIP Conference Proceedings **2462**, 020028 (2022); https://doi.org/10.1063/5.0075658

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Radiosensitivity and phenotypic characterization of gamma ray-induced mutant population of four *Capsicum annuum* L. cultivars grown in screen house

Andri Fadillah Martin, Dyah Retno Wulandari, Tri Muji Ermayanti, Betalini Widhi Hapsari, Erwin Al Hafiizh and Laela Sari
AIP Conference Proceedings **2462**, 020029 (2022); https://doi.org/10.1063/5.0075173

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Morphological performances of mutant butterfly pea (*Clitoria ternatea* L.)

Try Zulchi, Ali Husni, Dwinita Wikan Utami, Reflinur, Mia Kosmiatin, Tarkus Suganda and Agung Karuniawan
AIP Conference Proceedings **2462**, 020030 (2022); https://doi.org/10.1063/5.0075592

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Screening of beta carotene and its correlation with tuber flesh color in sweet potato

Kristina Dwi Atmini, Surya Diantina, Muhamad Sabda and Dodin Koswanudin
AIP Conference Proceedings **2462**, 020031 (2022); https://doi.org/10.1063/5.0075618

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Evaluation of morpho-agronomical characters and grain quality of red rice lines

Heni Safitri and Puji Lestari
AIP Conference Proceedings **2462**, 020032 (2022); https://doi.org/10.1063/5.0078807

- SHOW ABSTRACT
-
  - PDF
  - E-READER

- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Growth variation and relationship of clove progenies of high-yielding mother trees collected from various regions in Indonesia

Mariana Susilowati, Sri Wahyuni, Adi Setiadi and Nurliani Bermawie
AIP Conference Proceedings **2462**, 020033 (2022); https://doi.org/10.1063/5.0075824

- SHOW ABSTRACT
-
- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Screening on bast fiber plants resistant to spiral stem borer, *Agrilus acutus* (Coleoptera: Buprestidae)

Sujak, Nurindah, Dwi Adi Sunarto, Marjani and Nurul Hidayah
AIP Conference Proceedings **2462**, 020034 (2022); https://doi.org/10.1063/5.0075691

- SHOW ABSTRACT
-
- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Characteristic of indigenous *Leuconostoc mesenteroides* EN 17-11 protease and its stability during storage at cold and freezing temperatures

Tatik Khusniati, Ika, Harry Noviardi and Sulistiani
AIP Conference Proceedings **2462**, 020035 (2022); https://doi.org/10.1063/5.0076004

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Performance of introduced lines based on morphological markers for diversity enrichment of Indonesian chili pepper (*Capsicum annuum* L.) varieties

Rinda Kirana, Catur Hermanto, Reflinur and Derek W. Barchenger
AIP Conference Proceedings **2462**, 020036 (2022); https://doi.org/10.1063/5.0075186

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

The growth of garlic internal sprout on different storage condition

Chotimatul Azmi, Imas Rita Saadah, Nazly Aswani and Asih Kartasih Karjadi
AIP Conference Proceedings **2462**, 020037 (2022); https://doi.org/10.1063/5.0075180

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Genetic diversity analysis of *Castanopsis argentea* using random amplified polymorphic DNA markers

Muhammad Imam Surya, Lily Ismaini, Decky Indrawan Junaedi, Aisyah Handayani, Taufikurrahman Nasution, Muhammad Efendi, Andes Hamuraby Rozak, Zaenal Mutaqien, Musyarofah Zuhri, Imawan Wahyu Hidayat, Fitri Kurniawati, Vandra Kurniawan, Dwinda Mariska Putri and Risha Amilia Pratiwi
AIP Conference Proceedings **2462**, 020038 (2022); https://doi.org/10.1063/5.0077390

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

APPLICATION OF GENOMICS AND MOLECULAR MARKERS FOR GENETIC RESOURCE CONSERVATION AND CROP ADAPTATION TO CLIMATE CHANGE

FreeJanuary 2022

Current status of tidal swamp rice varieties and its improvement for Fe toxicity tolerance and biofortification

Muhamad Sabran, Dwinita Wikan Utami and Susilawati
AIP Conference Proceedings **2462**, 030001 (2022); https://doi.org/10.1063/5.0075202

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Agroforensic, a new emerging study using molecular marker technique

Edy Listanto, Ahmad Warsun, Ahmad Dadang, Eny Ida Riyanti, Saptowo Jumali Pardal, Sustiprijatno and Mastur
AIP Conference Proceedings **2462**, 030002 (2022); https://doi.org/10.1063/5.0075164

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Molecular diversity comparison in local rice accessions originated from Kalimantan and other islands of Indonesia

Puji Lestari, Rerenstradika Tizar Terryana, Kristianto Nugroho, Andari Risliawati, Nurul Hidayatun, Priatna Sasmita, Yudhi Sastro, I. Gusti Komang Dana Arsana and Ikhwani
AIP Conference Proceedings **2462**, 030003 (2022); https://doi.org/10.1063/5.0075665

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Genetic variation of Adan, a Krayan local rice mutant, using microsatellite markers

Joko Prasetiyono, Tio Fadel Rafsanjani, Tri Aminingsih, Tasliah and Sugiono Moeljopawiro
AIP Conference Proceedings **2462**, 030004 (2022); https://doi.org/10.1063/5.0075660

- SHOW ABSTRACT

-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

The genome sequence of Ciherang, an Indonesian rice mega variety, revealed the footprints of modern rice breeding

Ida Rosdianti, Dani Satyawan, Muhamad Yunus and Dwinita Wikan Utami
AIP Conference Proceedings **2462**, 030005 (2022); https://doi.org/10.1063/5.0075676

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Field adaptation and molecular characterization of Code-*qTSN4* and Code-*qDTH8* rice lines at two different locations

Tasliah, Kurniawan Rudi Trijatmiko and Joko Prasetiyono
AIP Conference Proceedings **2462**, 030006 (2022); https://doi.org/10.1063/5.0075661

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Hybrid purity assessment in F_1 hybrids segregating for phytophthora root rot resistance genes of chili pepper (*Capsicum annuum* L.)

Fatimah, Reflinur, Joko Prasetiyono, Wartono, Kristianto Nugroho, Rinda Kirana, Dani Satyawan, Rerenstradika Tizar Terryana, Aqwin Polosoro, Puji Lestari and I. Made Tasma
AIP Conference Proceedings **2462**, 030007 (2022); https://doi.org/10.1063/5.0075160

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Characterization of genomic variation on three Indonesian oil palm genotypes analyzed using next-generation sequencing HiSeq

I. Made Tasma, Habib Rijzaani, Dani Satyawan, Ida Rosdianti, Edy Supriyanto and Razak Purba
AIP Conference Proceedings **2462**, 030008 (2022); https://doi.org/10.1063/5.0075392

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Cytological and molecular identifications of seedless tangerine derived from endosperm culture

Chaireni Martasari, Mia Kosmiatin, Ali Husni, Kurniawan Budiarto and Innez Candri Gilang Purnama
AIP Conference Proceedings **2462**, 030009 (2022); https://doi.org/10.1063/5.0076395

- SHOW ABSTRACT

FreeJanuary 2022

Improvement of sex determination of salak plant using sequence characterized amplified regions

Reflinur, Ma'sumah, Namira Nur Arfa, Budi Setiadi Daryono and Azis Natawijaya
AIP Conference Proceedings **2462**, 030010 (2022); https://doi.org/10.1063/5.0075698

Table of Contents

THE SECOND INTERNATIONAL CONFERENCE ON GENETIC RESOURCES AND BIOTECHNOLOGY: Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture

PREV

Conference date: 24–25 May 2021
Location: Bogor, Indonesia
ISBN: 978-0-7354-4172-9
Editors:

I Made Tasma, Dwinita Winkan Utami, Ika Roostika, Yadi Suryadi, Chaerani, Eny Ida Riyanti, Puji Lestari, Toto Hadiarto, Reflinur, Joko Prasetyono, Fatimah, Surya Diantina, Tru Puji Priyanto, Kusumawaty Kusumanegara, Wening Enggarini, Rerenstradika Tizar Terryana and Dani Satyawan
Volume number: 2462
Published: Jan 19, 2022

APPLICATION OF INNOVATIVE CROP IMPROVEMENT TECHNIQUES FOR CONSERVATION AND SUSTAINABLE USE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Design and *in vitro* test of sgRNA for the CRISPR/Cas9 plasmid construct of the *SQS* gene of *Artemisia annua* L.

Sri Koerniati
AIP Conference Proceedings **2462**, 040001 (2022); https://doi.org/10.1063/5.0075695

The efficacy of genetically modified (GM) corn Bt11 against *Ostrinia furnacalis* (Guenee) and *Helicoverpa armigera* (Hubner)

Bahagiawati and Diani Damayanti
AIP Conference Proceedings **2462**, 040002 (2022); https://doi.org/10.1063/5.0075312

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Construction and introduction of OsAER1::LeAlaAT cassette to improve the nitrogen use efficiency in rice cv. Mekongga

Atmitri Sisharmini, Aniversari Apriana, Intan Kamila, Aqwin Polosoro, Wening Enggarini, Tri Joko Santoso, Toto Hadiarto, Bahagiawati A. Husin and Kurniawan Rudi Trijatmiko
AIP Conference Proceedings **2462**, 040003 (2022); https://doi.org/10.1063/5.0075458

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Environmental safety assessment of genetically engineered potato resistant to late blight caused by *Phytophthora infestans*

Alberta Dinar Ambarwati, Eny Ida Riyanti, Edy Listanto, Tri Joko Santoso, Toto Hadiarto and Kusmana
AIP Conference Proceedings **2462**, 040004 (2022); https://doi.org/10.1063/5.0075612

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES

- SHARE
- EXPORT CITATION

FreeJanuary 2022

Backcrossing of soybean lines containing aluminium tolerance gene into superior soybean variety, Biosoy

Saptowo J. Pardal, Amalia Prihaningsih, Suharsono, Ratna Utari and Riri Sundasari
AIP Conference Proceedings **2462**, 040005 (2022); https://doi.org/10.1063/5.0075187

- SHOW ABSTRACT
-
- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Phenotypic and genetic stability evaluation of the targeted *GA20ox-2* gene mutation in CRISPR/Cas9 mutant rice derived from Mentong cultivar

Aniversari Apriana, Tri Joko Santoso, Atmitri Sisharmini, Reflinur, A. Dinar Ambarwati, Toto Hadiarto, Sustiprijatno and Nuryati
AIP Conference Proceedings **2462**, 040006 (2022); https://doi.org/10.1063/5.0075603

- SHOW ABSTRACT
-
- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Transformation of *csp* gene into tobacco plant mediated by *Agrobacterium tumefaciens*

Sustiprijatno, Seagames Waluyo and Suharsono
AIP Conference Proceedings **2462**, 040007 (2022); https://doi.org/10.1063/5.0075571

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

PLANT CELL AND TISSUE CULTURE FOR CONSERVATION AND EFFECTIVE UTILIZATION OF GENETIC RESOURCES

FreeJanuary 2022

The application of gamma ray irradiation to increase triterpenoid compounds in embryogenic calli of *Centella asiatica* L. Urban

Ika Roostika, Suci Rahayu and Nurliani Bermawie
AIP Conference Proceedings **2462**, 050001 (2022); https://doi.org/10.1063/5.0076402

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

The effect of $FeSO_4$ concentration on the callus growth of two chili (*Capsicum annuum* L.) varieties

Rossa Yunita, Endang Gati Lestari, Iswari S. Dewi, Mastur and Bambang Sapta Purwoko
AIP Conference Proceedings **2462**, 050002 (2022); https://doi.org/10.1063/5.0075223

- SHOW ABSTRACT
-
  - PDF

- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Evaluation of ratooning ability in several sweet sorghum (*Sorghum bicolor* [L.] Moench) mutant lines

Endang Gati Lestari, Iswari Saraswati Dewi, Rossa Yunita and Amin Nur
AIP Conference Proceedings **2462**, 050003 (2022); https://doi.org/10.1063/5.0075542

- SHOW ABSTRACT
-
- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Response of gamma ray irradiation derived-cultures of three sugarcane varieties to drought stress induced by polyethylene glycol

Ragapadmi Purnamaningsih and Suci Rahayu
AIP Conference Proceedings **2462**, 050004 (2022); https://doi.org/10.1063/5.0075185

- SHOW ABSTRACT
-
- PDF
- E-READER
- ADD TO FAVORITES
- SHARE
- EXPORT CITATION

FreeJanuary 2022

Sucrose and putrescine increased callus induction in tomato anther culture

Iswari Saraswati Dewi, Imam Nur Kholis, Bambang Sapta Purwoko and Ratna Ningsih
AIP Conference Proceedings **2462**, 050005 (2022); https://doi.org/10.1063/5.0075666

Field evaluation of elephant grass mutant lines (*Pennisetum purpureum* Schumach.) in highlands

Ali Husni, Muhammad Rifay, Mia Kosmiatin and Vyta W. Hanifah
AIP Conference Proceedings **2462**, 050006 (2022); https://doi.org/10.1063/5.0076418

Increasing drought tolerance of sugarcane through gamma ray irradiation and *in vitro* selection

Sri Suhesti, Syafaruddin, I. Ketut Ardana, Endang Hadipoentyanti and Rr. Sri Hartati
AIP Conference Proceedings **2462**, 050007 (2022); https://doi.org/10.1063/5.0076155

Cells density affects cell production of *Citrus limonia* in flask and air-lift bioreactor cultures and limonin farming

Dita Agisimanto, Farida Yulianti and Hidayatul Arisah
AIP Conference Proceedings **2462**, 050008 (2022); https://doi.org/10.1063/5.0075651

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

THE USE OF MICROBIAL GENETIC RESOURCES AS BIOLOGICAL CONTROL AGENTS OF AGRICULTURAL PESTS AND DISEASES, AND FOR SOIL BIOREMEDIATION

FreeJanuary 2022

In Silico functional prediction of CAS2, a protein specifically expressed in appressorium and required for pathogenicity of *Colletotrichum gloeosporioides*

Tri Puji Priyatno, Farah Diba Abu Bakar, Rohaiza Ahmad Redzuan, Abdul Munir Abdul Murad and Ifa Manzila
AIP Conference Proceedings **2462**, 060001 (2022); https://doi.org/10.1063/5.0075625

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Biofertilizer increases nutrient use efficiency (NUE) of nitrogen, phosphorus, and potassium at leaves level of *Artemisia annua* L.

Wiguna Rahman, Arthur A. Lelono, Erwin Al Hafiizh and Tri Muji Ermayanti
AIP Conference Proceedings **2462**, 060002 (2022); https://doi.org/10.1063/5.0075503

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Effect of nitrogen fixation and phosphate solubilizing bacteria on growth and yield of lowland rice in different soil type

Ikhwani, Higa Afza, Siti Yuriyah and Waluyo
AIP Conference Proceedings **2462**, 060003 (2022); https://doi.org/10.1063/5.0077914

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Morphological, physiological, and molecular identification and characterization of yeast isolated from Indonesian fruits and woods

Rerenstradika Tizar Terryana, Nazhirotul Ilmiyah, Inda Setyawati, Titin Haryati, Karden Mulya, Eny Ida Riyanti, Yudi Sastro and Puji Lestari
AIP Conference Proceedings **2462**, 060004 (2022); https://doi.org/10.1063/5.0075170

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

The effect of coating application using chitosan enzymatic depolymerization on anthracnose disease suppression in mango (*Mangifera indica* L.) cv. 'Arumanis'

Yadi Suryadi, Dwi Ningsih Susilowati, I. Made Samudra, Alina Akhdiya and Karsinah
AIP Conference Proceedings **2462**, 060005 (2022); https://doi.org/10.1063/5.0075183

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Understanding yeast tolerance as cell factory for bioethanol production from lignocellulosic biomass

Eny Ida Riyanti and Edy Listanto
AIP Conference Proceedings **2462**, 060006 (2022); https://doi.org/10.1063/5.0075157

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Isolation and pathogenicity test of fusarium basal rot and purple blotch fungal pathogens from shallot and *Allium* spp

Chaerani, Ragapadmi Purnamaningsih and Suci Rahayu
AIP Conference Proceedings **2462**, 060007 (2022); https://doi.org/10.1063/5.0075209

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Morphological characters and efficacy of thirteen entomopathogenic fungi of *Aschersonia aleyrodis* Webber isolates on whitefly (*Bemisia tabaci* Gennadius)

Yusmani Prayogo, Marida Santi Yudha Ika Bayu, Sri Wahyuni Indiati and Made Jana Mejaya
AIP Conference Proceedings **2462**, 060008 (2022); https://doi.org/10.1063/5.0076067

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Physicochemical characteristics of yoghurt from various beans and cereals

Heny Herawati, Diana Nur Afifah, Eni Kusumaningtyas, Sri Usmiati, Agus S. Soemantri, Miskiyah, Elmi Kamsiati and Muchamad Bachtiar
AIP Conference Proceedings **2462**, 060009 (2022); https://doi.org/10.1063/5.0075712

- SHOW ABSTRACT

-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

The potential use of zeolite and exopolysaccharide bacteria for reduction of degradation and carbon emission on oil palm plantation in tropical peatland

Laksmita P. Santi, Haryo T. Prakoso and Donny N. Kalbuadi
AIP Conference Proceedings **2462**, 060010 (2022); https://doi.org/10.1063/5.0075506

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

FreeJanuary 2022

Application of phosphate solubilizing microbes to promote the effectiveness of rock phosphate on cacao seedling growth in acid soil

Kurnia Dewi Sasmita, Iswandi Anas, Syaiful Anwar, Sudirman Yahya and Gunawan Djajakirana
AIP Conference Proceedings **2462**, 060011 (2022); https://doi.org/10.1063/5.0075843

- SHOW ABSTRACT
-
  - PDF
  - E-READER
  - ADD TO FAVORITES
  - SHARE
  - EXPORT CITATION

Characterization of Japansche citroen rootstock somaclones and *in vitro* selection for aluminium tolerance

Cite as: AIP Conference Proceedings **2462**, 020008 (2022); https://doi.org/10.1063/5.0077888
Published Online: 19 January 2022

Deden Sukmadjaja, Mia Kosmiatin and Tiwi Wati

Characterization of Japansche Citroen Rootstock Somaclones and *In Vitro* Selection for Aluminium Tolerance

Deden Sukmadjaja[1, a)], Mia Kosmiatin[1] and Tiwi Wati[2]

[1]*Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, IAARD, Jln. Tentara Pelajar No. 3A, Bogor 16111, West Java, Indonesia*
[2]*Udayana University, Jln. Raya Kampus Unud, Jimbaran 80361, Bali, Indonesia*

[a)]Corresponding author: deden_sukmadjaja@yahoo.com

Abstract. Japansche citroen (JC) is a type of citrus which is widely used as rootstock in citrus cultivation. In order to expand citrus cropping on marginal acid land, a JC citrus clones that are tolerant of acid soil conditions are needed. Therefore, it is necessary to assemble the citrus genotype by increasing genetic diversity to obtain tolerant traits for aluminum and low pH. In this study, mutation induction experiments with gamma ray irradiation were carried out, followed by *in vitro* selection methods. The aims of this research was to increase genetic variation of JC citrus through induced mutation by gamma ray irradiation and to obtain candidates of JC citrus somaclones that are tolerant to Al at low pH. The research was conducted at the Tissue Culture Laboratory, Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIOGRAD), Bogor. The plant material used was JC citrus plantlet from immature embryos treated with gamma ray irradiation at doses of 0, 4.5, 5, and 5.5 Gy. Evaluation was conducted to morphological characters, followed by *in vitro* selection for tolerance to Al at low pH by using selecting agent of aluminium trichloride hexahydrate. The results showed that morphological variations found in JC citrus somaclones after being irradiated with gamma rays, including the formation of the winged leaves (*unifoliolatus*) that are not found in the control JC. There were 32 selected somaclones to be tolerant to Al at low pH.

INTRODUCTION

Orange is one type of fruit that is popular and widely consumed by the people of Indonesia. The consumption of citrus fruits in Indonesia has increased from year to year. Consumption of citrus fruit in the years 1995–2014 has increased by 11.65% per year [1]. Meanwhile, the national citrus productivity tends to decline. In 2011 the production of oranges amounted to 1,721,880 tons to 1,498,394 tons in 2012, in 2014 the production of oranges was 1,785,256 tons to 1,744,330 tons in 2015 [1]. The reduced productivity of oranges is caused by pests and diseases, especially citrus vein phloem degeneration (CVPD), and a reduction in fertile land due to the shift in function outside the agricultural sector [2].

The change in the function of the planting area on fertile soils out of the agricultural sector causes the agricultural area to be pushed over. Therefore, the use of marginal land is one way that can be used as agricultural area. Indonesia has marginal acid land that can be used for the development of annual crops including citrus plants of 50.94 million ha spread across Sumatra, Kalimantan, Papua, Maluku, Java, and Sulawesi [3]. The problem of using marginal acid land for agricultural land is that it requires high costs and labor, because it requires high liming and fertilization to improve the quality of the soil [4].

With the widespread marginal acid dry land and the transition of fertile agricultural areas, the use of citrus rootstock plant types or cultivars that are tolerant of acid soils is the most effective and efficient way to overcome the development of citrus farming in acid soils, so that production costs can be minimized possible [4]. In addition, these plants must also have high genetic compatibility with scion, be disease resistant and have a good root system [5]. Japansche citroen (JC) is a type of citrus that is widely used as rootstock by citrus breeders in Indonesia. The rootstock of JC is most preferred because of its wide adaptability, drought tolerance, and high salinity. However, JC

The Second International Conference on Genetic Resources and Biotechnology
AIP Conf. Proc. 2462, 020008-1–020008-8; https://doi.org/10.1063/5.0077888
Published by AIP Publishing. 978-0-7354-4172-9/$30.00

is sensitive to several diseases, such as CVPD, *Citrus tristeza virus* (CTV), *Citrus exocortis viroid* (CEV), and root and stem rot disease [6]. It is easily available in various regions in Indonesia, such as East Java, Central Java, South Sulawesi, North Sumatra, and Bali [7]. In addition, JC in Indonesia is widely used as a rootstock because it has several advantages, one of which is the compatibility between rootstock and scion, so that it has a positive effect on plant survival and productivity [8]. Although JC can provide several good properties, JC oranges are not tolerant to aluminum (Al) stress and low pH, and are not resistant to root rot disease of *Phytopthora* sp. [9].

To overcome this, it is necessary to assemble citrus through increasing genetic variation followed by *in vitro* selection methods in order to obtain traits that are tolerant of Al and low pH. The combination of physical (irradiation) and chemical treatment (Al simulation with low pH) on embryogenic cell populations of JC citrus in *in vitro* media is one way to obtain superior JC citrus plants, which can be used as rootstocks that are tolerant of Al toxicity and low pH in acid soils [4]. In addition, mutation induction with physical mutagens such as gamma ray irradiation in tissues or a group of cells (callus) is an alternative to obtain the desired variant. This variant can be seen from the change in morphology of the irradiated plants [10]. This is evident from the research conducted by Pramono [11] that the morphological form of the first leaves of the *iles-iles* plant at a dose of 10 Gy is the malformation of the leaves, as well as the emergence of variegata leaves (leaves that have a different color from the original, which are generally located adjacent to one part of the plant), the abnormality does not appear in the second or third leaves. In addition, plants irradiated with 10 Gy had a longer vegetative period and resulted in a longer plant life than the control. Therefore, in this study, mutation induction with gamma rays and *in vitro* selection was carried out using Al with different doses in the direction to analyze morphological characters and to obtain JC rootstock that tolerant to Al at low pH.

Several studies to increase cell tolerance to Al have been conducted. *In vitro* selection to obtain Al tolerant plants has been carried out on potato plants [12]. Sutjahjo [13] also carried out an *in vitro* selection for tolerance to Al who carried out research on four genotypes of maize. In addition, Mariska *et al.* [14] conducted research on soybean plants and found that *in vitro* selection could be used to increase soybean plant tolerance to Al stress and low pH, where the resulting traits could be passed on to the next generation. This research aims to obtain the variability of JC citrus through induction of gamma ray mutations as well as to obtain candidates for JC citrus plants that are tolerant of Al toxicity at low pH.

MATERIALS AND METHODS

The research was conducted from December 2018 to May 2019. Gamma ray irradiation was carried out at the Central Laboratory for Isotope and Irradiation Application (PAIR), BATAN, Jakarta. The research was conducted at the Tissue Culture Laboratory, Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIOGRAD), Bogor.

The research was carried out in two stages: (1) increasing the genetic variation by induced mutation by gamma ray irradiation, and (2) *in vitro* selection to Al stress at low pH. The plant material used in the first stage of the study was an embryo measuring ±3 mm from 1-month-old young JC citrus. The JC embryos were irradiated with gamma rays at doses of 0, 4.5, 5, and 5.5 Gy. A total of 10 embryos were planted on Murashige & Skoog basal media with Morel & Weitmore vitamins (VMW media) in 200 ml culture jar, incubated in a culture room with ±800 lux fluorescent light, for 16 h/day at 21–25°C. The experimental design used was a completely randomized design (CRD) with one factor, namely the dose of gamma ray irradiation. Observations were conducted on culture growth with the parameters of the number of germinated embryos, leaves, roots, lateral shoots, root length, and leaf morphology.

The sprouts or plantlets grown from each treatment in the first stage of the experiment were transferred to selection media containing $AlCl_3.6H_2O$ at low pH. The selection media used were modified MS basic media (MSKd) with the selection component of $AlCl_3.6H_2O$ at concentrations of 0, 250, 500, and 750 ppm with low acidity at pH 4 and VMW media with pH 4 and 5.8 as controls. The research design in the *in vitro* selection experiment for Al tolerance at low pH with the selection component of $AlCl_3.6H_2O$ was a two-factor CRD. Each treatment was repeated seven times. Selection was carried out for 8 weeks. After the selection, the culture was transferred to VMW recovery media without ZPT. During selection and recovery the cultures were stored in the culture room in light conditions (1,000 lux) for 16 h/day at 22–24°C [4]. Observations were conducted on shoot height, number of shoots, chlorotic leaves, number of leaves, number of nodes, number of roots, and root length. Data were analyzed using analysis of variance (ANOVA) analysis of variance with SPSS v22.0 for Windows at the real level $\alpha<5\%$.

RESULTS AND DISCUSSIONS

Increased Genetic Diversity with Gamma Ray Irradiation and Germination of JC Globular Embryos

Table 1 shows the number of nucellar embryos that germinated after being treated with mutation induction at several doses of gamma ray irradiation. In general, radiation administration increased the number of normal germinating nucellar embryos, however, an increase in radiation dose did not show a correlation with an increase in the number of normal sprouts.

TABLE 1. Germination of JC embryos after induced mutation at several levels of irradiation, 30 days age.

Irradiation (Gy)	Number of embryo cultured	Normal		Abnormal	
		Number	(%)	Number	(%)
0	34	10	29.41	24	70.59
4.5	96	49	51.04	47	48.96
5.0	199	98	49.25	101	50.75
5.5	114	74	64.91	40	35.09

Irradiation treatment caused decreasing the number of organs formed of gamma-irradiated cultures. This can be seen from all the parameters of the irradiated plant organs that have lower values than those without irradiation (Table 2). Fig. 1 shows the cultures of irradiated JC embryos. The number of organs was not significantly different, except the formation of lateral shoots. The increase in variation could be detected in leaf morphology. It indicated that the shape, tip, and edge of the leaves were not different, but the base of the leaves was different, which are called winged leaves and wingless leaves (Fig. 2). The number of leaf bases without wings was higher than that of winged leaves. The base of the leaves without wings in each treatment is more than 50%. The highest number of winged base leaves was at a dose of 5.5 Gy with as much as 35.63%. The control also found a winged base, but it had the lowest percentage compared to irradiated explants (Fig. 3).

TABLE 2. Number of organs from gamma-irradiated cultures, 8 weeks after planting.

Irradiation (Gy)	Number of							
	Leaf	SD	Root	SD	Lateral shoot	SD	Node	SD
0	6.98	3.63	1.58	1.21	1.02	0.74	4.88	2.35
4.5	4.94	2.10	0.99	0.74	0.91	0.61	3.46	1.77
5.0	4.25	1.68	0.95	0.84	0.89	0.70	3.09	1.29
5.5	4.45	1.71	1.05	0.85	0.55	0.55	3.21	1.77

SD = standard deviation.

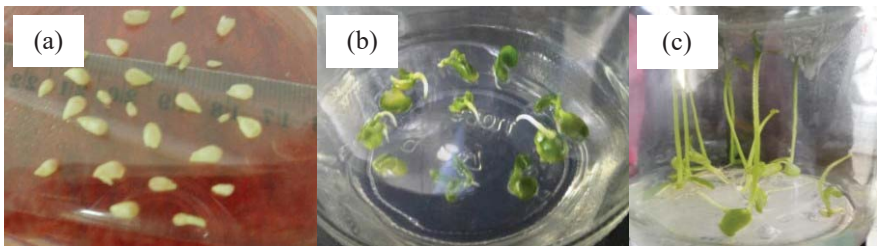

FIGURE 1. Germination of orange JC embryos after induced mutation by gamma ray irradiation. (a) Explant of nucellar embryos. (b) Germination of nucellar embryos. (c) Plantlets from nucellar embryos used for testing of tolerance to aluminum.

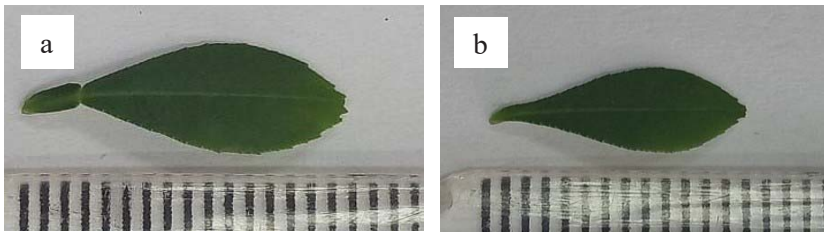

FIGURE 2. Morphological variation of JC citrus leaves. (a) Petiole winged. (b) Without petiole wing.

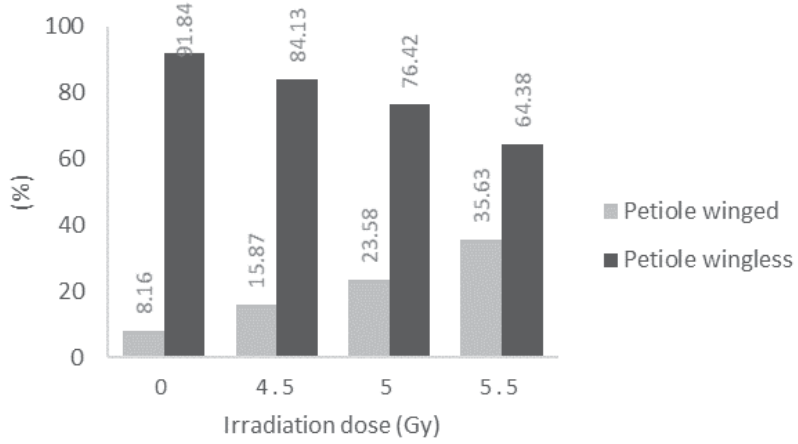

FIGURE 3. Percentage of winged and wingless JC petiole leaves after gamma ray irradiation.

In Vitro Selection for Tolerance to Aluminum (Al) Stress

In general, the growth of all organs on the VMW control media (both at pH 5.8 and 4) was better than that in the selection media. The growth of cultures planted on MS media with the addition of vitamin VMW was better than those planted on MSKd media. This is because the VMW media contains Ca-pantothenate and biotin, which play a role in the formation of cell membranes and the process of mitosis, and increase the multiplication of shoots and roots in *in vitro* culture. Meanwhile, biotin functions as an enzyme cofactor, where the use of biotin can stimulate callus growth, optimize embryogenesis, and increase the number and size of embryos.

Irradiation treatment tend to suppress culture growth in most of the growing organs. Meanwhile, an increase in the concentration of the Al selection component reduced the growth in some plant organs, but on the other hand it did not show an effect on other organs. High Al concentrations caused damage plant cells. Al is toxic to plants in the form of the trivalent Al^{3+} ion, which is dominant in acid conditions [15]. The low increase in leaf number is also influenced by genotype and environment. Leaf position in plants (number of plastochrons), which is mainly controlled by genotype, also has a significant effect on leaf growth rate [16]. Some plant organs have determinate growth patterns, while other organs are indeterminate. The determinate growth pattern is characterized by the growth of the organ until it reaches its maximum size, then the growth stops, the organ grows old (senescence) and finally falls out. One of the plant organs that has a determinate growth pattern is leaves [17].

The dose of 5 Gy was able to provide root addition in all media treatments, both VMW and MSK, with the addition of Al. It was assumed that the application of gamma ray irradiation can increase genetic variation, including to increase their tolerannce to Al and low pH. Induction treatment at a dose of 5 Gy was able to increase root growth in the treatment of selection media with 750 ppm Al, which at other doses including control did not cause additional roots. The selection media containing of 750 ppm Al did not affect on the number of root at 0, 4.5, and 5.5 Gy. This is probably because Al is able to stop the phytochemical properties and biological functions of plants.

TABLE 3. Number of organs originating from explants without irradiation on various selection media, 8 weeks after planting.

No.	Media selection	Number of				Root length	Shoot height
		Leaf	Node	Root	Shoot		
1	VMW pH 5.8	2.43	2.00	0.29	0.29	3.33	0.62
2	VMW pH 4.0	1.57	2.29	0.71	0.00	3.43	0.77
3	MSKd Al 0	1.57	1.14	0.29	0.43	0.82	0.59
4	MSKd Al 250	2.29	1.43	0.14	0.43	0.14	0.65
5	MSKd Al 500	2.29	1.57	0.00	0.43	0.23	0.53
6	MSKd Al 750	1.43	1.71	0.00	0.14	0.10	0.39

VMW = MS basal media with Morel & Weitmore vitamins, MSKd = modified MS basal media.

TABLE 4. The number of organs derived from explants irradiated by 4.5 Gy on various selection media, 8 weeks after planting.

No.	Media selection	Number of				Root length	Shoot height
		Leaf	Node	Root	Shoot		
1	VMW pH5.8	3.00	2.43	0.14	0.00	3.34	0.70
2	VMW pH4.0	3.57	2.57	0.57	0.14	8.66	0.81
3	MSKd Al 0	5.43	3.57	0.86	0.29	0.74	0.47
4	MSKd Al 250	1.57	1.29	0.00	0.00	0.14	0.10
5	MSKd Al 500	2.00	1.71	0.00	0.14	0.20	0.41
6	MSKd Al 750	2.71	2.43	0.00	0.00	0.33	0.25

VMW = MS basal media with Morel & Weitmore vitamins, MSKd = modified MS basal media.

TABLE 5. The number of plant organs derived from explants irradiated by 5 Gy on various selection media, 8 weeks after planting.

No.	Media selection	Number of				Root length	Shoot height
		Leaf	Node	Root	Shoot		
1	VMW pH5.8	3.71	3.71	0.43	0.14	8.29	0.69
2	VMW pH4.0	3.43	3.14	0.71	0.29	4.26	0.81
3	MSKd Al 0	2.29	1.86	0.71	0.00	3.47	0.55
4	MSKd Al 250	1.43	1.29	0.29	0.00	0.28	0.43
5	MSKd Al 500	1.71	1.71	0.29	0.00	0.30	0.31
6	MSKd Al 750	2.00	1.14	0.14	0.00	0.35	0.30

VMW = MS basal media with Morel & Weitmore vitamins, MSKd = modified MS basal media.

TABLE 6. Number of plant organs derived from explants irradiated by 5.5 Gy on various selection media, 8 weeks after planting.

No.	Media selection	Number of				Root length	Shoot height
		Leaf	Node	Root	Shoot		
1	VMW pH5.8	2.00	1.86	0.00	0.00	0.96	0.63
2	VMW pH4.0	3.14	2.57	0.29	0.14	4.05	0.47
3	MSKd Al 0	1.43	1.00	0.57	0.00	0.34	0.27
4	MSKd Al 250	1.57	1.00	0.00	0.29	0.15	0.33
5	MSKd Al 500	1.29	1.29	0.14	0.00	0.39	0.19
6	MSKd Al 750	0.86	1.14	0.00	0.00	0.15	0.19

VMW = MS basal media with Morel & Weitmore vitamins, MSKd = modified MS basal media.

Selection media containing Al affects the formation and growth of roots. The roots in the selection medium generally experience a color change from whitish green to brownish green to brown and morphology. Roots that are formed in media that do not contain Al will form root hairs and have a root cap that is useful for accelerating nutrient absorption. Meanwhile, those grown on media containing Al looked compact at the root tips and no root caps were visible. Roots that have tolerance to Al will form new roots or root branching (Fig. 4). Root damage in plants begins with interference with the root cap, which has a signal and is a detector of gravity force and mechanical tolerance, so that in turn it reduces the secretion of root cap cell mucilage where the cell is a source of endogenous growth regulators. According to Jones and Kochian [18], roots treated with Al will inhibit the extension of the cells and cause the root tips to swell and when given Al for longer it causes inhibition of elongation and division of root cells. Yamamoto *et al*. [19] found that Al toxicity in addition to causing plant nutrient deficiency also changes the structure and function of the plasma membrane and inhibits cell division at the root tips.

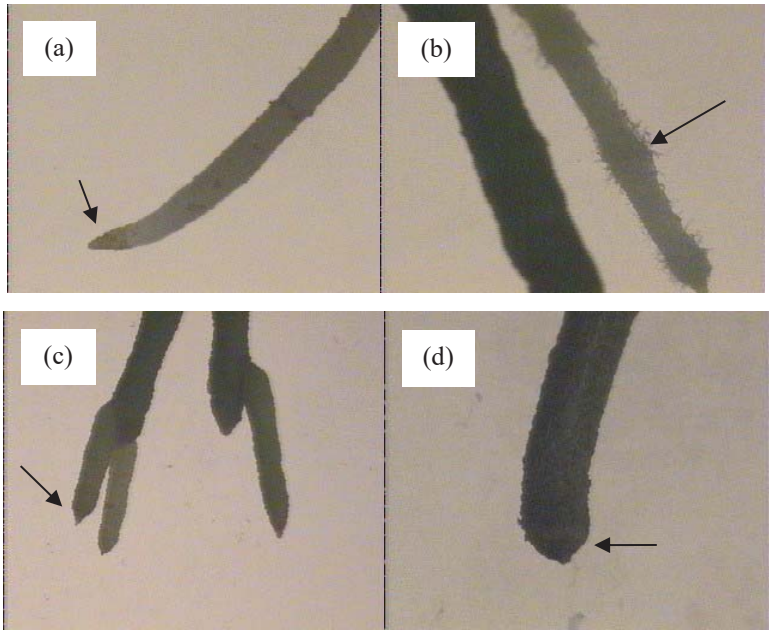

FIGURE 4. Results of root observation under a 10 × 10 magnification microscope. (a) Root cap. (b) Root hairs. (c) Root branches. (d) Compact root tips.

The increase in the number and height of shoots was only slightly in all treatments, this indicates that the presence of Al is thought to have caused damage to the root cap, thereby disrupting growth and culture development. According to MacDiarmid and Gardner [20], plants will reduce their root system and show various symptoms of nutrient deficiency due to Al poisoning.

JC citrus cultures that were susceptible to Al will show symptoms of wilting, leaves experiencing chlorosis, shoots turning brown, and stunted plant growth (Fig. 5). Enggarini and Marwani [21] stated that the symptoms of Al stress include stunted root growth, chlorosis, nutritional deficiency, and stunted plants.

Deficiency symptoms in explants, such as brown or yellow leaves, cause the development and growth of plants to be disturbed. Santoso and Nursandi [22] stated that browning is a character that appears brown or black, which often prevents growth and development of cultured plants. Chlorosis in plants begins with the appearance of yellow and brown on the leaves until finally all parts of the explants appear to be wilted.

Based on the results of observations of root growth, there were 32 culture numbers that grew on 500 and 750 ppm Al selection media. This result is considered an Al tolerant candidate because it has increased root length and not damage of root tips. Reported by Samuel *et al.* [23] who determined that there are two criteria for plants that are tolerant of Al stress, one of which is that the roots are able to grow continuously, and the root tips are not damaged. Somaclones considered Al tolerant are then numbered for further research on these plant mutants.

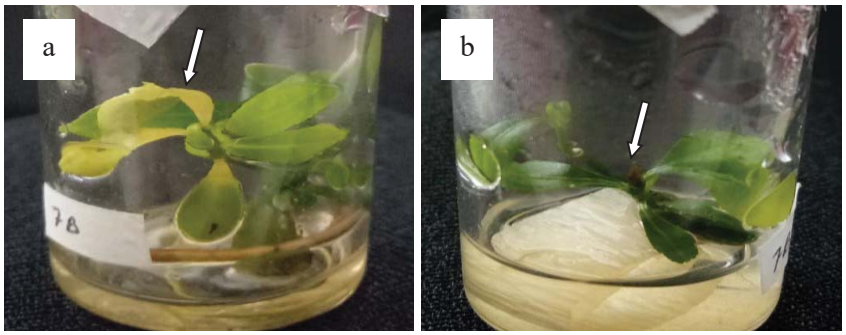

FIGURE 5. Symptoms of deficiency in JC citrus culture on selection media containing Al. (a) Leaves that turn yellow on MSKd 750 ppm Al media. (b) Shoots tip turn brown on MSKd 250 ppm Al media.

CONCLUSION

Increasing genetic variation of JC *in vitro* cultures occured after gamma ray irradiation of nucellar embryos. *In vitro* selection by using $AlCl_3.6H_2O$ selecting agent combined with low acidity (pH 4) of media culture could screened Al tolerant somaclones. There were 32 somaclones of JC citrus that were tolerant to Al stress.

ACKNOWLEDGMENTS

The authors thank to Ir. Mastur, M.Si., Ph.D., Director of ICABIOGRAD for the research fund support. The authors are also grateful to Sukmawan for his excellent technical assistance.

REFERENCES

1. Statistics Indonesia, *Harvested Area, Productivity, and Production of Orange* (BPS Statistics Indonesia, Jakarta, 2015).
2. Martias, J. Hortik. **14(1)**, 33–40 (2004).
3. A. K. Makarim, *Makalah Seminar Nasional Pemanfaatan Bioteknologi untuk Mengatasi Cekaman Abiotik pada Tanaman* (BB Biogen, Bogor, 2005).
4. M. Kosmiatin, R. Yunita and A. Husni, J. AgroBiogen **6(1)**, 33–39 (2010).
5. P. Spiegel-Roy and E. E. Goldschmidt, *Biology of Citrus* (Cambridge University Press, London, 1996), 230 pp.
6. A. Supriyanto and Setiono, "Evaluasi keragaan pertumbuhan vegetatif 10 varietas jeruk komersial pada empat varietas batang bawah di kabupaten Sambas, Kalimantan Barat," in *Prosiding Seminar Nasional Jeruk Tropika Indonesia, Pusat Penelitian dan Pengembangan Hortikultura* (Badan Penelitian dan Pengembangan Pertanian, Jakarta, 2006), pp. 212–220.
7. A. Sugiyatno, L. Setyobudi, M. D. Maghfoer and A. Supriyanto, J. Hortik. **23(4)**, 329–338 (2013).
8. R. Poerwanto, S. Susanto and S. S. Harjadi, "Pengembangan jeruk unggulan di Indonesia," in *Makalah Semiloka Nasional Pengembangan Jeruk dan Pameran Jeruk Unggulan 10–11 Juli 2002* (Direktorat Jendral Bina Produksi Hortikultura, Bogor, 2002), 25 p.
9. R. Triatminingsih and Karsinah, J. Hortik. **14(4)**, 238–245 (2004).
10. S. H. Sutjahjo, A. Kadir and I. Mariska, J. Ilmu-Ilmu Pertan. Indones. **9(1)**, 48–57 (2007).
11. S. Pramono, "Studi irradiasi sinar gama pada tanaman iles-iles (*Amorphophallus muelleri* Blume)," Bachelor thesis, Institut Pertanian Bogor, 2011.
12. G. Wersuhn, T. Kalettka, R. Gienapp, G. Reinke and D. Schultz, J. Plant Physiol. **143(1)**, 92–95 (1994).
13. S. H. Sutjahjo, J. Akta Agrosia **9(2)**, 61–66 (2006).
14. I. Mariska, E. Sjamsudin, D. Sopandie, S. Hutami, A. Husni, M. Kosmiatin and N. Vivi, J. Litbang Pertan. **23(2)**, 46–52 (2004).
15. E. Delhaize and P. R. Ryan, Plant Physiol. **107**, 315–321 (1995).
16. F. P. Gardrner, R. B. Pearce and R. L. Mitchell, *Fisiologi Tanaman Budidaya* (UI Press, Jakarta, 1991), 428 pp.

17. B. Lakitan, *Fisiologi Pertumbuhan dan Perkembangan Tanaman* (PT Raya Grafindo Persada, Jakarta, 1996), 218 pp.
18. L. D. Jones and L. V. Kochian, Plant Cell **7**, 1913–1922 (1995).
19. Y. Yamamoto, K. Ono, K. Mametsuka, M. Kasai and H. Matsumoto, Plant Cell Physiol. 404–406 (1995).
20. C. W. MacDiarmid and R. C. Gardner, Plant Physiol. **122**, 1101–1109 (1996).
21. W. Enggarini and E. Marwani, J. AgroBiogen **2**, 24–28 (2006).
22. U. Santoso and F. Nursandi, *Kultur Jaringan Tanaman* (Universitas Muhammadiyah Malang, Malang, 2003), 191 pp.
23. T. D. Samuel, K. Kucukakyuz and M. Rincon-Zachary, Plant Physiol. **113**, 527–534 (1997).