

ISSN: 1412-033X  
E-ISSN: 2085-4722

# BIODIVERSITAS

**Journal of Biological Diversity**

Volume 22 - Number 4 - April 2021

*Front cover: Nycticebus javanicus* É. Geoffroy, 1812  
(PHOTO: ADENG BUSTOMI)

---

Published monthly

PRINTED IN INDONESIA

ISSN: 1412-033X

E-ISSN: 2085-4722



9 771412 033757



9 772085 472751

# BIODIVERSITAS

Journal of Biological Diversity  
Volume 22 – Number 4 – April 2021

ISSN/E-ISSN:

1412-033X (printed edition), 2085-4722 (electronic)

## EDITORIAL BOARD:

**Abdel Fattah N.A. Rabou** (Palestine), **Agnieszka B. Najda** (Poland), **Ajay Kumar Gautam** (India), **Alan J. Lymbery** (Australia), **Annisa** (Indonesia), **Bambang H. Saharjo** (Indonesia), **Daiane H. Nunes** (Brazil), **Darlina Md. Naim** (Malaysia), **Ghulam Hassan Dar** (India), **Hassan Pourbabaei** (Iran), **Joko R. Witono** (Indonesia), **Kartika Dewi** (Indonesia), **Katsuhiko Kondo** (Japan), **Kusumadewi Sri Yulita** (Indonesia), **Livia Wannorp** (Sweden), **M. Jayakara Bhandary** (India), **Mahdi Reyahi-Khoram** (Iran), **Mahendra K. Rai** (India), **Mahesh K. Adhikari** (Nepal), **Maria Panitsa** (Greece), **Mochamad A. Soendjoto** (Indonesia), **Mohib Shah** (Pakistan), **Mohamed M.M. Najim** (Srilanka), **Nurhasanah** (Indonesia), **Praptiwi** (Indonesia), **Rasool B. Tareen** (Pakistan), **Sayed Aliakbar Hedayati** (Iran), **Sayed Mehdi Talebi** (Iran), **Shahabuddin** (Indonesia), **Shahir Shamsir** (Malaysia), **Shri Kant Tripathi** (India), **Subhash C. Santra** (India), **Sugeng Budiharta** (Indonesia), **Sugiyarto** (Indonesia), **Taufiq Purna Nugraha** (Indonesia), **Yosep S. Mau** (Indonesia)

## EDITOR-IN-CHIEF:

**S u t a r n o**

## EDITORIAL MEMBERS:

English Editors: **Graham Eagleton** (grahameagleton@gmail.com), **Suranto** (surantouns@gmail.com); Technical Editor: **Solichatun** (solichatun\_s@yahoo.com), **Artini Pangastuti** (pangastuti\_tutut@yahoo.co.id); Distribution & Marketing: **Rita Rakhmawati** (oktia@yahoo.com); Webmaster: **Ari Pitoyo** (aripitoyo@yahoo.com)

## MANAGING EDITORS:

**Ahmad Dwi Setyawan** (unsjournals@gmail.com)

## PUBLISHER:

The Society for Indonesian Biodiversity

## CO-PUBLISHER:

Department of Biology, Faculty of Mathematics and Natural Sciences, Sebelas Maret University, Surakarta

## ADDRESS:

Jl. Ir. Sutami 36A Surakarta 57126. Tel. +62-271-7994097, Tel. & Fax.: +62-271-663375, email: editors@smujo.id

## ONLINE:

biodiversitas.mipa.uns.ac.id; smujo.id/biodiv

.....



**Society for Indonesia  
Biodiversity**



**Sebelas Maret University  
Surakarta**

## GUIDANCE FOR AUTHORS

**Aims and Scope** *Biodiversitas*, *Journal of Biological Diversity* or abbreviated as *Biodiversitas* encourages submission of manuscripts dealing with all biodiversity aspects of plants, animals and microbes at the level of the gene, species, and ecosystem as well as ethnobiology.

**Article types** The journal seeks original full-length research papers, reviews, and short communication. Manuscript of original research should be written in no more than 8,000 words (including tables and picture), or proportional with articles in this publication number. Review articles will be accommodated, while, short communication should be written at least 2,000 words, except for pre-study.

**Submission** The journal only accepts online submission, through open journal system (<https://smujo.id/biodiv/about/submissions>) or email to the editors at [unsjournals@gmail.com](mailto:unsjournals@gmail.com). Submitted manuscripts should be the original works of the author(s). The manuscript must be accompanied by a cover letter containing the article title, the first name and last name of all the authors, a paragraph describing the claimed novelty of the findings versus current knowledge. Submission of a manuscript implies that the submitted work has not been published before (except as part of a thesis or report, or abstract); and is not being considered for publication elsewhere. When a manuscript written by a group, all authors should read and approve the final version of the submitted manuscript and its revision; and agree the submission of manuscripts for this journal. All authors should have made substantial contributions to the concept and design of the research, acquisition of the data and its analysis; drafting of the manuscript and correcting of the revision. All authors must be responsible for the quality, accuracy, and ethics of the work.

**Ethics** Author(s) must obedient to the law and/or ethics in treating the object of research and pay attention to the legality of material sources and intellectual property rights.

**Copyright** If and when the manuscript is accepted for publication, the author(s) still hold the copyright and retain publishing rights without restrictions. Authors or others are allowed to multiply article as long as not for commercial purposes. For the new invention, authors are suggested to manage its patent before published.

**Open access** The journal is committed to free-open access that does not charge readers or their institutions for access. Readers are entitled to read, download, copy, distribute, print, search, or link to the full texts of articles, as long as not for commercial purposes. The license type is CC-BY-NC-SA.

**Acceptance** The only articles written in English (U.S. English) are accepted for publication. Manuscripts will be reviewed by editors and invited reviewers(double blind review) according to their disciplines. Authors will generally be notified of acceptance, rejection, or need for revision within 1 to 2 months of receipt. The manuscript is rejected if the content does not in line with the journal scope, does not meet the standard quality, inappropriate format, complicated grammar, dishonesty (i.e. plagiarism, duplicate publications, fabrication of data, citations manipulation, etc.), or ignoring correspondence in three months. The primary criteria for publication are scientific quality and biodiversity significance. **Uncorrected proofs** will be sent to the corresponding author by email as .doc or .docx files for checking and correcting of typographical errors. To avoid delay in publication, corrected proofs should be returned in 7 days. The accepted papers will be published online in a chronological order at any time, but printed in the early of each month (12 times).

**A charge** Starting on January 1, 2019, publishing costs waiver is granted to authors of graduate students from **Least Developed Countries**, who first publish the manuscript in this journal. However, other authors are charged USD 250 (IDR 3,500,000). Additional charges may be billed for language editing, USD 75-150 (IDR 1,000,000-2,000,000).

**Reprints** The sample journal reprint is only available by special request. Additional copies may be purchased when ordering by sending back the uncorrected proofs by email.

**Manuscript preparation** Manuscript is typed on A4 (210x297 mm<sup>2</sup>) paper size, in a single column, single space, 10-point (10 pt) Times New Roman font. The margin text is 3 cm from the top, 2 cm from the bottom, and 1.8 cm from the left and right. Smaller lettering size can be applied in presenting table and figure (9 pt). Word processing program or additional software can be used, however, it must be PC compatible and Microsoft Word based (.doc or .rtf, not .docx). **Scientific names** of species (incl. subspecies, variety, etc.) should be written in italic, except for italic sentence. Scientific name (genera, species, author), and cultivar or strain should be mentioned completely for the first time mentioning it in the body text, especially for taxonomic manuscripts. Name of genera can be shortened after first mentioning, except generating confusion. Name of the author can be eliminated after first mentioning. For example, *Rhizopus oryzae* L. UICC 524, hereinafter can be written as *R. oryzae* UICC 524. Using trivial name should be avoided, otherwise generating confusion. **Biochemical and chemical nomenclature** should follow the order of the IUPAC - IUB. For DNA sequence, it is better used Courier New font. Symbols of standard chemical and abbreviation of chemistry name can be applied for common and clear used, for example, completely written butilic hydroxyl toluene (BHT) to be BHT hereinafter. **Metric measurement** use IS denomination, usage other system should follow the value of equivalent with the denomination of IS first mentioning. Abbreviations set of, like g, mg, mL, etc. do not follow by dot. Minus index (m<sup>-2</sup>, L<sup>-1</sup>, h<sup>-1</sup>) suggested to be used, except in things like "per-plant" or "per-plot". **Equation of mathematics** does not always can be written

down in one column with text, in that case can be written separately. **Number** one to ten are expressed with words, except if it relates to measurement, while values above them written in number, except in early sentence. The fraction should be expressed in decimal. In the text, it should be used "%" rather than "percent". Avoid expressing ideas with complicated sentence and verbiage, and used efficient and effective sentence.

**Title** of the article should be written in compact, clear, and informative sentence, preferably not more than 20 words. Name of author(s) should be completely written. **Name and institution** address should also be completely written with street name and number (location), postal code, telephone number, facsimile number, and email address. Manuscript written by a group, author for correspondence along with address is required. First page of the manuscript is used for writing above information.

**Abstract** should not be more than 200 words. **Keywords** is about five words, covering scientific and local name (if any), research theme, and special methods which used; and sorted from A to Z. All important **abbreviations** must be defined at their first mention. **Running title** is about five words. **Introduction** is about 400-600 words, covering the background and aims of the research. **Materials and Methods** should emphasize on the procedures and data analysis. **Results and Discussion** should be written as a series of connecting sentences, however, for manuscript with long discussion should be divided into subtitles. Thorough discussion represents the causal effect mainly explains for why and how the results of the research were taken place, and do not only re-express the mentioned results in the form of sentences. **Concluding** sentence should be given at the end of the discussion. **Acknowledgments** are expressed in a brief; all sources of institutional, private and corporate financial support for the work must be fully acknowledged, and any potential conflicts of interest are noted.

**Figures and Tables** of maximum of three pages should be clearly presented. Title of a picture is written down below the picture, while title of a table is written above the table. Colored figures can only be accepted if the information in the manuscript can lose without those images; chart is preferred to use black and white images. Author could consign any picture or photo for the front cover, although it does not print in the manuscript. All images property of others should be mentioned source. **There is no appendix**, all data or data analysis are incorporated into Results and Discussions. For broad data, it can be displayed on the website as a supplement.

**References** Author-year citations are required. In the text give the authors name followed by the year of publication and arrange from oldest to newest and from A to Z. In citing an article written by two authors, both of them should be mentioned, however, for three and more authors only the first author is mentioned followed by et al., for example: Saharjo and Nurhayati (2006) or (Boonkerd 2003a, b, c; Sugiyarto 2004; El-Bana and Nijs 2005; Balagadde et al. 2008; Webb et al. 2008). Extent citation as shown with word "cit" should be avoided. Reference to unpublished data and personal communication should not appear in the list but should be cited in the text only (e.g., Rifai MA 2007, pers. com. (personal communication); Setyawan AD 2007, unpublished data). In the reference list, the references should be listed in an alphabetical order (better, if only 20 for research papers). Names of journals should be abbreviated. Always use the standard abbreviation of a journal's name according to the **ISSN List of Title Word Abbreviations** ([www.issn.org/2-22661-LTWA-online.php](http://www.issn.org/2-22661-LTWA-online.php)). The following examples are for guidance.

### Journal:

Saharjo BH, Nurhayati AD. 2006. Domination and composition structure change at hemic peat natural regeneration following burning; a case study in Pelalawan, Riau Province. *Biodiversitas* 7: 154-158.

### Book:

Rai MK, Carpinella C. 2006. Naturally Occurring Bioactive Compounds. Elsevier, Amsterdam.

### Chapter in book:

Webb CO, Cannon CH, Davies SJ. 2008. Ecological organization, biogeography, and the phylogenetic structure of rainforest tree communities. In: Carson W, Schnitzer S (eds) *Tropical Forest Community Ecology*. Wiley-Blackwell, New York.

### Abstract:

Assaad AM. 2007. Seed production and dispersal of *Rhazya stricta*. 50<sup>th</sup> annual symposium of the International Association for Vegetation Science, Swansea, UK, 23-27 July 2007.

### Proceeding:

Alikodra HS. 2000. Biodiversity for development of local autonomous government. In: Setyawan AD, Sutarno (eds.) *Toward Mount Lawu National Park; Proceeding of National Seminary and Workshop on Biodiversity Conservation to Protect and Save Germplasm in Java Island*. Universitas Sebelas Maret, Surakarta, 17-20 July 2000. [Indonesian]

### Thesis, Dissertation:

Sugiyarto. 2004. Soil Macro-invertebrates Diversity and Inter-Cropping Plants Productivity in Agroforestry System based on Sengon. [Dissertation]. Universitas Brawijaya, Malang. [Indonesian]

### Information from internet:

Balagadde FK, Song H, Ozaki J, Collins CH, Barnet M, Arnold FH, Quake SR, You L. 2008. A synthetic *Escherichia coli* predator-prey ecosystem. *Mol Syst Biol* 4: 187. [www.molecularsystemsbiology.com](http://www.molecularsystemsbiology.com)

# BIODIVERSITAS

Journal of Biological Diversity  
Volume 22 - Number 4 - April 2021

---

- DNA barcoding of the tidal swamp rice (*Oryza sativa*) landraces from South Kalimantan, Indonesia** 1593-1599  
DINDIN HIDAYATUL MURSYIDIN, YUDHI AHMAD NAZARI, BADRUZSAUFARI, MUHAMMAD RIDHO DINTA MASMITRA
- Molecular identification of *blaCTX-M* and *blaTEM* genes encoding extended spectrum  $\beta$ -lactamase (ESBL) producing *Escherichia coli* isolated from raw cow's milk in East Java, Indonesia** 1600-1605  
RIBBY ANSHARIETA, SANCAKA CHASYER RAMANDINIANTO, MUSTOFA HELMI EFFENDI, HANI PLUMERIASTUTI
- Short Communication:** 1606-1611  
**Infanticide of Javan slow loris (*Nycticebus javanicus*) in captivity**  
PANGDA SOPHA SUSHADI, WIRDATETI, NI LUH PUTU RISCHA PHADMACANTY, MOHAMAD WAHYUDIN
- Population dynamics of mistletoes species on *Cassia fistula* L. in Purwodadi Botanic Garden, Indonesia** 1612-1620  
SOLIKIN
- Characterization of *Sardinella fimbriata* and *Clarias gariepinus* bones** 1621-1626  
WAN NOR ASIAH TUN MOHD ROSIDI, NURAINNI MOHD ARSHAD, NOR FAZLIYANA MOHTAR
- Architectural and physical properties of fungus comb from subterranean termite *Macrotermes gilvus* (Isoptera: Termitidae) mound** 1627-1634  
DINA TIARA KUSUMAWARDHANI, DODI NANDIKA, LINA KARLINASARI, ARINANA, IRMANIDA BATUBARA
- DNA barcode of Enggano hill myna, *Gracula religiosa enganensis* (Aves: Sturnidae) based on mitochondrial DNA cytochrome oxidase subunit I** 1635-1643  
JARULIS, CHOIRUL MUSLIM, SANTI NURUL KAMILAH, AHMAT FAKHRI UTAMA, DEBY PERMANA, MELISA MAYANG SARI, ALEX HADI PRAYITNO, IZUL MIFTAKHUL JANNAH
- Genetic variation of longtail tuna *Thunnus tonggol* landed in four fish markets in Indonesia based on mitochondrial DNA** 1644-1651  
IDA AYU ASTARINI, ENEX YUNIARTI NINGSIH, DEVY SIMANUNGKALIT, SHELLA AYU ARDIANA, M DANIE AL MALIK, NI LUH ASTRIA YUSMALINDA, ANDRIANUS SEMBIRING, NI PUTU DIAN PERTIWI, NI KADEK DITA CAHYANI, ALLEN COLLINS
- The effect of biological agent and botanical fungicides on maize downy mildew** 1652-1657  
JOKO PRASETYO, CIPTA GINTING, HASRIADI MAT AKIN, RADIX SUHARJO, AININ NISWATI, AULIANA AFANDI, REZA ADIWIJAYA, SUDIONO, MUHAMMAD NURDIN
- Six new species and a new record of *Curcuma* L. (Zingiberaceae) from Thailand** 1658-1685  
SURAPON SAENSOUK, THAWATPHONG BOONMA, PIYAPORN SAENSOUK
- Combination of plant growth-promoting bacteria and botanical pesticide increases organic red rice yield and reduces the *Leptocorisa acuta* population** 1686-1694  
MOHAMMAD HOESAIN, SIGIT PRASTOWO, SUHARTO, ANKARDIANSYAH PANDU PRADANA, IIS NUR ASYIAH, FARIZ KUSTIAWAN ALFARIZY, MUH ADIWENA
- Agronomic characteristics of 30 promising lines of aromatic, red, and black rice and their antioxidant and cytotoxic effects in some cancer cells** 1695-1700  
YUSUF LIMBONGAN, RICO RAMADHAN, KUNIYOSHI SHIMIZU, ENOS TANGKE ARUNG



<b>The potential of bird diversity in the urban landscape for birdwatching in Java, Indonesia</b> INSAN KURNIA, HARNIOS ARIEF, ANI MARDIASTUTI, RACHMAD HERMAWAN	1701-1711
<b>Comparison of the effectiveness of pregnancy diagnosis in Aceh cow through measurement of interferon-tau and progesterone concentrations</b> BUDIANTO PANJAITAN, TONGKU NIZWAN SIREGAR, HAFIZUDDIN, ARMAN SAYUTI, MULYADI ADAM, TEUKU ARMANSYAH, SYAFRUDDIN	1712-1716
<b>Potential of fungi isolated from a mangrove ecosystem in Northern Sulawesi, Indonesia: Protease, cellulase and anti-microbial capabilities</b> AGUS TRIANTO, OCKY KARNA RADJASA, SUBAGIYO, HARTUTI PURNAWENI, MUHAMMAD SYAIFUDIEN BAHRY, RIGNOLDA DJAMALUDIN, AIYEN TJOA, IAN SINGLETON, KAREN DIELE, DARREN EVAN	1717- 1724
<b>Isolation, characterization, activity test and molecular identification of thermophilic bacteria producing proteases from Dolok Tinggi Raja Natural Hot Springs, North Sumatra, Indonesia</b> EDY FACHRIAL, VISENSIUS KRISDIANILO, HARMILENI, I NYOMAN EHRICH LISTER, TITANIA T. NUGROHO, SARYONO	1725-1732
<b>Implementation of species protection act for the conservation of Tanimbar corella, <i>Cacatua goffiniana</i> (Finsch, 1863)</b> TRI HARYOKO , MARK O'HARA, BERENIKA MIODUSZEWSKA, HARI SUTRISNO, LILIK BUDI PRASETYO, ANI MARDIASTUTI	1733-1740
<b>Chemical composition, antibacterial and antioxidant activities of essential oils extracted from dry and fresh <i>Brocchia cinerea</i></b> NISRINE CHLIF, ABDELAZIZ ED-DRA, MOHAMMED DIOURI, NOUREDDINE EL MESSAOUDI, BADR ZEKKORI, FOUZIA RHAZI FILALI, AMAR BENTAYEB	1741-1749
<b>Application of selected teak clone and organic fertilizer to accelerate rehabilitation of lowland forest in Java, Indonesia</b> SURYO HARDIWINOTO, FIQRI ARDIANSYAH, WIDIYATNO	1750-1756
<b>Morphometric analysis of Gorontalo (Indonesia) native chickens from six different regions</b> ALFI SOPHIAN, ABINAWANTO, UPI CHAIRUN NISA, FADHILLAH	1757-1763
<b>DNA barcoding of lamp shells (Brachiopoda: <i>Lingula anatina</i>) from Probolinggo, East Java, Indonesia</b> RENI AMBARWATI, DWI A. RAHAYU, FIDA RACHMADIARTI, FIRAS KHALEYLA	1764-1774
<b>Growth rate and yield response of several sweet potato clones to reduced inorganic fertilizer and biofertilizer</b> HANNY HIDAYATI NAFI'AH, REGINAWANTI HINDERSAH, SYARIFUL MUBAROK, HARIS MAULANA2 ,TARKUS SUGANDA, VERGEL CONCIBIDO, AGUNG KARUNIAWAN	1775-1782
<b>Characterization and delineation of two infraspecific taxa of <i>Dioscorea esculenta</i> (Lour.) Burkill: The leaf architecture approach</b> MENISA A. ANTONIO, INOCENCIO E. BUOT JR.	1783-1789
<b>Snake pet ownership in the city: A case study in Greater Jakarta, Indonesia</b> MIRZA D. KUSRINI, SHARON PRATIWI PALESA, BURHANUDDIN MASY'UD	1790-1798
<b><i>Azolla microphylla</i> and <i>Pseudomonas aeruginosa</i> for bioremediation of bioethanol wastewater</b> KHOIRUL ANNISA, SUTARNO, SLAMET SANTOSA	1799-1805
<b>Ethnoecology of <i>Zanthoxylum acanthopodium</i> by local communities around Lake Toba, North Sumatra, Indonesia</b> YATI NURLAENI, JOHAN ISKANDAR, DECKY INDRAWAN JUNAEDI	1806-1818
<b>Screening of actinobacteria-producing amylolytic enzyme in sediment from <i>Litopenaeus vannamei</i> (Boone, 1931) ponds in Rembang District, Central Java, Indonesia</b> DIAH AYUNINGRUM, ANINDITIA SABDANINGSIH, OKTAVIANTO EKO JATI	1819-1828

<b>Identification of conserved peptide upstream open reading frames (CPuORFs) in oil palm (<i>Elaeis guineensis</i>) genome</b> ANDREA PUTRI SUBROTO, REDI ADITAMA, ZULFIKAR ACHMAD TANJUNG, CONDRO UTOMO, TONY LIWANG	1829-1838
<b>Antimicrobial activity and GC-MS analysis of bioactive constituents of <i>Aspergillus fumigatus</i> 269 isolated from Sungai Pinang Hot Spring, Riau, Indonesia</b> ZONA OCTARYA, RIRYN NOVIANTY, NABELLA SURAYA, SARYONO	1839-1845
<b>Species richness and conservation priority of dragonflies in the Suranadi Ecotourism Area, Lombok, Indonesia</b> MOHAMMAD LIWA ILHAMDI, AGIL AL IDRUS, DIDIK SANTOSO, GITO HADIPRAYITNO, MUHAMMAD SYAZALI	1846-1852
<b>The diversity and abundance of phytoplankton and benthic diatoms in varying environmental conditions in Kok River, Chiang Rai, Thailand as bio-indicators of water quality</b> TIPPAWAN PRASERTSIN, KRITTAWIT SUK-UENG, KITTIYA PHINYO, EKKACHAI YANA	1853-1862
<b>Evaluation of a promising tomato line (<i>Solanum lycopersicum</i>) derived from mutation breeding</b> ENIK NURLAILI AFIFAH, RUDI HARI MURTI, ADITYA WAHYUDHI	1863-1868
<b>Short Communication: Diversity of cellulolytic bacteria isolated from coastal mangrove sediment in Logending Beach, Kebumen, Indonesia</b> HENDRO PRAMONO, AFIFAH MARIANA, DINI RYANDINI	1869-1878
<b>Modified culture assay to obtain a diversity of hyphal structures of <i>Ceratobasidium theobromae</i>-VSD pathogen on cocoa</b> MUHAMMAD JUNAID, DAVID GUEST	1879-1886
<b>Fieldwork during pandemic: Backyard bird survey and making student's biological field practice works</b> NURUL L. WINARNI, BHISMA G. ANUGRA, SHANIA ANISAFITRI, NABILLA N. KAUNAIN, DIMAS H. PRADANA	1887-1894
<b>Epiphytic yeasts from Piperaceae as biocontrol agents for foot rot of black pepper caused by <i>Phytophthora capsici</i></b> DIAN SAFITRI, SURYO WIYONO, BONNY POERNOMO WAHYU SOEKARNO, ACHMAD	1895-1901
<b>Species composition, diversity and traditional uses of plants in homegardens in Kampung Masjid Ijok, Perak, Malaysia</b> MOHD RAZNAN RAMLI, POZI MILOW, SORAYYA MALEK	1902-1911
<b>The activity budgets of captive orangutan (<i>Pongo pygmaeus</i>) in two different Indonesian zoos</b> NURZAIDAH PUTRI DALIMUNTHE, HADI SUKADI ALIKODRA, ENTANG ISKANDAR, SRI SUCI UTAMI ATMOKO	1912-1919
<b>Effect of single and mixed inoculation of arbuscular mycorrhizal fungi and phosphorus fertilizer application on corn growth in calcareous soil</b> LILY ISHAQ, A.S.J. ADU TAE, MORESI A. AIRTHUR, PETERS O. BAKO	1920-1926
<b>Mucin-1 expression in endometrial tissue of <i>Macaca nemestrina</i> during mid-luteal phase after controlled-ovarian hyperstimulation</b> NURHUDA SAHAR, PONCO BIROWO, KUSMARDI, DIYAH KRISTIANITY, KARINA RAHMANINGRUM, ADRIANA VIOLA MIRANDA, AFIF RASYAD, VIVITRI DEWI PRASASTY	1927-1933
<b>Genetic identification of hydrocarbons degrading bacteria isolated from oily sludge and petroleum contaminated soil in Basrah City, Iraq</b> ENTISAR MUHSON ABOUD, AHMED ABD BURGHAL, ABDULLAH HAMAD LAFTAH	1934-1939
<b>Flower development, pollen viability and pollen storage test of <i>Aeschynanthus radicans</i></b> FRISCA DAMAYANTI, R. VITRI GARVITA, HARY WAWANGNINGRUM, SRI RAHAYU	1940-1945

<b>Coleoptera of the Penza region, Russia based on fermental crown trap</b> A.B. RUCHIN, L.V. EGOROV, O.A. POLUMORDVINOV	1946-1960
<b>Taxonomic investigation of the <i>Xanthium strumarium</i> L. complex (Asteraceae) distributed in Iran inferred from morphological, palynological and molecular data</b> FARIBA NOEDOOST, JAMIL VAEZI, SEDIGHEH NIKZAT SIAHKOLAEI	1961-1974
<b>The infection of ectoparasitic protozoa on farmed Nile tilapia (<i>Oreochromis niloticus</i>) at three reservoirs in Central Java, Indonesia</b> WALEED SULIMAN KRPOS KOLIA, SUNARTO, TETRI WIDIYANI	1975-1980
<b>The potential of cellulose-degrading fungi at various peat maturities in Teluk Bakung Peat Area, Kubu Raya District, Indonesia</b> SITI KHOTIMAH, SUHARJONO, TRI ARDYATI, YULIA NURAINI	1981-1990
<b>Morphological characteristics of <i>Phaius</i> spp. orchids from Indonesia</b> SRI HARTATI, SAMANHUDI, IDA RUMIA MANURUNG, ONGKO CAHYONO	1991-1995
<b>Population, habitat characteristic, and modelling of Endangered Orchid, <i>Paphiopedilum javanicum</i> in Mt. Lawu, Java, Indonesia</b> MUH. ARIF ROMADLON, FATIMAH AZZHARA, GILANG DWI NUGROHO, ARI PITOYO	1996-2004
<b>Evaluation of diversity in some genotypes of Algerian durum wheat using agronomical and biochemical markers</b> AICHA ATOUI, LEILA BOUDOUR, GHANIA CHAIB, BOUDERSA NABIL	2005-2011
<b>Physicochemical and microbiological properties of yogurt made with microencapsulation probiotic starter during cold storage</b> EVY ROSSI, FAJAR RESTUHADI, RASWEN EFENDI, YOSSIE KHARISMA DEWI	2012-2018
<b>Compendium of plants used for preparation of traditional alcoholic beverages by different major ethnic communities of Assam, northeast India</b> DIPANKAR BORAH, TRIDIP GOGOI, JINTU SARMA, PUNAM JYOTI BORAH, BICHITRA GOHAIN, CHIRANJIB MILI, ANKUR UPADHYAYA, JENIMA BASUMATARY, KASTURI NEOG, TONLONG WANGPAN, SUMPAM TANGJANG	2019-2031
<b>The structure of permaculture landscapes in the Philippines</b> JABEZ JOSHUA M. FLORES, INOCENCIO E. BUOT JR.	2032- 2044
<b>Traditional market, social relations, and diversity of edible plants traded in Beringharjo Market, Yogyakarta, Indonesia</b> BUDIAWATI SUPANGKAT ISKANDAR, JOHAN ISKANDAR, DEDE MULYANTO, RAHMAN LATIF ALFIAN, SUROSO	2045-2057
<b>Effects of copper on the leaf morpho-anatomy of <i>Rhizophora mucronata</i>: Implications for mangrove ecosystem restoration</b> KERSTIN LEI DJ. PEREZ, MARILYN O. QUIMADO, LERMA SJ. MALDIA, CRUSTY E. TINIO, JONATHAN O. HERNANDEZ, MARILYN S. COMBALICER	2058-2065
<b>Species diversity and composition, and above-ground carbon of mangrove vegetation in Jor Bay, East Lombok, Indonesia</b> ZULHALIFAH, ABDUL SYUKUR, DIDIK SANTOSO, KARNAN	2066-2071
<b>Short Communication: Assessing the state and change of forest health of the proposed arboretum in Wan Abdul Rachman Grand Forest Park, Lampung, Indonesia</b> RAHMAT SAFE'I, FRANSINA S. LATUMAHINA, BAINAH SARI DEWI, FERDY ARDIANSYAH	2072-2077
<b>The ethnobotany of <i>Ngusaba</i> ceremonial plant utilization by Tenganan Pegringsingan community in Karangasem, Bali, Indonesia</b> DEWA AYU SRI RATNANI, I KETUT JUNITHA, ENIEK KRISWIYANTI, I NYOMAN DHANA	2078-2087
<b>Projecting expansion range of <i>Selaginella zollingeriana</i> in the Indonesian archipelago under future climate condition</b> AHMAD DWI SETYAWAN, JATNA SUPRIATNA, NISYAWATI, ILYAS NURSAMSII, SUTARNO, SUGIYARTO, SUNARTO, PRAKASH PRADAN, SUGENG BUDIHARTA, ARI PITOYO, SAPTA SUHARDONO, PRABANG SETYONO, MUHAMMAD INDRAWAN	2088-2103



<b>Morphological and anatomical characters variation of <i>Indigofera</i> accessions from Java, Indonesia</b>	<b>2104-2116</b>
MUZZAZINAH, SURATMAN, NURMIYATI, SRI RETNO DWI ARIANI	
<b>Exogenous acetic acid pre-treatment increases drought tolerance of two Indonesian foxtail millet (<i>Setaria italica</i>) accessions</b>	<b>2117-2124</b>
CHOIROTIN NISA, NURUL JADID	
<b>Effect of termite activity on soil chemical properties using baiting systems at an arboretum area in Pontianak, West Kalimantan, Indonesia</b>	<b>2125-2130</b>
YULIATI INDRAYANI, SOFWAN ANWARI	
<b>Feeding habits of Tinfoil barb, <i>Barbonymus schwenenfeldii</i> in the Tasik River, South Labuhanbatu, North Sumatra, Indonesia</b>	<b>2131-2135</b>
DESRITA, FANNI K. HASUGIAN, ERI YUSNI, VINDY R. MANURUNG, RIDAHATI RAMBEY	
<b>Diversity of sea cucumber from intertidal area of Pacitan and Bangkalan, East Java, Indonesia</b>	<b>2136-2141</b>
ELSA DIANITA AULIA, FARID KAMAL MUZAKI, DIAN SAPTARINI, EDWIN SETIAWAN, DAVIN SETIAMARGA, ISWATUL DIAH LUTVIANI, SANIAH KUSNATUR ROSYIDAH, NUR ALI MUHAMMAD	
<b>Carbon emissions as impact of mangrove degradation: A case study on the Air Telang Protected Forest, South Sumatra, Indonesia (2000-2020)</b>	<b>2142-2149</b>
SYAIFUL EDDY, NORIL MILANTARA, MOHAMMAD BASYUNI	

---

## Growth rate and yield response of several sweet potato clones to reduced inorganic fertilizer and biofertilizer

HANNY HIDAYATI NAFT'AH<sup>1</sup>, REGINAWANTI HINDERSAH<sup>2</sup>, SYARIFUL MUBAROK<sup>2</sup>,  
HARIS MAULANA<sup>2</sup>, TARKUS SUGANDA<sup>2</sup>, VERGEL CONCIBIDO<sup>3</sup>, AGUNG KARUNIAWAN<sup>2,\*</sup>

<sup>1</sup>Faculty of Agriculture, Universitas Garut. Jl. Raya Samarang No. 52A, Hampor, Tarogong Kaler, Garut 44151, West Java, Indonesia

<sup>2</sup>Faculty of Agriculture, Universitas Padjadjaran. Jl. Raya Bandung-Sumedang Km. 21, Jatinangor, Sumedang 45363, West Java, Indonesia.  
Tel.: +62-22-7796316, Fax.: +62-22-7796316, \*email: agung.karuniawan@unpad.ac.id

<sup>3</sup>Sensient Colors, LLC. 2515 North Jefferson Avenue, St. Louis, Missouri, 63106, United States of America

Manuscript received: 23 February 2021. Revision accepted: 15 March 2021.

**Abstract.** Nafi'ah HH, Hindersah R, Mubarak S, Maulana H, Suganda T, Concibido V, Karuniawan A. 2021. Growth rate and yield response of several sweet potato clones to reduced inorganic fertilizer and biofertilizer. *Biodiversitas* 22: 1775-1782. Sweet potato has a high economic value because it is often utilized for staple food and industrial raw materials. Balanced fertilization, including inorganic and biofertilizer, is needed to enhance the production of sweet potatoes. Two-year field experiments conducted at two different agro climates were performed to determine the best response of growth rate and yield of sweet potato to reduced inorganic fertilizer and biofertilizer application rates. Three sweet potato clones, Mencrang, Biang, and Rancing, were grown with a combination of inorganic and biological fertilizers in a randomized complete block design of three replications. Results showed that Biang and Rancing have the best response under reduced inorganic and biofertilizer application rate. The application of biofertilizer enabled the reduction of inorganic fertilizer use but still resulted in increased growth rate and tuber yield of potatoes in both locations. However, the application of biofertilizer did not increase the total soluble solids, which is the main indicator of sweetness in sweet potato.

**Keywords:** Biang, biofertilizer, *Ipomoea batatas*, Mencrang, Rancing

### INTRODUCTION

Sweet potatoes are widely grown in Indonesia because it has high economic and nutritional values. Sweet potato contains carbohydrates, minerals, and vitamins (Abubakar et al. 2018; Shih et al. 2019; Tegeye et al. 2019). Currently, the demand for sweet potatoes has been increasing for food consumption and industrial raw materials, especially in West Java (Maulana et al. 2020). The use of sweet potato in the food industry has been previously reported (Lareo and Ferrari 2019; Sawicka et al. 2019). Many of the local sweet potato varieties typically grown by Indonesian farmers fail to meet the food industry specifications and requirements. Rancing, is an example of a commercial sweet potato variety that is yellow-fleshed with honey flavor and a sticky jelly appearance after roasting (Anda et al. 2018). Universitas Padjadjaran (UNPAD), Sumedang, Indonesia has developed new superior sweet potato clones, namely Mencrang and Biang (Maulana et al. 2020; Mustamu et al. 2018). However, yields of these varieties have decreased in recent years. Thus, new superior varieties that meet industry and consumer preferences are needed. However, the yield response to biofertilization and tuber roasting characteristics have not been evaluated for these varieties.

The interaction between variety and mineral fertilization has a significant effect on sweet potato yield. Previous studies showed that N and K inorganic fertilization could increase sweet potato yield (Ali 2019;

Kareem et al. 2020). However, inorganic fertilizers added continuously over a long period can decrease soil quality (Ojuederie et al. 2019; Sklenicka et al. 2020; Wu et al. 2019). Chandini et al. (2019) stated that inorganic fertilizers may cause poor development of root system which is very important for tuber development of sweet potato. Biofertilizers, such as mycorrhiza and Trichoderma, have been reported to increase sweet potato yield restore soil fertility (Novianantya et al. 2017; Mukhongo et al. 2017).

Biofertilizer is a type of fertilizer that enriches the nutrient quality of the soil. It contains living microorganisms that when added to the soil increases the supply of nutrients to the host plant, produce plant growing regulatory substances, and act as biocontrol agents (Mahanty et al. 2017). Biofertilizer can increase the photosynthetic activity in plants for optimal growth even under abiotic-stress conditions (Mahanty et al. 2017; Mahmud et al. 2020; Souza et al. 2014). However, the three types of fertilizers, organic, inorganic and biofertilizer, must be balanced and adjusted to the needs of the plant.

In order to fulfill the increasing demand for biofertilizers, UNPAD has developed a liquid consortia biofertilizer, containing a combination of nitrogen-fixing bacteria and phosphate-solubilizing bacteria. The impact of this biofertilizer on the growth of some important commodities has been reported (Hindersah et al. 2021; Fitriati et al. 2020) but their effect on sweet potato growth and productivity has not been investigated. However, Sembiring et al. (2017) reported that inoculation of

phosphate solubilizing bacteria enhanced the yield of sweet potatoes. The purpose of this study was to evaluate yield and growth rate response of new superior sweet potato clones to reduced rates of inorganic fertilizers and biofertilizers.

## MATERIALS AND METHODS

The research was carried out in two locations namely, Karangpawitan and Cilawu sub-districts in Garut, West Java, Indonesia. In Karangpawitan, the experiment was conducted in a farmers' field located at Jatisari, which is a wetland with a total land area of 1.400 m<sup>2</sup>. Planting was done at the end of the rainy season in 2018. The soil is characterized by a pH of 6.59, low C-organic content, low N, high P, high K, high cation exchange capacity (CEC) and a clay soil texture. The average temperature is 23.5, average rainfall of 86.12 mm, and average humidity of 81.33%. In Cilawu, the experiment was conducted in a farmer's field located at Margalaksana, which is dryland with a total area of 1,400 m<sup>2</sup>. The planting was carried out at the beginning of the dry season in 2019. The soil is characterized by a pH 6.27, low C-Organic content, low N, high P, high K, high CEC, and a dusty clay texture. The average temperature is 25°C, average rainfall of 65.56 mm, and average humidity of 78.4%.

The experiment was laid out in a randomized completed block design with 15 treatments, three replications in a 5 m x 0.7 m plot with a 20-cm row spacing. Three superior sweet potato clones were used in this experiment, namely Rancing (Yellow-fleshed), Mencrang (Orange-fleshed), and Biang (Purple-fleshed). The biofertilizer used contains nitrogen-fixating microbes and phosphate solvent microbes (*Azotobacter*, *Azopsirillum*, *Acinetobacter*, *Pseudomonas*, and *Penicillium*) (Table 1). These microbes developed by Soil Laboratory, Faculty of Agriculture, Padjadjaran University (UNPAD), Sumedang, Indonesia and commercialized by PT Pupuk Kujang Cikampek, Indonesia. Paturohman et al. (2015) outlined the inorganic fertilizer recommended rates for sweet potato as 40 - 75 kg N ha<sup>-1</sup>, 20 - 50 kg P ha<sup>-1</sup>, and 75 - 100 kg K ha<sup>-1</sup>. In this experiment, the following rates were used; 150 kg Urea, 100 kg SP-36, and 150 kg KCl.

**Table 1.** Inorganic biofertilizer treatments used on three new superior clones of sweet potato

Code	Treatment
R+100% IF	(Rancing+ 100% inorganic fertilizers)
R+BF	(Rancing+biofertilizer)
R+BF+100% IF	(Rancing+biofertilizer+100% inorganic fertilizers)
R+BF+75% IF	(Rancing+biofertilizer+75% inorganic fertilizers)
R+BF+50% IF	(Rancing+biofertilizer+50% inorganic fertilizers)
B+100% IF	(Biang+ 100% inorganic fertilizers)
B+BF	(Biang+biofertilizer)
B+BF+100% IF	(Biang+biofertilizer+100% inorganic fertilizers)
B+BF+75% IF	(Biang+biofertilizer+75% inorganic fertilizers)
B+BF+50% IF	(Biang+biofertilizer+50% inorganic fertilizers)
M+100% IF	(Mencrang+100% inorganic fertilizers)
M+BF	(Mencrang+biofertilizer)
M+BF+100% IF	(Mencrang+biofertilizer+100% inorganic fertilizers)

M+BF+75% IF (Mencrang+biofertilizer+75% inorganic fertilizers)  
M+BF+50% IF (Mencrang+biofertilizer+50% inorganic fertilizers)

The concentration of biofertilizer consortium used was 0.01% and was applied at one and three weeks after planting (WAP). Inorganic fertilizers were applied twice; 1/3 of Urea and KCl, and the entire biofertilizer dose was applied at planting; 2/3 parts of Urea and KCl were applied at four WAP.

Harvesting was done after 18 WAP. Harvesting was done by digging up the soil until the tuber was visible, then the tuber plucked from the base of the stem and measured according to the observation guide.

### Analysis of growth rate

Leaf Area Index (LAI), Crop Growth Rate (CGR), and Net Assimilation Rate (NAR) were measured by taking samples three separate times, i.e., when plants were at 30, 50, and 70 days after planting (DAP). Leaf area was measured manually using the gravimetric method, with the following formula:

$$\text{Leaf Area} = \frac{\text{Weight of duplicate leaf (g)}}{\text{Weight of standard papers (g)}} \times \text{Area of standard papers (cm}^2\text{)}$$

The formula used to calculate LAI is as follows :

$$\text{Leaf Area Index} = \frac{\text{Leaf Area (m}^2\text{)}}{\text{Ground Area (m}^2\text{)}}$$

The CGR formula is as follows :

$$\text{Crop Growth Rate} = \frac{W_2 - W_1}{t_2 - t_1}$$

Where: W<sub>2</sub> = Dry weight of sample 2, W<sub>1</sub> = Dry weight of sample 1, t<sub>2</sub> = time 2, t<sub>1</sub> = time 1.

NAR formula is as follows:

$$\text{Net Assimilation Ratio} = \frac{W_2 - W_1}{t_2 - t_1} - \frac{\ln L_2 - \ln L_1}{L_2 - L_1}$$

Where: W<sub>2</sub> = Dry weight of sample 2, W<sub>1</sub> = Dry weight of sample 1, t<sub>2</sub> = time 2, t<sub>1</sub> = time 1, L<sub>2</sub> = leaf area of sample 2, L<sub>1</sub> = leaf area of sampel 1.

### Analysis of plant yield

The number of tubers per plant and the weight of tubers per plant were observed by taking a sample of tubers on five separate plants. The weight of tubers per plot is observed by weighing the total yield per plot. The tuber length and diameter were observed by measuring the average length and diameter of 5 tuber samples per plot.

### Analysis of Total Soluble Solid (TSS)

TSS was carried out seven days after harvest. TSS measurement aims to determine the sweetness levels of fresh and baked sweet potato samples. The tool used was a handheld refractometer - atc 0-50% Brix. The TSS measurement for fresh sweet potato was carried out by taking a sample with a size of 1 cm<sup>3</sup>, crushed using a mortar and pestle, juice extracted and smeared on a refractometer glass. Measurement of TSS of baked sweet

potatoes was carried out by taking a 1 cm<sup>3</sup> sample, crushed with a spoon and added with a little water on a plastic dish. The juice was then extracted, and a drop applied on a refractometer glass. The scale was observed at the bottom of the lamp. The results were obtained in ° Brix units.

### Statistical data analysis

Data were analyzed used one-way ANOVA in a randomized completed block design. The effect of treatment was tested by the F test at a 5% level. The effect's average value used a further test with Duncan's Multiple Range Test level 1%. Data analysis was performed with DSASTAT Software ver. 1,101.

## RESULTS AND DISCUSSION

The best Leaf Area Index (LAI) for LAI 50 and LAI 70 DAP in Karangpawitan was observed in B+BF treatment (Figure 1.A). The best LAI in Cilawu with the highest value was observed in M+BF+75% IF treatment (Figure 1.B). There was an increase in the Crop Growth Rate (CGR) and Net Assimilation Rate (NAR) on sweet potatoes across two test locations.

The treatments with the best CGR in 30-50 DAP and 50-70 DAP, in Karangpawitan were R+BF+75%IF, M+100%IF, M+BF+75%IF, and B+BF, respectively (Figure 2.A). By contrast, the best CGR in Cilawu was observed in treatment M+BF+100%IF (Figure 2.B). The best NAR in Karangpawitan were observed in treatments R+100%IF, R+BF+100%IF, R+BF+75%IF, M+100%IF, M+BF, M+BF+75%IF, BB+BF, B+BF+100%IF, and B+BF+75%IF (Figure 3.A). While in Cilawu, the best NAR was observed in treatment R+BF+50%IF (Figure 3.B).

Weight of tuber (Table 2), size of tuber (Table 3), and total soluble solids (Table 4) across two different locations showed differential responses due to a combination of biofertilizer and inorganic fertilizer application. Positive responses were observed on yield and yield components on Rancing and Biang clones in both locations to inorganic fertilizer reduction of up to 75% with the addition of biological fertilizers.

The growth rate and yield of the three sweet potato clones in both locations showed the best results on the combination of biofertilizers with 75% to 100% inorganic fertilizers. Biang clones (Figure 4) showed a very high growth rate even with the provision of biological fertilizers alone. However, for tuber yield, provision of inorganic fertilizers was still needed but can be reduced to 75% of the recommended dose. Mencrang clones (Figure 5) without additional inorganic fertilizers showed smaller tuber formations compared to the combination of biological fertilizers and inorganic fertilizers. Clone Rancing (Figure 6) with a combination of biological fertilizers and 100% inorganic fertilizer showed the best tuber yields.

### Discussion

#### *Growth rate of new superior clones of sweet potato*

The growth response rate at each location was different from each treatment. Land type and rainfall can be a determining factor for the success of biological fertilizers' performance in reducing the use of inorganic fertilizers in the field. Land conditions in Karangpawitan tend to be wet, and sweet potatoes were planted during the rainy season. Biological fertilizers can significantly reduce inorganic fertilizers by up to 50% in Biang and 75% in Mencrang. Cilawu is dry land, and sweet potatoes were planted at the beginning of the dry season so that the soil conditions did not support the development of bio-fertilizers under this condition. Biofertilizer must still be balanced with 100% inorganic fertilizers.

**Table 2.** Number of tubers per plant, weight of tuber per plant, yield of tuber of three clones of sweet potato due to the application of a combination of biofertilizer and inorganic fertilizer in two different locations

Code	Karangpawitan			Cilawu		
	Number of tubers per plant	Weight of tuber per plant (g)	Yield of tuber (kg)	Number of tuber per plant	Weight of tuber per plant (g)	Yield of tuber (kg)
R+100%IF	6.78 a	691.39 c	20.74 b	5.67 c	377.00 c	6.52 a
R+BF	3.06 a	162.11 a	4.86 a	2.60 a	232.00 b	5.99 a
R+BF+100%IF	5.11 a	898.33 c	26.95 b	2.27 a	164.67 a	3.97 a
R+BF+75%IF	4.67 a	652.50 c	19.58 b	3.63 b	117.50 a	3.02 a
R+BF+50%IF	4.22 a	520.83 c	15.63 b	2.42 a	70.00 a	2.71 a
B+100%IF	4.56 a	616.11 c	18.48 b	1.98 a	59.56 a	1.37 a
B+BF	4.11 a	666.94 c	20.01 b	3.15 a	421.00 c	7.32 a
B+BF+100%IF	6.00 a	414.22 b	12.43 a	5.07 c	238.33 b	9.03 a
B+BF+75%IF	6.17 a	738.89 c	22.17 b	6.00 c	304.00 c	6.02 a
B+BF+50%IF	4.61 a	779.72 c	23.39 b	5.00 c	258.67 b	8.70 a
M+100%IF	5.22 a	430.28 b	12.91 a	7.00 c	318.67 c	6.33 a
M+BF	4.61 a	296.94 b	8.91 a	3.87 b	244.67 b	6.14 a
M+BF+100%IF	3.83 a	153.50 a	4.61 a	3.87 b	246.00 b	6.55 a
M+BF+75%IF	3.61 a	159.72 a	4.79 a	3.87 b	321.33 c	7.26 a
M+BF+50%IF	6.44 a	330.98 b	9.93 a	3.80 b	225.33 b	5.57 a

Note: Means followed by the same letter are not significantly different according to the Scott Knott test at 5%

**Table 3.** Tuber size of three clones of sweet potato due to the application of a combination of biofertilizer and inorganic fertilizer in two different locations

Code	Karangpawitan				Cilawu			
	Length of tuber (cm)		Diameter of tuber (cm)		Length of tuber (cm)		Diameter of tuber (cm)	
R+100% IF	24.99	b	4.68	a	18.53	b	5.10	d
R+BF	24.93	b	5.03	a	18.33	b	4.99	d
R+BF+100% IF	21.82	a	4.06	a	15.66	a	3.43	a
R+BF+75% IF	25.22	b	5.12	a	14.42	a	3.09	a
R+BF+50% IF	24.58	b	4.67	a	16.20	a	3.19	a
B+100% IF	16.54	a	3.03	a	15.56	a	3.20	a
B+BF	27.62	b	5.91	a	15.40	a	3.69	b
B+BF+100% IF	20.78	a	4.02	a	18.33	b	4.40	c
B+BF+75% IF	26.73	b	5.59	a	20.20	b	5.13	d
B+BF+50% IF	22.62	a	4.32	a	18.27	b	4.25	b
M+100% IF	21.07	a	3.68	a	18.80	b	4.86	d
M+BF	24.08	b	5.67	a	19.02	b	4.86	d
M+BF+100% IF	25.07	b	5.69	a	17.60	b	4.87	d
M+BF+75% IF	19.94	a	5.58	a	18.00	b	4.70	d
M+BF+50% IF	24.97	b	4.79	a	17.87	b	4.43	c

Note: Means followed by the same letter are not significantly different according to the Scott Knott test at 5%

**Table 4.** Total soluble solid (fresh) and total soluble solid (oven) of three clones of sweet potato due to the application of a combination of biofertilizer and inorganic fertilizer in two different locations

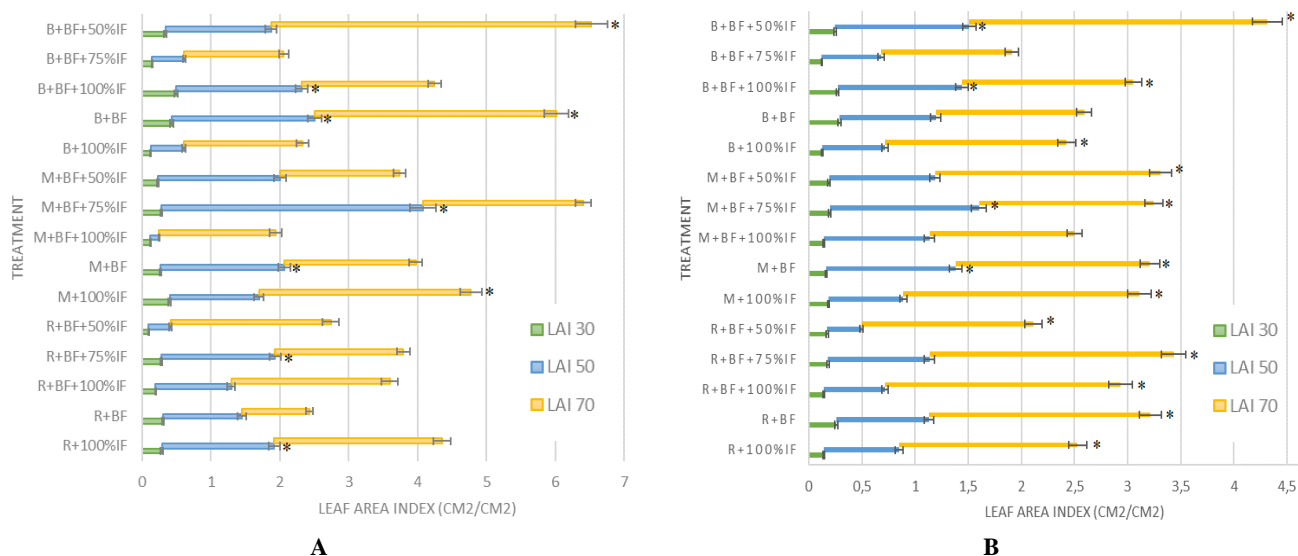
Code	Karangpawitan				Cilawu			
	Total soluble solid fresh		Total soluble solid oven		Total soluble solid fresh		Total soluble solid oven	
R+100% IF	11.00	b	13.00	b	10.00	a	8.50	b
R+BF	10.33	a	10.33	a	12.00	b	9.67	b
R+BF+100% IF	12.00	b	14.67	c	12.33	b	11.33	c
R+BF+75% IF	9.67	a	12.00	b	12.67	b	6.83	a
R+BF+50% IF	11.67	b	13.33	b	12.17	b	9.00	b
B+100% IF	9.33	a	10.67	a	15.33	c	10.33	b
B+BF	10.67	a	12.33	b	14.17	c	6.00	a
B+BF+100% IF	11.67	b	12.00	b	15.33	c	8.40	b
B+BF+75% IF	10.67	a	9.67	a	14.50	c	11.67	c
B+BF+50% IF	9.67	a	10.00	a	13.67	c	9.00	b
M+100% IF	12.00	b	12.00	a	15.33	c	9.33	b
M+BF	11.33	b	11.00	a	13.00	c	13.33	c
M+BF+100% IF	13.67	c	13.00	b	9.33	a	8.00	b
M+BF+75% IF	13.00	c	12.33	b	14.33	c	9.67	b
M+BF+50% IF	12.00	b	13.67	c	13.67	c	14.00	c

Note: Means followed by the same letter are not significantly different according to the Scott Knott test at 5%.

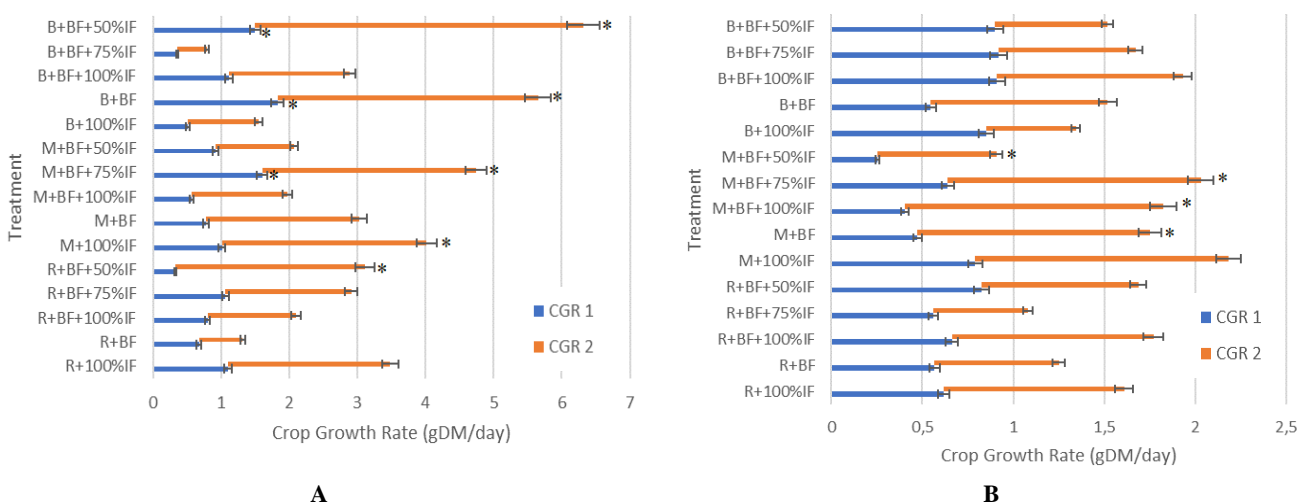
According to (Marques et al. 2019), biological fertilizers' effect was not always expected, and genotypic responses and environmental factors have a stronger influence on yield. The positive responses from the clones to the provision of biofertilizers could be due to the interaction between roots and microbes that could have increased plant growth and yield and improved soil fertility (Byju and Ravindran 2009; Liu et al. 2019). In this experiment, biofertilizer can reduce the application of inorganic fertilizers by up to 50% depending on the genotype. Rancing and Biang clones tended to give a more favorable response compared to Mencrang.

#### *Yield of new superior clones of sweet potato*

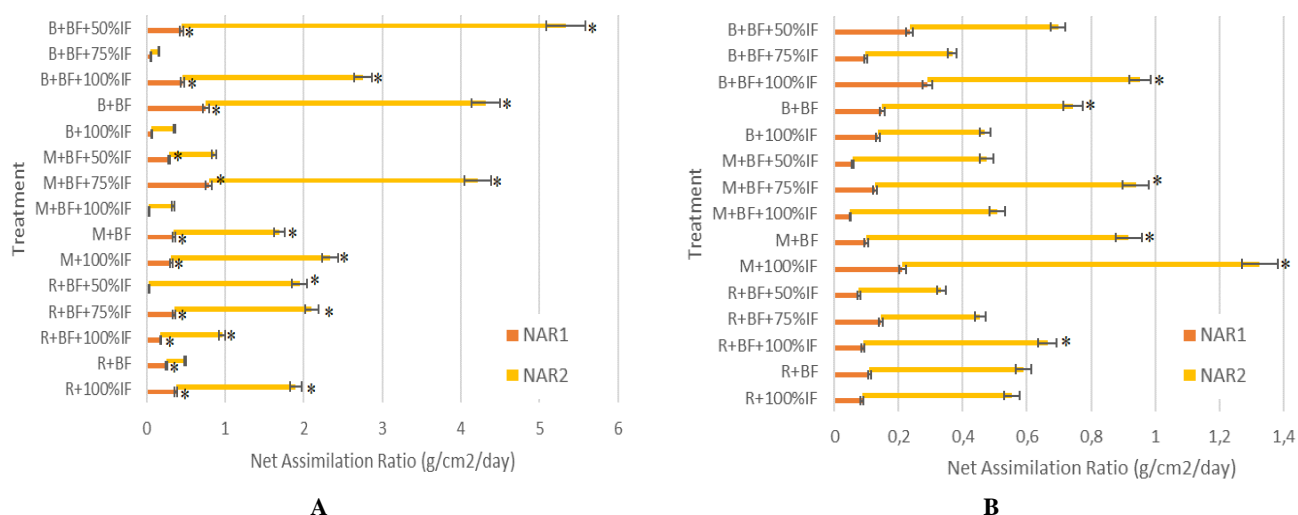
A long tuber with a small to medium diameter is usually preferred for baked sweet potatoes. The longest tubers in both locations were observed on treatment BF+50% IF for both Rancing and Biang. By contrast, it was observed in Mencrang on treatment BF+75% IF. The effect of treatment BF+75% IF on sweet potato clones appeared to be significant increases in tuber weight and length. However, in Karangpawitan location, the diameter of tubers did not respond at all to fertilization. There was favorable response on tuber diameter at Cilawu location on treatment BF+50% IF as observed on both Rancing and Biang clones.



**Figure 1.** Leaf area index of three clones of sweet potato as a result of the application of combination of biofertilizer and inorganic fertilizer in Karangpawitan (A), and Cilawu (B), West Java, Indonesia



**Figure 2.** The crop growth rate of three clones of sweet potato due to the application of a combination of biofertilizer and inorganic fertilizer in Karangpawitan (A), and Cilawu (B), West Java, Indonesia



**Figure 3.** The net assimilation ratio of three clones of sweet potato due to a result of the application of biofertilizer and inorganic fertilizer in Karangpawitan (A), and Cilawu (B), West Java, Indonesia





**Figure 4.** The formation of sweet potato tubers from the Biang clone. a. B + BF. b. B + BF + 75% IF. c. B + BF + 100% IF



**Figure 5.** The formation of sweet potato tubers from the Mencrang clone. a. M + BF. b. M + BF + 75% IF. c. M + BF + 100% IF



**Figure 6.** The formation of sweet potato tubers from the Rancing clone. a. R + BF. b. R + BF + 75% IF. c. R + BF + 100% IF

Biofertilizers can improve the growth and yield of sweet potato (Abdel-Razzak et al. 2013; Sakha et al. 2019) by enhancing photosynthesis and nutrient uptake (Gao et al. 2020; Mpanga et al. 2018; Radziah and Saad 2009). Biofertilizers can also protect against some soilborne diseases (Singh et al. 2020). The application of biofertilizers in this study can improve the growth rate and yield of sweet potatoes.

Sweet potatoes have been reported to respond favorably to the combined application of biofertilizer and inorganic fertilizer. Reddy et al. (2018) observed that the yield was influenced by tuber weight and diameter, and the number of leaves per plant. Several researchers reported that biofertilizer application combined with the maximum level of inorganic fertilizer gave the maximum sweet potato yield (Al-Zabee and AL-Maliki 2019; Pérez-pazos and

Sánchez-lópez 2018; Valpato et al. 2020). Others claim that biofertilizers combined with N and K fertilizers can improve biomass and yield (Mukhongo et al. 2017). It can also be applied as a phosphate solvent to P fertilizer up to 25% (Susan John et al. 2020).

#### *Biofertilizer ability to reduce inorganic fertilizers*

Biofertilizers are needed for soil fertility. There was a significant increase in N and P absorption in plants planted in soils applied with biofertilizers (Dekhane et al. 2011). Even with a reduction in inorganic fertilizers due to biological fertilizers, it still improves yields and soil fertility. However, in sweet potato, inorganic fertilizers could not be eliminated and replaced with biofertilizers. The balanced use of fertilizers can improve soil fertility and crop production (Akbari et al. 2011; Meshram et al. 2019). Inorganic fertilizers are still needed in combination with biofertilizers to increase soil fertility and crop yields.

The longer contact period between the roots and biofertilizers can be associated with a balanced supply of nutrients resulting in higher water absorption and nutrients by sweet potato plants (Oliveira et al. 2010). Biofertilizer can replace half or the full dose of inorganic fertilizer required, depending on microbial strains and growing environments (Ouyabe et al. 2020; Yasmin et al. 2020). Reduction of inorganic fertilizers by biofertilizers still can result in high yield of sweet potato (Pérez-pazos and Sánchez-lópez 2018), without disturbing the environmental balance (Asoegwu et al. 2020; Kour et al. 2020). TSS was not directly affected by the fertilizer and biofertilizer consortium (Senthilkumar et al. 2014). Biofertilizer can reduce the application of inorganic fertilizers in sweet potatoes as shown in this study. However, the value of TSS, an indicator of sweet potato sweetness level, was not influenced by any of the treatments used in this study.

In conclusion, biofertilizers can be recommended to farmers as potential replacements to inorganic fertilizers or complementary fertilizers to increase sweet potato production. Rancing and Biang showed better responses to a combination of inorganic and biofertilizer.

## ACKNOWLEDGEMENTS

This research was funded by RISPRO LPDP, Ministry of Finance of the Republic of Indonesia (contract number: 41/LPDP/2018) that awarded to Dr. Agung Karuniawan, and was partially supported by a research grant from Sensient Colors LLC, USA. The authors declare that they have no conflict of interest.

## REFERENCES

- Abdel-Razzak HS, Moussa AG, Abd El-Fattah MA, El-Morabet GA. 2013. Response of sweet potato to integrated effect of chemical and natural phosphorus fertilizer and their levels in combination with mycorrhizal inoculation. *J Biol Sci* 13 (3): 112-122. DOI: 10.3923/jbs.2013.112.122.
- Abubakar AS, Yahaya SU, Shaibu AS, Yahaya SU, Ibrahim H, Ibrahim AK, Lawan ZM, Isa AM. 2018. In vitro propagation of sweet potato (*Ipomoea batatas* (L.) Lam.) cultivars. *Agric Sci Digest - Res J* 38: 17-21. DOI: 10.18805/ag.d-128.
- Akbari KN, Ramdevputra MV, Sutaria GS, Vora VD, Padmani DR. 2011. Effect of organics, bio and inorganic fertilizer on groundnut yield and its residue effect on succeeding wheat crop. *Legume Res* 34 (1): 45-47.
- Al-Zabee MR, AL-Maliki SM. 2019. Interactions between biofertilizers and chemical fertilizers affected soil biological properties and potato yield. *Euphrates J Agric Sci* 11 (1): 1-13.
- Ali RA. 2019. Effect of nitrogen fertilizer types and microelements on growth, yield and chemical constituents of tuberous root of sweet potato (*Ipomoea batatas* L. Lam). *Alexandria J Agric Sci* 64 (5): 319-329. DOI: 10.21608/alexja.2019.80488
- Anda M, Suryani E, Widaningrum W, Nursyamsi D. 2018. Soil potassium nutrient, temperature and rainfall required to generate 'Honey Taste' of Cilembu sweet potato. *Indonesian J Agric Sci* 19 (1): 33. DOI: 10.21082/ijas.v19n1.2018.p33-47.
- Asoegwu CR, Awuchi CG, Nelson KCT, Orji CG, Nwosu OU, Egbufor UC, Awuchi CG. 2020. A review on the role of biofertilizers in reducing soil pollution and increasing soil nutrients. *Himalayan J Agric* 1(October): 34-38.
- Byju G, Ravindran CS. 2009. Effect of *Azospirillum* in increasing yield and nitrogen use efficiency of sweet potato cultivation in India. *Adv Hort Sci* 23 (4): 254-258. DOI: 10.1400/121242.
- Chandini, Kumar R, Kumar R, Prakash O. 2019. The impact of chemical fertilizers on our environment and ecosystem. *Res Trends Environ Sci* 69-86.
- Dekhane SS, Khafi HR, Raj AD, Parmar RM. 2011. Effect of biofertilizer and fertility levels on yield, protein content and nutrient uptake of cowpea [*Vigna unguiculata* (L.) Walp.]. *Legume Res* 34 (1): 51-54.
- Gao C, El-Sawah AM, Ismail Ali DF, Hamoud YA, Shaghaleh H, Sheteiwy MS. 2020. The integration of bio and organic fertilizers improves plant growth, grain yield, quality and metabolism of hybrid maize (*Zea mays* L.). *Agronomy* 10 (3): 1-25. DOI: 10.3390/agronomy10030319.
- Kareem I, Akinrinde EA, Oladosu Y, Eifediyi EK, Abdulmalik SY, Alasinrin SY, Kareem SA, Adekola OF. 2020. Influence of organic, inorganic and organo-mineral fertilizers on yield and quality of sweet potato (*Ipomoea batatas*). *J Appl Sci Environ Manage* 24 (1): 111. DOI: 10.4314/jasem.v24i1.16.
- Kour D, Rana KL, Yadav AN, Yadav N, Kumar M, Kumar V, Vyas P, Dhaliwal HS, Saxena AK. 2020. Microbial biofertilizers: Bioresources and eco-friendly technologies for agricultural and environmental sustainability. *Biocatalys Agric Biotechnol* 23: 101487. DOI: 10.1016/j.bcab.2019.101487.
- Lareo C, Ferrari MD. 2019. Chapter 7 - Sweet Potato as a Bioenergy Crop for Fuel Ethanol Production: Perspectives and Challenges. In RCR, S Ramachandran (Ed.), *Bioethanol Production from Food Crops* 115-147. DOI: 10.1016/B978-0-12-813766-6.00007-2.
- Liu F, Hewezi T, Lebeis SL, Pantalone V, Grewal PS, Staton ME. 2019. Soil indigenous microbiome and plant genotypes cooperatively modify soybean rhizosphere microbiome assembly. *BMC Microbiol* 19 (1): 1-19. DOI: 10.1186/s12866-019-1572-x.
- Mahanty T, Bhattacharjee S, Goswami M, Bhattacharyya P, Das B, Ghosh A, Tribedi P. 2017. Biofertilizers: A potential approach for sustainable agriculture development. *Environ Sci Pollution Res* 24 (4): 3315-3335. DOI: 10.1007/s11356-016-8104-0.
- Mahmud K, Makaju S, Ibrahim R, Missaoui A. 2020. Current progress in nitrogen-fixing plants and microbiome research. *Plants* 9 (1): 1-17. DOI: 10.3390/plants9010097.
- Marques JM, Mateus JR, da Silva TF, de Almeida Couto CR, Blank AF, Seldin L. 2019. Nitrogen-fixing and phosphate mineralizing bacterial communities in sweet potato rhizosphere show a genotype-dependent distribution. *Diversity* 11 (12): 1-11. DOI: 10.3390/d11120231.
- Maulana H, Dewayani S, Solihin MA, Arifin M, Amien S, Karuniawan A. 2020. Yield stability dataset of new orange-fleshed sweet potato (*Ipomoea batatas* L. (lam)) genotypes in West Java, Indonesia. *Data in Brief* 32: 106297. DOI: 10.1016/j.dib.2020.106297.
- Meshram NA, Ismail S, Shirale ST, Patil VD. 2019. Impact of long-term fertilizer application on soil fertility, nutrient uptake, growth and productivity of soybean under soybean-safflower cropping sequence in vertisol. *Legume Res* 42 (2): 182-189. DOI: 10.18805/LR-3676.
- Mpanga IK, Dapaah HK, Geistlinger J, Ludewig U, Neumann G. 2018. Soil type-dependent interactions of p-solubilizing microorganisms with organic and inorganic fertilizers mediate plant growth promotion in tomatoes. *Agronomy* 8 (10). DOI: 10.3390/agronomy8100213.

- Mukhongo RW, Tumuhairwe JB, Ebanyat P, Abdel Gadir AH, Thuita M, Masso C. 2017. Combined application of biofertilizers and inorganic nutrients improves sweet potato yields. *Front Plant Sci* 8: 1-17. DOI: 10.3389/fpls.2017.00219.
- Mustamu YA, Tjintokohadi K, Grüneberg WJ, Karuniawan A, Ruswandi D. 2018. Selection of superior genotype of sweet-potato in Indonesia based on stability and adaptability. *Chilean J Agric Res* 78 (4): 461-469. DOI: 10.4067/S0718-58392018000400461.
- Novianantya AC, Fardany NK, Nuraini Y. 2017. Improvement of sweet potato yield using mixtures of ground fishbone and plant residues. *J Degraded Mining Lands Manag* 4 (2): 759-765. DOI: 10.15243/jdmlm.2017.042.759.
- Ojuederie OB, Olanrewaju OS, Babalola OO. 2019. Plant growth-promoting rhizobacterial mitigation of drought stress in crop plants: Implications for sustainable agriculture. *Agronomy* 9 (11). DOI: 10.3390/agronomy9110712.
- Oliveira AP, Santos JF, Cavalcante LF, Pereira WE, Maria do Carmo CA, Oliveira ANP, Silva NV. 2010. Yield of sweet potato fertilized with cattle manure and biofertilizer. *Hortic Brasileira* 28 (3): 277-281. DOI: 10.1590/s0102-05362010000300006.
- Ouyabe M, Irie K, Tanaka N, Kikuno H, Pachakkil B, Shiwachi H. 2020. Response of upland rice (*Oryza sativa* L.) inoculated with non-native plant growth-promoting bacteria. *Agronomy* 10 (6): 1-16. DOI: 10.3390/agronomy10060903.
- Paturohman E, Sumarno D. 2015. Pemupukan sebagai penentu produktivitas ubi jalar. *Iptek Tanaman Pangan* 10 (2): 77-84. [Indonesian]
- Pérez-pazos JV, Sánchez-lópez DB. 2018. Influence of plant growth promoting bacteria in seed yields of super-elite sweet potato (*Ipomoea batatas* Lam) in the field. *Biotecnologia Aplicada* 35 (2): 397-400.
- Radziah Y, Saad OS. 2009. Growth and storage root development of sweet potato inoculated with rhizobacteria under glasshouse conditions. *Australian J Basic Appl Sci* 3 (2): 1461-1466.
- Sakha MA, Jefwa J, Gweyi-Onyango JP. 2019. Effects of arbuscular mycorrhizal fungal inoculation on growth and yield of two sweet potato varieties. *J Agric Ecol Res Int* 18 (3): 1-8. DOI: 10.9734/jaeri/2019/v18i330063.
- Sawicka B, Krochmal-Marczak B, Skiba D, Pszczolkowski P. 2019. Quality of sweet potato as a raw material for food processing. *Proceedings of the 9th International Scientific Conference Rural Development*. DOI: 10.15544/RD.2019.001.
- Sembiring M, Elfiati D, Sutarta ES, Sabrina T. 2017. Phosphate solubilization agents in increasing potatoes production on andisol Sinabung area. *Asian J Plant Sci* 16 (3): 141-148. DOI: 10.3923/ajps.2017.141.148.
- Senthilkumar M, Ganesh S, Srinivas K, Panneerselvam P. 2014. Integration of fertigation and consortium of biofertilizers and their effects on quality attributes of banana cv. Robusta (AAA). *Plant Archives* 14 (1): 401-404.
- Shih CK, Chen CM, Hsiao TJ, Liu CW, Li SC. 2019. White sweet potato as meal replacement for overweight white-collar workers: A randomized controlled trial. *Nutrients* 11 (1): 1-12. DOI: 10.3390/nu11010165.
- Singh J, Sharma MK, Bano R, Mahawar AK, Singh SP. 2020. Comparative effect of organic and inorganic sources of NPK and bio-fertilizer on growth attributes and yield of sweet potato cv. IGSP-14. *Chem Sci Rev Lett* 9 (35): 728-733. DOI: 10.37273/chesci.CS212048121.
- Sklenicka P, Zouhar J, Molnarova KJ, Vlasak J, Kottova B, Petrzalka P, Gebhart M, Walmsley A. 2020. Trends of soil degradation: Does the socio-economic status of landowners and land users matter?. *Land Use Policy* 95: 103992. DOI: 10.1016/j.landusepol.2019.05.011.
- Souza EM, Chubatsu LS, Huergo LF, Monteiro R, Camilios-Neto D, Wassem R, de Oliveira Pedrosa F. 2014. Use of nitrogen-fixing bacteria to improve agricultural productivity. *BMC Proc* 8 (S4): O23. DOI: 10.1186/1753-6561-8-s4-o23.
- Susan John K, Anju PS, Chithra S, Beegum SUS. 2020. Utilization of resources as a component of integrated nutrient management strategy in tropical tuber crops. *Indian J Fertilisers* 16 (2): 142-148.
- Tegeye M, Kaur A, Kaur J, Singh H. 2019. Value-added convenience food from composite sorghum-maize-sweet potato flour blends. *Indian J Agric Sci* 89 (11): 1906-1910.
- Valpato S, Masoero G, Giovanetti G, Nuti M. 2020. Arbuscular mycorrhizal biofertilizer sources in the potato (*Solanum tuberosum*) plant show interactions with cultivars on yield and litter-bags spectral features. *J Agronomy Res* 2 (4): 1-17. DOI: 10.14302/issn.2639-3166.jar-20-3185.
- Wu C, Huang J, Zhu H, Zhang L, Minasny B, Marchant BP, McBratney AB. 2019. Spatial changes in soil chemical properties in an agricultural zone in southeastern China due to land consolidation. *Soil Tillage Res* 187: 152-160. DOI: 10.1016/j.still.2018.12.012.
- Yasmin F, Othman R, Maziz MNH. 2020. Yield and nutrient content of sweet potato in response of plant. *Jordan J Biol Sci* 13 (1): 117-122.