

International Journal of Plant Physiology and Biochemistry

Volume 7 Number 1, March 2015

ISSN 2141-2162



*Academic
Journals*

ABOUT IJPPB

The **International Journal of Plant Physiology and Biochemistry (IJPPB)** (ISSN 2006-9871) is published Monthly (one volume per year) by AcademicJournals.

International Journal of Plant Physiology and Biochemistry (IJPPB) provides rapid publication (monthly) of articles in all areas of the subject such as plant hormones, seed biology, plant DNA repair, Concepts of target cells in plant differentiation etc.

The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in IJPPB are peer-reviewed.

Submission of Manuscript

Please read the **Instructions for Authors** before submitting your manuscript. The manuscript files should be given the last name of the first author

[Click here to Submit manuscripts online](#)

If you have any difficulty using the online submission system, kindly submit via this email ijppb@academicjournals.org.

With questions or concerns, please contact the Editorial Office at ijppb@academicjournals.org.

Editors

Prof Dr. Ishrak Khafagi

*Faculty of Science,
Suez Canal University,
Ismailia,
Egypt*

Prof. Mohamed Mahgoub Azooz

*Biology Department
Faculty of Science
King Faisal
University,
Saudi Arabia.*

Dr. Bansal Parveen

*National Institute of Ayurvedic Pharmaceutical
Research
Moti Bagh Road,
Patiala-(Punjab) India.*

Prof. Bechan Sharma

*Department of Biochemistry,
University of Allahabad,
Faculty of Science,
Allahabad-211002,
India.*

Editor Board

Prof. Weimin Zhang

*Guangdong Institute of Microbiology
100 Central Xian lie Road, Guangzhou,
Guangdong 510070,
China.*

Dr. Xu Suxia

*Fujian Institute of Subtropical Botany,
780-800, Jiahe Road, Xiamen,
China361006,
China.*

Dr. Adaku Vivien Iwueke

*Department of Biochemistry,
Federal University of Technology,
Owerri
Nigeria.*

Ass. Prof. Turgay CELIK

*Gulhane Military Medical Academy,
School of Medicine,
Department of Cardiology,
Turkey.*

Dr.Topik Hidayat

*Department of Biology Education
Indonesia University of Education (UPI)
Jalan Dr. Setiabudhi 229 Bandung 40154 Indonesia
Indonesia.*

Dr.Tariq Mahmood

*Quaid-i-Azam University,
Department of Plant Sciences, Quaid-i-Azam
University,
Islamabad,
Pakistan.*

Dr.Neveen B. Talaat

*Department of Plant Physiology,
Faculty of
Agriculture,
Cairo University,
Egypt.*

Dr. Sudhamoy Mandal

*Fulbright Visiting Fellow
Department of Plant Pathology
University of Nebraska Lincoln
USA*

Asso. Prof. Chankova Stephka Georgieva

*Central Laboratory of General Ecology,
Bulg Acad
Sci 1113 Sofia, 2 Gagarin str,
Bulgaria.*

Shijie Han

*Center of Forestry,
Institute of Applied Ecology,
Chinese Academy of Sciences,
72 Wenhua Road, Shenyang City,
Liaoning Province 110016, PR China.*

Szu-Chuan Shen

*Department of Medical Nutrition,
I-Shou University
Yanchao Township,
Kaohsiung County 824, Taiwan.*

Seddik Khennouf

*Dept of Biology,
Faculty of Science
University Ferhat Abbas,
SETIF, 19000, ALGERIA.*

Saranyu Khammuang

*Maharakham University
Department of Chemistry,
Faculty of Science
Thailand.*

Samir Ranjan Sikdar

*Bose Institute
P-1/12, C.I.T. Scheme VII M,
Kolkata 700 054,
India.*

Dr. M. Abdul Salam

*Department of Agronomy,
College of Agriculture,
Kerala Agricultural University,
Vellayani 695 522, Trivandrum,
Kerala.*

Dr.Saeed Aminzadeh

*National Institute of Genetic Engineering and
Biotechnology (NIGEB)
Shahrak-e-Pajoohesh Km 15, Tehran-Karaj
Highway, Tehran, I.R.Iran.*

Dr.Ruzica Stricevic

*Faculty of Agriculture,
University of Belgrade
Nemanjina 6, Zemun, 11080,
Serbia.*

Rumbos Christos

*University of Thessaly
Fytokoy Str, 384 46
Volos, Greece.*

Dr. Özge Zencir

*Kemah Vocational Training School,
Erzincan University,
Kemah, Erzincan,
Turkey.*

Riyazali Zafarali Sayyed

*SI P Arts, GBP Science & STSKVS Comm. College
SHAHADA Dist Nandurbar,
Maharashtra, India.*

Raul Rodriguez-Herrera

*Universidad Autonoma de Coahuila
School of Chemistry
Blvd. V. Carranza y González Lobo s/n Col República
Saltillo Coahuila México.*

Dr. A. H. M. Mahbubur Rahman

*Rajshahi University, Bangladesh.
Department of Botany,
University of Rajshahi,
Bangladesh.*

Paul S. Marley

*Department of Crop Protection, IAR/FOA
Ahmadu Bello University,
P.M.B. 1044, Samaru, Zaria,
Nigeria.*

Patrick Addo-Fordjour

*Department of Theoretical and Applied Biology,
Kwame Nkrumah University of Science And
Technology (Knust),
Kumasi,
Ghana.*

Battu.Prasanna Reddy

*Nosch Labs Pvt Ltd
Hyderabad, India.*

Noureddine Benkeblia

*UWI - Department of Life Sciences
Mona Campus, Kingston 7,
Jamaica.*

Keutgen, Norbert

*Uniwersytet Technologiczno-Przyrodniczy
im. Jana i Jędrzeja Śniadeckich w Bydgoszczy
Kadra Katedry Fizjologii Roslin (Institute of
Plant Physiology)
ul. Bernardynska 6/8, 85-029 Bydgoszcz,
Poland.*

Nicholas E. Korres

*University College Cork,
Environmental Research Institute.
Lee Road, Cork,
Ireland.*

Dr Naveen Kumar

*University of Florida
2685 SR 29 N SWFREC/IFAS/UFL,
Immokalee, FL34142,
USA.*

Dr Modala Venkateswarlu

*Seribiotech research Laboratory,
Kodathi Carmelaram post,
Bangalore.*

Mirza Hasanuzzaman

*Department of Agronomy,
Faculty of Agriculture,
Sher-e-Bangla Agricultural University,
Dhaka-1207, Bangladesh.*

Maybelle Gaballah

*National Research Centre,
El Behoos street, Dokki, Cairo.*

Mauro Guida Santos

*Universidade Federal de Pernambuco Street
Moraes Rego – CDU – CCB – Botany Department,
s/n. 50670-901. Pernambuco State, Brazil.*

Marcelo Rodrigo Pace

*University of Sao Paulo
Rua do Matão, 277,
Cidade Universitária
São Paulo, Brazil.*

Marcelo Francisco Pompelli

*Federal University of Pernambuco
Department of Botany, Profª Moraes Rego Av.,
Recife – PE – Brazil, 50670-901.*

Luca Catalina Mariana

*University of Bucharest, Faculty of Biology, Dept of
Biochemistry and Molecular Biology
Spl. Independentei, no.91-95, Bucharest 5,
Romania.*

Lin Wang

*Institute of Biostatistics, Fudan University
220 Handan Road, Shanghai 200433, China
genetics, microbiology
China.*

Li Qiang

*Institute of karst geology,MLR
50 Qixing Road,
China.*

Dr. Ayanakumar Kumar

*C.Abdul Hakeem College of Engg. & Tech.,
Melvisharam-632 509, Vellore Dist, Tamil Nadu,
INDIA.*

P. Krishnamoorthy

*P.G. AND RESEARCH DEPARTMENT OF ZOOLOGY
RAJAH SERFOJI GOVT. COLLEGE.
India.*

Hare Krishna

*Central Institute of Temperate Horticulture-
Regional Station,
Mukteshwar-263 138, District- Nainital,
Uttarakhand, India.*

K.G. Mandal

*Directorate of Water Management (formerly Water
Technology Centre for Eastern Region)
Indian Council of Agricultural Research
C.S. Pur, Bhubaneswar-751023, ORISSA, INDIA.*

Dr. Jukta Adhikari

*Presidency College
86/1, College Street, Kolkata – 700 073, India.*

Jorge Teixeira

*Botany Department, Faculty of Sciences,,
University of Porto,
Edifício FC4, Rua do Campo Alegre, S/N, 4169-
007
Porto, Portugal.*

Johnson Toyin Fasinmirin

*Federal University of Technology, Akure,
Nigeria Department of Agricultural
Engineering, FUT, P.M.B. 704, Akure, Ondo
State, Nigeria..*

Joel K. Ransom

*North Dakota State University
166 Loftsgard Hall, Department of Plant
Sciences, NDSU Dept. 7670, PO Box 6050,
Fargo, ND 58108-
6050.*

João Claudio Damasceno de Sá

*UENF
Av. José Carlos Pereira Pinto, 39. Pq. Vicente
Dias. Campos RJ. Brazil.*

Jalal Jalali Sendi

*University of Guilan
Department of Plant Protection, university of
Guilan, Rasht, Iran.*

Íuri Drumond Louro

*Universidade Federal do Espírito Santo
Rua Horácio Andrade de Carvalho, 210, Victoria,
ES, 29052-620, Brazil.*

Hong Bo Guo

*Northwest A and F University
22 Xinong, Yangling 712100, Shaanxi, PR China.*

Harsukh P. Gajera

*Junagadh Agricultural University Department
of Biochemistry, College of Agriculture, JAU,
Junagadh- 362 001, Gujarat, India.*

Hanan Abdel Fattah El-Sadawy

*National Research Center
El-Buhoth St.,Dokki, Giza, Egypt.*

Assist. Prof .Azime KÜÇÜKGÜL GÜLEÇ

*Tunceli University Fisheries Faculty 62000,
Tunceli/TURKEY.*

Greg T. Hannig

*DuPont
1090 Elkton Road Newark, DE 19711.*

Gilberto Santos Andrade

*Instituto de Biotecnologia Aplicada a Agropecuária
(BIOAGRO), Departamento de Biologia Animal,
Universidade Federal de Viçosa, Viçosa, MG 36571-
000, Brazil.*

Dr. T. Muthukumar

*Department of Botany, Bharathiar University
Coimbatore -641 046, Tamilnadu, India.*

Kunjupillai Vijayan

*Institute of Plant and Microbial Biology
Academia Sinica, Taipei, Taiwan-115, ROC.
Taiwan.*

Badre Alam

*National Research Centre For Agroforestry
Gwalior Road, Jhansi-284003, U.P., India.*

Abeer Essam El-Din Mahmoud

*Biochemistry Department
Genetic Engineering & Biotechnology Division
National Research Center El Tahrir St., El Dokki
12622, Cairo, Egypt.*

Qazi Fariduddin

*Aligarh Muslim University
Department of Botany, Aligarh 202 002, India.*

Darmawan Darma

*Faculty of Agriculture, Andalas University
Kampus Limau Manis Padang-25163, Indonesia.*

Barbara Chaves

Institute for Agricultural and Fisheries Research.

Sudhamoy Mandal

*Central Horticultural Experiment Station
(ICAR) Aiginia, Bhubaneswar, PIN-751019.*

Cavit Bircan

*Adnan Menderes University
Faculty of Agriculture
Department of Food
Engineering
09100/Aydin/Turkey.*

Carlos Alberto Ortega-Ojeda

*Central University of Ecuador. Faculty of Agriculture Sciences. Quito, Ecuador
Calle 12 # 29 B - 78, Apto. 102 F, Unidad Residencial
Colseguros, Cali, Colombia.*

Brian Wade Jamandre

*National Taiwan University
Rm. 622, life science bldg., NTU, no.1, sec.4, Roosevelt rd. Taipei 10617, Taiwan (ROC).*

Bitá Naseri

*Agricultural Research Institute
Department of Plant Protection, Agricultural Research Institute, PO Box 45195474, Zanjan, Iran..*

Behzad Kaviani

*Adeyemi Oluyomi Stephen
Bells University of Technology
Chemical Sciences Department, Km 8 Ididroko Road, Ota, Ogun
State, Nigeria.*

Ajayi Adedayo Olajide

*Adekunle Ajasin University
Dept. of Microbiology, P.M.B 01, Akungba-Akoko, Ondo State, Nigeria.*

Alexandre Igor Azevedo Pereira (Pereira, A.I.A.)

Universidade Federal de Viçosa, Departamento de Biologia Animal, Programa de Pós-Graduação em Entomologia. 36570-000, Viçosa, Minas Gerais State, Brazil.

Gilberto Santos Andrade

Instituto de Biotecnologia Aplicada a Agropecuária (BIOAGRO), Departamento de Biologia Animal, Universidade Federal de Viçosa, Viçosa, MG 36571-000, Brazil.

Pradeep. A.R., Ph.D

*Seribiotech Research Laboratory
Carmelaram.P.O; Bangalore, INDIA.*

Azamal Husen

*University of Gondar
Department of Biology, Faculty of Natural Sciences, University of Gondar
P.O. Box #196, Gondar, Ethiopia.*

Muhammad Aslam

*University College of Agriculture, Bahauddin Zakariya University
Multan 60800, Pakistan.*

Autumn J. Smith

Sam Houston State University, Texas.

La Sara

*Haluoleo University
Kampus Baru Tridharma, Kendari,
Southeast Sulawesi, Indonesia.*

Aliyu Mohammed

*Department of Human Physiology, ABU, Zaria.
Nigeria.*

Prof. EL-Said Ahmed AL-Sayed Ragab

National Research Institute of Astronomy and Geophysics, 11421, Helwan, Egypt.

Shnoudy Anwar Bakhom

National Institute of Oceanography & Fisheries (NIOF), Egypt.

Antonio Americo Barbosa Viana

*Embrapa Recursos Genéticos e Biotecnologia PBI-LPP1
PqEB Final W/5 Norte, Brasília, DF – Brazil*

Dr.Shirish Rajmalwar

National Research Laboratory for Conservation, Shirish Rajmalwar, LIG Plot No. 43, Mhada colony, Wardha – 442001, (MS) India.

Dr. Amaresh Chandra

Universidade Federal de Viçosa, Departamento de Biologia Animal, Programa de Pós-Graduação em Entomologia. 36570-000, Viçosa, Minas Gerais State, Brazil.

Dr. Atul Kumar

*GB PANT University of Agriculture & Technology
Department of Basic Science, College of Forestry &
Hill Agriculture, HILL CAMPUS, PO Ranichauri,
Tehri Garhwal, Uttarakhand State, India.*

Prof. Levenko Boris

*Natl. Botanical Gardens, NAS of Ukraine
01014 Kiev, 1 Timiryasevska st. Ukraine.*

Dr. Dionisio G. Alvindia

*Bureau of Postharvest Research and
Extension CLSU Compound, Science City of
Munoz, Nueva Ecija 3120, Philippines.*

Dr. Bhoopander Giri

*University of Delhi
Department of Botany, SSNC (University of
Delhi) Alipur, Delhi 110036, India.*

Dr. Anjali Sood

*University of Delhi
Department of Botany, University of Delhi, Delhi-
110 007, INDIA.*

Dr. A. K. Verma

*G.B. Pant University of Agriculture & Technology,
Pantnagar, Department of Biochemistry, College
of
Basic
Sciences,
India.*

Dr. Anjana Jajoo

*School of Life Science, Devi Ahilya
University, Indore, DAVV
Khandwa Road campus, Indore 452 017,
M.P., India.*

Dr. Deepak Ganjewala

*Vellore Institute of Technology University
55 Thennaraam Street, Vellore-632 014 (T.N.),
India.*

Dr. Geetha Govind

*Max-Planck-Institute for Chemical Ecology
Hans-Knöll Straße 8, 07745 Jena, Germany.*

Dr. Hossam El-Din Saad El-Beltagi

*Biochemistry Department, Faculty of Agriculture,
Cairo University, Giza, Egypt, P.O.Box 12613
Egypt.*

Prof. Dr. Md. Shahidul Haque

*Dept. of Biochemistry and Molecular Biology
University of Rajshahi, Rajshahi-6205, Bangladesh
Bangladesh.*

DR. P.K.NAGAR

*Retired Senior Scientist, IHBT, Palampur, (H.P.),
B.21/115-10A Batuk Dham Colony, Kamachha,
Varanasi 221 010, INDIA.*

Dr. Satyawati Sharma

*Indian Institute of Technology
Centre for Rural Development & Technology, IIT
Delhi-110016
Biomass Production on waste land, India.*

Dr. Uğur Çakılcıoğlu

*Firat University Elazığ/TURKEY
Cumhuriyet M. Malatya C. No:50/A.*

Prof. Abdelrhani Elachqar

*Faculty of Sciences Dhar El Mahraz, Fez, Morocco
BP 1796, Fès-Atlas, Fès, Maroc, Morocco.*

Ass. Prof. Jianfeng Xu

*Arkansas State University
PO Box 639, State University, AR 72467 USA.*

Ass.Prof. Jin Xu

*Center for Agricultural Resources Research, Institute
of Genetics and Developmental Biology, Chinese
Academy of Sciences
Huaizhong RD 286, Shijiazhuang, HeBei, China.*

José Carlos Rebuglio Velloso Ph.D

*PARANÁ STATE UNIVERSITY OF PONTA GROSSA
(Universidade Estadual de Ponta Grossa – UEPG)
General Carlos Cavalcanti Avenue, 4748, Uvaranas,
Ponta Grossa/PR – PO box 84030-900*

Dr. Krouma Abdelmajid

*Centre of Biotechnology, Borj Cedria Ecopark
BP 901, Hammam-Lif 2050, Tunisia
College of Science and Arts, Qassim University, BP 53,
Al-Rass 3330353, Qassim, Saudi Arabia
Saudi Arabia*

Dr. Majid Rostami

*Malayer University
Department of Agriculture and Natural
Resources, Postal code: 65719- 95863,
University of Malayer Malayer, Iran.*

Dr. Mohammad Nasir Khan

*Aligarh Muslim University, Aligarh, INDIA
Plant Physiology Section, Department of
Botany, Aligarh Muslim University, Aligarh-
202 002, U.P., India.*

Prof. N.K.Matta

*Kurukshetra University
Department of Botany, Kurukshetra
University, Kurukshetra 136119, INDIA.*

Dr. Naceur Djebali

*Centre of Biotechnology Borj-Cedria
(CBBC) BP 901, Hammam-Lif 2050
Tunisia.*

Dr. Nader Chaparzadeh

*Azarbaijan University of Tarbiat Moallem,
Tabriz, Iran.*

Nautiyal Prakash Chandra

*Directorate Of Groundnut Research (Icar)
Post box, No. 5, Ivnagar Road, Junagadh-362001,
Gujarat, India.*

Prof. Hussein Fawzy Hussein Abouzienna

*National Research Center
Botany Department, National Research
Center, Elbhos Street, Dokki, Cairo, Egypt.*

Dr. D.E. Chandrashekar Rao

*National Research Council Canada / Plant
Biotechnology Institute (NRC-PBI)
110 Gymnasium Place / Saskatoon, Saskatchewan
S7N 0W9
Canada.*

Dr. S.R Madhan Shankar

*PSG College of Arts & Science
Civil Aerodrome Post, Coimbatore-641 014, India.*

Prof. Dr. Safdar Hussain Shah

*Institute of Biotechnology and Genetic Engineering
NWFP, Agricultural University Peshawar, Pakistan.*

Prof. Dr. Md. Shahidul Haque

*Dept. of Biochemistry and Molecular Biology
University of Rajshahi, Rajshahi-6205, Bangladesh.*

Dr. Sivakumar Swaminathan

*Iowa State University (ISU)
G-319, Agronomy Department, ISU, Ames, Iowa -
50011, USA*

Dr. Subrahmanyam Desiraju

*Directorate of Rice Research (ICAR)
Plant Physiology Division, Rajendranagar,
Hyderabad-500030, A.P. India.*

Dr. Tariq Aziz Dr. Deepak Ganjewala

*University of Agriculture, Faisalabad, Sub-Campus
Depalpur, Dist. Okara, Pakistan.*

Dr. Thangavel Palaniswamy

*SUN YAT-SEN UNIVERSITY
GUANGZHOU, PR CHINA.*

Yi-Ping Chen Ph.D

*Institute of Earth Environment,
Chinese Academy of Science Fenghui S.R, 10,
Xi'an Hi-Tech Zone, Xi'an, Chnia.*

Saha Prasenjit

*The Samuel Roberts Noble Foundation
2510 Sam Noble Parkway, Ardmore, Ok USA.*

Abdul Khaliq Ph.D

*Department of Agronomy
University of Agriculture
Faisalabad 38040, Pakistan.*

Dr. Arafat Abdel Hamed abdel Latef

*Assistant Professor of Plant physiology
Botany Department
Faculty of Science at Qena
South Valley University
Egypt.*

Dr. Ahmad Bybordi

*Research Center of Agriculture and Natural
Resources of East Azarbaijan
Member of Scientific Board of Research Center of
Agriculture and Natural Resources of East
Azarbaijan,
Tabriz. Iran.*

Dr. Arijit Sinhababu

Bankura Christian College (under –The University of Burdwan)

Department of Botany, Bankura Christian College, P.O. + Dist. Bankura, Pin.-722101, West, Bengal, India.

Dr. Maria Alejandra Equiza

University of Alberta,

4-51 Earth Sciences Building, Dept. Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3, Canada

Dr. Suphla Bajpai Gupta

Indian Institute of integrative Medicine –CSIR, Scientist, Plant biotechnology division, Canal Road, Jammu, Jammu & Kashmir, India-180001. India.

Dr. Linga R Gutha

Washington State University, 2410 N Bunn Road, Prosser, WA 99350, USA.

Dr. Medhat Mekhail Tawfik

National Research Center, El Bohooth Str. Dokki, Giza. Egypt, PO Box 12311, Egypt.

Dr. Rafiq Islam

The Ohio State University South Centers, 1864 Shyville Road, Piketon, OH 45661.

Dr. Rakesh Kumar

V.S.P. Govt. P.G. College, Kairana, Muzaffarnagar (Uttar Pradesh), Department of Botany, V.S.P. Govt. P.G. College, Kairana, Muzaffarnagar (Uttar Pradesh), India-247774.

Dr. Ivan Sestari

University of São Paulo, Av. Pádua Dias, 11: CP 9. CEP 13418-900.

D.Sc. Rachel Fatima Gagliardi

State University of Rio de Janeiro, Rua São Francisco Xavier, 524 – PHLC sala 602.

Dr. Ullas Pedmale

Salk Institute for Biological Studies, 10010 N Torrey Pines RD, La Jolla, CA 92037.

Dr. Allah Bakhsh Dr. Deepak Ganjewala *Department of Field Crops, Faculty of Agriculture, University of Ankara, Apartment No. 12/10, Sanatorym Caddesi, Kalaba, Kecioren, Ankara, Turkey.*

Dr. Atilgan Atilgan

Suleyman Demirel University, Agriculture Faculty, Department of Agricultural Structures and Irrigation, Isparta, Turkey.

Mr. Andrej Pilipovic

University of Novi Sad – Institute of Lowland Forestry and Environment, Antona Cehova 13, 21000 Novi Sad, Serbi.

Dr. Zulfiqar Ahmad Saqib

Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Civil Line Road, Faisalabad, Pakistan.

MS. C. Mehrnoush Eskandari Torbaghan

North Khorasan Agricultural & Natural Resource Research Center (NKANRRC) P.O. Box: 94155-1416, No. 52, Hassan Kallate Alley, Tarbiyat St., Mother Sq. Bojnourd, Iran.

Dr. Vinod Kumar

Department of Zoology & Environmental Science, Gurukula Kangri University, Haridwar-249404 (UK), India.

Dr . Panda Tribhubana

Kalahandi Institute for Tribiology and Ethnobiology(KITE), At-Jilingdar, PO-Deydar, Dist-Kalahandi,Odisha, India,766014, India

Dr. Sabarinath Sundaram

Institute of Developmental and Molecular Biology, Texas A&M University, Biological Sciences Building West Suite 403.

Dr. Diogo Pineda Rivelli

*University of São Paulo,
Av. Prof. Lineu Prestes 580, São Paulo, SP, 05508-000.*

Dr. Qiang Wang

*Virginia Tech,
427 Latham Hall.*

Dr. Foteini Hassiotou

*University of Western Australia,
35 Stirling Highway, Crawley, WA
6009, Australia.*

Dr. Nivedita Sahu

*Indian Institute of Chemical
Technology, Chemical Biology
Laboratory
(NaturalProductChemistry), Uppal
Road, Hyderabad-500607.*

Dr. Mohammad Anwar Hossain

*Bangladesh Agricultural University,
Assistant Professor, Dept. of Genetics and
Plant Breeding, Bangladesh Agricultural
University, Mymensingh-2202, Bangladesh.*

Dr. Ahmad Ali

*National Institute of Pharmaceutical
Education & Research,
Dept of Biotechnology, NIPER, Jandaha
Road, Hajipur, Bihar, India, Pin – 844102,
India.*

Mr. Karthikkumar V

*Annamalai University,
Department of Biochemistry & Biotechnology.*

Dr.K.Rajendiran

*Dept of plant science, Tagore Govt. college,
9, 4th cross, Tagore Nagar, Pondicherry – 605
008, India.*

Dr. V. Balakrishnan

*K.S.Rangasamy College of
Technology, Department of
Biotechnology, KSR Kalvi
nagar, Tiruchengode-
637215, Tamilnadu, India.*

Dr. NourAli Sajedi

*Department of Agronomy and plant Breeding,
Islamic Azad University, Arak Branch, Arak,
Iran.*

(Dr) Ms. Rachel Predeepa

*Not Applicable ,
2/387 Gokul Nagar, Kannanenthal Madurai.*

Dr. Rajendra Gyawali

*Department of Pharmacy and Biology, Kathmandu
University,
Dhulikhel,
Nepal.*

Ms. Rocheli de Souza

*UFRGS,
Porto Alegre,
Brazil.*

Dr. Om Prakash Verma

*Sam Higginbottom Institute of Agriculture,
Technology & Sciences (Formerly Allahabad
Agricultural Institute), Allahabad, U.P.,
Department of Molecular & Cellular Engineering,
Jacob School of Biotechnology & Bioengineering,
India.*

Dr. Ashwani Kumar

*JMIT, Radaur,
Department of Biotechnology, JMIT, Radaur-
135133, Haryana, India.*

Dr. Sarfaraz F. A. Al-Bamarny

*University of Duhok, College of Agriculture, Dept.
of Horticulture,
Duhok, Iraqi Kurdistan Region,
Iraq.*

Prof. Wafaa Mohamed Shukry Abdel Meamem

*Dammam University - Saudi Arabia,
Faculty of Science for Girl.
Biology Department,
P.O.Box: 838 Dammam 31113,
Saudi Arabia.*

Dr. Stepka G. Chankova

*Institute of Biodiversity and ecosystem Research,
BAS,
2 Gagarin str, 1113 Sofia, Bulgaria.*

Dr. Nana Ewusi-Mensah

*Kwame Nkrumah University of Science and Technology,
Dept. of Crop and Soil Sciences, Faculty of Agriculture, KNUST, Kumasi.*

Dr. Mukesh Lokanath Chavan

*K.r.c. College of horticulture, arabhavi 591 310, karnataka,
University of horticultura sciences, bagakot, India.*

Dr. Maiti Parthapratim

Dept. of Botany Midnapore College, Midnapore-721101, Paschim Medinipur, West Bengal, India.

Mr. Mohammad Anwar Hossain

*Kagawa University (Present), Bangladesh Agricultural University (Permanent)
Lab. of Plant Stress Responses, Faculty of Agriculture, Kagawa University, Miki-cho, Kitagun, Kagawa 761 0795, Japan.*

Dr. Antonia Tathiana Batista Dutra

*Universidade Federal do Ceará,
Av. Humberto Monte s/n – Pici Bloco 907, laboratório 1080.*

Dr. Kuntal Das

*St. John's Pharmacy College,
#6, II Main, 9th Cross, Vijayanagar, Bangalore-104. India.*

Dr. Amitava Rakshit

*Banaras Hindu University,
Department of Soil Science & Agril Chemistry.*

Dr. Kranthi Kiran Mandadi

*Texas A&M University,
2132 TAMU, Peterson-Rm408, College Station, Texas-77840, USA.*

Dr. Monica Butnariu

*Banat's University of Agricultural Sciences and Veterinary Medicine from Timisoara,
Chemistry and Vegetal Biochemistry Department, Calea Aradului no.119, 300645 Timisoara, Romania.*

Dr. Ahmad Bybordi

*East Azarbaijan Research Center for Agriculture and Natural Resources,
Tabriz, Iran.*

Dr. Haiwei Gu

903 Fifth St., West Lafayette, IN 47906.

Dr. Hu Yanbo

*Northeast Forestry University,
26# Hexing Road, Xiangfang District, Harbin city, 150040, P.R., China.*

Dr. Arash Kianianmomeni

Institute of Biology / Humboldt-University Berlin, Invalidenstr. 42.

Dr. Zvonko Pacanoski

*Faculty for Agriculture Sciences and Food,
Boul. Aleksandar Makedonski bb, 1000 Skopje, R.of Macedonia..*

Dr. Lingjuan Zheng

Department of Organismic Biology, University of Salzburg, Hellbrunnenstraße 34, 5020, Salzburg, Austria.

Dr. Md. Mokter Hossain

Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

Dr. Forouzandeh Soltani

Department of Horticultural Sciences, College of Agriculture and Natural Resources, University of Tehran, Daneshkadeh Street, Karaj 31587-11167, Iran.

Dr. M.C.Harish

*Bharathiar University,
Department of Biotechnology, Coimbatore, India.*

Dr. Zong-shen Zhang

*School of Biological Engineering, Dalian Polytechnic University,
Qinggongyuan, Ganjingzi District, Dalian, China, postcode 116034.*

Prof. T. V. Ramana Rao

*B R Doshi School of Biosciences,
Sardar Patel University,
Vallabh Vidyanagar, Gujarat,
India.*

Dr. Sanjeev Chandel

*Baba Isher Singh Institute of Sciences &
Technology, Gagra (Moga), Punjab,
India.*

Dr. Kuladip Jana

*Bose Institute Centenary Campus, P 1/12, C.I.T.
Scheme VIIM, Kolkata-700 054, India.*

Prof. Ljubinko Jovanovic

*University Educons,
Faculty for Ecological Agriculture,
Sremska Kamenica, Vojvode Putnika 87,
Serbia.*

Dr. Luis F. Goulao

*Instituto de Investigacao Cientifica Tropical
[Tropical Research Institute] Eco-Bio / IICT,
Av. da Republica - Quinta do Marques,
2784-505 Oeiras, Portugal.*

Dr. Lucky K. Attri

*College of Punjabi University Patiala, E-41,
Sector-14, Panjab University, Chandigarh.*

Prof. Bassam Taha Yasseen

*Flat 307 Point Red,
146 Midland Road, Luton, LU2
OBL, UK.*

Dr. Massimo Piccotto

*Tecna S.r.l.,
Area Science Park, Loc. Padriciano, 99, I-34149
Trieste, Italy.*

Instructions for Author

Electronic submission of manuscripts is strongly encouraged, provided that the text, tables, and figures are included in a single Microsoft Word file (preferably in Arial font).

The **cover letter** should include the corresponding author's full address and telephone/fax numbers and should be in an e-mail message sent to the Editor, with the file, whose name should begin with the first author's surname, as an attachment.

Article Types

Three types of manuscripts may be submitted:

Regular articles: These should describe new and carefully confirmed findings, and experimental procedures should be given in sufficient detail for others to verify the work. The length of a full paper should be the minimum required to describe and interpret the work clearly.

Short Communications: A Short Communication is suitable for recording the results of complete small investigations or giving details of new models or hypotheses, innovative methods, techniques or apparatus. The style of main sections need not conform to that of full-length papers. Short communications are 2 to 4 printed pages (about 6 to 12 manuscript pages) in length.

Reviews: Submissions of reviews and perspectives covering topics of current interest are welcome and encouraged. Reviews should be concise and no longer than 4-6 printed pages (about 12 to 18 manuscript pages). Reviews are also peer-reviewed.

Review Process

All manuscripts are reviewed by an editor and members of the Editorial Board or qualified outside reviewers. Authors cannot nominate reviewers. Only reviewers randomly selected from our database with specialization in the subject area will be contacted to evaluate the manuscripts. The process will be blind review.

Decisions will be made as rapidly as possible, and the journal strives to return reviewers' comments to authors as fast as possible. The editorial board will re-review manuscripts that are accepted pending revision. It is the goal of the AJFS to publish manuscripts within weeks after submission.

Regular articles

All portions of the manuscript must be typed double-spaced and all pages numbered starting from the title page.

The Title should be a brief phrase describing the contents of the paper. The Title Page should include the authors' full names and affiliations, the name of the corresponding author along with phone, fax and E-mail information. Present addresses of authors should appear as a footnote.

The Abstract should be informative and completely self-explanatory, briefly present the topic, state the scope of the experiments, indicate significant data, and point out major findings and conclusions. The Abstract should be 100 to 200 words in length. Complete sentences, active verbs, and the third person should be used, and the abstract should be written in the past tense. Standard nomenclature should be used and abbreviations should be avoided. No literature should be cited.

Following the abstract, about 3 to 10 key words that will provide indexing references should be listed.

A list of non-standard **Abbreviations** should be added. In general, non-standard abbreviations should be used only when the full term is very long and used often. Each abbreviation should be spelled out and introduced in parentheses the first time it is used in the text. Only recommended SI units should be used. Authors should use the solidus presentation (mg/ml). Standard abbreviations (such as ATP and DNA) need not be defined.

The Introduction should provide a clear statement of the problem, the relevant literature on the subject, and the proposed approach or solution. It should be understandable to colleagues from a broad range of scientific disciplines.

Materials and methods should be complete enough to allow experiments to be reproduced. However, only truly new procedures should be described in detail; previously published procedures should be cited, and important modifications of published procedures should be mentioned briefly. Capitalize trade names and include the manufacturer's name and address. Subheadings should be used. Methods in general use need not be described in detail.

Results should be presented with clarity and precision. The results should be written in the past tense when describing findings in the authors' experiments. Previously published findings should be written in the present tense. Results should be explained, but largely without referring to the literature. Discussion, speculation and detailed interpretation of data should not be included in the Results but should be put into the Discussion section.

The Discussion should interpret the findings in view of the results obtained in this and in past studies on this topic. State the conclusions in a few sentences at the end of the paper. The Results and Discussion sections can include subheadings, and when appropriate, both sections can be combined.

The Acknowledgments of people, grants, funds, etc should be brief.

Tables should be kept to a minimum and be designed to be as simple as possible. Tables are to be typed double-spaced throughout, including headings and footnotes. Each table should be on a separate page, numbered consecutively in Arabic numerals and supplied with a heading and a legend. Tables should be self-explanatory without reference to the text. The details of the methods used in the experiments should preferably be described in the legend instead of in the text. The same data should not be presented in both table and graph form or repeated in the text.

Figure legends should be typed in numerical order on a separate sheet. Graphics should be prepared using applications capable of generating high resolution GIF, TIFF, JPEG or Powerpoint before pasting in the Microsoft Word manuscript file. Tables should be prepared in Microsoft Word. Use Arabic numerals to designate figures and upper case letters for their parts (Figure 1). Begin each legend with a title and include sufficient description so that the figure is understandable without reading the text of the manuscript. Information given in legends should not be repeated in the text.

References: In the text, a reference identified by means of an author's name should be followed by the date of the reference in parentheses. When there are more than two authors, only the first author's name should be mentioned, followed by 'et al'. In the event that an author cited has had two or more works published during the same year, the reference, both in the text and in the reference list, should be identified by a lower case letter like 'a' and 'b' after the date to distinguish the works.

Examples:

Abayomi (2000), Agindotan et al. (2003), (Kelebeni, 1983), (Usman and Smith, 1992), (Chege, 1998;

1987a,b; Tijani, 1993,1995), (Kumasi et al., 2001) References should be listed at the end of the paper in alphabetical order. Articles in preparation or articles submitted for publication, unpublished observations, personal communications, etc. should not be included in the reference list but should only be mentioned in the article text (e.g., A. Kingori, University of Nairobi, Kenya, personal communication). Journal names are abbreviated according to Chemical Abstracts. Authors are fully responsible for the accuracy of the references.

Examples:

Chikere CB, Omoni VT and Chikere BO (2008). Distribution of potential nosocomial pathogens in a hospital environment. *Afr. J. Biotechnol.* 7: 3535-3539.

Moran GJ, Amii RN, Abrahamian FM, Talan DA (2005). Methicillinresistant *Staphylococcus aureus* in community-acquired skin infections. *Emerg. Infect. Dis.* 11: 928-930.

Pitout JDD, Church DL, Gregson DB, Chow BL, McCracken M, Mulvey M, Laupland KB (2007). Molecular epidemiology of CTXM-producing *Escherichia coli* in the Calgary Health Region: emergence of CTX-M-15-producing isolates. *Antimicrob. Agents Chemother.* 51: 1281-1286.

Pelczar JR, Harley JP, Klein DA (1993). *Microbiology: Concepts and Applications*. McGraw-Hill Inc., New York, pp. 591-603.

Short Communications

Short Communications are limited to a maximum of two figures and one table. They should present a complete study that is more limited in scope than is found in full-length papers. The items of manuscript preparation listed above apply to Short Communications with the following differences: (1) Abstracts are limited to 100 words; (2) instead of a separate Materials and Methods section, experimental procedures may be incorporated into Figure Legends and Table footnotes; (3) Results and Discussion should be combined into a single section.

Proofs and Reprints: Electronic proofs will be sent (e-mail attachment) to the corresponding author as a PDF file. Page proofs are considered to be the final version of the manuscript. With the exception of typographical or minor clerical errors, no changes will be made in the manuscript at the proof stage.

Fees and Charges: Authors are required to pay a \$550 handling fee. Publication of an article in the International Journal of Plant Physiology and Biochemistry is not contingent upon the author's ability to pay the charges. Neither is acceptance to pay the handling fee a guarantee that the paper will be accepted for publication. Authors may still request (in advance) that the editorial office waive some of the handling fee under special circumstances

Copyright: © 2015, Academic Journals.

All rights Reserved. In accessing this journal, you agree that you will access the contents for your own personal use but not for any commercial use. Any use and or copies of this Journal in whole or in part must include the customary bibliographic citation, including author attribution, date and article title.

Submission of a manuscript implies: that the work described has not been published before (except in the form of an abstract or as part of a published lecture, or thesis) that it is not under consideration for publication elsewhere; that if and when the manuscript is accepted for publication, the authors agree to automatic transfer of the copyright to the publisher.

Disclaimer of Warranties

In no event shall Academic Journals be liable for any special, incidental, indirect, or consequential damages of any kind arising out of or in connection with the use of the articles or other material derived from the IJPPB, whether or not advised of the possibility of damage, and on any theory of liability.

This publication is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability, fitness for a particular purpose, or non-infringement. Descriptions of, or references to, products or publications does not imply endorsement of that product or publication. While every effort is made by Academic Journals to see that no inaccurate or misleading data, opinion or statements appear in this publication, they wish to make it clear that the data and opinions appearing in the articles and advertisements herein are the responsibility of the contributor or advertiser concerned. Academic Journals makes no warranty of any kind, either express or implied, regarding the quality, accuracy, availability, or validity of the data or information in this publication or of any other publication to which it may be linked.

ARTICLES

Effect of different seed priming treatments and priming duration on biochemical parameters and agronomic characters of okra (*Abelmoschus esculentus* L.)

Hardeep Kaur, Neena Chawla and Mamta Pathak

Full Length Research Paper

Effect of different seed priming treatments and priming duration on biochemical parameters and agronomic characters of okra (*Abelmoschus esculentus* L.)

Hardeep Kaur^{1*}, Neena Chawla² and Mamta Pathak²

¹Department of Biochemistry, Punjab Agricultural University, Ludhiana, India.

²Department of Vegetable Sciences, Punjab Agricultural University, Ludhiana, India.

Received 28 January, 2015; Accepted 3 March, 2015

Maintaining optimum plant population is an important factor in maximizing crop production and productivity. Establishment of okra in the field could be improved by applying suitable priming treatment to seeds. The present investigation was undertaken to find out the effect of seed priming treatments and soaking durations on biochemical parameters and agronomic characters of okra seeds. Okra seeds primed with three priming treatments T₁, T₂ and T₃ (hydropriming, osmopriming with 5% PEG and 10% PEG solution) with soaking durations from 24 to 48 h at 6 h interval, that is, 24, 30, 36, 42 and 48 h were used. Dry okra seeds were considered control treatment. Priming treatments and soaking durations significantly increased biochemical components such as crude protein, total minerals, dry matter, iodine, phosphorus and mucilage content compared to control. Priming with T₂ treatment for 24 h soaking duration gave the best results, followed by T₁ and T₃. Agronomic characters such as number of days taken to 50% flowering, maximum number of nodes and fruiting nodes on main stem, fruit length, fruit width, plant height at first picking, plant height at final harvest, marketable yield per plant, total yield per plant and average fruit weight were improved with priming while control seeds proved to be the poorest. Primed seeds showed better performance of okra than control treatment in aspects of studied criteria.

Key words: Okra, priming duration, biochemical parameters, yield.

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is one of the most widely known dicotyledonous plants and utilized species of the family Malvaceae (Naveed et al., 2009). It is a popular summer crop. Okra are nutritious but might have poor seedling emergence and vigor. Okra seeds are

sown in early April in plain areas and in last week of April at the higher elevations. It does not germinate below 20°C (Sadiq et al., 1998). The slow and uneven germination of okra seed is the main hurdle in the early spring planting (Pandita et al., 2010). The edible part of

*Corresponding author. E-mail: Khardeep632@gmail.com.

okra is the immature pod, which is harvested when tender. The young tender pods are cooked in curries, stewed and used in soups. Young okra leaves are also edible.

Okra pods are a good source of flavonoid antioxidants like beta carotene, xanthin and lutein (Dilruba et al., 2009). Okra has been known to be beneficial to people suffering from leucorrhoea and general weakness. Due to its high iodine content, its fruits are considered useful to control goiter and have medicinal value in curing ulcers and relief from haemorrhoids (Demir, 2001). This vegetable provides an important input of vitamins and mineral salts, including calcium which are often lacking in the diet of people in developing countries (Kahlon et al., 2007).

Seed priming is pre-sowing treatment used as a technique to enhance seed performance, notably with respect to rate and uniformity of germination (Taylor and Vananen, 1998), thereby improving seedling stand and enabling better crop establishment (Job et al., 2000). It is a simple, low cost and effective approach for early seedling growth and yield under stressed and non stressed conditions. Priming may increase resistance to abiotic stresses (Farooq et al., 2008). Primed seeds have been reported to give rise to crops, which matured earlier, and gave higher yields (Ndunguru and Rajabu, 2004).

Okra plants are known to have high amounts of essential nutrients, vitamins, minerals, fatty acids and fibre. Okra (*A. esculentus* L.) is widely consumed as a fresh vegetable in both temperate and tropical countries. Although the seed pods are most often used, the mature seed is known to have superior nutritional quality. Okra is a powerhouse of valuable nutrients, nearly half of which is soluble fibre in the form of gums and pectins which help to lower serum cholesterol, reducing the risk of heart diseases. The other half is insoluble fibre, which helps to keep the intestinal tract healthy (Shalau, 2002). Hassan et al. (1997) reported that okra contains high iodine content which is useful to control goiter and has medicinal value in curing ulcers and providing relief from haemorrhoids.

Okra is also a crop of significant nutritional value that contains a high percentage of water, averaging 85% (Kumar et al., 2010; Siemonsma and Kouame, 2004). It is highly perishable because of its high moisture content and respiratory activities; thus, it is necessary to preserve the commodity. It also contains fair proportion of carbohydrates which are present as cellulose, starch in small quantity, protein, and sugar (Kumar et al., 2010). It is a source of protein, vitamin C, vitamin A, iron, calcium and dietary fibre. Okra contains large quantities of glycans, which are responsible for the viscosity of the aqueous suspension (Kumar et al., 2010). Sliminess property of the okra fruit is of great importance to its acceptability and food value to consumers. According to Wayne et al. (1984) fruit length, fruit diameter, chlorophyll

content, mucilage and fibre content determine okra fruit quality. The nutrient requirements of crops depend upon soil texture, types of previous vegetation cover, cropping intensity and soil moisture. Nitrogen, phosphorus and potassium are among the common major nutrients, which are essential for the growth and development of all plant species. Nitrogen is an important part of plant parts such as chlorophyll, amino acid, proteins and pigments. It also increases the protein content of food and feed. Phosphorus (P) is one of the major essential elements required for the development of plants (Hartmann and Geneve, 2000). Plants need P during the rapid growth period and P is a structural component of macromolecules, such as the nucleic acids (DNA, RNA) and ATP. It also creates disease resistance, triggers growth and gives early maturity.

Yield is the key parameter which depends upon both the environmental and genetic factors. Priming speeded up and synchronized seed germination, enhanced the seedling vigour and improved their vegetative and reproductive characters, which finally led to the higher yield. According to Diaz-Franco et al. (1997) fruit quality plays an important role in okra productivity and marketability in addition to yield. Fruit quality is mainly related to pod length, dry matter content, plant height, no of pods per plant and no of days to flowering. Flowering characteristics is highly correlated with physiological maturity of the crop (Sanjaykumar et al., 1996; Vijayaraghavan, 1999). It is considered as the termination of vegetative cycle and start of reproductive cycle.

Number of nodes per plant is a major component which determines the final yield. Number of nodes has direct relationship with number of leaves (Arif et al., 2005). The higher numbers of leaves have resulted in more number of nodes per plant. Priming effect on seed emergence, seedling growth and vigour has been translated to higher number of leaves and hence more pod production. Ullah et al. (2002 b) reported that priming increased yield parameters in raya like number of primary branches per plant and number of nodes and fruiting nodes on main stem. Priming enhanced the seedling vigour, improved the vegetative and reproductive characters, which finally led to the higher yield. The number of fruits per plant and number of seeds per fruit are the major yield components that determine the seed yield.

Okra farmers in Punjab and other Northern states have a major problem with germination of the seeds after planting. In order to understand the effect of different seed priming treatments on quality of okra, as well as to evaluate the best soaking sources and priming period for okra, the present study was carried out to study the effect of selected seed priming treatments on biochemical composition and yield of okra (*A. esculentus* L.) fruits.

The objective of this study was to increase quality of biochemical constituents and yield of okra with seed priming treatments and soaking durations at very wide range of favoured and unfavoured environmental

conditions.

MATERIALS AND METHODS

Experimental details and seed priming

Experiment was conducted in the field at the Vegetable Research Farm, Department of Vegetable Science, Punjab Agricultural University, Ludhiana to evaluate the effect of seed priming treatments and soaking durations on biochemical parameters and agronomic characters of okra (*A. esculentus* L) viz. Punjab 8. Seed priming treatments included T₁ (hydropriming), T₂ (osmopriming with 5% (w/v) Polyethylene glycol) and T₃ (osmopriming with 10% (w/v) Polyethylene glycol).

Seeds were fully immersed in priming solutions for soaking durations of 24, 30, 36, 42 and 48 h. Dry seeds were considered as control treatment. To avoid fungal growth during the priming process, a fungicide Captan (2 g/L) was added to the priming solutions. At the end of each priming period, the seeds were air dried at room temperature for at least 3 h close to original moisture level (85%).

Extraction and estimation of biochemical parameters

Crude protein

One gram of powdered sample, 5 g of the digestion mixture (1 part of CuSO₄: 9 parts of K₂SO₄) and 15 ml concentrated sulphuric acid were mixed in the Kjeldhal digestion flask and heated till a clear light green or colorless solution was obtained. Digested contents were cooled to room temperature and the volume was made to 100 ml with distilled water in volumetric flask. 100 ml of the sample solution after dilution was distilled with 50 ml of 40% sodium hydroxide solution using Kjeldahl distillation unit. About 100-150 ml of the distillate was collected in 25 ml of 4% boric acid solution. The boric acid solution was titrated against 0.01 N sulphuric acid till a grey colour was obtained as end point; the volume of acid used was recorded. Nitrogen content of the sample was calculated using the following formula (Micro Kjeldahl method, A.O.A.C. 2000):

$$\% N = [(X - \text{blank}) \times 0.00014 \times \text{dilution factor (25)}] / Y \times 100$$

X, Titre value; Y, weight of sample (g).

Dilution factor – Volume made / Volume taken for distillation.

The crude protein content was calculated by multiplying %N with a factor 6.25.

Mucilage content

One hundred (100 ml) millilitre of distilled water were added to 25 g of sample and kept for 24 h. The suspension was filtered through muslin cloth and 50 ml of ethanol added to the filtrate. It was stirred on the magnetic stirrer for 15 min and filtered through pre-weighed filter paper, and kept in the oven for drying. After drying the material, it was again weighed along with filter paper. Mucilage content was calculated using the following formula (Rao and Sulladurath, 1977):

$$\text{Mucilage content (\%)} = \frac{W_2 - W_1}{W}$$

W₂, Weight of filter paper along with material after drying; W₁, weight of pre-weighed filter paper; W, weight of sample.

Total minerals

An empty crucible was weighed and 1.0 g dry powder of the material added. This was ignited on the heater to remove fumes and kept in the muffle furnace at 500°C overnight. The furnace was switched off, cooled and the crucible weighed. Total minerals were calculated using the following formula (A.O.A.C., 1965):

$$\text{Total minerals (\%)} = \frac{W_2 - W_1}{W} \times 100$$

W, Weight of sample in g; W₁, weight of empty crucible in g; W₂, weight of empty crucible + ignited sample in g.

Dry matter

Fifty (50 g) gram sliced okra fruits from each treatment were oven dried in pre-weighed petri-plates at 65 ± 2°C till constant weight was obtained. The dried samples were cooled in a desiccator for 10 min. These were weighed and dry matter content calculated using the following formula:

$$\text{Dry matter content (\%)} = \frac{\text{Final dry weight of the sample}}{\text{Initial fresh weight of the sample}} \times 100$$

Iodine content

The glassware were thoroughly cleaned with teepol, washed with water, soaked overnight in 10% hydrochloride acid, followed by washing with tap water. These were then rinsed thoroughly with distilled water followed by drying in the oven before use. Samples were dried at 60°C in hot air oven. The dried samples were ground to a fine powder in an electric mixer-cum-grinder and stored in sealed polyethylene bags, making them airtight. One gram of dried and finely ground sample was weighed and transferred into clean test tube.

One (1 ml) millilitre of 10 times diluted 6 M potassium hydroxide solution was added to the sample and kept overnight along with blank at 95±1°C in an oven for drying. The tubes were thereafter transferred to the muffle furnace at 100°C. The temperature of the furnace was brought to 600°C at which the samples were incinerated for 1 h, renewing the air for 15 s after every 15 min. Then the tubes were transferred to the desiccators and allowed to cool to room temperature. If ashing was incomplete, then 1 ml of 10 times diluted zinc sulphate solution was added to all the tubes, continuing drying and ashing as above. After completion of ashing, 0.2 ml of water was added to test tube, stirred thoroughly, vortexed and the volume was made to 5 ml with water. The tubes were centrifuged at 3500 rpm for 30 min. The supernatant was kept for final assay.

Into the test tube 0.5 ml of double distilled water, 0.5 ml of H₂SO₄: HCl solution, 0.5 ml of cerate reagent (Dissolved 0.316 g) of ammonium ceric (IV) sulphate in 15 ml of water was transferred add 40 ml of concentrated nitric acid added drop by drop. 5 ml of concentrated H₂SO₄ was then added and made up to final volume of 100 ml with distilled water and 0.5 ml of arsenic reagent (Dissolved 0.593 g of Arsenic trioxide and 0.6 g of potassium hydroxide in 30 ml of water, then added 0.1 ml concentrated HCl made the final volume to 100 ml with distilled water) in the same order. This was well mixed and incubated for 1 min at room temperature. Then 0.5 ml of blank or standard or sample was added, mixed well and immediately the reaction occurred for 1 min by measuring O.D. at 400 nm. The slope was calculated from standard curve using pure KI (Mahesh et al., 1988).

Iodine content was calculated from the following formula:

$$\text{Dry Matter Content (\%)} = \frac{\text{Final dry weight of the sample}}{\text{Initial fresh weight of the sample}} \times 100$$

A_s – Change in A/min in sample; A_b , change in A/min in blank; m , slope of standard curve; d , dilution in ml

Phosphorus

One gram of sample was taken in digestion tubes and digested with 20-25 ml of triple acid mixture (Nitric acid (HNO_3): Concentrated Sulphuric acid (H_2SO_4): Perchloric acid (HClO_4): 9:1:3) till white fumes ceased and 5-6 ml aliquot was left. The volume was made to 100 ml with distilled water.

To 5 ml of the extract was added 5 ml of 5% nitric acid and 5 ml of Ammonium Molybdate-Vanadate Reagent (Ammonium Vanadate [1.25 g in 500 ml DW] and Ammonium Molybdate [25 g in 500 ml 1 N Nitric Acid] in 1:1). The intensity of the yellow color was measured at 470 nm against a blank containing 5 ml of triple acid, 5 ml of 5% nitric acid and 5 ml of Ammonium Molybdate-Vanadate Reagent. The concentration of phosphorus was calculated by plotting a standard curve using pure KH_2PO_4 (Jackson, 1973).

Agronomic characters

Days taken to 50% flowering: The number of days taken from sowing to 50% flowering was recorded.

Number of nodes on main stem: Number of nodes on main stem was counted.

Number of fruiting nodes on main stem: Number of fruiting nodes on main stem was counted.

Fruit length: Fruit length was taken in centimeters. Length of five randomly selected fruits was taken and average of these was computed.

Fruit width: Fruit width was taken in centimeters. Width of five randomly selected fruits was taken and average of these was computed. Width was taken from the center of fruit.

Average fruit Weight: The weight of five randomly selected fruits was recorded in grams and average was computed.

Total yield per plant: The total yield per plant in grams was obtained by summing up the weight of fruits of various pickings.

Marketable yield per plant: The marketable yield was recorded after excluding the weight of fruit infected by virus and fruit borer from the total yield.

Plant height at first picking: The plant height was measured from ground level to the tip of the main stem at first picking. The average height was computed and expressed in centimeters. Average heights of five plants were taken.

Plant height at final harvest: The plant height was measured from ground level to the tip of the main stem at final harvest. The average height was computed and expressed in centimeters. Average heights of five plants were taken.

Statistical methods

Experimental units were arranged factorially in a randomized block design (RBD) with three replications. Mean \pm S. D. was calculated and data was analyzed CRD at $p < 0.05$.

RESULTS AND DISCUSSION

Biochemical parameters

Crude protein

Effect of seed priming treatments and soaking durations on the crude protein was found to be statistically at par in okra fruit and has been reported in Table 1. Various priming sources and soaking durations cause significant increase in crude protein content of okra. Maximum increase was observed in T_2 followed by T_3 and T_1 . Results of various soaking durations indicate that maximum crude protein content was observed in seeds soaked for 24 h followed by 30, 36 and 42 h, while minimum crude protein was observed in seeds soaked for 48 h. However, in their interaction, highest crude protein content was recorded in seeds soaked for 24 h in T_2 followed by T_3 and lowest crude protein was recorded in seeds which were soaked for 42 h in T_3 . Okra is considered as high protein vegetable.

Total mineral

Mineral content was significantly affected by seed priming treatment and soaking durations. The data on the total mineral content has been presented in Table 2. Maximum mineral content was observed in T_2 followed by T_1 and T_3 . Soaking durations, indicate that seeds soaked for 24 h duration showed maximum mineral content followed by 36 h, 30 h. In their interaction, maximum mineral content was recorded in seeds which were soaked for 24 h in T_2 followed by 36 h in T_2 and 36 h in T_1 while minimum was observed in seeds soaked for 42 h in T_3 . Similar results were obtained by Oguntona (1998) that total mineral content in dry fruit of okra varies from 1.19-2.63%.

Dry matter

Olugbemi et al. (2010) reported that dry matter (DM) values increased in primed seeds as compared to non primed seeds. Primed seeds result in increased dry matter production at vegetative stage due to continuous gain in plant height, number of branches and uniform plant stand. Data presented in Table 3 showed that various seed priming treatments and soaking durations had significant effect on dry matter. Maximum dry matter was observed in T_2 followed by T_3 and T_1 . However, in their interaction, highest dry matter was recorded in seeds which were soaked for 24 h in T_2 followed by 30 h

Table 1. Crude protein content in okra fruit in response to various soaking durations and seed priming treatments (%).

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	9.56±0.42	-	-	-	9.56
24	-	13.68±0.36	16.02±0.86	14.82±0.34	14.84
30	-	12.32±0.69	13.52±0.92	11.58±0.72	12.47
36	-	10.82±0.33	10.72±0.41	11.89±0.57	11.14
42	-	10.28±0.93	11.77±0.58	8.63±0.65	10.23
48	-	8.79±0.36	9.52±0.83	9.01±0.50	9.11
Mean	9.56	11.18	12.31	11.19	11.56
CD 5%	A=Seed priming treatments=0.265; B=soaking durations=0.343; A*B = 0.594				

Table 2. Total Mineral content in okra fruit in response to various soaking durations and seed priming treatments (%).

Soaking duration (h)	Treatment				Mean
	control	T ₁	T ₂	T ₃	
0	0.38±0.05	-	-	-	0.38
24	-	2.36±0.12	2.95±0.08	1.94±0.09	2.42
30	-	2.08±0.09	2.45±0.10	1.30±0.13	1.94
36	-	2.56±0.05	2.68±0.14	1.49±0.10	2.24
42	-	2.38±0.11	1.15±0.09	0.58±0.08	0.87
48	-	1.40±0.10	1.96±0.06	0.63±0.14	1.02
Mean	0.38	2.16	2.24	1.19	1.86
CD 5%	A=Seed priming treatments=0.139; B=soaking durations=0.179; A*B=0.31				

Table 3. Dry matter in okra fruit in response to various soaking durations and seed priming treatments (%).

Soaking duration (h)	Treatment				Mean
	control	T ₁	T ₂	T ₃	
0	4.08±0.31	-	-	-	4.08
24	-	6.43±0.26	7.96±0.24	6.10±0.36	6.83
30	-	5.88±0.42	7.30±0.44	6.50±0.24	6.59
36	-	6.80±0.27	5.12±0.49	5.40±0.49	5.77
42	-	6.24±0.40	5.98±0.53	6.95±0.23	6.11
48	-	5.05±0.46	5.96±0.17	6.14±0.128	5.72
Mean	4.08	6.08	6.46	6.22	6.25
CD 5%	A=Seed priming treatments=0.134; B=soaking durations=0.173; A*B=0.300				

in T₂ and lowest dry matter was observed in seeds which were soaked for 48 h in T₁.

Mucilage content

Mucilages are water soluble polysaccharides found in a wide variety of plants and their contents in okra genotype are reported to vary a great deal. The data on the mucilage content was found to be statistically at par in

okra fruit and has been reported in Table 4. Various priming sources and soaking durations cause significant increase in mucilage content. Maximum mucilage content was observed with T₂ followed by T₃. Results of various soaking durations indicate that seeds soaked for 24 h duration recorded maximum mucilage content followed by 42, 30 and 36 h. Interaction effects due to seed priming treatment and soaking durations showed that maximum mucilage content was recorded in seeds soaked for 24 h in T₃ followed by 24 h in T₂ and minimum

Table 4. Mucilage content in okra fruit in response to various soaking durations and seed priming treatments (%).

Soaking duration (h)	Treatment				Mean
	control	T ₁	T ₂	T ₃	
0	2.68±0.14	-	-	-	2.68
24	-	4.97±0.16	5.30±0.27	5.42±0.34	5.23
30	-	4.19±0.29	4.34±0.30	4.48±0.36	4.34
36	-	3.14±0.26	4.40±0.25	4.19±0.29	3.91
42	-	4.78±0.18	4.80±0.28	4.51±0.21	4.70
48	-	4.61±0.28	3.24±0.33	3.34±0.17	3.73
Mean	2.68	4.34	4.42	4.39	4.37
CD 5%	A=Seed priming treatments=NS; B=Soaking durations=0.150; A*B=0.260				

Table 5. Iodine content in okra fruit in response to various soaking durations and seed priming treatments (mg/kg)

Soaking duration (h)	Treatment				Mean
	control	T ₁	T ₂	T ₃	
0	7.01±0.68	-	-	-	7.01
24	-	10.30±0.53	13.25±0.21	12.56±0.41	11.78
30	-	10.65±0.36	10.25±0.24	11.34±0.28	10.95
36	-	9.66±0.14	10.40±0.31	9.21±0.39	9.76
42	-	9.68±0.32	8.35±0.33	7.40±0.42	7.88
48	-	8.03±0.34	9.23±0.24	8.46±0.57	8.57
Mean	7.01	9.40	10.54	9.93	9.96
CD 5%	A =Seed priming treatments = 0.908; B = soaking durations = 0.117; A*B=0.203				

mucilage content was recorded in seeds soaked for 48 h in T₂.

Similar results were shown by Maurya and Kaufmann, (1978) that primed seeds showed higher mucilage content ranging from 3.40 to 5.93%.

Iodine content

Improvement in iodine content of primed seeds can be attributed to hydration and imbibitions. The data on the iodine content has been reported in Table 5. Maximum iodine content was recorded in T₂ followed by T₃. Results of various soaking durations indicate that maximum iodine content was observed in seeds soaked for 24 h followed by 30, 36 and 48 h, while minimum was observed in seeds soaked for 42 h. This result is supported by Basra et al. (2003) that iodine content is higher in primed seeds such as wheat.

The data on the phosphorus content have been reported in Table 6. With respect to phosphorus content, significant differences were noticed among seed priming treatments and soaking durations. Maximum phosphorus content was observed in T₂ followed by T₁ and T₃. Results of various soaking durations indicate that maximum phosphorus content was observed in seeds soaked for

24 h followed by 30 and 42 h, while minimum was observed in seeds soaked for 48 h. However, in their interaction, maximum phosphorus content was recorded in seeds soaked for 24 h in T₂ followed by 48 h in T₃ and minimum was recorded in seeds soaked for 36 h in T₁. This result is supported by Arif et al. (2005) who reported that priming increases the P content that supports early phase of crop development, synchronizes the germination process leading to enhanced final yield, especially in P deficient soil.

Agronomic characters

The data on the days to 50% flowering as influenced by various priming sources, soaking durations and their interactions has been presented in Table 7. Untreated control took maximum number of days to 50% flowering, while T₂ treated seeds took minimum number of days. Soaking duration treatment showed that highest number of days was taken in plot having seeds soaked for 36 h. Likewise, in their interaction maximum number of days to 50% flowering was recorded in un-primed seed and minimum was taken by seeds soaked for 24 h in T₂ followed by T₁. Similar results are also reported by Ullah et al. (2002 b) who noted that primed crops emerged

Table 6. Phosphorus content in okra fruit in response to various soaking durations and seed priming treatments (mg/kg)

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	0.65±0.02	-	-	-	0.65
24	-	1.68±0.05	2.25±0.09	1.09±0.07	1.67
30	-	1.47±0.08	1.72±0.04	1.49±0.04	1.56
36	-	0.98±0.04	1.21±0.07	1.35±0.03	1.18
42	-	1.55±0.06	0.94±0.05	1.09±0.09	1.19
48	-	1.37±0.05	1.24±0.04	1.86±0.08	1.02
Mean	0.65	1.41	1.47	1.38	1.42
CD 5%	A=Seed priming treatments=0.841; B=soaking durations=0.109; A*B = 0.188				

Table 7. Days taken to 50% flowering in okra in response to various soaking durations and seed priming treatments

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	34.86±1.29	-	-	-	34.86
24	-	26.86±1.56	24.30±1.98	27.00±1.08	26.05
30	-	31.00±1.07	27.00±1.03	34.20±1.02	30.73
36	-	34.00±1.87	29.23±1.25	31.06±1.71	31.43
42	-	31.46±1.84	28.63±1.57	28.96±1.21	29.68
48	-	31.59±1.58	31.23±1.63	31.00±1.03	31.27
Mean	34.86	30.98	28.08	30.44	29.83
CD 5%	A = Seed priming treatments = 0.308; B = soaking durations = 0.398; A*B = 0.689				

Table 8. Number of nodes on main stem of okra in response to various soaking durations and seed priming treatments.

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	9.55±0.41	-	-	-	9.55
24	-	13.91±0.28	15.86±0.33	13.44±0.58	14.40
30	-	11.08±0.82	14.54±0.67	11.92±0.51	12.51
36	-	11.96±0.53	12.65±0.71	11.85±0.61	12.15
42	-	10.94±0.72	10.43±0.66	10.84±0.81	10.73
48	-	10.63±0.52	10.71±0.83	9.43±0.86	10.67
Mean	9.55	11.70	12.84	11.49	12.01
CD 5%	A=Seed priming treatments=0.223; B=soaking durations=0.288; A*B = 0.500				

faster, flowered earlier and gave higher yield. Mauromicale et al. (2000) reported that osmopriming improved early flowering, maturity time and yield of summer squash (*Cucurbitapepo* L.).

Number of nodes and fruiting nodes on main stem is a major component which determines the final yield. Priming effect on seed emergence, seedling growth and seed vigour index have been translated to higher number of leaves and hence more number of nodes and fruiting

nodes produced on main stem. The data on the number of nodes and fruiting nodes on main stem has been reported in Tables 8 and 9.

Various priming sources soaking durations as well as their interaction significantly increased the number of nodes and fruiting nodes on main stem. Maximum number of nodes and fruiting nodes on main stem was recorded in T₂ followed by T₁. Likewise, results of various soaking durations showed that maximum number of

Table 9. Number of fruiting nodes on main stem of okra in response to various soaking durations and seed priming treatments.

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	7.53±0.56	-	-	-	7.53
24	-	9.80±0.63	10.95±0.46	9.30±0.66	10.02
30	-	9.25±0.74	10.06±0.42	9.41±0.61	9.57
36	-	8.76±0.57	10.14±0.56	9.03±0.52	8.90
42	-	8.82±0.43	9.69±0.62	8.35±0.45	8.95
48	-	8.33±0.59	9.75±0.49	7.45±0.49	7.89
Mean	7.53	9.28	9.61	8.93	9.27
CD 5%	A=Seed priming treatments = 0.211; B = soaking durations = 0.273; A*B = 0.473				

Table 10. Fruit length of okra in response to various soaking durations and seed priming treatments (cm).

Soaking duration (h)	Treatment				Mean
	control	T ₁	T ₂	T ₃	
0	7.85±0.61	-	-	-	7.85
24	-	9.59±0.72	9.85±0.78	11.91±0.55	9.72
30	-	10.27±0.74	12.95±0.67	11.03±0.41	11.61
36	-	9.13±0.78	9.62±0.59	10.35±0.71	9.38
42	-	9.68±0.51	9.23±0.70	8.54±0.91	9.46
48	-	9.22±0.77	9.46±0.86	9.08±0.52	9.34
Mean	7.85	9.58	10.22	10.18	9.90
CD 5%	A=Seed priming treatments = 0.489; B = soaking durations = 0.631; A*B = 1.093				

Table 11. Fruit width of okra in response to various soaking durations and seed priming treatments (cm).

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	0.81±0.03	-	-	-	0.81
24	-	0.84±0.06	0.93±0.03	1.05±0.06	1.16
30	-	0.95±0.04	0.98±0.05	1.09±0.04	1.02
36	-	0.99±0.07	0.89±0.06	0.86±0.08	0.88
42	-	1.13±0.08	1.09±0.04	0.97±0.07	1.03
48	-	0.97±0.02	0.92±0.05	0.87±0.02	0.90
Mean	0.81	0.98	0.92	1.01	0.92
CD 5%	A=Seed priming treatments=0.960; B=soaking durations=0.123; A*B = 0.214				

nodes and fruiting nodes on main stem was noted in plot in which seeds were soaked for 24 h, followed by plot in which seeds were soaked for 30 h. Minimum number of nodes and fruiting nodes on main stem was recorded in plot in which seeds were soaked for 48 h. In their interaction highest number of nodes and fruiting nodes on main stem was recorded in plot in which seeds were soaked for 24 h in T₂ followed by 24 h in T₁. Minimum number of nodes and fruiting nodes on main stem was noted in plot in which seeds were soaked for 48 h in T₃.

Ullah et al. (2002 a) reported that priming increased yield parameters in raya like number of primary branches per plant and number of nodes and fruiting nodes on main stem.

Data presented in Tables 10 and 11 show that various soaking sources, durations and their interaction significantly enhanced fruit length and width. Maximum fruit length was recorded in plot in which seeds were soaked in T₂ and fruit width was recorded in plot in which seeds were soaked T₃. Similarly, results of various soaking

Table 12. Average fruit weight of okra in response to various soaking durations and seed priming treatments (g).

Soaking duration (h)	Treatment				Mean
	control	T ₁	T ₂	T ₃	
0	9.71±0.72	-	-	-	9.71
24	-	11.39±0.66	13.51±0.57	11.04±0.42	11.98
30	-	10.97±0.45	12.46±0.50	10.75±0.56	11.39
36	-	10.51±0.59	11.32±0.54	10.28±0.49	10.71
42	-	9.99±0.35	11.18±0.34	10.44±0.68	10.54
48\	-	9.67±0.53	10.03±0.56	8.78±0.62	9.49
Mean	9.71	10.72	12.12	10.63	11.15
CD 5%	A=Seed priming treatments = 0.337 B = Soaking durations = 0.436 A*B = 0.755				

Table 13. Total yield per plant of okra in response to various soaking durations and seed priming treatments (g).

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	92.32±3.56	-	-	-	92.32
24	-	125.31±4.18	132.50±4.72	128.32±4.80	128.71
30	-	120.65±4.49	128.96±5.41	118.36±4.79	122.66
36	-	115.65±4.80	123.40±5.45	107.56±5.54	115.54
42	-	121.30±3.60	125.30±3.19	104.30±4.89	111.97
48	-	109.82±5.40	105.36±4.83	106.23±3.86	107.16
Mean	92.32	115.56	123.10	112.95	176.61
CD 5%	A=Seed priming treatments = 0.249; B = soaking durations = 0.322; A*B = 0.558				

Table 14. Marketable yield per plant of okra in response to various soaking durations and seed priming treatments (g).

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	84.52±4.25	-	-	-	84.52
24	-	119.21±4.80	126.23±4.71	120.18±3.83	121.87
30	-	114.56±5.92	117.65±5.00	110.98±3.47	114.34
36	-	100.98±4.41	116.15±4.04	103.40±4.58	106.84
42	-	117.93±4.90	95.20±3.37	88.58±4.78	100.57
48	-	98.12±3.71	98.50±4.68	100.26±4.77	98.96
Mean	84.52	107.01	115.29	104.68	108.99
CD 5%	A=Seed priming treatments = 0.311; B = soaking durations = 0.401; A*B = 0.695				

durations showed that maximum pod length and width was recorded in the seeds soaked for 30 and 24 h soaking duration, while minimum was recorded in 48 h soaking duration. Similar results were shown by Harris et al. (2001) and Saikia et al. (2006) who documented larger ear production in wheat with osmopriming (10% PEG).

Data presented in Table 12 show that various priming sources and soaking durations had significant effects on average fruit weight of okra. Maximum fruit weight was noted in T₂ followed by T₁. Results of various soaking

durations showed that maximum fruit weight was observed in plot in which seeds were soaked for 24 h. Similarly, in their interaction maximum fruit weight was recorded in seeds which were soaked for 24 h in T₂ followed by 30 h in T₂ and 24 h in T₁.

The data on the total yield and marketable yield per plant have been reported in Tables 13 and 14. Significantly maximum yield was recorded in T₂ followed by T₁ and T₃. Results of various soaking durations indicated that 24 h seed soaking gave the highest yield,

Table 15. Plant height at first picking of okra in response to various soaking durations and seed priming treatments (cm)

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	15.56±0.79	-	-	-	15.56
24	-	23.37±0.67	23.78±0.87	21.19±0.97	23.54
30	-	21.50±0.81	26.05±0.64	22.50±0.67	22.59
36	-	19.75±0.43	21.63±0.52	18.45±0.83	19.94
42	-	17.14±1.05	20.12±0.80	18.09±1.04	18.45
48	-	22.87±0.60	16.47±0.55	17.32±1.15	18.89
Mean	15.56	19.65	22.89	19.51	20.68
CD 5%	A = Seed priming treatments = 0.204; B = soaking durations = 0.264; A*B = 0.458				

Table 16. Plant height at final harvest of okra in response to various soaking durations and seed priming treatments (cm)

Soaking duration (h)	Treatment				Mean
	Control	T ₁	T ₂	T ₃	
0	72.46±3.37	-	-	-	72.46
24	-	90.02±3.14	97.34±3.72	92.68±2.54	93.35
30	-	84.45±2.88	93.39±2.83	86.78±3.47	85.62
36	-	89.95±3.15	80.17±2.43	81.53±2.78	80.85
42	-	79.15±2.86	84.46±2.16	79.69±2.89	81.10
48	-	73.42±2.10	74.25±3.88	80.29±3.78	73.97
Mean	72.46	83.40	84.65	85.52	84.52
CD 5%	A=Seed priming treatments = 0.202; B=soaking durations = 0.261; A*B = 0.452				

followed by 30 and 36 h, while 48 h seed soaking resulted in the least yield. Likewise, in their interaction maximum yield was recorded in plot in which seeds were soaked for 24 h in T₂, followed by T₃. Minimum yield was recorded in plot in which seeds were soaked for 42 h in T₃. Ndunguru and Rajabu (2004) reported that seed priming improved yield in okra which may be attributed to early germination and better stand establishment. Zhang et al., (1998), Basra et al., (2003) and Arif et al., (2010) also reported that priming treatment significantly increased total biomass and resulted in higher yield in soybean and wheat.

The data on the plant height at first picking and at final harvest have been presented in Tables 15 and 16. The maximum plant height at first picking was observed in plot having seeds soaked in T₂, followed by T₁ and plant height at final harvest was observed in plot having seeds soaked in T₃. Results of various soaking durations indicated that the tallest plants were recorded in plot in which the seeds were soaked for 24 h, followed by plot with soaked seed of 30 h. Least plant height was recorded in control plot. The interaction results showed that plot having seed soaked in T₂ for 30 h and in T₂ for 24 h gave the longest plant at first picking and at final harvest. Unprimed seed plot had the shortest plants. Osmopriming causes significant increase in plant height

in okra (Omran et al., 1980), tomato (Jagadish et al., 1994), and onion (Nalini et al., 2001). The increased plant height may be due to rapid cell division in meristematic region, number of cells and increase in cell elongation due to multiplication of various parts of the plant tissue, auxin metabolism, cell wall plasticity, permeability of cell membrane, cell enlargement and rapid cell elongation (Sandyarani et al., 2002). Sathiskumar (2005) has also reported that brinjal seed treated with osmopriming solution increased the plant height, number of leaves per plant, fruit yield, fruit length and lesser number of days to 50% flowering as compared to control

Conclusions

It has been concluded from the research work that seed priming treatments resulted in increase biochemical parameters and yield of okra than un-primed seed. Maximum increase was observed with T₂ treatment, but both T₁ and T₃ treatments gave almost equal and better results than control treatment. Okra seed priming with T₂ treatment (osmo-priming with 5% PEG) for 24 h duration lead to better yield and biochemical quality parameter by tolerating adverse environmental effects. T₂ treatment can therefore be recommended to okra farmers.

Conflict of interests

The authors did not declare any conflict of interest.

REFERENCES

- A.O.A.C (1965). Official methods of analysis, Association of Official Agricultural Chemists (10theds). Washington, DC.
- A.O.A.C (2000). Official methods of analysis, Association of Official Analytical Chemists (16theds). Washington, DC.
- Arif M, Ali S, Shah A, Rashid A (2005). Seed priming in maize for improving emergence and seedling growth. *Sarhad. J. Agric.* 21:539-543.
- Arif M, Jan MT, Khan NU, Khan A, Khan MJ, Munir I (2010). Effect of seed priming on growth parameters of soybean. *J. Bot.* 42:2803-2812.
- Basra SMA, Zia MN, Mehmood T, Afzal I, Khaliq A (2003). Comparison of different invigoration techniques in wheat (*Triticum aestivum*L.) seeds. *J. Arid. Agric.* 5:6-11.
- Demir I, (2001). Variation in shoot and root characteristics and their association with drought tolerance in lentil landraces. *Sci. Hort.* 89:1-7.
- Diaz-Franco A, Loera J, Ortegón MA (1997). Fruit characteristics and yield of new okra hybrids. *Plant. Sci.* 49:8-11.
- Dilruba S, Hasanuzzaman, M, Karim R, Nahar K (2009). Yield response of okra to different sowing time and application of growth hormones. *J. Hort. Sci.* 1:10-14.
- Farooq M., Basra SMA, Rehman H, Saleem BA (2008). Seed priming enhances the performance of late sown wheat (*Triticum aestivum* L.) by improving chilling tolerance. *J. Agron. Crop. Sci.* 194:55-60.
- Harris D, Tripathi RS, Joshi A (2001). On-farm seed priming to improve crop establishment and yield in direct-seeded rice. *Int. Workshop on Dry-seeded Rice Tech*, Pandey. pp. 231-240.
- Hartmann TH, Geneve LR (2000). *Plant Propagation: Principles and Practices*. Prentice. Hall. New.8:10-14.
- Hassan MB, Emarat J, Farsad N (1997). The effect of osmopriming on germination and seedling growth of *Brassica napus*L. under salinity conditions. *J. Food. Agric. Environ.* 7:620-622.
- Jackson ML (1973). Phosphorus determination for soils. In: *Soil Chemical Analysis*, Prentice Hall of India Ltd. New Delhi, India. pp. 134-182.
- Jagdish GV, Prasanna KPR, Ranganathaiah KG (1994). Influence of storage conditions and containers on seed storability in onion (*Allium cepa*L.). *Seed. Tech.* 2:165-167.
- Job D, Carpron I, Job C (2000). Identification of specific protein markers and their use in seed priming technology. *Seed. Sci. Res.* 7:449-459.
- Kahlon TS, Chapman MH, Smith GE (2007). In vitro binding of bile acids by okra, beets, asparagus, eggplant, turnips, green beans, carrots and cauliflower. *Food. Chem.* 103: 676-680.
- Kumar S, Dagnoko S, Haougui A, Ratnadass A, Pasternak D, Kouame C (2010). Okra in West and Central Africa: potential and progress on its improvement. *J. Agric. Res.* 5:3590-3598.
- Mahesh DL, Deasthale YG, Narasinga BS (1988). A sensitive kinetic assay for the determination of iodine, 57th Annual meeting of Society of Biological Chemists India. 9:11.
- Mauromicale G, Cavallaro V, Stoffella PJ, Cantiliffe DJ, Damato G (2000). Effects of seed osmopriming on the harvest time and yield of summer squash (*Cucurbitapepo* L.). *Acta. Hort.* 533:83-88.
- Maurya BE, Kaufmann MR (1978). The osmotic potential of polyethylene glycol 6000. *Plant. Physiology.* 51:914-916.
- Moyin-Jesu WM, West SH (2007). Priming and Seed Orientation affect emergence and seed coat adherence and seedling development of muskmelon transplants. *Hort. Science.* 33: 847-848.
- Nalini T, Poonam S, Lal C, Katiyar PK, Vaish CP (2001). Effect of presowing seed treatment on germination, growth and yield of onion (*Allium cepa* L.). *Seed. Res.* 29: 238-239.
- Naveed A, Khan AA, Khan IA (2009). Generation mean analysis of water stress tolerance in okra (*Abelmoschus esculentus* L.). *J. Bot.* 41: 195-205.
- Ndunguru J, Rajabu A (2004). Effect of okra mosaic virus disease on the above-ground morphological yield components of okra. *Sci. Hort.* 99: 225-235.
- Oguntona T (1998). Green leafy vegetables in quality of plant foods. *Post-Harvest Research Unit, Osagie A.U and Eka O.U, Benin City.* pp. 120-130.
- Olugbemi TS, Mutayoba SK, Lekule FP (2010). Effect of *Moringaoleifera* inclusion in Cassava based diets to broiler chickens. *J. Poul. Sci.* 9:363-367.
- Omran AF, El-Bakry AM, Gawish RA (1980). Effect of soaking seeds in some growth regulator solutions on the growth, chemical constituents and yield of okra. *Seed. Sci. Tech.* 8:161-168.
- Pandita VK, Anand A, Nagarajan S, Seth R, Sinha SN (2010). Solid matrix priming improves seed emergence and crop performance in okra. *Plant. Physiol.* 38:665-674.
- Rao KP, Sulladurath UV (1977). Changes in certain chemical constituents associated with maturation of okra (*Abelmoschus esculentus*L.). *Veg. Sci.* 4:37-42.
- Sadiq W, Amin M, Shahzoor NU (1998). Performance of okra cultivars under soil and climatic condition of Peshawar. *Sarhad. J. Agric.* 4:633-638.
- Saikia TP, Barman B Ferrara GO (2006). Participatory evaluation by farmers of on-farm seed priming in wheat in Assam, India. *Aust. Soc. Agric.* 37:403-415.
- Sandyrani GM (2002). Influence of seed treatment with chemicals and botanical on storability and field performance of fresh and aged hybrid cotton seeds. *J. Sci. Agro.* 45: 390-391.
- Sanjaykumar, Poonam S, Katiyar RP, Vaish CP and Khan AA (1996). Beneficial effect of some plant growth regulators on aged seeds of okra (*Abelmoschus esculentus* L.) under field conditions. *J. Agric.* 24:15-20.
- Sathishkumar L (2005). Influence of pre-sowing seed treatment and seed pelleting on storability in brinjal (*Solanum melongena* L.). *Ind. Hort.* 32:78-82.
- Shalau J (2002) *Backyard Gardener*. www.ag.arizona.edu.
- Siemonsma JS and Kouame C (2004). In plant resources of tropical Africa Vegetable. *J. Nutr.* 7:21-29.
- Taylor AG, Vananen I (1998). Seed enhancements. *Seed. Sci. Res.* 8:245-256.
- Ullah MA, Sarfraz M, Sadiq M, Mehdi SM, Hassan G (2002 a). Effect of pre-sowing seed treatment with micronutrients on growth parameters of raya. *Asian. J. Plant. Sci.* 1: 22-23.
- Ullah MA, Sarfraz M, Sadiq M, Mehdi SM, Hassan G (2002 b) Effect of pre-sowing seed treatment of raya with micronutrients on yield parameters. *Asian. J. Plant. Sci.* 1: 277-78.
- Vijayaraghavan H (1999) Effect of seed treatment with plant growth regulators on bhendi. *J. Agron.* 38: 498-500.
- Wayne J, McLaurin WJ, Fontenot RJ, Newsom DW (1984). Effects of nitrogen and quality factors of canned okra. *J. Hort. Sci.* 109:524-526.
- Zhang M, Nyborg M, McGill WB (1998). Phosphorous imbibed by barley seed: location within the seeds and assimilation by seedlings. *Seed. Sci. Technol.* 26:325-332.

International Journal of Plant Physiology and Biochemistry

Related Journals Published by Academic Journals

- *African Journal of Plant Science*
- *Journal of Microbiology and Antimicrobials*
- *International Journal for Biotechnology and Molecular Biology Research*
- *Journal of Botany and Plant Pathology*
- *International Journal of Biodiversity and Conservation*

academicJournals