

Mirza Hasanuzzaman  
Editor

# The Plant Family Brassicaceae

Biology and Physiological Responses  
to Environmental Stresses

# Contents

<b>The Plant Family Brassicaceae: Introduction, Biology, And Importance</b> .....	1
Ali Raza, Muhammad Bilal Hafeez, Noreen Zahra, Kanval Shaukat, Shaheena Umbreen, Javaria Tabassum, Sidra Charagh, Rao Sohail Ahmad Khan, and Mirza Hasanuzzaman	
<b>Agricultural, Economic and Societal Importance of Brassicaceae Plants</b> .....	45
Nusrat Jabeen	
<b><i>Arabidopsis thaliana</i>: Model Plant for the Study of Abiotic Stress Responses</b> .....	129
Ali Raza, Sidra Charagh, Nida Sadaqat, and Wanmei Jin	
<b>Newly Revealed Promising Gene Pools of Neglected <i>Brassica</i> Species to Improve Stress-Tolerant Crops</b> .....	181
Mohammad Mafakheri and Mojtaba Kordrostami	
<b>Enhancement of Abiotic Stress Tolerance in <i>Camelina sativa</i>: Conventional Breeding and Biotechnology</b> .....	195
Larysa V. Nishchenko and Mirza Hasanuzzaman	
<b>Brassicaceae Plants Response and Tolerance to Salinity</b> .....	203
Subhankar Mondal and Koushik Chakraborty	
<b>Brassicaceae Plants Response and Tolerance to Drought Stress: Physiological and Molecular Interventions</b> .....	229
Ali Raza, Sidra Charagh, Ali Razzaq, Rida Javed, Rao Sohail Ahmad Khan, and Mirza Hasanuzzaman	
<b>Rapeseed: Biology and Physiological Responses to Drought Stress</b> .....	263
Mojtaba Kordrostami and Mohammad Mafakheri	

<b>Responses and Tolerance of Brassicas to High Temperature</b> . . . . .	277
Pushp Sharma	
<b>Brassicaceae Plants Response and Tolerance to Waterlogging and Flood</b> . . . . .	311
Mrinalini Prasad and Rajiv Ranjan	
<b>Brassicaceae Plants Response and Tolerance to Nutrient Deficiencies</b> . . . . .	337
K. S. Karthika, Prabha Susan Philip, and S. Neenu	
<b>Brassicaceae Plants Response and Tolerance to Metal/Metalloid Toxicity</b> . . . . .	363
Shyamashree Roy and Sanchita Mondal	
<b>Toxic Metals/Metalloids Accumulation, Tolerance, and Homeostasis in <i>Brassica</i> Oilseed Species</b> . . . . .	379
Muhammad Mudassir Nazir, Zaid Ulhassan, Muhammad Zeeshan, Sharafat Ali, and Muhammad Bilal Gill	
<b>Phytoremediation of Toxic Metals/Metalloids and Pollutants by Brassicaceae Plants</b> . . . . .	409
Neerja Srivastava	
<b>Molecular and Biotechnological Interventions for Improving Brassicaceae Crops for Abiotic Stress Tolerance</b> . . . . .	437
Pankaj Kumar and Dinesh Kumar Srivastava	
<b>Biotechnological Approach for Enhancing Capability of <i>Brassica oleracea</i> var. <i>italica</i> Against Stresses Under Changing Climate</b> . . . . .	451
Mohammad Mafakheri and Mojtaba Kordrostami	
<b>Genome Editing for the Improvement of Brassicaceae for Abiotic Stress Tolerance</b> . . . . .	473
Syed Uzma Jalil and Mohammad Israil Ansari	
<b>Bioinformatics Studies on the Identification of New Players and Candidate Genes to Improve <i>Brassica</i> Response to Abiotic Stress</b> . . . . .	483
Heba T. Ebeed	
<b>Use of Biostimulants for Improving Abiotic Stress Tolerance in Brassicaceae Plants</b> . . . . .	497
M. H. M. Borhannuddin Bhuyan, Sayed Mohammad Mohsin, Jubayer Al Mahmud, and Mirza Hasanuzzaman	

# Brassicaceae Plants Response and Tolerance to Nutrient Deficiencies



K. S. Karthika, Prabha Susan Philip, and S. Neenu

**Abstract** The plant family Brassicaceae commonly known as the cabbage family or mustard family has several agriculturally important crops. The major vegetable crops include cauliflower, cabbage, broccoli, kale, Brussels sprouts, turnip, radish, etc., and major oilseed crops are mustard and canola. Every essential nutrient has an inevitable role to play in a plant's growth and development; however some may be critical towards some crops such as in providing resistance to pests and diseases, or in terms of improving quality of the crop. Among macronutrients, S is one of them, very much essential to the plants of Brassicaceae family as it has got prominent effect on oilseed crops. Striking a perfect balance between N and S is important in growth and development of Brassicaceae plants. An understanding on the role of nutrients in the growth and development of plants belonging to Brassicaceae family is essential to identify their requirements for nutrients. This would provide an insight into identification of the symptoms exhibited as a result of nutrient deficiencies. The chapter deals with the nutrient deficiencies in Brassicaceae plants, and their responses and tolerance to stresses such as nutrient deficiencies. Hence, a better knowledge on these would aid in enhancing productivity of Brassicaceae plants by properly managing nutrient deficiencies and related abiotic stresses.

**Keywords** Brassicaceae · Critical concentration · Plant nutrition · Deficiencies · Symptoms

---

K. S. Karthika (✉)

ICAR-National Bureau of Soil Survey and Land Use Planning, Regional Centre, Hebbal,  
Bangalore 560 024, India  
e-mail: [kskavukattu@gmail.com](mailto:kskavukattu@gmail.com)

P. S. Philip

ICAR-National Bureau of Soil Survey and Land Use Planning, Regional Centre, Delhi 110 012,  
India

S. Neenu

ICAR-Central Plantation Crops Research Institute, Kasaragod 671 124, Kerala, India