ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 10, Issue, 07(H), pp. 33814-33817, July, 2019

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Review Article

STUDY OF BRASSINOSTEROIDS IN AMELIORATION OF CERTAIN UNIQUE ABIOTIC STRESSES – A MINI REVIEW

Vidya Vardhini B*., Latha P., Vasudev J., Rajesh G., Deepak P and Raghu D

Dept. of Botany, Telangana University, Dichpally-503322 Nizamabad – Telangana State

DOI: http://dx.doi.org/10.24327/ijrsr.2019.1007.3494

ARTICLE INFO

Article History:

Received 10th April, 2019
Received in revised form 2nd May, 2019
Accepted 26th June, 2019
Published online 28th July, 2019

Key Words:

ABA stress, abiotic stresses, brassinosteroids (BRs), herbicide stress, inorganic compound stress, pesticide Stress, phenantharene stress, pyrene stress

ABSTRACT

Brassinosteroids (BRs) are considered as the 6th group of plant growth regulators (PGRs) with significant growth promoting activity. BRs have been extensively studied for their physiological roles on growth and metabolism of plants, stress-protective properties against numerous abiotic stresses like heat, chilling, freezing, drought, flooding, oxidative, salt, radiation, heavy metals stresses and biotic stresses. The present mini - review is a study on the role of BRs on certain unique abiotic stresses in plants.

INTRODUCTION

Brassinosteroids (BRs) are a novel type of plant growth regulators (PGRs) that emphatically exhibit marked growth-promoting influence [1]. The discovery of this novel type of PGRs by Mitchell *et al*. [2] and extraction and identification from the rape seed pollen by Grove *et al*. [3] paved way for BRs being considered as the 6th group of PGRs. BRs can be classified as C_{27}, C_{28} or C_{29} BRs according to the number of carbons in their structure and brassinolide (BL), 28-homobrassinolide (28-HomoBL) and 24-epibrassinolide (24-EpiBL) are the three bioactive BRs being widely used in most research studies [4].

BRs have proved to exhibit profound role in ameliorating different abiotic stresses like heat [5], chilling [6], freezing [7], salt [8], drought [9], flooding [10] heavy metals [11, 12] etc. BRs ameliorated different biotic stresses caused by viruses [13], nematodes [14], fungus [15], insects [16] etc.

Apart from the above mentioned stresses, BRs were reported to ameliorate certain unique stresses and the present mini- review is to give an insight to these certain unique abiotic stresses ameliorated by BRs.

BRs and Certain Unique Stresses related to light

Foliar treatment with 24-EpiBL resulted in improved leaf morphology and photosynthetic characteristics in tomato plant cultivated under low light stress [17]. Cui *et al*. [18] observed that application of 24-EpiBL increased the plant tolerance to stress induced by poor light intensities in tomato (*Lycopersicon esculentum* Mill.). Supplementation of BL to sunflower seedlings resulted in enhanced hypocotyl growth under low light stress [19]. Spraying of 24-EpiBL altered the pericarp photosynthetic activity and seed lipid accumulation in *Styrax tonkinensis* cultivated under shade stress [20]. Foliar application of BL positively monitored photosynthesis and chlorophyll fluorescence traits of *Leymus chinensis* grown under varying levels of shade stress [21].

Cevahir *et al*. [22] reported that BRs influence the pigment content of *Glycine max* L. (soybean) grown in dark and light, thus enhancing the photosynthetic ability of the plants and Even the studies in tomato (*Lycopersicon esculentum* Mill) seedlings revealed that the exogenous supplementation of EpiBL enhanced the photosynthetic characteristics of the plants under weak light stress [23].

Corresponding author:* **Vidya Vardhini B
Dept. of Botany, Telangana University, Dichpally-503322 Nizamabad – Telangana State

BRs and Herbicide/Pesticide/Weedicide Stress

Choi *et al*. [24] observed that supplementation of BL reduced the herbicidal phytotoxicity of rice seedlings. Application of a BR-analouge showed a positive effect on the photosynthetic apparatus of *Eucalyptus grandis* seedlings under herbicide stress [25]. Xia *et al*. [26] studied that pretreatment of 24-EpiBL to *Cucumis sativus* L alleviated the pesticides-induced reduction in the rate of photosynthesis to normal growth and development. Further studies revealed that BRs played an important role in mitigating the ill effects of herbicides and pesticides in cucumber plants suggesting that BRs may be promising, environmentally friendly, natural substances suitable for wide application to reduce the risks of human and environment exposure to pesticides [27]. Even, Pinol and Simon [28] proved that application of 24-EpiBL ameliorated the negative action the photosynthesis-inhibiting herbicide, terbutryn treated *Vicia faba* plants by increasing the chlorophyll fluorescence and photosynthetic CO_2 assimilation. Exogenous spraying of BL and salicylic acid accelerated the degradation of chlorpyrifos in Ya pear fruits [29]. Filek *et al*. [30] reported that 24-EpiBL and selenium protected the chloroplasts from the oxidative stress induced by zearalenone in wheat plants. Further, Filek *et al*. [31] also reported that 24-EpiBL served as a potential modifier of antioxidant activities and membrane properties of wheat cells subjected to zearalenone stress. BR pretreatment improved the tolerance of Sigma Broad, a weedicide in foxtail millet by improved activity of antioxidant enzymes, smooth electron transport and enhanced photochemical efficiency of PS II and PSI [32].

BRs and Phenantharene stress

Studies revealed that BRs induced plant tolerance against phenanthrene by enhancing its degradation and detoxification in *Solanum lycopersicum* L. [33] and regulating the secondary metabolism [34] in tomato plants. Ahammed *et al*. [35, 36] reported that BRs improved the seed germination and early development of tomato seedlings grown under phenanthrene stress. BRs also alleviated phenanthrene phytotoxicity in tomato plants by increasing the rate of photosynthesis and detoxification activity [37]. Ahammed *et al*. [38] observed enhanced photosynthetic capacity and antioxidant potential mediated BRs in tomato leaves subjected to phenanthrene stress, germination and early development of tomato seedlings grown under phenanthrene stress.

BRs and Pyrene stress

BRs also alleviated pyrene phytotoxicity in tomato plants by increasing the rate of photosynthesis and detoxification activity [37].

BRs and ABA stress

BRs mitigated the ABA-induced germination inhibition in of *Trigonella foenu-graecum* L. by increasing seed germination and seedling frowth in terms of seedling length, fresh and dry weights [39]. Hu *et al*. [40] studied that BL increased the photosynthetic characteristics in *Leymus chinensis* grown under ABA stress grown in Songnen Plain grassland in Northeast China.

BRs and inorganic compound stresses

Cui *et al*. [41] stated that application of BRs and nitric acid promoted hydrogen peroxide-dependent induction of abiotic stress tolerance in cucumber. Root proteomics studies clearly revealed the mitigating nature of 24-EpiBL responses on cucumber grown under Ca $(NO_3)_2$ stress [42]. Further, it was also reported that 24-EpiBL-induced alterations in the root cell walls of *Cucumis sativus* L. under Ca $(NO_3)_2$ stress which paved the way for its stress tolerance.

Yuan *et al*. [43] studied that 24-EpiBL improved the photosynthetic characteristics, antioxidant system, and chloroplast ultrastructure in *Cucumis sativus* L. subjected to $Ca(NO_3)_2$ stress. Yue *et al*. [44] observed that supplementation of exogenous BL increased the growth and quality of *Brassica chinensis* under calcium nitrate stress. BRs improved the photosynthetic responses in Indian bread wheat cultivars during recovery from calcium chloride [45]. Naz *et al*. [46] observed that 24-EpiBL altered the physiological and biochemical traits of *Brassica juncea* plants due to low level of selenium. Liu *et al*. [47] reported that application of BRs improved the growth and tolerance of maize to nicosulfuron toxicity. Application of 24-EpiBL induced alterations in the root cell walls of *Cucumis sativus* L. cultivated under Ca $(NO_3)_2$ stress [48]. Recently, Nie *et al*. [49] also reported that exogenous application of 24-EpiBL was capable of promoting growth and maintaining the redox balance in cucumber seedlings grown under $NaHCO_3$ stress.

CONCLUSION

Apart from the above mentioned stresses, BRs played pivotal roles in overcoming various other abiotic stresses in plants. 24-EpiBL acts as a growth-promoting and resistance-mediating factor in strawberry plants [50] and the physiological role of BL in improving yield of six wheat cultivars (*Triticum aestivum* L.) grown under newly reclaimed sandy soil [51] was also reported. Further, application of 24-EpiBL and 28-HomoBL denigrated the seasonal stress in *Brassica junceae* by increasing shoot length, dry weight, proteins, proline and antioxidative systems [52] and Hu *et al*. [53] observed that exogenous application of BL improved the growth and resistance of maize seedling with preservative stress.

BRs are also used in amelioration of certain unique stresses like petroleum polluted soil [54], benzene [55] etc. BRs modulate plant immunity at multiple levels [56] concluding the importance of BRs in alleviating/mitigating/ameliorating various abiotic stresses in plants by modulating its morphological and anatomical aspects.

References

1. Vardhini B V. Does application of brassinosteroids mitigate the temperature stress in plants?- A review *International Journal of Earth Science and Geology*. 2019; 1(2):59-65.
2. Mitchell J W, Mandava N B, Worley J F *et al*. Brassins - a new family of plant hormones from rape pollen. Nature. 1970; 225: 1065-1066.
3. Grove M D, Spencer F G, Rohwededer W K *et al*. Brassinolide, a plant growth promoting steroid isolated from *Brassica napus* pollen. Nature.1979; 281: 216-217.
4. Latha P, Vardhini BV. Effect of homobrassinolide on bio-chemical activities and chlorophyll pigments of mustard plants grown in semi-arid tropics of Nizamabad.

European Journal of Biomedical and Pharmaceutical Sciences. 2017; 4(8): 613-618.
5. Kaur H, Sirhindi G, Bhardwaj R *et al*. 28-Homobrassinolide regulates antioxidant enzyme activities and gene expression in response to salt- and temperature-induced oxidative stress in *Brassica juncea*. Scientific Reports. 2018; 8: 8735.
6. Chen ZY. Wang YT, Pan XB *et al*. Amelioration of cold-induced oxidative stress by exogenous 24-epibrassinolide treatment in grapevine seedlings: toward regulating the ascorbate-glutathione cycle. Sci. Horti. 2019; 244: 379-387.
7. Gallo J, Balas M, Linda R *et al*. Growth performance and resistance to ground late frosts of *Fagus sylvatica* L. plantation treated with a brassinosteroid compound. J. Forest Sci. 2017; 63: 117-125.
8. Hegazi, AM, El-Shraiy, AM, Ghoname AA. Mitigation of salt stress negative effects on sweet pepper using arbuscular mycorrhizal fungi (AMF), *Bacillus megaterium* and brassinosteroids (BRs). Gesunde Pflanzen. 2017; 69: 91-102
9. Li H, Mo Y, Cui Q, Yang X *et al*. Transcriptomic and physiological analyses reveal drought adaptation strategies in drought-tolerant and -susceptible watermelon genotypes. Plant Sci. 2019; 278: 32-43.
10. Liang L, Liang Y. Effects of plant growth substances on water-logging resistance of oilseed rape seedling. Xinan Shifan Daxue Xuebao, Ziran Kexueban. 2009; 34: 58-62.
11. Dalyan E, Yuzbasioglu E, Akpinar I. Effect of 24-epibrassinolide on antioxidative defence system against lead-induced oxidative stress in the roots of *Brassica juncea* L. seedlings. Russ. J. Plant Physiol. 2018; 65: 570-578.
12. Zhou YL, Huo SF, Wang LT *et al*. Exogenous 24-epibrassinolide alleviates oxidative damage from copper stress in grape (*Vitis vinifera* L.) cuttings. Plant Physiol. Biochem. 2018; 130: 555-565.
13. Gunupuru LR, Perochon A, Doohan FM *et al*. Virus-induced gene silencing (VIGS) for functional characterization of disease resistance genes in barley seedlings. Methods in Molecular Biology. 2019; 1900: 95-114.
14. Song LX, Xu XC, Wang FN *et al*. Brassinosteroids act as a positive regulator for resistance against root-knot nematode involving RESPIRATORY BURST OXIDASE HOMOLOG-dependent activation of MAPKs in tomato. Plant Cell Environ. 2018; 41: 1113-1125.
15. Filek M, Sieprawska A, Kościelniak J, *et al*. The role of chloroplasts in the oxidative stress that is induced by zearalenone in wheat plants – The functions of 24-epibrassinolide and selenium in the protective mechanisms. Plant Physiol. Biochem. 2019; 137: 84-92.
16. Pan G, Liu Y, Ji L *et al*. Brassinosteroids mediate susceptibility to brown planthopper by integrating with the salicylic acid and jasmonic acid pathways in rice. *J. Exptl. Bot*. 2018; 69: 4433-4442.
17. Li N, Guo SR, Shu S *et al*. Effects of exogenous 24-epibrassinolde on leaf morphology and photosynthetic characteristics of tomato seedlings under low light stress. Ying Yong Sheng Tai Xue Bao. 2015; 26: 847-852.
18. Cui LR, Zou ZR, Zhang J *et al*. 24-Epibrassinoslide enhances plant tolerance to stress from low temperatures and poor light intensities in tomato (*Lycopersicon esculentum* Mill.). Functional & Integrative Genomics. 2016; 16: 29-35.
19. Kurepin LV, Joo SH, Kim SK *et al*. Interaction of brassinosteroids with light quality and plant hormones in regulating shoot growth of young sunflower and *Arabidopsis* seedlings. J. Plant Growth Regul. 2012; 31: 156-164.
20. Zhang Z, Luo Y, Wang X *et al*. Fruit spray of 24-epibrassinolide and fruit shade alters pericarp photosynthesis activity and seed lipid accumulation in *Styrax tonkinensis*. J. Plant Growth Regul. 2018; 37: 1066-1084.
21. Yang AJ, Anjum SA, Wang L *et al*. Effect of foliar application of brassinolide on photosynthesis and chlorophyll fluorescence traits of *Leymus chinensis* under varying levels of shade. Photosynthetica. 2018; 56: 873-883.
22. Cevahir G, Yentur S, Eryilmaz F *et al*. Influence of brassinosteroids on pigment content of *Glycine max* L. (soybean) grown in dark and light. *J. Appl. Biol. Sci*. 2008; 2: 23-28.
23. Wang M, Jiang WJ, Yu HJ. Effects of exogenous epibrassinolide on photosynthetic characteristics in tomato (*Lycopersicon esculentum* Mill) seedlings under weak light stress. J. Agric. Food Chem. 2010; 58: 3642-3645.
24. Choi CD, Kim SC, Lee SK. Agricultural use of the plant growth regulators: 3. Effect of brassinolide on reducing herbicidal phytotoxicity of rice seedling. Research Reports of Rural Development Administration (Suweon) 1990; 32(1): 65-71.
25. Silva CMM, Gomes MMA, Freitas SP. Effects of herbicides, associated to a brassinosteroid analogue, on the photosynthetic apparatus of *Eucalyptus grandis* seedlings. Planta Daninha 2009; 27: 789-797.
26. Xia XH, Huang YY, Wang L *et al*. Pesticides-induced depression of photosynthesis was alleviated by 24-epibrassinolide pretreatment in *Cucumis sativus* L. Pest. Biochem. Physiol. 2006; 86: 42-48.
27. Xia XJ, Zhang Y, Wu JX *et al*. Brassinosteroids promote metabolism of pesticides in cucumber. *J. Agric. Food Chem*. 2009; 57: 8406-8413.
28. Pinol R, Simon E. Effect of 24-epibrassinolide on chlorophyll fluorescence and photosynthetic CO_2 assimilation in *Vicia faba* plants treated with the photosynthesis-inhibiting herbicide terbutryn. *J. Plant Growth Regul*. 2009; 28: 97-105.
29. Zhang Y, Du GQ, Zhang YX. Efficacy of spraying of brassinolide and salicylic acid to accelerate degradation of chlorpyrifos in Ya pear fruits. Hebei Nongye Daxue Xuebao. 2015; 38: 66-70.
30. Filek M, Sieprawska A, Oklestkova J *et al*. . 24-Epibrassinolide as a modifier of antioxidant activities and membrane properties of wheat cells in zearalenone stress conditions. *J Plant Growth Regul*. 2018; 37: 1085-1098.
31. Filek M, Sieprawska A, Oklestkova J *et al*. 24-Epibrassinolide as a modifier of antioxidant activities

and membrane properties of wheat cells in zearalenone stress conditions. *J. Plant Growth Regul*. 2018; 37: 1085-1098.
32. Yuan XY, Zhang LG, Huang L *et al*. Spraying brassinolide improves Sigma Broad tolerance in foxtail millet (*Setaria italica* L.) through modulation of antioxidant activity and photosynthetic capacity. Scientific Reports. 2017; 7: 11232.
33. Ahammed GJ, Gao CJ, Ogweno JO *et al*. Brassinosteroids induce plant tolerance against phenanthrene by enhancing degradation and detoxification in *Solanum lycopersicum* L. Ecotoxicol. Environ. Safety. 2012; 80: 28-36.
34. Ahammed GJ, Zhou YH, Xia XJ *et al*. Brassinosteroid regulates secondary metabolism in tomato towards enhanced tolerance to phenanthrene. Biol. Plant. 2013; 57: 154-158
35. Ahammed GJ, Zhang S, Shi K *et al*. Brassinosteroid improves seed germination and early development of tomato seedling under phenanthrene stress. Plant Growth Regul. 2012; 68: 87-96.
36. Ahammed GJ, Choudhary SP, Chen S *et al*. Role of brassinosteroids in alleviation of phenanthrene-cadmium co-contamination-induced photosynthetic inhibition and oxidative stress in tomato. J. Exptl. Bot. 2013; 64: 199-213.
37. Ahammed GJ, Yuan HL, Ogweno JO *et al*. Brassinosteroid alleviates phenanthrene and pyrene phytotoxicity by increasing detoxification activity and photosynthesis in tomato. Chemosphere. 2012; 86: 546-555.
38. Ahammed GJ, Li X, Xia XJ *et al*. Enhanced photosynthetic capacity and antioxidant potential mediate brassinosteriod-induced phenanthrene stress tolerance in tomato. Environ. Poll. 2015; 201: 58-66.
39. Vardhini BV, Rao SSR. Effect of brassinosteroids on ABA-induced germination inhibition. *J. Phytological Res*. 1997; 10: 5-7.
40. Hu YJ, Shi LX, Sun W *et al*. Effects of abscisic acid and brassinolide on photosynthetic characteristics of *Leymus chinensis* from Songnen Plain grassland in Northeast China. Botanical Studies. 2013; 54: 42 (doi: 10.1186/1999-3110-54-42).
41. Cui JX, Zhou YH, Ding JG *et al*. Role of nitric oxide in hydrogen peroxide-dependent induction of abiotic stress tolerance by brassinosteroids in cucumber. Plant Cell Environ. 2011; 34: 347-358.
42. An YH, Zhou H, Zhong M *et al*. Root proteomics reveals cucumber 24-epibrassinolide responses under $Ca(NO_3)_2$ stress. Plant Cell Reports. 2016; 35: 1081-1101.
43. Yuan XY, Zhang LG, Huang L, *et al*. Spraying brassinolide improves Sigma Broad tolerance in foxtail millet (*Setaria italica* L.) through modulation of antioxidant activity and photosynthetic capacity. Scientific Reports. 2017; 7: 11232.
44. Yue D, Shu S, Sun J *et al*. Effects of exogenous brassinolide on the growth and quality of *Brassica chinensis* under calcium nitrate stress. *Journal of Shenyang Agricultural University*. 2013; 44: 696-699
45. Hairat S, Khurana P. Improving photosynthetic responses during recovery from heat treatments with brassinosteroid and calcium chloride in Indian bread wheat cultivars. *Am. J. Plant Sci*. 2015; 6: 1827-1849.
46. Naz FS, Khan TA, Ahmad A *et al*. Low level of selenium increases the efficacy of 24-epibrassinolide through altered physiological and biochemical traits of *Brassica juncea* plants. Food Chem. 2015; 185: 441-448.
47. Liu S, He Y, Tian H *et al*. Application of brassinosteroid mimetics improves growth and tolerance of maize to nicosulfuron toxicity. J. Plant Growth Regul. 2018; 10.1007/s00344-018-9883-y.
48. An YH, Zhou H, Yuan *et al*. 24-Epibrassinolide-induced alterations in the root cell walls of *Cucumis sativus* L. under Ca $(NO_3)_2$ stress. Protoplasma. 2018; 255: 841-850.
49. Nie WJ, Wang SS, Jing X *et al*. Effects of exogenous 24-epibrassinolide on the growth and redox balance of cucumber seedlings under $NaHCO_3$ stress. Ying Yong Sheng Tai Xue Bao. 2018; 29: 899-908.
50. Asghari M, Zahedipour P. 24-Epibrassinolide acts as a growth-promoting and resistance-mediating factor in strawberry plants. *J. Plant Growth Regul*. 2016; 35: 722-729.
51. Ahmed MA, Shalaby MAF. Physiological role of brassinolide in improving yield of six wheat cultivars (*Triticum aestivum* L.) grown under newly reclaimed sandy soil. *J. Appl. Sci. Res*. (Ma'an, Jordan). 2013; 9: 6387-6393.
52. Kumar S, Sirhindi G, Bhardwaj R *et al*. Brassinosteroids denigrate the seasonal stress through antioxidant defense system in *Brassica junceae* L. *J. Stress Physiol. Biochem*. 2014;10: 74-83.
53. Hu CH, Guo J, Chen L *et al*. Influence of exogenous brassinolide on growth and resistance of maize seedling with preservative stress. Hunan Nongye Daxue Xuebao. 2014; 40: 113-116.
54. Han YY, Gang H, Li KR *et al*. Effects of brassinolide on photosynthetic parameters of *Robinia pseudoacacia* seedlings in petroleum polluted soil. Nature, Environment and Pollution Technology. 2017; 16: 199-204.
55. Setsungnern A, Treesubsuntorn C, Thiravetyan P. Exogenous 24-epibrassinolide enhanced benzene detoxification in *Chlorophytum comosum* via over expression and conjugation by glutathione. Science of the Total Environment. 2019; 662: 805-815.
56. Wang ZY. Brassinosteroids modulate plant immunity at multiple levels. Proceedings of the National Academy of Sciences of the United States of America**.** 2012; 109: 7-8

****