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Assess Effect of Growth Regulator (Gibberellin Hormone) on Crop Production under Abiotic Stress

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REVIEW ARTICLE

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ABSTRACT

The development and growth of plants are influenced by a variety of factors, including phytohormones with their designated roles. Plant growth regulators are known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates thereby helping in effective flower formation, fruit and seed development and ultimately enhance productivity of the crop. Growth regulators can improve the physiological efficiency including photosynthetic ability and can enhance the effective partitioning of accumulates from source to sink in the field crops. Gibberellic acid (GA) a well-known phytohormone, has numerous physiological effects on plants including seed germination, growth, stem elongation, leaf expansion, photosynthesis, flowering and cell expansion. In recent years, growth hormones have attracted much attention to enhance yield and its related traits of crops. The synthesis and regulation of gibberellins in plants involve complex biosynthetic pathways that integrate both endogenous and environmental signals. Additionally, GA play a role in stress response, helping plants adapt to challenging conditions like salinity and water scarcity. Research continues to explore the biotechnological applications of GA, including their use in floriculture, fruit production, and improving plant resilience under stress conditions, making them essential for sustainable agriculture. It can be concluded that the exogenous application of gibberellic acid improves the morphological characteristics, physiological and metabolic processes, in addition to increasing the yield and quality of plants grown under different environmental conditions.

KEYWORDS: *Metabolic pathways, Organic compounds, Physiological processes, Phytohormone, Yield.*

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1. BACKGROUND

Growth regulators are organic substances besides nutrients, synthesized in plants, causing alteration in their cellular metabolism. Synthesis of some plant hormones is adversely affected by environmental factors, which causes restriction on physiological processes of the plant and ultimately, limits their growth potential (Copur *et al*., 2010). The application of these hormones in low concentration regulates growth, differentiation and development, either by promotion or inhibition (Naeem *et al*., 2004), and allows physiological processes to occur at their normal rate (Gulluoglu, 2004). Major plant growth regulators (PGRs) significantly enhanced fiber yield in cotton (Copur *et al*., 2010), protein content in pea (Bora and Sarma 2006), chemical constituents in *Croton* (Soad *et al*., 2010), fruit size in *Molina* (Vwioko and Longe 2009), seed germination rate in black gram and horse gram (Chauhan *et al*., 2009), floral buds in *Jojoba* (Prat *et al*., 2008) and other growth parameters in different plants. Thus, to overcome the production constraints, chemical manipulation could be done to improve yield and growth parameters. Gibberellins are numerous groups of plant hormones that in addition to auxins are one of the main groups of plant regulators (Bethke and Jones, 1998). Gibberellins, (GA) a group of diterpenoid plant hormones, have an important role in regulation of diverse developmental processes in plants such as seed germination, cell and organ elongation as well as flowering and have wide applications in modern agriculture (Taiz and Zeiger, 2010). Extensive studies have been conducted on the research of GA in which (Khatri *et al*., 2005) reported that GA extremely significant phytohormones for multiple processes in which stem elongation, leaf extension, pollen maturation and flowering induction are well known instances. A very a smaller number of studies have been conducted on the foliar application of GA to understand that how this hormone reacts with such kind of application. But it is clear that a diluted GA is used in very small amounts in the form of foliar application to speed up favorable conditions for the growth and development of plants at a proper time in canola (Shah *et al*., 2008). Gibberellins are produced in plants through the terpenoid route, which requires three enzymes for the production of bioactive GA from GGDP: terpene synthase (TPSs), cytochrome P450 monooxygenase (P450s), and 2-oxoglutarate dependent dehydrogenase (2 ODDs) (Fig.1.). Also, Gibberellins biosynthesis pathway is presented in Fig. 2. Gibberellins (GA) are the most important natural growth regulators and generally involved in the growth and development of different plant. They control seed germination, leaf expansion, stem elongation, and flowering (Kumar *et al*., 2018).

2. OBJECTIVES

Current research was done to evaluation effect of gibberellin acid on physiological process and effective traits on crop production under abnormal situation.

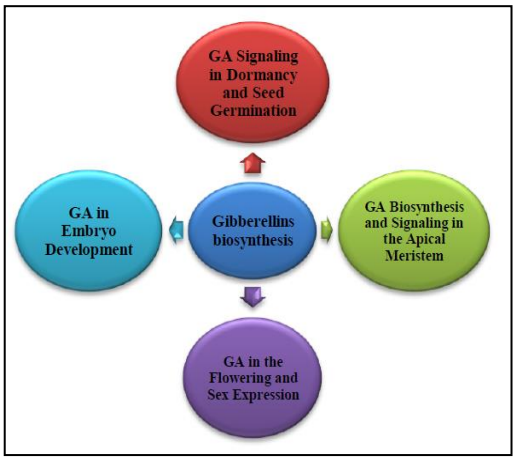

Fig. 1. Gibberellins Biosynthesis, a (Roopa *et al*., 2023).

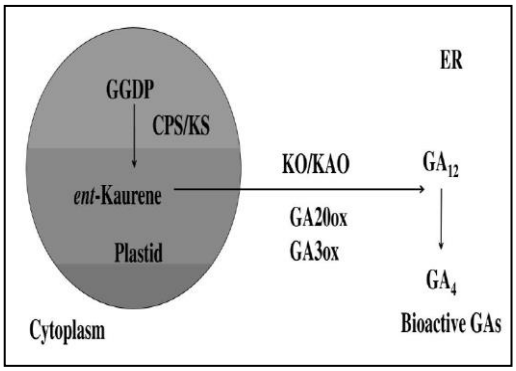

Fig. 2. Gibberellins biosynthesis pathway, b; residing in three different cellular compartments (cytoplasm, endoplasmic reticulum, and plastid). *ent*-CDP: ent-copalyl diphosphate; GGDP: geranylgeranyl diphosphate; KS: *ent*-kaurene synthase; CPS: *ent*-copalyl diphosphate synthase; KAO: *ent*-kaurenoic acid oxidase, KO: *ent*-kaurene oxidase (Azizi *et al*., 2023).

3. EVIDENCE ACQUISITION

Current research was conducted according evaluate results of valid researcher.

4. RESULT AND DISCUSSION

Gibberellins are plant growth hormones which promote cell division and regulate numerous physiological processes including seed germination, stem elongation, leaf, root and reproductive organs expansion (Colebrook *et al*., 2014). Several studies described the inhibition of gibberellin biosynthetic pathway by growth retardants in order control crop production. Growth retardants were employed to reduce the shoot system, thereby lowering the risk of lodging in cereal crops, also used in making ornamental plants more compact with better canopy structure as well as improving the formation of reproductive structures in many other crops (Rademacher, 2016). El-Khourya *et al*. (2019) suggested that it is very useful in commercial horticulture for betterment of plant growth and yields. They further added that effective cell growth and cell elongation were caused by GA effects on stem and root growth. Nizamani *et al*. (2018) further said that sustainable improvement of yield has been a big challenge for plant breeders to secure food in upcoming years in which fertilization is a very critical challenge. George *et al*. (2008) explained that GA might have participated in the formulation of seeds and a greater number of seed is produced in pods when their nourishment normal, but when their nourishment is abnormal more aborted seeds come into being. For the modification of crop plants, both natural as well as artificial phytohormones are used in agriculture so that better and most useful cultivation of plants can be put into practice for unlike processes of development (Wang *et al*., 2020). Similar results for seed index were in conformity with Mir *et al*. (2009). Moreover, many studies have shown that GA3 plays an important role in seed quality. According to Hedden and Sponsel (2015), GA is one of the most vital en-

dogenous hormones in plants, because they bring development in the body of a plant for the regulation of lots of physiological mechanisms. In the plant growth phase, gibberellins trigger cell division and elongation processes, meristem transcription for shoot development, the change of leaf stage from juvenile to adult, flowering and sexual expression (Khan *et al.*, 2020). Gibberellins mitigate the negative impacts of salinity by improving the efficiency of nutrient use and absorption, enzymatic activity and chlorophyll content, resulting in better physiological performance of plants. Research indicates that the exogenous application of GA promoted improvements in several cultivated plants, strengthening their physiological and biochemical attributes. GA not only improves metabolic attributes but also increases plant yield where it increases the number of flowers, fertile seeds, fruit weight and total fruit/plant through foliar spray processes (Kuchi *et al.*, 2017). Abiotic stresses, such as soil salinity or drought, negatively affect plant growth and productivity, causing osmotic, ionic and oxidative stress. GA helps protect plants from salinity damage by maintaining membrane stability, ionic homeostasis and upregulating antioxidant enzymes. Furthermore, it promotes the concentration of compatible solutes, protects photosystems, and induces the expression of stress-related genes. In general, exogenous application of gibberellic acid improves the morphological characteristics, physiological and metabolic processes, in addition to increasing the yield and quality of plants grown under different environmental conditions (Isayenkov and Maathuis, 2019). Water stress is an acute environmental condition that affects several plant processes, leading to reduced productivity in different crops around the world (Seleimann *et al.*, 2021). It can generate physical-biochemical disorders, interrupting the plant's cellular metabolism, and causing damage due to ionic and oxidative stress, generating rapid loss of water through the stomata, leading to cellular dehydration and tissue death. Evidence suggests GA plays an important role in improving plant development in this water stress condition, showing exogenous GA reduces the effects generated (Shah *et al.*, 2023). Gibberellic acid effect on growth, photosynthesis and antioxidant defense of crops mentioned in Fig.3.

5. CONCLUSION

Gibberellins play a key role in many metabolic pathways affecting these characteristics, such as chlorophyll production and degradation, translocation of assimilates, nitrogen metabolism, and nitrogen redistribution. As stated above, these effects can vary greatly among different species, growth stages, application dose and methods, and cultivation techniques. It can be concluded that the exogenous application of gibberellic acid improves the morphological characteristics, physiological and metabolic processes, in addition to increasing the yield and quality of plants grown under different environmental conditions.

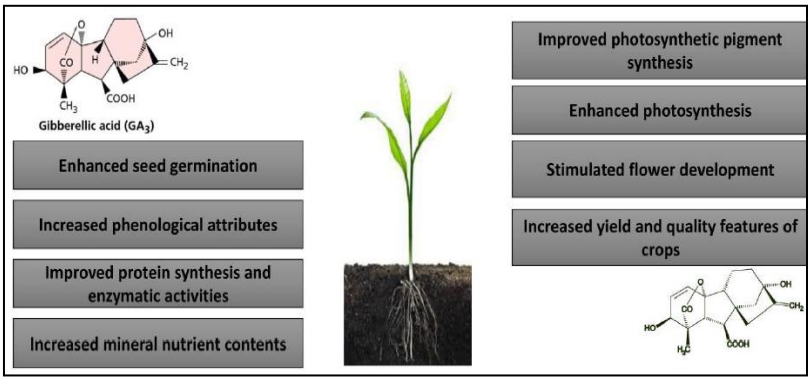

Fig. 3. Effects of gibberellic acid on growth, photosynthesis and antioxidant defense of crops (Azizi *et al*., 2023).

REFRENCES

Azizi, M. H., A. Soleymani. and H. R. Javanmard. 2023. Gibberellic acid application and Wheat production. Res. Crop Ecophysiol. 2(2): 89-104.

Barani, M., N. Akbari. and H. Ahmadi. 2013. The effect of gibberellic acid (GA3) on seed size and sprouting of Ootato tubers (*Solanum tuberosum* L.). Afr. J. Agri. Res. 8(29): 3898-3903.

Bethke, P. C. and R. L. Jones. 1998. Gibberellin signaling. Current Opinion in Plant Biol. 1: 440-446.

Bora, R. K. and C. M. Sarma. 2006. Effect of gibberellic acid and cycocel on growth, yield and protein content of Pea. Asian J. Plant Sci. 5: 324-330.

Chauhan, J. S., Y. K. Tomar, I. K. Singh, S. Ali. and A. Debarati. 2009. Effects of growth hormones on seed germination and seedling growth of Black gram and horse gram. J. Am. Sci. 5: 79-84.

Colebrook, E. H., S. G. Thomas, A. L. Phillips. and P. Hedden. 2014. The role of gibberellin signaling in plant responses to abiotic stress. J. Exp. Biol. 217: 67-75.

Copur, O., U. Demirel. and M. Karakus. 2010. Effects of several plant growth regulators on the yield and fiber quality of Cotton (*Gossypium hirusutum* L.). Notulae Botanicae Horti Agrobotanici Cluj. 38: 104-110.

El-Khourya, R., S. Naser El Deena, N. Boustanyb, G. A. Rizka. and L. Geagea. 2019. Effect of different concentrations of gibberellic acid on the growth of Euphorbia pulcherrima. Intl. J. Plant, Animal and Environ. Sci. 9(1): 54-62.

George, E. F., M. A. Hall. and G. J. De Klerk. 2008. Plant propagation by tissue culture. (3rd Edition), Vol. 1. Springer, Dordrecht, The Netherlands. 501 p.

Gulluoglu, L. 2004. Determination of usage of plant growth regulators in Soybean (*Glycine max* Merr) farming under Harran plain conditions. J. Faculty Agri. 8: 17-23.

Hedden, P. and V. Sponsel. 2015. A century of gibberellin research. J. Plant Growth Regul. 34: 740-760.

Isayenkov, S. V. and F. J. M. Maathuis. 2019. Salinity stress in

plants: many unanswered questions remain. Frontiers in Plant Sci. 10: 80. https://doi.org/10.3389/fpls.2019.00080.

Khan, A., S. Bilal, A. L. Khan, M. Imran, R. Shahzad, A. Al-Harrasi, A. Al-Rawahi, M. Al-Azhri, T. K. Mohanta. and I. J. Lee. 2020. Silicon and gibberellins: synergistic function in harnessing ABA signaling and heat stress tolerance in date Palm (*Phoenix dactylifera* L.). Plants. 9(5): 620. https://doi.org/10.3390/plants9050620

Khatri, A., I. A. Khan, M. A. Siddiqui. S. Raza, S. and G. S. Nizamani. 2005. Evaluation of high yielding mutants of (*Brassica juncea* L.) S-9 developed through Gamma rays and EMS. Pak. J. Bot. 37: 279-284.

Kuchi, V. S., J. Kabir. and M. W. Siddiqui. 2017. Gibberellins: roles in pre- and post-harvest quality of horticultural products. *In*: Siddiqui, M. W. and Ali, A., Editors. Post-harvest management of horticultural crops. Apple Academic Press, pp. 181-230.

Kumar, A. S., N. Sakthivel, E. Subramanian, R. Kalpana, P. Janaki. and P. Rajesh. 2018. Influence of foliar spray of nutrients and plant growth regulators on physiological attributes and yield of finger Millet (*Eleusine coracana* (L.) Gaertn.). Intl. J. Chem. Studies. 6(3): 2876–2879.

Mir, M. R., N. A. Lone. and N. A. Khan. 2009. Impact of exogenously applied ethephon on physiological and yield attributes of two mustard cultivars under rainfed conditions. Appl. Biol. Res. 11: 44-46.

Naeem, M., I. Bhatti, R. H. Ahmad. and M. Y. Ashraf. 2004. Effect of some growth hormones (GA3, IAA and Kinetin) on the morphology and early or delayed initiation of bud of Lentil (Lens culinaris Medik). Pak. J. Bot. 36: 801-809.

Nizamani, M. R., M. A. Ansari, M. A. Siddiqui, G. H. Nizamani, F. Nizamani, M. Naz. and A. H. Mastoi. 2018. Effect of gibberellic acid on yield and yield attributes of canola (*Brassica napus* L.) varieties. Global Scientific J. 6(8): 863-880.

Prat, L., C. Batti. and T. Fichet. 2008. Effect of plant growth regulators on floral differentiation and seed production in jojoba (*Simmondsia chinesis* (Link) Schneider). Industrial Crops and Prod. 27: 44-49.

Rademacher, W. 2016. Chemical regulators of gibberellin status and their application in plant production. Annual Plant Review. 49: 359-404.

Roopa, B., S. J. Premalatha, A. C. Manjula, S. Bhattacharya, V. Guru Prasad, V. D. Reddy, R. Shrivastava. and Sh. J. Patil. 2023. Role of Gibberellin in plant growth, development and senescence. *European Chemical Bulletin*, 12, pp. 1-8. *In*: Helliwell, C. A., Chandler, P. M., Poole, A., Dennis, E. S., and Peacock, W. J. 2001. The CYP88A cytochrome P450, ent-kaurenoic acid oxidase, catalyzes three steps of the gibberellin biosynthesis pathway. Proc. Natl. Acad. Sci. 98(4): 2065-2070.

Seleiman, M. F., N. Al-Suhaibani, N. Ali, M. Akmal, M. Alotaibi, Y. Refay. and M. L. Battaglia. 2021. Impacts of water stress on plants and different approaches to alleviate its adverse effects. Plants. 10(2): 259.

Shah, S. H., S. Islam, F. Mohammad. and M. H. Siddiqui. 2023. Gibberellic acid: a versatile regulator of plant growth, development and stress responses. J. Plant Growth Regulation. 42: 7352–7373. https://doi.org/10.1007/s00344-023-11035-7.

Shah, S., M. R. Molla, D. Chandra. and L. Rahman. 2008. Assessment of genetic variation and relationships within the varieties of four Brassica species by RAPD markers. Aust. J. Crop Sci. 2: 105-114.

Soad, M. M. I., S. Lobna Taha. and M. M. Farahat. 2010. Vegetative growth and chemical constituents of croton plants as affected by foliar application of benzyl adenine and gibberellic acid. J. Am. Sci. 6: 126-130.

Taiz, L. and E. Zeiger. 2010. Gibberellins: regulators of plant height. *In*: Zeiger, E. (Ed.), Plant Physiology. Sinauer Associates, Incorporated: Hard Cover. pp. 461-493.

Vwioko, E. D. and M. U. Longe. 2009. Auxin and gibberellin effects on growth and fruit size in *Lagenaria siceraria* (*Molina standley*). BioSci. Res. Communications. 21: 263-271.

Wang, X., L. Sun, W. Li, M. Peng, F. Chen, W. Zhang, C. Sun, S. Chen, W. Hua. and J. Zhang. 2020. Dissecting the genetic mechanisms of waterlogging tolerance in Brassica napus through linkage mapping and a genome-wide association study. Indus. Crops and Prod. 1(147): 112269.