



Effect of Glycine Betaine as a Growth Promoter and Stress Mitigator in *Brassica oleraceavar. Italica*

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Abstract

Glycine betaine performs a crucial role as an osmoprotectant and, also acts as a cytoplasmic osmotic solute specifically in the members of family Gramineae and Chenopodiaceae. *Brassica oleracea var. Italica* due to the presence of glucosinolates and various other chemicals, plays vital roles for humans. GB when applied to broccoli mitigate the stress effects and increase the shoot fresh and dry weight, shoot length, root dry weight, shoot calcium, potassium, nutrient uptake of sodium, calcium, potassium, SOD, peroxidase, and total soluble proteins of broccoli (*Brassica oleracea var. Italica*). Implementation of GB also enhanced the performance of various parameters such as antioxidant photosynthetic pigments (chlorophyll a, b, a/b, carotenoids, and total chlorophyll), and mineral nutrient use efficiency, nutrient uptake of sodium, calcium and catalase activity.

Introduction

Plant's life cycle goes through an enormous phase of environmental changes. The most widespread or harmful is the reduction of osmotic nutrients, denaturation of enzymes that is unfriendly for higher plants. It results in the accumulation of ROS, membrane dysfunction, physiological, and biochemical habituations which occur at the cellular level. As a result, plant synthesize natural protectant glycine betaine and plant hormones. GB important compatible solute which maintains the osmotic potential and normalizes the expression of genes (Bhuiyan *et al.*, 2017). In response to these changes, plants gather trehalose, GB, proline, and other consistent compounds to maintain osmotic homeostasis, against cold, drought, or salt stress (Xu *et al.*, 2018).

Glycine betaine being quaternary amphoteric compound that is stable over a varied range of pH values. It responds to both hydrophobic and hydrophilic areas. In plants improved the action of antioxidants, proteins, enzymes, and photosynthetic activity of plants (Banu *et al.*, 2009). Exogenous application of glycine betaine in sweet potato under water-scarce conditions. The exogenous implementation enables the sweet potato by changing its physiological adaptations by the accumulation of sugar elements soluble in nature. Moreover, it also alleviates the production of photosynthetic pigments, chlorophyll, and enhance morphological features such as shoot fresh dry weight, leaf length, and number (Tisarum *et al.*, 2019).

It is suggested that glycine betaine reduced stress through several different mechanisms. The best approach is the protection of photosynthetic machinery by acting as a cofactor. It regulates the transporters or ion channel results in low Na⁺ and high K⁺ that helped in opening and closing of channel gates (Chen & Murata, 2011). A significant function of GB in higher plants or different crops for example sugar beet, spinach, maize, and barley determined by the availability of GB-accumulating transgenic plants (Rhodes & Hanson, 1993; Chen & Murata, 2008).

D₁ protein growth and synthesis are stimulated by glycine betaine which helped in the repairment of photodamaged photosystem II. By heat stress, photosynthesis inhibition has occurred in common plants of subtropical, tropical, or the plants of the region exposed to temperatures. During growth and germination of the seed, plant transformation with cDNA enabled plants to survive against stress by the accumulation of GB especially as in *Nicotiana tabacum* plants to synthesize betaine (Allakhverdiev *et al.*, 2007).

Currently, there are many pieces of evidence that foliar-applied glycine betaine protects vegetables and different fruits from harms and injuries such as peaches (Shan *et al.*, 2016; Wang *et al.*, 2019) for example loquat and zucchini (Yao *et al.*, 2018), *Arabidopsis thaliana* (Xing and Rajashekar, 2001) and sweet pepper (Wang *et al.*, 2016).

The sprouts of broccoli are famous because of rich in vitamin contents, minerals, and glucosinolate secondary metabolites act as phenolic compounds increased by foliar spray of glycine betaine (Baenas *et al.*, 2012). The high GSL levels present in leaves are stabilized due to a decline in myrosinase enzymes, because of their medicinal influence linked to the indoles. As glucosinolate level decreased it damaged the membrane (Hassini *et al.*, 2017).

In Brassicaceae pungent flavors of broccoli or their family members is the result of glucosinolate, which are the natural plant compounds found in broccoli. Isothiocyanates present in broccoli, help in the prevention of cancer. The presence of glucoraphanin sulforaphane in broccoli high concentration completely hinder the chemical induction of breast cancer (Meyer & Adam, 2008). It supposed that regular consumptions of various brassica vegetables such as cabbage, brussels sprouts, broccoli, and cauliflower decrease risks of cancer. For example, slight progress made in the treatment of cancers for example lung cancer. The advantage is given to these vegetables, because of their elevated level of specific glucosinolate known as phytochemicals (Di Paolo & De Camilli, 2006).

Plant growth regulators are commonly known as phytohormones because some plants can develop them endogenously. There are various types of hormones that act as a chemical messenger, take part in different physiological processes. Broccoli (*Brassica oleracea* var. *Italica*) naturally consists of these plant hormones that function differently in growth. Besides this essential dietary minerals Na, Ca, Zn, Mg, Fe, K, and vitamin KI, B2 secondary metabolites known as glucosinolates are also present in broccoli (Hameed *et al.*, 2015).

Results and Discussion

It was evident from many investigations that glycine betaine diminishes the deleterious injuries under water deficit conditions and improves growth in different such as cotton (Naidu *et al.*, 1998), rice (Rahaman *et al.*, 2002), sunflower (Iqbal *et al.*, 2005), wheat (Mahmood *et al.*, 2009) and maize (Ali *et al.*, 2007).

Exogenous glycine betaine established the positive effects in the growth of shoot fresh weight. As the level of GB increased from 5, 10, 15 mM enhanced the growth of shoot fresh weight. Water spray plants show less growth as compared to control plants, similarly, 15mM showed

an increase in shoot fresh weight in comparison to control (Sakamoto and Murata, 2002). Plant hormones and glycine betaine both were used as a foliar application in many crops to enhance growth and mitigates environmental stress. Some plants can synthesize glycine betaine for example sugar beet and improve their tolerance (Khalid *et al.*, 2015).

Those plants which cannot endogenously accumulate even a smaller level of glycine betaine were subjected to a foliar spray of GB against stress protection (Ashraf and Foolad, 2007). Various kinds of osmoprotectant known as glycine betaine, trehalose, and proline comparatively were vital and similar solutes increased physiological features under control and stress conditions (Hasegawa *et al.*, 2000; Bartels and Sunkar, 2005)

Exogenously applied glycine betaine also increased shoot dry weight and showed a considerable result. Water sprayed plants showed more growth as compared to other treatments of GB. Similar results were observed in soybean (Rezaei *et al.*, 2012).

It is, hence, concluded that glycine betaine increased morphological parameters with or without stress. However, those plants which cannot accumulate GB naturally then exogenous application enhanced level of glycine betaine (Hossain *et al.*, 2010).

Conclusion

Plants disturbed by different kinds of stresses or from environmental pressure, but the foliar application saved the plants not only from the harsh environment but plays an important part in terms of growth especially when it compatible with to plant. Foliar spray of glycine betaine act as growth promoter applied through different means (rooting medium, seed soaking, or as a foliar spray) has undergone a renaissance during the last decade. GB is an important organic osmolyte that regulates plant growth by improving osmotic adjustment, photosynthesis, antioxidant capacity, and uptake of ions. Glycine betaine is an essential osmoprotectant which actively practiced in regulating the normal processes of plants. In Conclusion, glycine betaine applied possessed several beneficial effects as it protects the overall machinery of plant and improves growth or mitigates the harmful effects. It also plays a role to improve the activities of essential enzymes. Finally, given the above results, deleterious effects can be alleviated when GB was exogenously applied to plants.

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