Effect of Exogenous Applications of Glycine Betaine on Chlorophyll and Biochemical Attributes of Two Maize (Zea mays L.) Cultivars under Saline Conditions

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Abstract: This experiment was conducted to observe that whether the glycine betaine exogenous application induce the salt tolerance in maize cultivars or not. Experiment was laid down in CRD at University of Gujrat, Gujrat-Paksitan during 2011. On the basis of results of the present studies it can be concluded that Salt stress greatly affect chlorophyll a,b, Carotenoids and biochemical parameters of both maize cultivars but exogenous application of glycinebetaine ameliorates the harmful effects of salt stress. However the 100mM GB spray was more affective than 50mM GB application. As whole the glycine betaine induced the salt tolerance in both cultivars in relation chlorophyll and biochemical attributes of maize under saline conditions.

Key words: GB · Chlorophyll · Biochemical · Maize · Salinity

INTRODUCTION

Corn (Zea mays L.) is a main food and economical crop. It is one of the most important crops throughout the world [1]. In Pakistan, maize is the third important crop after wheat and rice. In the year 2010-2011 total area under maize crop inPakistan was 974.3 thousand hectares with 3706.9 thousand tons of total production [2]. High salts concentration has badly affected about 5% of arable land all around the world which reduces cropgrowth and yield [3]. Salt stress has been reported to cause a reduction in chlorophyll, carotenoids photosynthesis enzymes, respiration and protein synthesis in sensitive species [4].

Two major approaches being used to improve stress tolerance are: (1) Exploitation of natural genetic variations and (2) generation of transgenic plants with novel genes or altered expression levels of the existing genes [5]. Accumulation of metabolites that act as compatible solutes is one of the probable universal responses of plants to changes in the external osmotic potential. Metabolites with osmolyte function like sugar alcohols, complex sugars and charged metabolites are frequently observed in plants under unfavorable conditions [7].

Glycine betaine is known to serve as compatible osmolytes, protectants of macromolecules and also as scavengers of ROS under stressful conditions [7]. Plants under various stress conditions showed improvement in growth, survival, leaf water potential, ion uptake and stress tolerance due to exogenous application of GB [8].

Hence, the present studies were conducted to improve the salt tolerance of two maize varieties by foliar application of GB at seedling stage.

MATERIALS AND METHODS

This study was conducted to induce salt tolerance in two maize cultivars by foliar application of Glycinebetaine at seedling stage. The experiment was conducted in growth chamber of Botany Lab University of Gujrat, Gujrat-Pakistan.

The seeds of two maize cultivars were obtained from Botany department of University of Gujrat. River sand was used as growth medium. Six seeds were sown in each pot; before sowing the sand was washed with adequate amount of distill water to remove the salt present in it. After sowing, 20ml full strength Hoagland’s solution was given to each pot. Plants were thinned after full germination and only healthy four plants were selected. Salt (NaCl) treatment (10 dS m$^{-1}$) was applied after 10 days of germination. Three levels (0mM, 50mM and 100mM) of Glycine betaine were applied as foliar spray after two weeks of germination. The experiment was laid out in a Completely Randomized Design (CRD) with 4 replicates.

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There Were Following Four Treatments:

- $T_0$, Control (distill water)
- $T_1$, 100mM NaCl
- $T_2$, 100mM NaCl + 50mM GB foliar spray
- $T_3$, 100mM NaCl + 100mM GB foliar spray

The chlorophyll $a$, $b$ and carotenoids were determined with the method as described by Arnon [9]. To calculate the chlorophyll $a$, $b$ and carotenoids values the fresh leaves were cut and their 0.1 (g) weight was taken, leaf was crushed in pestle mortar until the paste formed then added the 80% acetone pour into test tube and total volume was made 10ml. Leave material overnight at -10 C° next day extract readings at 663, 645 and 470nm was noted by using a spectrophotometer. (UV 3000)

For determination of mineral elements in plant tissue the dried ground shoots and root material (0.5 g) was digested with sulphuric acid ($H_2SO_4$) and Hydrogen peroxide ($H_2O_2$) according to the method of Wolf [10]. $Na^+$ and $K^+$ cations were determined with a flame photometer (Spectro Lab S20-4) graded series of standards (ranging from 10 to 100 mg/L) of $Na^+$ and $K^+$ were made and standard curve for each element was drawn.

**RESULTS**

**Chlorophyll “a,b”**:
Analysis of variance of data for chlorophyll “a” and “b” showed that chlorophyll “a” and “b” contents significantly ($P<0.001$) reduced under salt stress, but the foliar application of GB improved. This improvement was more in $V_1$ as compared to $V_2$ (Fig. 1, 2) 50mM GB and level was more effective in $V_1$.

**Carotenoids**:
Analysis of variance of data for carotenoids that carotenoids contents were significantly ($P<0.001$) reduced under salt stress in both maize cultivars However, the foliar spray of GB improved the carotene content, two levels of GB i.e. 50mM and 100mM were applied but the 50mM GB was more effective than 100mM (Fig. 3).

**K$^+$ conc. in Root and Shoot**:
Analysis of variance of data for K$^+$ in root and shoot shows that salt significantly reduce the K$^+$ in root of both cultivars. Application of two levels of GB i.e. 50mM and 100mM increased the K$^+$ in root and shoot under salt stress (Fig. 4, 5).

**Na$^+$ conc. in Root and Shoot**:
Analysis of variance for data Na$^+$ conc. in roots shows that Na$^+$ in roots significantly increased by the application of 100mM NaCl in both maize
cultivars. However application of GB at two levels i.e. 50mM and 100mM decreased the Na⁺ in root of both maize cultivars (Fig. 6, 7).

**DISCUSSIONS**

In present studies the salinity adversely affects the rate of biochemical and chlorophyll attributes. Salt stress severely affects the biochemical attributes (Fig 1-6). Chlorophyll contents decrease because salinity cause the disruption of chloroplasts by oxidative stress which cause a decrease in chlorophyll content as well as decreased the photosynthetic reactions [11]. According to Cha-Um and Kirdmanee [12], salinity decreased the total chlorophyll “a”, “b” and carotene concentration of two maize varieties. These results are in accordance with that of

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Al-aghabary et al.[13]. In present studies it was also observed that chlorophyll content decreased due to salt stress but increased by the exogenous application of 50Mm GB and 100Mm GB because exogenous application of GB increased the chlorophyll and caroten contents by repairing the chloroplast structure [14]. In present study it was also observed that Na+ decreases the concentration of K+ ions within the cells within the roots and shoots (Fig 4.19, 4.20). These results were explained in view of earlier reports that GB application reduced the accumulation of Na+ and promotes the accumulation of K+ in the cells of most plant species e.g. in rice plants [15] and prevent the leakage of K+ ion and enhance the activity of H+-ATPase [16].

CONCLUSION

This experiment was conducted to find out that whether the foliar spray of GB induces the salt tolerance in maize cultivars or not. On the basis of results of the present studies it can be concluded that salt stress negatively affects the chlorophyll and biochemical parameter of maize but the exogenous application of glycinebetaine significantly ameliorates the harmful effects of salt.100mM GB application was affective than 50mM produce the more positive results. As whole the GB induce the salt tolerance in both cultivars of maize.

REFERENCES