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# Mitigating The Effect of Salinity Stress through Foliar Application of Benzoic Acid in Spring Maize (Zea mays. L)

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**Abstract**- In Pakistan, the third main cereal crop is maize but it faces salinity stress on a large scale. The exogenous Benzoic acid is considered a potential strategy to ameliorate the salinity stress. A field trial was carried out at Warehouse of SARC, ISES, Saline Agriculture Research Center, University of Agriculture, and Faisalabad during Kharif season, 2019 to explore the role of foliar-applied benzoic acid on the growth of spring-planted maize. The treatments of the trial comprised of Salinity stress (control, 6 dS/m, and 12 dS/m) and Benzoic acid (control, 0.5 mM and 1 mM) in pots. Fisher's analysis of variance technique for the data analysis was used with the Least Significant Difference test (LSD) to find the differences among treatment means. Data related to agronomic and chlorophyll related traits under the salinity stress through applying benzoic acid were recorded following standard protocols. The agronomical parameters were measured, whereas, chlorophyll through Green seekerTM and SPAD-chlorophyll. The results were found significant for various agronomic traits including plant height, leaf length, root length, inter-nodal length, shoot length, root dry weight, and shoot dry weight, leaf area. Our study concludes that the growth of maize is inhibited by the salinity in the medium of growth and by foliar application of benzoic acid; the harmful effects on the biomass of growth and contents of chlorophyll were mitigated. Thus, we might conclude that in salt stress, foliar application of benzoic acid had stimulatory effects on maize crop.

**Keywords: Benzoic acid, salinity, maize, chlorophyll, growth**

## I. INTRODUCTION

Maize is exclusively cultivated crop in all over the world because it is the main staple food for man and also important food for animals [1]. Maize belongs to family Poaceae. In Pakistan, it is a crop having high yield. Maize is third main cereal crop following wheat and rice cultivation but it is the fourth position including cash crops after wheat cotton and rice in Pakistan. Maize is also known as "Queen of cereals" due to its multipurpose uses of crops like as fodder, food etc [2].

During 2018-2019 the maize was grown in Pakistan on 1348 ha and total production was 4.640 million tons. In Pakistan maize is grown in two seasons; one is spring crop (February to march) and other is autumn crop (1stJune to mid July) and it is irrigated with canals or tube well and also grown areas. Maize grown best on organic, deep, well drained and medium soil textured pH 5.6 to 7.5 while pH other range is required for sandy and clay soils. Pakistani soils are favorable for the cultivation of maize crop. Maize grains consist of vitamins A, C and E. Maize grains contain as 75.4% carbohydrates, 7.7% fats, 14.6% protein, 2.3% crude fibers and 1.3% ash [3].

The main factors which are badly affecting the maize growth and development are low-quality seeds; lack of research uncertainty of soil other many abiotic and biotic factors which are involved in low yield of maize crop. Biotic stresses are plants intra competition, insects', weeds,etc and abiotic stresses are heavy metal, drought, water and salt stress [4]. In the world the main purpose of cultivation of maize is food, because it consists of more calories than wheat and rice. Maize is C4 plant and its life span is more [5].

Salt stress is important worldwide problem for the crop production and highly adverse effects on cereal crops. Salt stress affects every aspects of plants physiology, chemical reaction that causes the virtually reduction in crop production and yields and destroye quality of products [6]. Stresses can alter the signaling pathways, metabolic reactions and change the physical state of the plant [7]. All abiotic stresses specially salinity stress disturbs the metabolism by ions concentration (mainly due to Na+, Cl- and So42-) also disturbs the nutrients imbalance and osmotic adjustment. Salt stress the main effects on oxidative stress for glycophytes [8]. Photosynthesis is also affected by salinity by decreasing stomatal conductivity. The CO2

concentration is also decreased in internal storage of the plants and gaseous exchange decreased through stomata. The decreasing photosynthesis is most effecting important factor by high salinity levels [9].
Salt stress increases the synthesis rate of reactive oxygen species (ROS) such as singlet oxygen (1O2), hydrogen peroxides (H2O2), super oxide radical (O2-) and hydroxyl radical (OH-) are included. The ROS species increase the chance of leakage of electron from oxygen. The enzymes are used to prevent the storage of ROS species which destroye the lipid, protein, RNA and DNA structures. Catalase takes part in breakdown of H2O2 farming O2 which results detoxification [10]. Although many studies on salinity is tolerance were conducted, in this research the salinity tolerance has been carried out through exogenous benzoic acid but the basic research biochemical and physiological role of exogenous applied benzoic acid on salinity tolerance of maize is scarce. Proline accumulation resulted in a decrease of osmotic potential which aided the maintenance of adequate water absorption and an increase in cell turgor pressure. This prolonged the physiological activity of the plant during water-stressed conditions which cause of osmotic imbalance in plants [11].To elevate this problem many experiment were done to remove the inhibitory effect of salinity through applying of different chemicals on different crop. Thus the present study was conduct to examine whether benzoic acid acts as growth regulator to ameliorate the adverse effect of salinity on growth of maize crop. The primary objectives of the study were to assess whether exogenous application of benzoic acid could alleviate the inhibitory effect of salinity on the growth of maize crop.

## II. MATERIALS AND METHODS

The experiment was carried out at the warehouse of(SARC, ISES) Saline Agriculture Research Center, University of Agriculture, Faisalabad to study the morphological and physiological traits of spring-planted maize as affected by varying levels of salinity and to ameliorate the benzoic acid effect. The seeds of maize hybrid 'MMRI Yellow' were obtained from the Ayub research institute. The sand was taken from river Sindh and with tap and distilled water, it was twice washed. Then salt was mixed in soil (0 as a normal, 6dSm-1 to 12dSm-1). Each plastic pot 34cm length and 28cm diameter was filled with 15 kg soil. For sterilization of maize seeds, solution of sodium hypochloride was used for about five minutes. This will prevent it from any fungal or bacterial contamination. In equal depth and distance, eight seeds were planted in each pot. After germination, the seedling thinned two plants left of equal size in each pot. Normal requirements of nutrients were applied in each pot. The BA treatments were applied after 20 days of germination. Two levels of Benzoic acid were used (0 as a control, 0.5mM and 1mM). The solutions were used as foliar application which is absorbed by leaf tissues at vegetative stage. Spray was done in each pot with manual of spryer. The sampling was done after four weeks of treatment. After harvest, shoot and root length and fresh and dry weights were documented. The contents of Chlorophyll a and b were fined out after fresh leaves (0.1g) of maize were homogenized in 80% acetone (10mL) and then centrifugation was done for 15 minutes at 3000 ×g. with the help of the spectrophotometer, the absorbance of supernatant was determined at 480nm, 645nm, and 663nm. The content of chlorophyll was determined similar to previous study done by Yoshida etal[12]. The design of the experiment was randomized and completed in three replicates. All the data was entered analyzed by SPSS version 19.

## III. RESULTS AND DISCUSSION

Among all abiotic stresses, the salinity stress is the major abiotic stress which cause death of plants in higher level but in lover level it decreases the development and growth of plants[13]. NaCl is the predominant salt in most saline environments. Other salts like sulphate salt are less harmful than NaCl. It decreases the crops growth, development and productivity. The salinity affects the root zone of plants by ion accumulation and toxicity produced. Salinity mostly affects the seedling stage of plants. Plants internal mechanism try to resists against external or internal harmful conditions but it is in limited to specific point when the extreme condition cross through the external or internal harsh environments then the plants shows symptom's due to those stresses. The salinity stress mainly effects during developmental stage of plant. Benzoic acid (BZA) known to provide abiotic stress tolerance similar to that reported for salicylic acid [14] but benzoic acid-induce salt stress tolerance has been not reported yet widely.
Data pertaining to various plant growth characteristics are given in table 1 that show the impact of benzoic acid under salinity stress in maize crop plants. Data show that salt stress as well as foliar application of benzoic acid has significant affect. Analysis of variance (ANOVA) shows that there is noticeably impact of sodium chloride on plant height of maize crop hybrid MMRI Yellow. Maximum plant height was observed under the growth regulator benzoic acid foliar application conditions while under salt stress conditions minimum maize plants height was observed. The root length was an important attributes; plant root length

is affected by the climatic condition and the concentration of minerals in the soil. Analysis of variance (ANOVA) revealed that there is noticeably impact of salinity stress on leaf area weight is minimum than in control and Benzoic acid application. The maximum leaf area was observed under control and foliar application while minimum area was observed under salinity stress plants. The nutrients imbalance causes the shortage of nutrients which altered the concentration and composition of plants [15]. By the changing of micronutrients causes the inhibition of root emergence and the root growth (Chen et al., 2003). Analysis of variance (ANOVA) related that there is noticeably impact of Benzoic acid on shoot fresh weight and is maximum than in salinity stress conditions. Statistically highest value of fresh weight of shoot was estimated under Benzoic acid while minimum weight was observed under salinity stress plants. Analysis of variance (ANOVA) present that there is noticeably impact of Benzoic acid on shoot dry weight and is maximum than the in salinity stress condition of maize plants. The maximum dry weight of shoot was measured under Benzoic acid different levels whereas the minimum weight was observed under salinity stress plants. Analysis of variance (ANOVA) revealed that there is noticeably impact of benzoic acid under salinity stress condition on root fresh weight and is minimum under the high salt stress condition. The maximum fresh weight of root under benzoic acid foliar application was observed while under salinity stress condition the minimum fresh weight of root was observed. Analysis of variance (ANOVA) revealed that there is noticeably impact of Benzoic acid on root dry weight and is minimum than the salinity stress conditions.

The maximum root dry weight was observed under Benzoic acid while minimum weight was observed under salinity stress conditions of the maize plants. The reduction in growth biomass in maize induced by salt is in accordance with another study who reported reduction in growth biomass due to salt [16]. Foliar application of benzoic acid has ability to improve the vegetative growth by growing fresh and dry biomass. These results are consistent with the previous studies done by El-Tayeb [17] and Gautam and Singh [18] who reported that in wheat and barley, foliar application of benzoic acid has ability to improve the vegetative growth.

Table 1: Plant height (PH), leaf area (LA), shoot fresh weight (SFW), shoot dry weight (SDW), root frish weight (RFW), root dry weight (RDW) of Maize as affected by exogenous foliar application of benzoic acid (BZA) in salinity stress.

| Treatments | **PH (cm)** | **LA ($cm^2$)** | **SFW (g)** | **SDW (g)** | **RFW (g)** | **RDW** |
|---|---|---|---|---|---|---|
| No. Salinity | 209.72±1.88 ab | 231.89±3.43 b | 253.81±1.98 b | 53.99±0.68 b | 18.32±1.01 c | 5.07±0.011 b |
| No.Salinity+BZA | 213.10±1.26 a | 248.99±1.84 a | 271.44±2.36 a | 59.86±1.12 a | 20.08±0.47 cd | 4.81±0.011 a |
| Salinity stress | 195.78±1.97 d | 195.07±2.46 d | 196.08±2.57 d | 39.09±1.78 d | 15.88±0.78 a | 3.11±0.009 d |
| Salinity stress + BZA | 198.96±2.83 cd | 212.98±1.68 c | 218.02±1.99 c | 47.83±1.51 c | 16.96±1.02 b | 3.83±0.017 c |

The maximum chlorophyll b was observed under control and under the treatment of growth regulator Benzoic acid while minimum chlorophyll b was observed under salinity stress plants. It is clear that the salinity stress has decreased the chlb the maize than the control and Benzoic acid treatment plant. Analysis of variance (ANOVA) is expressed that there is noticeably impact for Benzoic acid on chla+b is maximum than in control and salinity stress. Statistically maximum chlorophyll observed under control while minimum was observed under salinity stress plants.

Table 2: Chlorophyll (a and b) contents of Maize as affected by exogenous application of benzoic acid (BZA) in salinity and normal conditions.

| **Condition** | **Chlorophyll a (mgg$^{1}$N)** | | | **Chlorophyll b (mgg$^{1}$N)** | | |
|---|---|---|---|---|---|---|
| | 6 days | 10 days | 14 days | 6 days | 10 days | 14 days |
| N | 1.59±0.02 a | 1.78±0.03 ab | 2.33±0.04 b | 2.09±0.05 ab | 1.48±0.04 a | 1.77±0.03 b |
| NBZA | 1.72±0.02 a | 1.96±0.05 a | 2.43±0.03 a | 2.18±0.04 a | 1.53±0.03 a | 1.91±0.04 a |
| S | 1.34±0.07 b | 1.64±0.02 c | 1.99±0.06 c | 1.88±0.06 c | 1.31±0.03 b | 1.63±0.04 c |
| SBZA | 1.66±0.02 ab | 1.77±0.02 bc | 2.21±0.03 bc | 1.88±0.03 bc | 1.37±0.01 b | 1.76±0.01 bc |

The foliar application of benzoic acid mitigates the reduction in the chlorophyll contents. Our findings are similar with previous other studies who reported that the reduction in content of chlorophyll is mitigated by foliar application of benzoic acid [19-21].

The phenolic compound salicylic acid and benzoic acid last 20 year remain important compound against stress tolerance of many crop plants which are used to improve the physiological process in plants for example photosynthetic rate, transpiration rate, stomatal conductance and improve the growth and development of plants. The ions uptake from the soil is important factors which are involving the plant metabolism is improved. In these entire factors the photosynthesis is an important physiological compound which is known to be life on earth or backbone of plants is improved by these chemical applied by exogenously to the plants. These chemical becomes the great interest plant scientist due to the systemic acquired resistance (SAR) in plants against different pathogen, which is manifested in the appearance of the many pathogeneses related to protein that is investigated by Gunes et al.[22]. Benavides-Mendoza (2002) stated that the Benzoic acid act as signaling molecules against salinity stress tolerance. The stress can tolerate by signaling way. BA is effective in low concentration (less than 1mM)[23]. Through foliar application BA tolerate the salinity stress in cabbage and tomato plant. (Talaat et al. stated that the impact of BA is applied on different areas crops on different concentration by many researchers to point out that the BA can control the harmful effect of different stress[24]. Benzoic acid promotes some physiological process and inhibit many other process, the foliar application of BA at 5-20ml L-1 is affective in growth parameter, increase yield, oil content is increased in (ammivis naga L.).

## IV. CONCLUSION

Our study concludes that the growth of maize is inhibited by the salinity in the medium of growth and by foliar application of benzoic acid; the adverse effects on the growth biomass and contents of chlorophyll were mitigated. Thus, we might conclude that in salt stress, foliar application of benzoic acid had stimulatory effects on maize crop.

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