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Comparative studies on the effect of salinity and drought stress on enzymatic antioxidant defense system of two maize (*Zea mays I.*). varieties

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Soil salinization and drought are serious threat to crop productivity and predicted to increase in face of global climate change. Studies have shown that as much as the 12 billion US dollar will be lost globally each year, due to the reduction in agricultural production from drought and salt-affected areas. Maize is an economically important cereal crop affected by high salinity and drought stress, maize seedling was subjected to 50 mM, 100 mM and 150 mM NaCl and 4, 6 and 8 days to emulate high soil salinity and drought stress. Root and mature leaves were harvested after 21 days of sowing. High salinity induced oxidative stress in the root and mature leaves. The root and matured leaves showed increased malondialdehyde (MDA) and the hydrogen peroxide (H_2O_2) concentration at 50, 100 and 150 mM NaCl and 4, 6, and 8 days of drought strss. Activities of enzymatic antioxidants, Catylase (CAT, E .C 1.11.1.6) increase in all organs of salt treated maize seedling, while superoxide dismutase (SOD, 1.15.1.1) and peroxidase (POX, E.C. 1.11.1.7) increased specifically in mature leaves. This indicates a possible role of reactive oxygen species (ROS) in the systemic signaling from roots to leaves, allowing leaves to activate their defense mechanism for better protection against salt and drought stress.

Keywords: Maize, salinity, Oxidative stress, Antioxidant.

1. Introduction

Maize (*Zea mays* L.) is one of the most important cereal grains grown worldwide in a wider range of environments because of its greater adaptability (Kogbe and Adediran, 2003). Maize is a good source of carbohydrate, vitamins, minerals and dietary fiber (Allen and Ort, 2001). It is mainly used as a food source and has become the most important raw material for animal feed (Pooja and Rajesh, 2015). Maize is glycophytes species and generally show limited growth and development due to soil salinity (Ashraf and Harris, 2004). It is an economically important cereal crop and its production is affected by soil salinity in various part of the world (Konopka *et al.,* 2009).

Salinity is defined as the presence of an excessive concentration of salt in the soil which suppresses plant growth and productivity (Zaki, 2011). Salinity stress induces a multitude of responses in plants including morphological, physiological, biochemical and molecular changes (Ambede *et al*., 2012). It causes ionic imbalance, which results in ionic toxicity, osmotic stress, and generation of reactive oxygen species (Chaparzadeh *et al*., 2004). One of the biochemical changes occurring in plant subjected to environmental stress condition is the production of reactive oxygen species (ROS) (Munne-Bosch, 2005). ROS attack protein, nucleic acids and lipid, and the degrees of damage depend on the balance between formations of reactive oxygen species (Vranova *et al.,* 2002).

Drought is one of the most important abiotic stresses that severely reduce crop productivity. Drought stress damage the thylakoid membrane, disturb its functions, and ultimately decrease photosynthesis and crop yield (Huseynova *et al.,* 2007). The reduction of the photosynthetic activity under drought stress can be ascribed to both stomatal and non-stomatal factors. Drought is sold factors which affect agricultural crops more than any other stress and is becoming more severe in different regions of the world (Passioura, 2007). Changes in plant productivity due to changes in gas exchange, especially

photosynthetic rate, have received much attention worldwide. The ability of crop plants to acclimate to different environments is directly or indirectly linked with their ability to acclimate at the level of photosynthesis (Chandra, 2003).

The ability of plants to cope with salinity and drought stress is an important determinant of crop distribution and productivity in many areas, so it is important to understand the mechanisms that confer tolerance to saline environment (Gilbert *et al*., 1998). High salinity induces the formation of reactive oxygen species within plant cells, to scavenge high reactive oxygen species levels; an efficient system of non-enzymatic and enzymatic antioxidant is involved (Apel and Hirt, 2004). Non-enzymatic antioxidants include phenolics, flavonoids, tocopherols, ascobate and glutathione (Munne-Bosch, 2005; Rai *et al*., 2013). Enzymatic antioxidant include superoxide dismutase (SOD), preoxidase (POX), catalase (CAT), ascorbate peroxidase (APX) and glutathione reductase (GR) that detoxify reactive oxygen species (Gill and Tuteja, 2010). Antioxidants could be used as potential growth regulator to improve salinity stress resistance in several plant species (Gunes *et al*., 2007). These Antioxidant enzymes are very good biochemical makers of stress and their increased activity attest to potential for remediation (Vangronsveld and Clijstrs, 1994).

Different organs and/or leaf tissues of different developmental stages may respond differently to salinity stress and trigger specific defence mechanisms, Roots are the first organs to encounter salinity stress and show greater reduction in growth than shoots (Lazof and Bernstein, 1999). Moreover, some developmental stages, including germination, young leaves, and matured leaves are more sensitive to salt stress, and therefore the effects of high salinity depend on the developmental stages (Houle *et al*., 2001). However, differences in oxidative stress and antioxidant defenses, in different organs and developmental stages of plant species are much less studied, therefore The aim of this study was carried out to evaluate the effect of salinity stress on the antioxidant defense responses of roots, mature leaves, and young leaves of maize cultivars (Oba super 2 16-11-kd-155-159 and Sammaz 37) cultivated at various NaCl concentration.

2. Materials and Methods

2.1 Sample Collection and Treatment

The two varieties of maize seeds (Oba super 2 16-11-kd-155-159 and sammaz-37) were obtained from Sokoto Agricultural Development Project (SADP), Sokoto State, Nigeria. The seed were sown into sandy soil (85.9 % sand, pH 6.34) the soil initially contained 0.64 % carbon, 0.060 kg nitrate-nitrogen, 0.3 9 kg sodium, 0.82 kg potassium, 5.8 kg cation exchange capacity, 0.45 kg calcium and 0.50 kg magnesium. Germination was carried out in the Botanical Garden of the Department of Biological Sciences, Sokoto State University, Sokoto. Salinity irrigation water treatments were applied as sodium chloride (NaCl) solution at the following levels (0.00, 50, 100 and 150 mM). Plants were irrigated daily with different NaCl concentration. Each treatment was replicated three times. Roots, mature leaf and young leaf were harvested after 21 days of treatment and samples were immediately taken for analysis.

2.2 Enzyme Assay

0.5 g of each fresh tissue (young leaves, matured leaves and roots) harvested from the 21 days old salt-treated and non-treated maize seedling were washed and homogenized with a motar and pestle in a 3 ml ice-cold and 100 mM potassium phosphate buffer pH 7.6 containing 0.1 mM EDTA for 5 min. After filtration, the homogenate was centrifuged at 3000 rpm for 15 min and the supernatant was used for the determination of various antioxidant enzymes.

2.3 Determination of Enzymatic Antioxidants

2.3.1 Catalase (CAT)

Activity of catalase was determined according to the method of Aebi (1984). Catalase activity was determined by adding crude enzyme preparation to 1 ml of potassium phosphate buffer (pH 7.0), 0.1 ml of H_2O_2 and 0.1 M EDTA. This was allowed to incubate for 3 min, after which it was mixed by inversion and absorbance was measured at 240 nm.

2.3.2 Superoxide dismutase (SOD)

SOD was assayed according to the method of Velikova *et al.* (2000). SOD activity of roots, young leaves and matured leaves tissues was determined by adding 0.2 ml of the enzyme extract to 1 ml of potassium phosphate buffer (pH 7.0) and 0.83 ml distilled water in a test tube. The mixture was incubated at 25 ^{o}C for 10 min. 0.02 ml of pyrogallol was also added to the mixture and then transferred into a cuvette; change in absorbance was read using spectrophotometer at 420 nm after 3 min.

2.3.3. Peroxidase (POX)

Activity of peroxidase was determined according to the method of Kar and Mishra, (1976).
Peroxidase activity of roots, young leaves and matured leaves tissues of maize was determined

by adding 1 ml of the enzyme extract to 2.40 ml of 0.1 M potassium phosphate buffer pH 6.3, 0.30 ml of pyrogallol and 0.2 ml hydrogen peroxide all in a test tube. The mixture was incubated for 5 min of 25 ^{o}C. The amount of purpurogallin formed was determined by measuring the absorbance using spectrophotometer at 420 nm.

2.4 Determination of Lipid Peroxidation Marker

2.4.1 Malondialdehyde (MDA)

MDA was determined using the method of Hodges *et al.* (1999). 0.5 g each of fresh roots, young leaves and matured leave were homogenized in 1 % metaphosphoric acid and then incubated at room temperature for 30 min. 1 ml of 10 % trichloroacetic acid (TCA) was added and centrifuged at 2000 rpm for 15 min and the supernatant was used for the assay.

1 ml of the supernatant was mixed with 1 ml of 5 % thiobarbituric acid (TBA) in the test tubes, followed by addition of equal volume of 40% trichloroacetic acid. The mixture was placed in boiling water for 30 min at 95 ^{o}C. The samples were allowed to cool at room temperature and then the absorbance was measured using spectrophotometer at 532 nm.

2.5 Hydrogen Peroxide (H_2O_2)

Hydrogen peroxide content was estimated according to the method of Velikova *et al*. (2000). 0.5 g fresh tissues of roots, matured leafs and young leafs were homogenized in 5 ml of 0.1% (w/v) trichloroacetic acid (TCA) in an ice bath. The homogenate was centrifuged at 3000 rpm for 15 min. Then 0.5 ml of the supernatant was made up to 1 ml with 10 mM potassium Phosphate buffer (pH 7.0) to which 1 ml of 1M KI was added. The absorbance was measured using spectrophotometer at 390 nm.

2.6 Statistical Analysis

Statistical analysis was carried out using the Instat software. Parameters were analysed statistically by one-way analysis of variance (ANOVA). Results were presented as Means ± SEM and significant difference between means ($p<0.05$) was established using the Duncan multiple range test.

3. Results and Discussion

3.1 Results

3.1.1 Catalase Activity

Table 1 show that salinity stress resulted an increase in catalase activity in the root and matured leaves of Oba super 2 varieties in each of the treatment (50, 100 and150 mM NaCl), only at 50 mM in the root, decrease in CAT activity was observed but the decrease, however, is not statistically significant. CAT activity in sammaz 37 exhibited significant increase at ($P<0.05$) with increasing salinity levels up to (150mM NaCl) in the root and matured leaves.

CAT activity of the two varieties showed significant increase at ($P<0.05$) in the entire drought treatment regime when compared to the control.

3.1.2 SOD Activity

In the roots of Oba super 2 variety SOD activity decreased significantly at 50, 100 and 150 mM NaCl when compare to control (Table 2). Salinity stress increases SOD activity in matured leaves at all salt when comparedto the control. In the sammaz 37 variety, SOD activity in the root remained unaffected at 50 mM NaCl, but Declined at 100 and 150 mM NaCl respectively. In mature leaves SOD activity only increased at 150 mM NaCl.

3.1.3 Peroxidase Activity

Table 3 shows a concentration-dependent decrease in oba super 2 peroxidase activity in the root. POX activity in matured leaves of oba super 2 show a concentration-dependent decreased up to 100 mM NaCl and increased at 150 mM NaCl. In sammaz 37 variety root POX activity decreased when compared to control. in the matured leaves POX activity increased at 50 mM NaCl.

3.1.4 Hydrogen peroxide levels.

Increase in salinity stress resulted a significant increase in hydrogen peroxide (H_2O_2) content in roots at 50 mM NaCl of Oba super 2. In sammaz 37 variety significant increase in hydrogen peroxide content was observed only at 50 mM NaCl in matured leaves (Table 4)

3.1.5 Malondialdehyde (MDA) levels.

MDA increased significantly ($p<0.05$) in root and mature leaves. The effect of salt stress was observed at highest concentration (100 and 150 mM NaCl) in roots and matured leaves of both the two varieties investigated.

Table 1: Catalase Activity (unit/ml) of two varieties of maize exposed to different concentrations of NaCl for 21 days and the same level of different days of drought stress.

Salinity Stress marker		OBA SUPER 2		SAMMAZ 37	
	Nacl (mM)	**Root**	**Matured Leaves**	**Root**	**Mature Leaves**
Catalase (unit/ml)	**0**	4926.6 ± 2.000^{b}	4800.0 ± 50.000^{c}	3049.0 ± 87.100^{c}	4850.0 ± 50.005^{c}
	50	3993.0 ± 159.001^{a}	5202.4 ± 273.800^{b}	4723.2 ± 205.370^{b}	5800.0 ± 50.003^{b}
	100	4928.6 ± 0.000^{b}	5202.4 ± 273.000^{b}	4723.2 ± 205.370^{b}	5812.0 ± 48.000^{b}
	150	8625.0 ± 0.000^{c}	6516.7 ± 383.333^{a}	5756.0 ± 6.001^{a}	6900.0 ± 0.667^{a}
Drought stress markers					
	0 days	2925.5 ± 120.015^{c}	3517.0 ± 212.002^{c}	1432.4 ± 60.002^{c}	2927.7 ± 4.015^{d}
Catalase	**4 days**	3049.0 ± 87.213^{c}	4801.3 ± 50.015^{b}	2049.4 ± 88.025^{b}	3882 ± 143.005^{c}
(unit/ml)	**6 days**	4928.0 ± 0.002^{b}	5124.0 ± 223.005^{a}	2927.6 ± 4.015^{b}	4840 ± 50.004^{b}
	8 days	6202.1 ± 0.001^{a}	5323.1 ± 271.334^{a}	3994.1 ± 143.010^{a}	5812.0 ± 48.002^{a}

Values are expressed as mean ± SEM of three replicates. Significant difference between the means was determined using Duncan's test at ($p < 0.05$), mean in the column followed by the same letter (s) are not significantly difference at 5% level.

Table 2: Superoxide Dismutase SOD Activity (unit/ml) of two varieties of maize exposed to different concentrations of NaCl for 21 days and the same level of different days of drought stress.

Salinity Stress marker		OBA SUPER 2		SAMMAZ 37	
	Nacl (mM)	**Root**	**Matured Leaves**	**Root**	**Mature Leaves**
SOD (unit/ml)	**0**	89.233 ± 0.667^{a}	4.823 ± 0.047^{d}	89.232 ± 0.667^{a}	14.640 ± 0.021^{b}
	50	4.069 ± 0.033^{b}	22.447 ± 0.023^{c}	89.232 ± 0.667^{a}	12.407 ± 0.067^{b}
	100	2.453 ± 0.098^{c}	44.413 ± 0.018^{b}	44,430 ± 0.012^{b}	14.640 ± 0.022^{b}
	150	4.242 ± 0.033^{b}	89.232 ± 0.660^{a}	30.850 ± 0.250^{c}	89.232 ± 0.667^{a}
Drought stress markers					
	0 days	10.667 ± 2.133^{a}	8.228 ± 0.002^{d}	12.016 ± 3.002^{c}	14.153 ± 0.015^{d}
SOD	**4 days**	4.5000 ± 1.400^{b}	12.523 ± 0.015^{b}	17.092 ± 2.025^{b}	16.456 ± 0.005^{c}
(unit/ml)	**6 days**	3.4000 ± 1.220^{c}	14.740 ± 0.005^{a}	22.37 ± 1.015^{a}	21.642 ± 0.004^{b}
	8 days	2.156 ± 0.861^{c}	15.809 ± 0.004^{a}	20.349 ± 3.010^{a}	34.974 ± 0.002^{a}

Values are expressed as mean ± SEM of three replicates. Significant difference between the means was determined using Duncan's test at ($p < 0.05$), mean in the column followed by the same letter (s) are not significantly difference at 5% level.

Table 3: Peroxidase Activity (unit/ml) of two varieties of maize exposed to different concentrations of NaCl for 21 days and the same level of different days of drought stress.

Salinity Stress marker		OBA SUPER 2		SAMMAZ 37	
	Nacl (mM)	**Root**	**Matured Leaves**	**Root**	**Mature Leaves**
Peroxidase (unit/ml)	**0**	7.557 ± 0.007^{a}	5.875 ± 0.007^{b}	4.827 ± 0.007^{a}	5.063 ± 0.007^{b}
	50	7.110 ± 0.005^{a}	5.010 ± 0.005^{b}	4.193 ± 0.012^{a}	7.733 ± 0.012^{a}
	100	5.420 ± 0.005^{b}	4.320 ± 0.006^{c}	4.307 ± 0.007^{a}	4.333 ± 0.009^{c}
	150	4.507 ± 0.007^{b}	7.390 ± 0.010^{a}	3.920 ± 0.006^{b}	4.207 ± 0.007^{c}
Drought stress markers					
	0 days	6.153 ± 0.015^{a}	5.228 ± 0.002^{a}	7.016 ± 0.002^{a}	6.153 ± 0.015^{a}
Peroxidase	**4 days**	5.569 ± 0.213^{b}	4.523 ± 0.015^{a}	6.920 ± 0.025^{a}	5.456 ± 0.005^{b}
(unit/ml)	**6 days**	4.736 ± 0.002^{b}	4.340 ± 0.005^{a}	6.372 ± 0.015^{a}	5.142 ± 0.004^{b}
	8 days	4.156 ± 0.001^{b}	3.809 ± 0.004^{b}	5.349 ± 0.010^{b}	4.974 ± 0.002^{b}

Values are expressed as mean ± SEM of three replicates. Significant difference between the means was determined using Duncan's test at ($p < 0.05$), mean in the column followed by the same letter (s) are not significantly difference at 5% level.

Table 4: Hydrogen Peroxide Levels (µg/g) of two varieties of maize exposed to different concentrations of NaCl for 21 days and the same level of different days of drought stress.

Salinity Stress marker		OBA SUPER 2		SAMMAZ 37	
	Nacl (mM)	**Root**	**Matured Leaves**	**Root**	**Mature Leaves**
H_2O_2 (µg/g)	**0**	0.039 ± 0.000^b	0.088 ± 0.001^a	0.037 ± 0.000^c	0.038 ± 0.005^c
	50	0.038 ± 0.001^b	0.033 ± 0.000^c	0.038 ± 0.003^b	0.044 ± 0.003^b
	100	0.038 ± 0.001^b	0.062 ± 0.001^b	0.039 ± 0.000^b	0.051 ± 0.002^a
	150	0.042 ± 0.001^a	0.074 ± 0.001^b	0.045 ± 0.001^a	0.056 ± 0.001^a
Drought stress markers					
	0 days	0.049 ± 0.005^b	0.089 ± 0.002^a	0.039 ± 0.002^c	0.044 ± 0.003^c
H_2O_2 (µg/g)	**4 days**	0.052 ± 0.003^a	0.074 ± 0.005^b	0.042 ± 0.001^b	0.049 ± 0.005^b
	6 days	0.054 ± 0.002^a	0.070 ± 0.005^b	0.046 ± 0.005^b	0.052 ± 0.004^b
	8 days	0.055 ± 0.001^a	0.062 ± 0.004^c	0.051 ± 0.002^a	0.060 ± 0.002^a

Values are expressed as mean ± SEM of three replicates. Significant difference between the means was determined using Duncan's test at ($p < 0.05$), mean in the column followed by the same letter (s) are not significantly difference at 5% level.

Table 5: Malondialdehyde Levels (µg/g) of two varieties of maize exposed to different concentrations of NaCl for 21 days and the same level of different days of drought stress.

Salinity Stress marker		OBA SUPER 2		SAMMAZ 37	
	Nacl (mM)	**Root**	**Matured Leaves**	**Root**	**Mature Leaves**
MDA (µg/g)	**0**	0.153 ± 0.015^d	0.228 ± 0.002^d	0.016 ± 0.002^c	0.153 ± 0.015^c
	50	0.569 ± 0.213^c	0.523 ± 0.015^c	0.092 ± 0.025^c	0.456 ± 0.005^b
	100	0.736 ± 0.002^b	0.740 ± 0.005^b	0.370 ± 0.015^b	0.642 ± 0.004^b
	150	1.156 ± 0.001^a	1.809 ± 0.004^a	1.349 ± 0.010^a	0.974 ± 0.002^a
Drought stress markers					
	0 days	0.253 ± 0.015^d	0.428 ± 0.002^d	0.026 ± 0.002^c	0.253 ± 0.015^d
MDA (µg/g)	**4 days**	0.669 ± 0.213^c	0.723 ± 0.015^c	0.102 ± 0.025^c	0.443 ± 0.005^c
	6 days	0.836 ± 0.002^b	0.940 ± 0.005^b	0.527 ± 0.015^b	0.634 ± 0.004^b
	8 days	1.256 ± 0.001^a	2.009 ± 0.004^a	1.649 ± 0.010^a	0.962 ± 0.002^a

Values are expressed as mean ± SEM of three replicates. Significant difference between the means was determined using Duncan's test at ($p < 0.05$), mean in the column followed by the same letter (s) are not significantly difference at 5% level.

3.2 Discussion

Adverse effects of Salinity in plants include reduction in overall growth and productivity due to perturbation of various physiological and biochemical parameters, conveniently, a number of such parameters have saved as markers of stress response, as well as, indicators of the severity of stress. To contribute to our understanding of the mechanisms underlying salinity stress responses, maize seedlings were exposed to three different salinity levels (50, 100 and 150 mM), and investigate responses in roots, mature leaves (M.L) and young leaves (Y.L). Salinity tolerance is an important trait for plants such as maize that grow in arid and semi-arid areas where water has high concentrations of salts (Yaish and Kumar, 2015). Plant species and cultivars vary in their ability to tolerate salinity, due to changes in their genetic and epigenetic makeup which took a long time to evolve (Yaish, 2017). Tolerance may involve a single mechanism or several mechanisms, such as the ability to avoid salts in the soil, the ability to compartmentalize Na^+ ions among different tissues and cells, or the ability to deal with the consequences of excessive amounts of salt in cells by producing additional quantities of antioxidants (Munns and Tester, 2008). This study focused on the role of antioxidants in salt tolerance in two varieties of maize. The salt tolerance in (Oba super 2 16-11-kd-155-159 and sammaz-37) may also involve a high activity of SOD, CAT and POX when the seedlings are exposed to salinity.

3.2.1 Malondialdehyde and Hydrogen peroxide

Salinity has been reported to induce oxidative stress in different plants and tissues (Ashraf and Harris, 2004; Chawla *et al.,* 2013). Under salinity Stress, the levels of ROS increases in the plant tissues as a result of irregularities in the electron transport chain and accumulation of photo

reducing power. One of the early changes in plants physiology and metabolism during abiotic stresses such as salinity is the production of reactive oxygen species (ROS) which include O_2^-, H_2O_2, and $OH.^-$ Among these, H_2O_2 appears to be one of the earliest stress signalling factor, and a stable ROS intermediate (Gill and Tujeta, 2010). This study was shows increased in MDA and hydrogen peroxide (H_2O_2) in root, mature leaves and young leave of both the two varieties. Tatar and Gevrek (2008) have also reported high MDA content with increase in the degree of salt stress in wheat. However, another result reported by Weisany *et al,* (2012) showed an increase in MDA and H_2O_2 levels in soybeans.

3.2.2 Superoxide dismutase

SOD plays central role in defense against oxidative stress, it is the most effective intracellular enzymatic antioxidant because it catalyse the dismutation of superoxide to molecular oxygen and hydrogen peroxide (Racchi *et al.,* 2001). SOD activity has been reported to increase in plants exposed to various environmental stresses, including salinity (Sharma and Dubey, 2005). Increased SOD activity indicate tolerance of the plant against environmental stresses (Noctor and Foyer, 2008). In this study, salt stress resulted an increased in SOD activity in mature leave of both the two varieties (Oba super and sammaz 37) which is similar with the findings of Chawla *et al.* (2013) in their study reported increased SOD levels in leaves of tolerant rice cultivar under salinity. The result of the present study also showed decrease in SOD activity in root and young leaf of Oba super and sammaz 37 variety with respect to the control which is similar to the result of chorianopoulou *et al,* (2012) had also reported decrease in SOD activity in root and leaf sheaths of maize under salinity stress.

3.2.3 Catalase

catalase catalyzes the dismutation of H_2O_2 into water and oxygen (Corpas *et al.,* 2008). It has been reported that environmental stresses cause enhancement of CAT activity. In this study, an increase in CAT activity under salinity stress was observed in the roots, young and mature leave of both the two variety. CAT has been reported by (Gao *et al.,* 2008) to be a major enzymatic antioxidant in radicles of *Jatropha curcas* L. challenged with salinity, especially under moderate salinity levels of 50 to 100 mM NaCl, compared to *hypocotyls and cotyledons*. Similarly, Chaparzadeh *et al.* (2004) showed increased CAT activity in leaves of *Calendula officinalis* under NaCl concentrations.

3.2.4 Peroxidase

POX are large group of enzymatic antioxidant which play a role in various biological processes. They are named after the fact the commonly break up peroxide (Atamna, 2006). Results of the present study reveal overall decrease in POX activity in response to salinity stress which is similar to the report of Chaparzadeh *et al.,* (2004) in their study revealed that POX activity did not increase in either leaves or roots of *Calendula officinalis* under salinity stress.

4. Conclusion

This study revealed that the antioxidants system invoked by root, mature leaves and young leaves of Oba super 2 and sammaz 37 maize seedlings under salt and drought stress comprise of enzymatic (CAT, SOD and POX). Thes e biochemical events thus make the maize seedling tolerant to salinity up to 150 mM and drought stress up to 6 days.

Conflict of Interest

The author declares that there is no conflict of interest.

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