



Study on Exogenous Application of Organics for Alleviating Salt Stress in Sorghum Crop

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Abiotic stresses soil salinity is one of the major restricting the use of land for agriculture because it limits the crop growth and development. In these stressful conditions, improving productivity is important challenge because salinity has different effects on crop growth and developmental stages in different crops. Exogenous application of proline, humic acid and ascorbic acid has improved salt stress tolerance in various plant species. An experiment was conducted in farmer's field at Raparla village, Battiprolu mandal during spring season, 2018 and 2019 to evaluate the effect of exogenous application of organics for alleviating salt stress on sorghum crop. The experiment was conducted in randomized block design with five treatments which replicated four times. Five treatments in this study were applied as follows: (T1) control *i.e* farmer's practice; (T2) proline application at 0.6 g/L; (T3) ascorbic acid application at 0.2 g/L; (T4) humic acid application at 2 g/L; (T5) Combination of T1, T2, T3 and T4. The Results showed that all treatments (T2, T3 T4 and T5) effected on the yield characteristic and yield (kg/ha). The highest yield attributes and yield of sorghum crop (3460 and 3240 kg/ha) was significantly recorded by T5 (the combined application of proline + ascorbic acid + humic acid) followed by T2 (alone proline application).

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1. INTRODUCTION

Salinity is a major abiotic stress that severely affects on crop growth and development from seed germination to harvest. Total land more than 20% of agricultural land is affected by salinity, which is expanding day by day and already affects almost 954 million hectares of the world's total land area and salinity affected areas increasing at an annual rate of 1–2% [1]. It is predicted that more than 50% of arable land will be rendered unproductive by 2050 due to increase the salt stress in different crops. This trend affects the global food security, so it is even more urgent to be able to exploit more arable land and increase crop productivity by developing efficient and tolerant salt stress mechanism in crops and growing salt tolerant crops saline conditions [2]. Sodium chloride (NaCl) stress is one of the typical salt stresses that have tremendous harmful effects on crop growth by osmotic stress and/or specific ion toxicities in all crop growth stages. Salinity is known to generate oxidative stress in plants by the extreme production of reactive oxygen species (ROS) including superoxide radical (O_2^-), hydroxyl radical (OH^-), hydrogen peroxide (H_2O_2), and singlet oxygen (O^-), is characteristic of the biochemical changes during abiotic stresses.

Sorghum is fifth most important cereal crop of the world and third most important staple food crop in India for millions of people after rice and wheat. The uses of sorghum include such as human food, feed (grain and biomass), fermentation (methane production), fertilizer (utilization of organic byproducts), and fuel (ethanol). In semi-arid regions it is also considered as main source of minerals, vitamins and protein for millions people. The increased demands for sorghum cultivation in semi arid regions [3] are extensively in saline soils. Sorghum is known to be relatively more tolerant to soil salinity than maize reported by Krishnamurthy et al. [4].

Application of organic amendments for salt-affected lands is considering as one of the most effective way to alleviate salt stress. Exogenous application of plant growth regulators, fertilizers, and non-enzymatic antioxidants has been successfully used to minimize the adverse effects of salinity on plant growth, development and yield. In saline condition proline is the most

common endogenous osmolyte accumulated under salinity stress [5]. Ascorbic acid is one of the essential plant growth regulators and considered as an effective tool to mitigate damage in plant stress. More over ascorbic acid act as regulates physiological and biochemical processes and defenses mechanisms of crops. It can regulate plant responses against biotic stresses by improving early seedling growth and plant development. Most efficient role of exogenously applied ascorbic acid is to protect lipids and proteins against salinity induced oxidative adversaries [6]. It can improve tolerance against abiotic stresses by enhancing plant growth, rate of photosynthesis, transpiration and oxidative defense potential and photosynthetic pigments. Hence the present study was initiated to examine the effect of exogenous application of organics on growth and yield of sorghum under salinity stress.

2. MATERIALS AND METHODS

A field experiment was carried in farmer's fields at Raparla village in Bhattiprolu mandal during spring season, 2018 and 2019. The farmers using brackish water; having water salinity of 19.0 (dSm^{-1}) for life saving irrigation of sorghum crop. The soil has a pH of 9.6 and EC of 19.6 dSm^{-1} initially. The experiment was carried in randomized block design with five treatments in four replications. The treatments were T1-control i.e farmer's practice (without exogenous application), T2-proline application at 0.6 g/L, T3-ascorbic acid application at 0.2 g/L, T4-humic acid application at 2 g/L and T5-proline at 0.6 g/L+ ascorbic acid at 0.2 g/L+ humic acid at 2 g/L. As per the treatments foliar application of organic amendments were applied to the crop. 80 kg nitrogen was applied through urea, 40 kg phosphorus was applied through single super phosphate and 40 kg potassium was applied through murate of potash/ha, respectively. 40 kg nitrogen+ 40 kg phosphorus and 40 kg potassium was applied at sowing and remaining 40 kg nitrogen was applied at 30 days after sowing. Atrazine @ 0.5 kg a.i/ha was applied as a pre-emergence herbicide on 3rd day after sowing. During the crop growth period all the recommended plant protection package of practices were followed to the sorghum crop. Pre and post harvest data was collected. The data recorded were analysed following standard statistical analysis of variance procedure.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

Data revealed that sorghum crop plant height was significantly affected by different treatments. Application of proline+ humic acid +ascorbic acid treatment recorded significantly maximum plant height (111 and 118cm) which was on par with proline alone treatment and significantly superior to rest of all the treatments. The lowest plant height was noticed with farmer's practice (85 and 108). [7] reported that exogenous proline application significantly increased plant height and number of roots in salt stressed condition in rice crop. In salt-stress condition foliar application of proline increased plant growth and yield attributing characters in maize crop [8].

3.2 Panicle Length (cm)

Panicle length was significantly affected by exogenous application of organics. Significantly, the maximum panicle length was recorded with T5 treatment (22.8 and 23.5 cm) which was statistically on par with T2 and T3 treatments and significantly superior to T4 treatment and farmer's practice (19.2 and 21.3 cm). Exogenous proline application affected the plant growth and development under salt stress condition and increase the biomass and productivity of the crop [9].

3.3 Test Weight (g)

Among the treatments there is a significant difference was observed in test weight in

sorghum crop. The maximum test weight (27.2 and 26.6 g) was noticed with T5 treatment whereas, the lowest test weight (25.8 and 25.2 g) was observed in T₁ (Farmer's practice) which was on par with T2 and T3 treatments. In maize crop foliar application of proline increased the number of seeds per plant, total grain weight and the 100-grain weight in salt stress situation [8].

3.4 Grain Yield (kg/ha)

Significant differences were noticed among different sources of organics applied to the sorghum crop in salt stress condition. In sorghum crop the T5 treatment *i.e.* proline+ humic acid + ascorbic acid treatment recorded the maximum grain yield (3460 and 3240 kg/ha) which was followed by proline alone application treatment (3380 and 3180 kg/ha). Under high-salt conditions, proline application enhances plant growth with increases in seed germination, biomass, photosynthesis, gas exchange and grain yield. These positive effects are mainly driven by better nutrient acquisition, water uptake and biological nitrogen fixation. Exogenous proline also alleviates salt stress by improving antioxidant activities and reducing Na⁺ and Cl⁻ uptake and translocation while enhancing K⁺ assimilation by plants. Exogenous proline increased fresh and dry biomasses, grain yield and 1000 grain weight of salt-stressed in wheat crop [10]. However the lowest grain yield was recorded with farmer's practice *i.e.* in control treatment (2925 and 2870 kg/ha).

Table 1. Effect of organics on growth, yield attributes and yield of sorghum by using saline water irrigation

Treatments	Plant height (cm)		Panicle length (cm)		Test weight (g)		Grain yield (kg/ha)		Stover yield (kg/ha)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
T ₁ -Farmer's practice	85	108	19.2	20.3	25.8	25.2	2925	2870	3856	3820
T ₂ -Proline application (0.6 g L ⁻¹)	108	110	22.5	22.6	27.0	26.5	3380	3180	4670	4230
T ₃ -Ascorbic acid (0.2 g L ⁻¹)	102	107	21.6	21.4	26.4	25.8	3159	3150	4264	4250
T ₄ -Humic acid (2 g L ⁻¹)	98	103	20.9	21.2	26.2	26.2	3071	3070	4053	4010
T ₅ - T ₂ +T ₃ +T ₄	111	118	22.8	23.5	27.2	26.6	3460	3240	4860	4360
SEm (±)	2.9	3.0	0.6	0.7	0.3	0.4	101	99	205	116
CD at 5%	8.8	9.0	1.7	2.1	1.0	1.2	314	297	631	348
CV (%)	5.7	5.3	5.2	6.4	2.4	2.9	6.3	6.4	9.4	5.6

3.5 Stover Yield

The data indicated that significantly the maximum stover yields (4860 and 4360 kg/ha) were recorded with T5 treatment *i.e.* proline+humic acid + ascorbic acid treatment and minimum stover yield (3856 and 3820 kg/ha) was recorded with farmer's practice. In maize crop application of proline increased dry weight of leaves and roots and their soluble protein contents in salt stressed situation [11].

4. CONCLUSION

In this study exogenous application of organics *i.e.* proline, ascorbic acid and humic acid can improve salt tolerance by regulating physiological, biochemical and enzymatic processes and have a positive effect on plant growth, development and productivity under salt stress conditions. The results indicated that application of proline, ascorbic acid and humic acid combination recorded highest yield and yield attributing characters followed by proline alone application.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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