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Purohit Harsh B
Department of Biochemistry and Biotechnology College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Patel Riddhi S
Department of Biochemistry and Biotechnology College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Talavia BP
Directorate of Student's Welfare College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Kandoliya UK
Department of Biochemistry and Biotechnology College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Corresponding Author:
Purohit Harsh B
Department of Biochemistry and Biotechnology College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Effect of gibberellic acid, potassium nitrate and silicic acid on antioxidative enzymes in groundnut (*Arachis hypogaea* L.) seedling irrigated with saline water

Purohit Harsh B, Patel Riddhi S, Talavia BP and Kandoliya UK

Abstract
Salinity is one of the most serious limiting factors for growth and production in groundnut and silicic an important phenolics, gibberellic acid an important growth hormone, potassium nitrate known to alleviates its adverse effect. Thus, Green house experiment was conducted to investigate the effect of gibberellic acid, potassium nitrate and silicic acid under salt stress on physiological, biochemical parameters and enzymatic activities of groundnut. The observations were recorded for enzymes *viz*., polyphenol oxidase, peroxidase and catalase. The result suggested that the antioxidant enzymes activity was affected due to salinity stress in groundnut. The antioxidant enzymes activities *viz.*, polyphenol oxidase, peroxidase and catalase that increased with higher concentration of salt stress. On application of GA_3, KNO_3 and silicic acid decreased polyphenol oxidase, peroxidase and catalase enzymatic activity. This investigation has suggested gibberellic acid, potassium nitrate and silicic acid are potential biomolecules affecting the ROS scavenging enzyme under abiotic stress like salinity.

Keywords: Groundnut (*Arachis hypogaea* L.), gibberellic acid, silicic acid, potassium nitrate and salinity stress

Introduction
Groundnut (*Arachis hypogaea* L.) is an annual prostrate herbaceous leguminous oilseed crop. Groundnut is native of South America (Hammons, 1982) [4]. After cereals, oilseeds are the second largest agricultural commodity sharing 14 per cent of country's gross cropped area and account for nearly 5 per cent of gross national products and 10 per cent of the value of all agricultural products. Soil salinity adversely affects plant growth and development. Worldwide, about one-third of irrigated arable land is already affected and that level is still rising (Lazof and Bernstein, 1999) [8]. Under high salinity stress, reactive oxygen species (ROS) formed and accumulated in plant cells cause severe damage to plants. However, plants equipped with a variety of defense mechanism scavenging ROS formed due to biotic as well as various abiotic stresses. These mechanism includes, accumulation of different osmolites and phenolics compounds, induction of antioxidant and its related enzymatic system etc., (Vakharia *et al*., 1997; Kandoliya and Vakharia, 2013; Kandoliya and Vakharia, 2015 and Joshi *et al*., 2018) [20, 6, 7, 5]. Induced salt tolerance by exogenious application of various chemicals and hormones is a highly attractive approach to overcome the salinity threat (Trivedi *et al*., 2018; Solanki *et al*., 2018 a, b and Patel *et al*., 2019) [19, 17, 18, 14]. Gibberellic acid, growth hormone which enhances the flowering, increases fruit set as well as fruit size. It shows positive responses to increase the shelf life as well as quality parameters of the fruits and vegetables. Potassium enhanced resistance toward the bacterial, viral, nematodes and fungal pathogens (Perrenoud, 1990) [15]. Silicon deposited on the plant surfaces and serves as a protective layer against the biotic and abiotic stress as well as enhances the rate of photosynthesis and yield of the crop (Miyake and Takahashi, 1983) [10].

Materials and Methods
The green house experiment was conducted during kharif 2018-19 at Food testing Laboratory, Department of Biochemistry, Junagadh Agricultural University, Junagadh. Groundnut (*Arachis hypogaea* L.) seeds of varieties GG-20 were obtained from Main Oilseeds Research Station, J.A.U., Junagadh for the experiment.

Treatments

a) Salinity level (2): Plant irrigated with saline water prepared by appropriate dilution of sea water. [S_1- Tap water, S_2- Saline water (4 EC)]

b) Gibberellic acid, Potassium nitrate, Silicic acid (8): T_1- Control (without spray), T_2- Sprayed with GA_3 @ 100 ppm, T_3- Sprayed with KNO_3 @ 500 ppm, T_4- Sprayed with Silicic acid @ 50 ppm, T_5- Sprayed with GA_3 @ 100 ppm + KNO_3 @ 500 ppm, T_6- Sprayed with KNO_3 @ 500 ppm + Silicic acid @ 50 ppm, T_7- Sprayed with GA_3 @ 100 ppm + Silicic acid @ 50 ppm, T_8- Sprayed with GA_3 @ 100 ppm + KNO_3 **@** 500 ppm + Silicic acid @ 50 ppm.

c) Growth stage (2): G_1- 30 DAS, G_2- 50 DAS

Groundnut leaf were collected at different stages (G_1 and G_2) after the spray of gibberellic acid, potassium nitrate and silicic acid the pot irrigated with saline water having a concentration 4 dSm^{-1} and packed in plastic bag and brought to the laboratory under ice cold condition. Leaf tissues were taken for first two stages (G_1 and G_2) at ten day after the gibberellic acid, potassium nitrate and silicic acid spray. The experimental materials were cleaned, weighed and then transferred immediately to the respective medium for various biochemical and physiological analysis.

Enzyme Assay

Polyphenol oxidase (PPO) activity (EC 1.14.18.1)

Leaf tissue weighed 0.1 gm and grind in 5 ml of 100 mM sodium phosphate buffer, pH 6.5. The homogenate was centrifuged at 10,000 rpm for 15 min at 4°C and the supernatant was used for enzyme assay.

The reaction mixture contained 2.9 ml of catechol (10 mM catechol in 10 mM phosphate buffer, pH 6.5) and reaction was initiated by the addition of 100 µl of enzyme extract. The changes in the colour due to the oxidized catechol were read at 490 nm for one minute at an interval of 15 second. Blank was carried out without substrate. The enzyme activity was expressed as $\Delta OD.min.^{-1}g.^{-1}Fr.Wt.$ tissues (Esterbaner *et al*. 1977 and Mori *et al*. 2017) [3, 12].

Peroxidase (POX) activity (EC 1.11.1.7)

Leaf tissue (100 mg) was homogenized in a pre-chilled mortar and pestle with 2 ml of extraction buffer, containing 50 mM sodium phosphate buffer pH 7.0. The homogenates were centrifuged at 10,000 rpm for 15 minutes and the supernatant was used for the assay of antioxidant enzymes *viz*. peroxidase and catalase.

The reaction mixture contained 2.99 ml of 0.03% H_2O_2 in 0.1 M phosphate buffer (pH 6.0) containing 0.01% orthodianisidine dye (freshly prepared, dissolved in methanol). The reaction was initiated by the addition of 10 µl of enzyme extract. The change in color of oxidized dye was read at 460 nm up to 1 minute at the interval of 15 seconds. Blank was run without the addition of enzyme (Malik and Singh, 1980) [9]. The enzyme activity was expressed as $\Delta OD.min.^{-1}g.^{-1}Fr.Wt$**.**

Catalase (EC 1.11.1.6)

Catalase activity was measured immediately in fresh extract and was assayed as described by Aebi (1984) [1]. Three ml reaction mixture contained 50 mM sodium phosphate buffer (pH 7.0), 18 mM H_2O_2 and 50 µl enzyme extract. The hydrogen peroxide dependent oxidation was estimated by measuring the decrease in the absorbance at 240 nm. The enzyme activity was expressed as $\Delta OD.min.^{-1}$ $g.^{-1}$ Fr. Wt.

Results and Discussion

Polyphenol oxidase (PPO) activity (EC 1.14.18.1)

Polyphenol oxidase (PPO, *O*-diphenol: O_2 oxido-reductase) is also known as phenolase, phenol oxidase, catechol oxidase and tyrosine. The enzyme is widely distributed in nature. It is known to be present in soluble forms in cytoplasm or bound to mitochondria, chloroplasts and certain other sub-cellular organelles. The data on enzyme activity of polyphenol oxidase activity ($\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$) analyzed from leaf tissues of groundnut collected from plants treated at 20 DAS and 40 DAS with different concentration of gibberellic acid, potassium nitrate, silicic acid and their combination (T_1 to T_8) grown in a pot irrigated with tape water (S_1) and saline water (S_2) 4 EC at two different stages G_1 (30 DAS) and G_2 (50 DAS) are depicted in Fig. 1.

Mean effect of salinity level irrespective of gibberellic acid, potassium nitrate, silicic acid treatment and their combination and growth stages i.e. before and after spraying of gibberellic acid, potassium nitrate, silicic acid and their treatment combination were found statistical significant for polyphenol oxidase activity (Fig. 1 A). Among the salinity level, treatment S_1 irrigated with tap water showed lowest amount of polyphenol oxidase activity (5.86 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$) while the pot irrigated with saline water 4 EC (S_2) showed highest value for polyphenol oxidase activity (6.45 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$). Among the different stages, mean value of polyphenol oxidase activity significantly varied between 6.48 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$ and 5.84 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$ (Fig. 1 B). The content was decreased from 30 DAS (6.48 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$) to 50 DAS (5.84 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$).

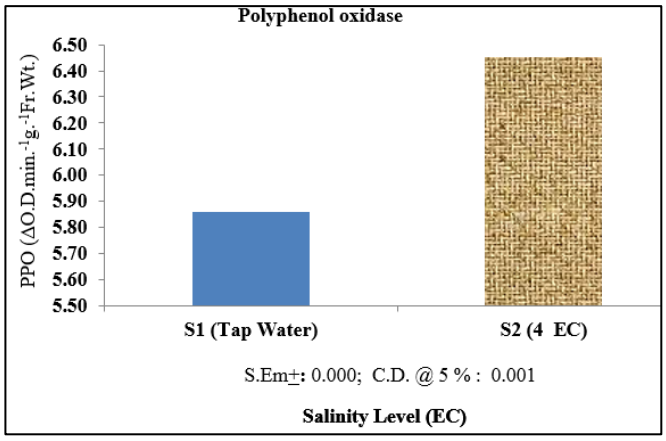
Application of spray treatment of gibberellic acid, potassium nitrate, silicic acid and their combination found statistical significant (Fig. 1 C). Treatment T_8 [GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acid @ 50 ppm] caused marked decrease in polyphenol oxidase activity in groundnut leaf tissues. The tissues obtain from groundnut pots treated with T_8 [GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acid @ 50 ppm] revealed lower amount of mean polyphenol oxidase activity (4.57 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$) and which was followed by T_7 [GA_3 @ 100 ppm + silicic acid @ 50 ppm (5.70 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$)] and T_6 [KNO_3 @ 500 ppm + silicic acid @ 50 ppm (5.79 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$)] irrespective of salinity level and growth stages. The mean highest content was noted for the tissues received from T_1 (7.11 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$).

S X T interaction effect for polyphenol oxidase activity was revealed significant differences in leaf tissues of groundnut (Fig. 2 A). The lowest value of polyphenol oxidase activity content was observed for the S_1T_8 i.e. in plant irrigated with tap water combine with GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acids @ 50 ppm treatment (4.38 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$). The highest value (7.42 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$) of polyphenol oxidase activity was observed in plant irrigated with saline water (4 EC) under control condition (S_2T_1).

Interaction effect of G X T for polyphenol oxidase activity was revealed significant differences in leaf tissues of groundnut (Fig. 2 B). The lowest value of polyphenol oxidase activity was observed in G_2T_8 i.e. in plant treated with GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acid @ 50 ppm after at 50 DAS (4.02 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$). The highest value of polyphenol oxidase activity was observed for G_1T_1 i.e. plant was control condition after 30 DAS (7.50 $\Delta O.D.min.^{-1}g.^{-1}Fr.Wt.$). The observation from interaction effect of S X G for polyphenol oxidase activity was founded significant

differences in leaf tissues of groundnut (Fig. 2 C). The lowest value of polyphenol oxidase activity was observed in S_1G_2 i.e. in plant irrigated with tap water after 50 DAS (5.46 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). The highest value of polyphenol oxidase activity was observed for S_2G_1 (6.69 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.).These results were in agreement with Mohan and Shashidharan (2018) [11] who reported that salinity increase polyphenol oxidase activity in groundnut seedling. Patel *et al.* (2010) [13] also noted that the polyphenol oxidase generated H_2O_2 could also be a component of significantly process for defense against stress condition.

Polyphenol oxidase



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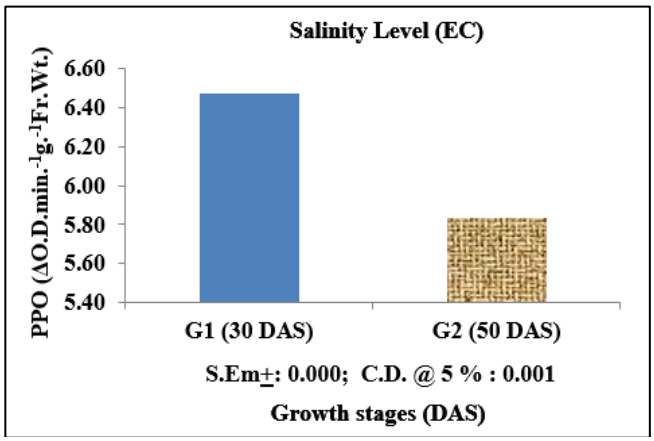

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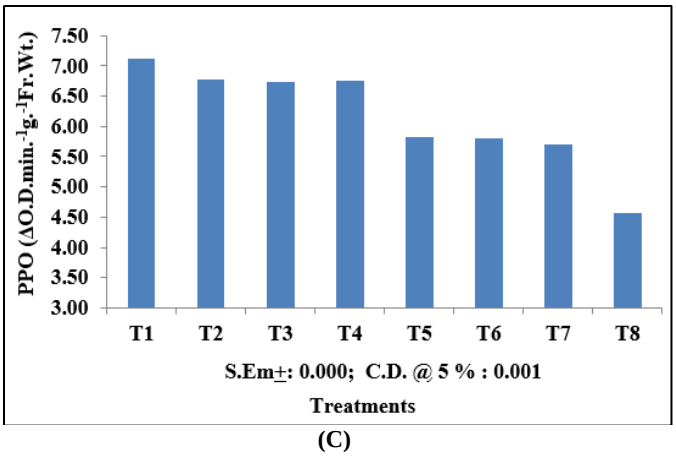
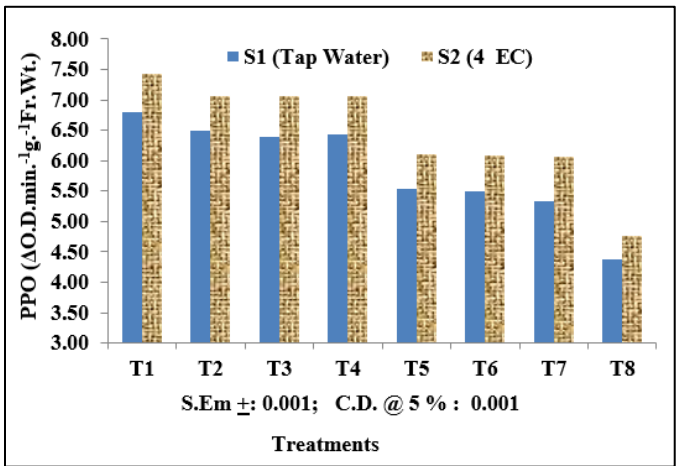


(C)

Fig 1: Mean effect of [A] salinity (S), [B] growth stages (G) and [C] treatments (T) on polyphenol oxidase activity (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) in leaf tissues of groundnut



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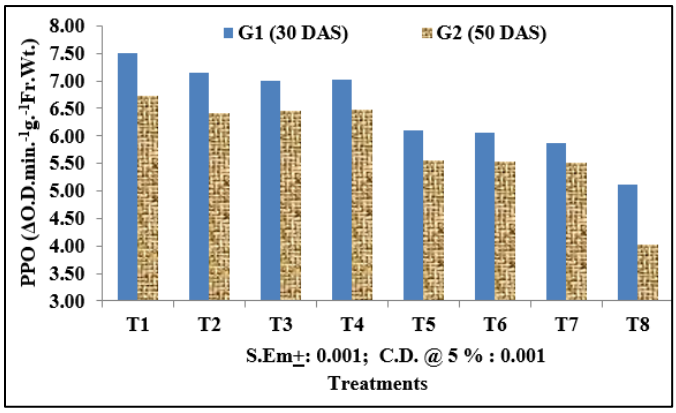

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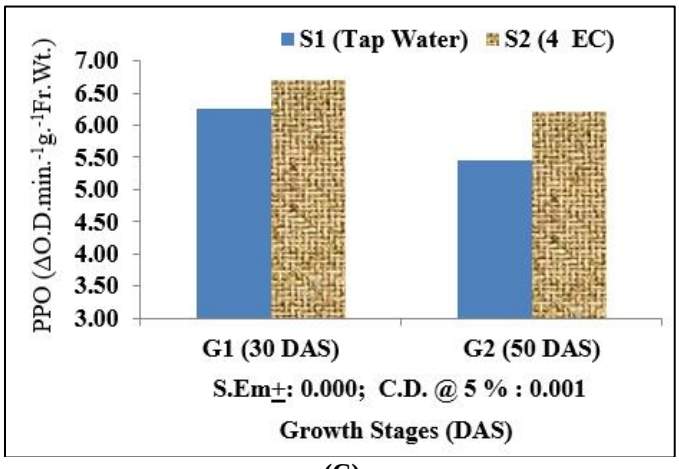


(C)

Fig 2: Interaction effect of [A] salinity (S) X treatments (T), [B] growth stages (G) X treatments (T), [C] salinity (S) X growth stages (G) on polyphenol oxidase activity (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) in leaf tissues of groundnut

Peroxidase (EC 1.11.1.7)

Peroxidase, a group of heme-containing glycosylated protein, was found to play significant role in defense mechanisms in plant against infection with pathogen. The data on enzyme activity of peroxidase activity (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) analyzed from leaf tissues of groundnut collected from plants treated at 20 DAS and 40 DAS with different concentration of gibberellic acid, potassium nitrate, silicic acid and their combination (T_1 to T_8) grown in a pot irrigated with tape water (S_1) and saline water (S_2) 4 EC at two different stages G_1 (30 DAS) and G_2 (50 DAS) are depicted in Fig. 3.

Mean effect of salinity level irrespective of gibberellic acid, potassium nitate, silicic acid treatment and their combination and growth stages i.e. before and after spraying of gibberellic acid, potassium nitrate, silicic acid and their treatment combination were found statistical significant for peroxidase activity (Fig. 3 A).

Among the salinity level, treatment S_1 irrigated with tap water showed lowest amount of peroxidase activity (6.30 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) while the pot irrigated with saline water 4 EC (S_2) showed highest value for peroxidase activity (7.23 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). Trivedi *et al*. (2018) also reported an increased in peroxidase activity under salinity stress in green gram.

Among the different stages, mean value of peroxidase activity significantly varied between 7.14 and 6.38 (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) (Fig. 3 B). The content was decreased from 30 DAS (7.14) to 50 DAS (6.38) (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.).

Differences were found on imposition of spray treatment of gibberellic acid, potassium nitrate, silicic acid and their combination statistical significant (Fig. 3 C). Treatment T_8 [GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acid @ 50 ppm] caused marked increase in peroxidase activity in groundnut leaf tissues. The tissues obtain from groundnut pots treated with T_8 [GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acid @ 50 ppm] revealed higher amount of mean peroxidase activity (7.98 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) and which was followed by T_7 [GA_3 @ 100 ppm + silicic acid @ 50 ppm (7.31 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.)] and T_6 [KNO_3 @ 500 ppm + silicic acid @ 50 ppm (7.37 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.)] irrespective of salinity level and growth stages. The mean lowest content was noted for the tissues received from T_1 (5.22 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.).

S X T interaction effect for peroxidase activity was revealed significant differences in leaf tissue of groundnut (Fig. 4 A). The highest value of peroxidase activity was observed for the S_2T_8 i.e. in plant irrigated with saline water combine with GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acids @ 50 ppm treatment after 50 DAS (8.35 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). The lowest value (4.78 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) of peroxidase activity was observed in plant irrigated with tap water under control condition (S_1T_1).

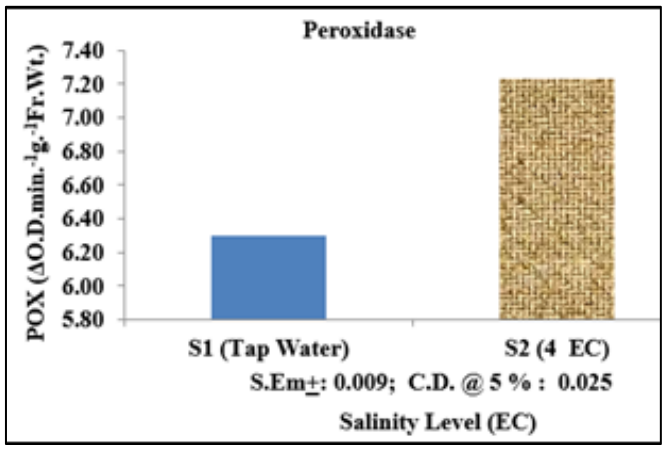
Interaction effect of G X T for peroxidase activity was revealed significant differences in leaf tissue of groundnut (Fig. 4 B). The highest value of peroxidase activity was observed in G_1T_8 i.e. in plant treated with GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acid @ 50 ppm after at 30 DAS (8.33 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). The lowest value of peroxidase activity was observed for G_2T_1 i.e. plant was control condition after 50 DAS (4.87 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.).

Interaction effect of S X G for peroxidase activity was revealed significant differences in leaf tissue of groundnut (Fig. 4 C). The highest value of peroxidase activity was observed in S_2G_1 i.e. in plant irrigated with saline water (4 EC) after 30 DAS (7.69 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). The lowest alue of peroxidase activity was observed for S_1G_2 (5.99 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.).

These results were in agreement with Shinde *et al*. (2017) [16] who reported that salinity increase peroxidase activity in groundnut seedling.

Imposition of abiotic stress significantly reduced relative water content, membrane stability and total carotenoid content in all the cultivars.

Relationship among different physiological parameters showed that the level of oxidative stress, in terms of production of reactive oxygen species, was negatively correlated with activities of different antioxidant enzymes such as catalase and peroxidase (Chakraborty *et al*., 2015) [2].



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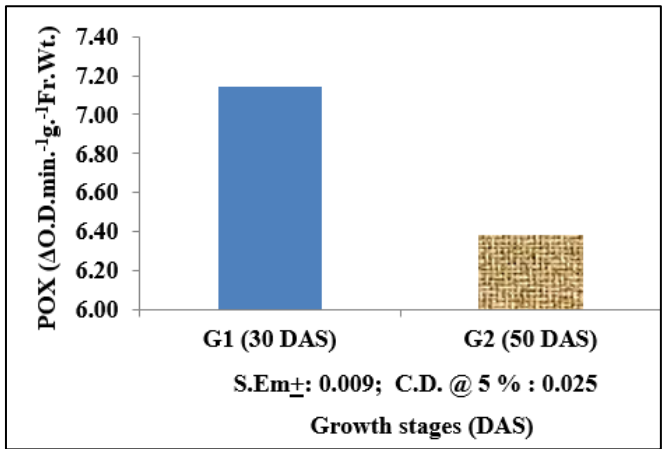

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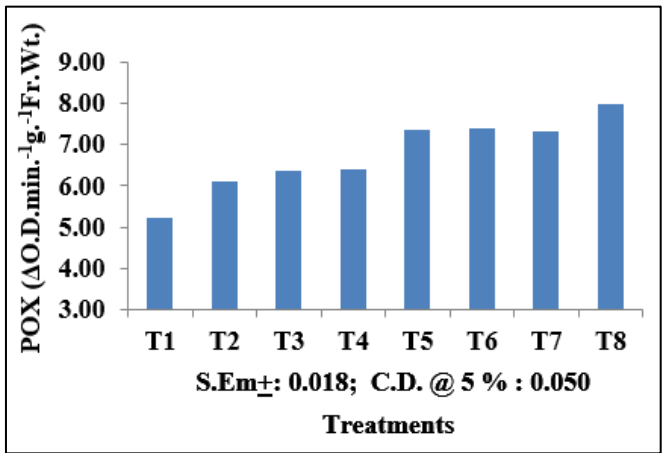
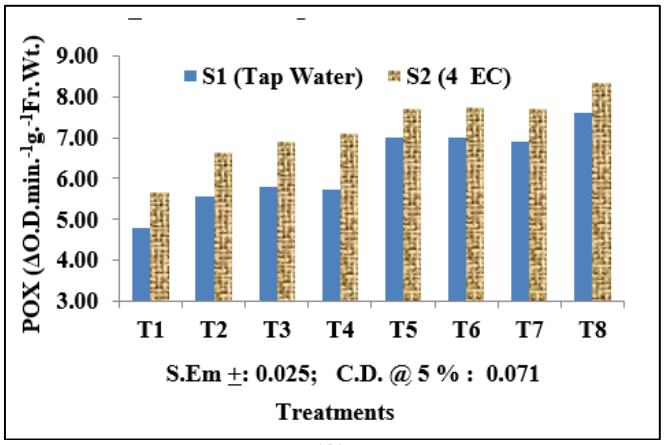


(C)

Fig 3: Mean effect of [A] salinity (S), [B] growth stages (G) and [C] treatments (T) on peroxidase activity (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) in leaf tissues of groundnut.



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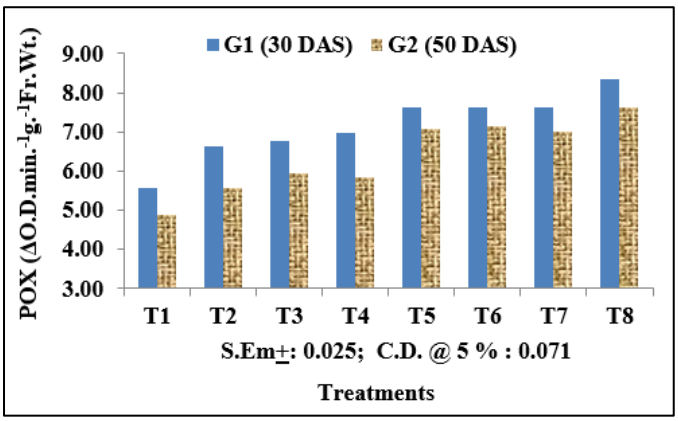

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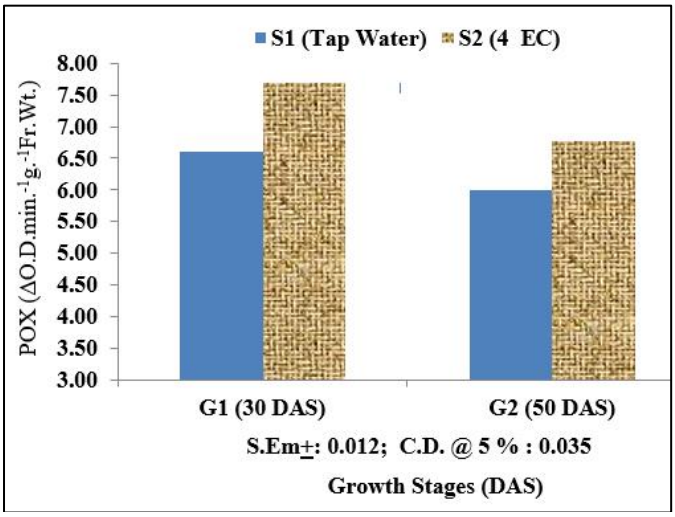


(C)

Fig 4: Interaction effect of [A] salinity (S) X treatments (T), [B] growth stages (G) X treatments (T), [C] salinity (S) X growth stages (G) on peroxidase activity (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) in leaf tissues of groundnut.

Catalase (E.C 1.11.1.6)

One of the main enzymes playing a role in catabolism of hydrogen peroxide is catalase. The catalase is tetrameric heme protein, occurring in almost all aerobic organisms including plants. The data on enzyme activity of catalase activity (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) analyzed from leaf tissues of groundnut collected from plants treated at 20 DAS and 40 DAS with different concentration of gibberellic acid, potassium nitrate, silicic acid and their combination (T_1 to T_8) grown in a pot irrigated with tape water (S_1) and saline water (S_2) 4 EC at two different stages G_1 (30 DAS) and G_2 (50 DAS) are depicted in Fig. 5.

Mean effect of salinity level irrespective of gibberellic acid, potassium nitate, silicic acid treatment and their combination and growth stages i.e. before and after spraying of gibberellic acid, potassium nitrate, silicic acid and their treatment combination were found statistical significant for catalase activity (Fig. 5 A). Among the salinity level, treatment S_1 irrigated with tap water showed lowest amount of catalase activity (3.45 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) while the pot irrigated with saline water 4 EC (S_2) showed highest value for catalase activity (4.06 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). Earlier it was reported that the catalase increase with the increase in the concentration of Nacl.

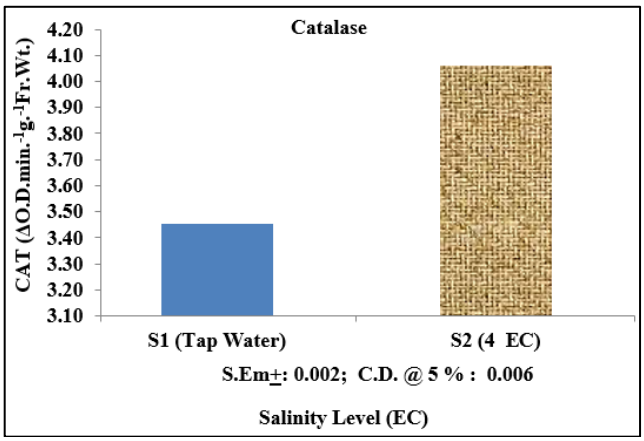
Among the different stages, mean value of catalase activity significantly varied between 4.08 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt. and 3.43 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt. (Fig. 5 B). The content was decreased from 30 DAS (4.08 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) to 50 DAS (3.43 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.).

Mean data on imposition of spray treatment of gibberellic acid, potassium nitrate, silicic acid and their combinations were found statistical significant (Fig. 5 C). Treatment T_8 [GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acid @ 50 ppm] caused marked decrease in catalase activity in groundnut leaf tissues. The tissues obtain from groundnut pots treated with T_8 [GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acid @ 50 ppm] revealed lower amount of mean catalase activity (2.67 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) and which was followed by T_7 [GA_3 @ 100 ppm + silicic acid @ 50 ppm (3.29 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.)] and T_6 [KNO_3 @ 500 ppm + silicic acid @ 50 ppm (3.32 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.)] irrespective of salinity level and growth stages. The mean highest content was noted for the tissues received from T_1 (4.97 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.).

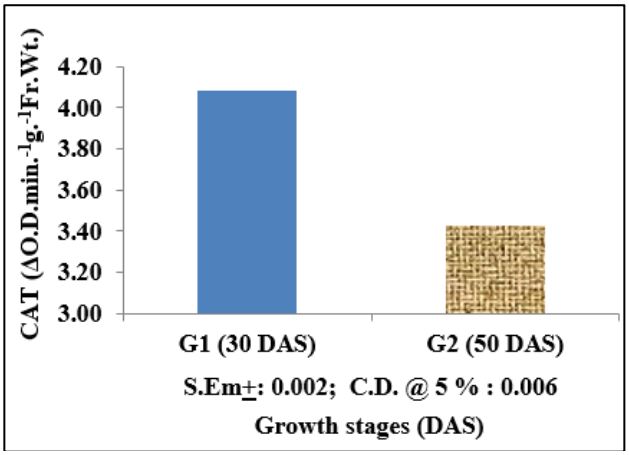
Interaction effect of S X T for catalase activity was revealed significant differences in leaf tissues of groundnut (Fig. 6 A). The lowest value of catalase activity content was observed for the S_1T_8 i.e. in plant irrigated with tap water combine with GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acids @ 50 ppm treatment (2.45 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). The highest value (5.39 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) of catalase activity was observed in plant irrigated with saline water (4 EC) under control condition (S_2T_1).

G X T interaction effect for catalase activity was observed statistically significant in leaf tissues of groundnut (Fig. 6 B). The lowest value of catalase activity was observed in G_2T_8 i.e. in plant treated with GA_3 @ 100 ppm + KNO_3 @ 500 ppm + silicic acid @ 50 ppm after at 50 DAS (2.33 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). The highest value of catalase activity was observed for G_1T_1 i.e. plant was control condition after 30 DAS (5.38 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.).

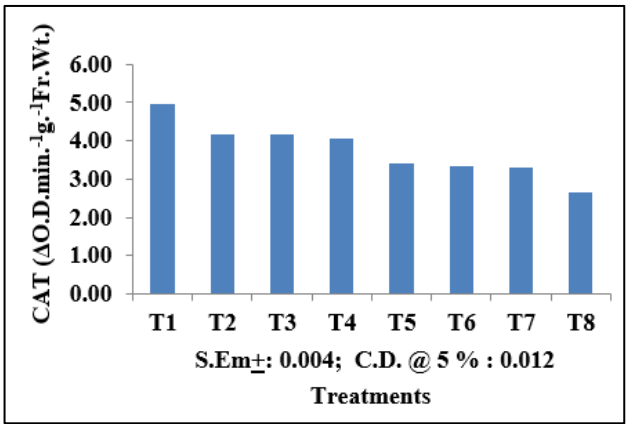
The data recorded from S X G interaction effect for catalase activity was revealed significant differences in leaf tissue of groundnut (Fig. 6 C). The lowest value of catalase activity was observed in S_1G_2 i.e. in plant irrigated with tap water after 50 DAS (3.18 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). The highest value of catalase activity was observed for S_2G_1 (4.44 ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.). These results were in agreement with Mohan and Shashidharan (2018) [11] who reported that salinity increase catalase activity in groundnut seedling.



(A)

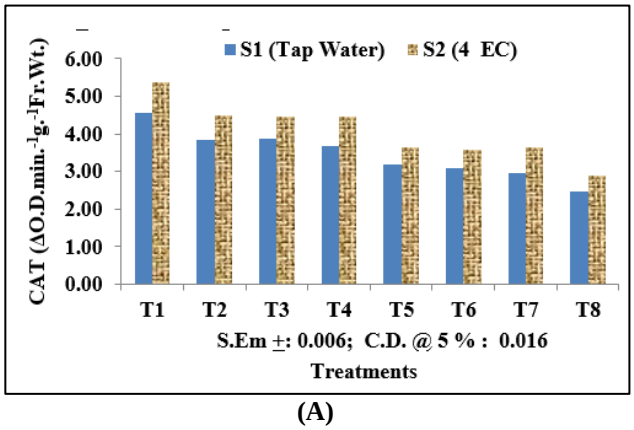


(B)

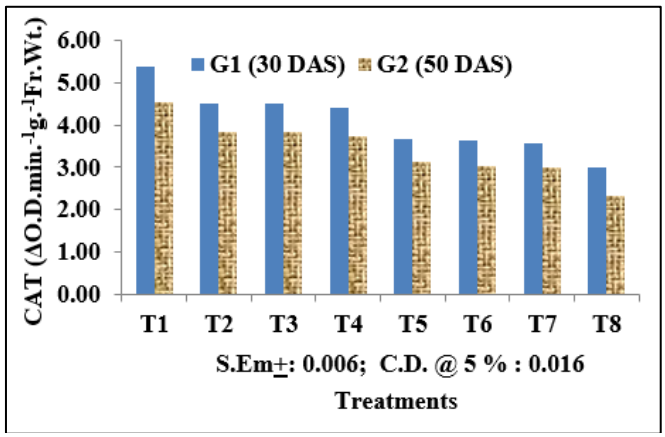


(C)

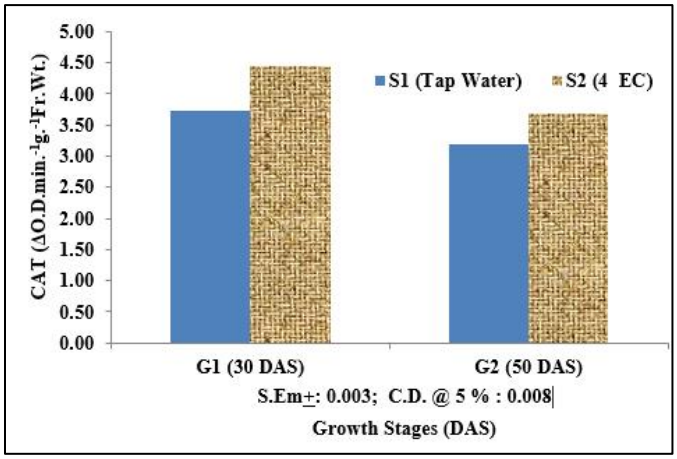
Fig 5: Mean effect of [A] salinity (S), [B] growth stages (G) and [C] treatments (T) on catalase activity (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) in leaf tissues of groundnut.



(A)



(B)



(C)

Fig 6: Interaction effect of [A] salinity (S) X treatments (T), [B] growth stages (G) X treatments (T), [C] salinity (S) X growth stages (G) on catalase activity (ΔO.D.min.$^{-1}$g.$^{-1}$Fr.Wt.) in leaf tissues of groundnut.

Conclusion

The results suggest that the antioxidant enzymes activities were affected due to salinity stress in groundnut. The polyphenol oxidase, peroxidase and catalase were increased with higher concentration of salt stress. On application of GA_3, KNO_3 and silicic acid decreased polyphenol oxidase, peroxidase and catalase enzymatic activity. This investigation has proved gibberellic acid, potassium nitrate and silicic acid as a potential biomolecules affecting the ROS scavenging enzyme under abiotic stress like salinity.

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