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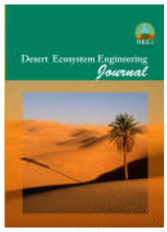

Exploring the Saltiness Resilience of one Rangeland's Species (*Agropyron desertorum*) in Several Phenological Stages

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Abstract

The Resistance to environmental salinity in rangeland plant species has different mechanisms, and one of the most effective factors in this field is different phenological stages. In The current study salinity tolerance of one rangeland's species (*Agropyron desertorum*) at different phenological stages was examined. The treatments included five saline irrigation levels: 0.50 (Well water as control), 2, 4, 8 and 10 dS m-1 and three phenological stages at which salinity was applied: Germination, (2-leaf), flowering and before seeding. Growth parameters, ions accumulation and oxidative effects in this rangeland's spices were evaluated. According to the results, the effect of salinity varied from phenological stages and a significant reduction in plant shoot and root dry weights, root length, height, and potassium (shoot and root) concentration was observed under salinity stress. Also, tissue sodium concentration and antioxidant enzymes activities were enhanced due to salt stress.The negative effects on growth parameters and biochemical attributes were quite evident in higher levels of salinity. The salt stress at the early phenological stage had a more severe effect on plant growth than that applied at the later phenological stages. Based on Van-Genuchtan and Hoffman equation, the salt tolerance threshold analysis worked out as 50% reduction of *Agropyron desertorum* that were 6.50, 7.98 and 10.00 dS m-1 at germination, (2-leaf), flowering and before seeding, respectively. However, the plants were able to recover in terms of accumulation of ion and antioxidant enzymes as well as those without stress when salt stress was introduced at the seed germination stage. Overall, *Agropyron desertorum* has been shown to have a sensitivity at early phenology and relatively tolerance in subsequent phases of development.

Key words: Environmental stress, Dry weight, Salinity, Phenology, Growth stage.

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1. Introduction

The Poaceae, which produce staples from domestic cereal crops that include maize, wheat, rice, barley and millet as well as feed for meat animals, are the major plant family with an economic importance. They provide, through direct human consumption, just over one-half (51%) of all dietary energy; rice provides 20%, wheat supplies 20%, maize (corn) 5.5%, and other grains 6%.A few individuals of the Poaceae are utilized as building materials (bamboo, cover, and straw); others can give a source of biofuel, essentially by means of the transformation of maize to ethanol. As of late, the development of a few of the rangeland's species are expanding due to a several harvests, quick phenological, freshness, and quality of scrounge generation (Khan et al., 2006). Agropyron species are broadly skewered in Iran, where the soil salt concentration is one of the vital foes for edit phenological and surrender (Burnett et al., 2005). *Agropyron desertorum* like other plants within the Poaceae family, is set among the foremost delicate plants, since its resistance limit was assessed to be near to 1.5 dS m-1 (Al-whaibi et al., 2011). Tall saltiness can harm the plant at the cellular or/and whole-plant level coming about in a serious decrease in plant phenological and abdicate generation. In any case, salt- tolerant plants can keep up phenological by barring salts or causing osmotic alteration inside the cells. Beneath saline conditions, all major forms inside a plant are more often than not influenced such as vitality and lipid digestion system, protein amalgamation, photosynthesis, and particle amassing (Frary et al., 2010). Salt push causes osmotic impacts which lead to the over-generation of receptive oxygen species (ROS) counting singlet oxygen, hydrogen peroxide, superoxide, and hydroxyl radical (Aftab et al., 2011). In shifting degrees, plants overexpress antioxidant chemicals such as catalase, peroxidase, superoxide dismutase, and ascorbic peroxidase which secure the cells/tissues against cytotoxic species of responsive oxygen (Sairan and Tyagi, 2004).

Plant affectability depends on soil saltiness conditions as well as the age of plants. The seedling arrangement of plant phenological is more touchy to salt push relative to afterward plant phenological stages counting the vegetative and regenerative stages (Safarnezhad and Hamidi, 2008; Hosseini and Razavi Moghadam., 2006). In different study, Khalid and da Silva (2010) detailed that sixteen cultivars of maize were more tolerant to saltiness at the germination organize, in spite of the fact that plant seedlings were helpless to soil saltiness. So, the saltiness limit level at the regenerative (ear and grain yields) and vegetative stages was generally higher than that at the seedling organize. In Sorghum, it was watched a few chosen cultivars were touchy to salt stretch at the vegetative organize as compared to that at generation (Hameed and Ashraf 2008). Falagella et al. (2004) detailed that cowpea was less delicate to saltiness at the afterward plants' phenological stages than that the beginning phenological stages. Comparative studies were watched by Guan et al. (2013) in wheat showing that plants were more tolerant to saline push at afterward phenological stages. They prescribed that wheat plants (durum and bread) were comparatively tolerant to saltiness amid the last mentioned 90 days of plant phenology. Agreeing to what has been expressed over, salt affectability of a few plants such as maize, sorghum, cowpea and wheat at different phenological stages has been examined, be that as it may, there's no/little data approximately saltiness resistance limit at diverse phenological arrange for *Agropyron desertorum*. Hence, this consideration was conducted to look at the impact of salt push forced at distinctive phenological stages on phenological, particle aggregation and dissemination, and antioxidant proteins in *Agropyron desertorum*.

2. Material and Methods

A totally randomized plan (CRD) with four reproduces was carried-out at the Faculty of Natural Resources and Earth Sciences university of of Kashan, Iran. The pots of uniform estimate were filled with field soil (Fine, blended, mesic, Cacixerollic Xerochrepts), sand and humus as 2:1:1 proportion. The utilized soil surface was sandy clay with pH = 7.08 and EC = 0.55 dS m-1. The seeds of *Agropyron desertorum* were sterilized in sodium hypochlorite arrangement (5%) and after that in 96% ethanol for 30 sec.

Ten seeds *Agropyron desertorum* were sown in 2-3 cm profundity in each pot and after seedling rise they were diminished to five. The brightening, 14 h day by day; relative mugginess, 60-65% and temperature, 15 (minimum) and 26°C (greatest) within the nursery were recorded amid the complete period of the expriment . Medications were combination of two components: saltiness levels and phenological organize at which saltiness was connected Germination, (2-leaf), blooming and some time recently seeding Saltiness levels included 2, 4, 8 and 10 dS m-1, which were accomplished utilizing 2:1 weight proportion of NaCl: CaCl2. The combination of these two salts were utilized for dodging the harmful affect of sodium and drawing closer to normal saltiness. Moreover, the *Agropyron desertorum* plants were flooded with tap water (EC = 0.50 dS m-1) all through the explore as control. Electrical conductivity of and seepage were controlled by a convenient EC meter (Show 2052 computerized USA) in each water system. The pots were inundated to achieve field capacity each week.

The characters measured included shoot tallness (Ht), shoot dry matter (SDM), root length (RL), root dry matter (RDM) as well as exercises of peroxidase (Unit), ascorbic peroxidase (APX), catalase (CAT) and superoxide dismutase (Grass) chemicals. Besides, shoot sodium (Na) and potassium (K) concentrations of the root and shoot were measured. One plant in each plot was considered for antioxidant chemicals evaluation, and the remaining four plants in each pot were gathered for other estimations. The tests were oven-dried at 70°C for 48 h, and weighed after division of shoot and root. To test concentrations of distinctive particles within the shoots and roots, they were processed in 40 mL of 4% HNO3 at 95°C for 6 hours in a 54-well Hot Piece (Natural Express, Mt Wonderful, South Carolina, USA). The concentrations of Na+ and K+ within the processed tests were decided employing a fire photometer (SL-CC-102 India). The exercises of Turf and CAT chemicals were evaluated taking after Dhindsa et al., (1981), the Case chemical action taking after Chance & Maehly (1995) which of APX taking after Nakano & Asada (1981). The information so collected were subjected to investigation of change (ANOVA) and multivariate relapse utilizing SAS v. 9.1 software. Limit values (50% lessening) were assessed based on the Van-Genuchtan & Hoffman (1984) strategy utilizing SAS v. 9.1 computer program.

3. Results and Discussion

Saltiness forced at diverse stages altogether decreased plant stature (Fig. 1a) and shoot dry weight (Fig. 1b) of Agropyron desertorum, be that as it may, the degree of diminishment was found to be subordinate on the seriousness of the stress. So, 2 dS m-1 saltiness level forced at flowering and before seeding, and 4 dS m-1 saltiness level connected at flowering had no noteworthy impact on plant stature. The higher lessening in plant stature was recorded when saltiness was forced at the germination taken after by at before seeding, and higher saltiness level had a more negative impact (Fig. 1a). Undoubtedly, saltiness pushes as 2, 4, 8and 10 dS m-1imposed at germination driven to 36.0%, 38.7%, 46.6% and 59.4% decrease in plant tallness, individually. These values were 10.6%, 20.0%, 27.7% and 39.4% for before seeding and were 3.8%, 8.5%, 14.4% and 28.3% for flowering, individually. In spite of the fact that salt push of any levels forced at any organize had a critical negative impact on shoot dry weight, the negative impact was more at germination and due to higher salt stretch levels. On normal, saltiness push forced at germination, before seeding and blossoming diminished shoot dry weight by 58.4%, 48.6% and 37.1%, separately.

Salt stress essentially diminished root length (Fig. 1c) as well as root dry weight (Fig. 1d) of Agropyron desertorum, be that as it may, there were critical contrasts among the medicines. Root length diminished due to saltiness of 4, 8 and 10 dS m-1 forced at before seeding and flowering stages, and due to all salt levels when forced at the germination. Saltiness treatment as 2, 4, 8 and 10 dS m-1 decreased root length by 31.7%, 35.8%, 47.5% and by 60.8% at germination, 3.9%, 15.3%, 30.4% and 40.6% at 6-leaf and by 2.6%, 16.5%, 22.9% and 25.4% at the flowering, individually. The negative impact of saltiness was more when connected at the germination and at higher salt push levels (Fig. 1c). The diminishments in root dry weight were more noteworthy when saltiness was connected at the germination (63.2%) and before seeding stages (45.8%) than that at the flowering (28.1%) as appeared in Fig. 3d. On the other hand, higher saltiness levels forced at all distinctive development stages significantly decreased root dry weight. For illustration, 3, 6, 9 and 12 dS m-1 salt levels forced at the germination decreased root dry weight by 37.1%, 60.9%, 67.5% and 87.2%, separately. These diminishments were 12.0%, 38.4%, 54.2% and 78.6% when salt stress was forced at the before seeding arrange and were 4.5%, 21.0%, 31.7% and 55.2% when salt stress was forced at flowering, separately.

Resilience limit examination appeared that limit levels of *Agropyron desertorum* were 6.54, 7.99 and 10.00 dS m-1 when salt stress was forced at the germination, before seeding and flowering stages, individually. The distinction in affectability of *Agropyron desertorum* may well be observed in development parameters (Fig. 1), or within the slant of lessening in plant dry matter (Fig. 3). The incline of decrease due to salt push in plant dry matter was more when it was forced at the germination (-0.26) taken after by at the before seeding (-0.25) compared to that at flowering (-0.23).

But in 10 dS m-1 salt level, the most reduced shoot and root Na+ concentrations were found in plants subjected to salt push at germination, the treatment connected at blooming appeared the highest Na+ concentrations. Diminished shoot and root development due to salt push within the current think about could be credited to the negative impact of this particle. Saltiness push expanded Na+ amassing, but diminished that of potassium (K+) within the shoot and root of *Agropyron desertorum* plants (Fig. 2c and 2d).

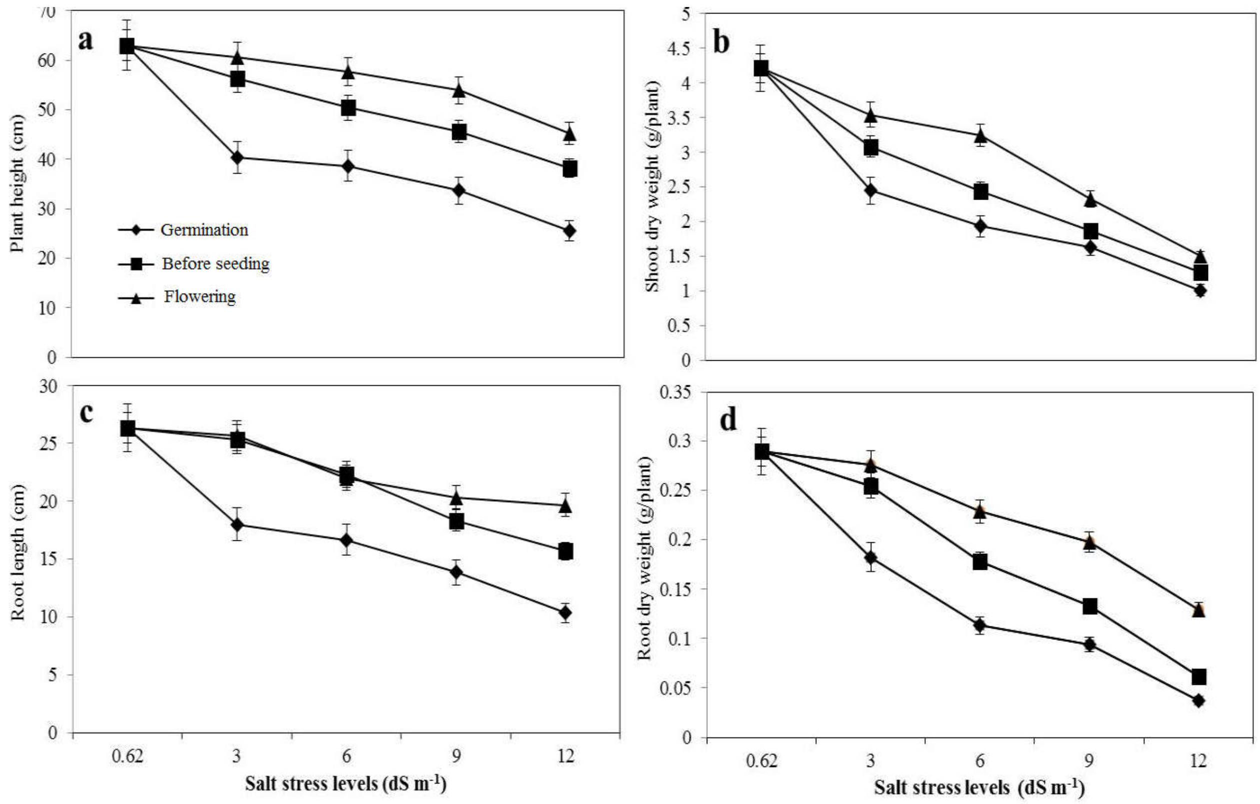

Figure (1): Effect of different salt stress levels imposed at three phenological stages on phenological parameters. Bars represent standard errors (±SE)

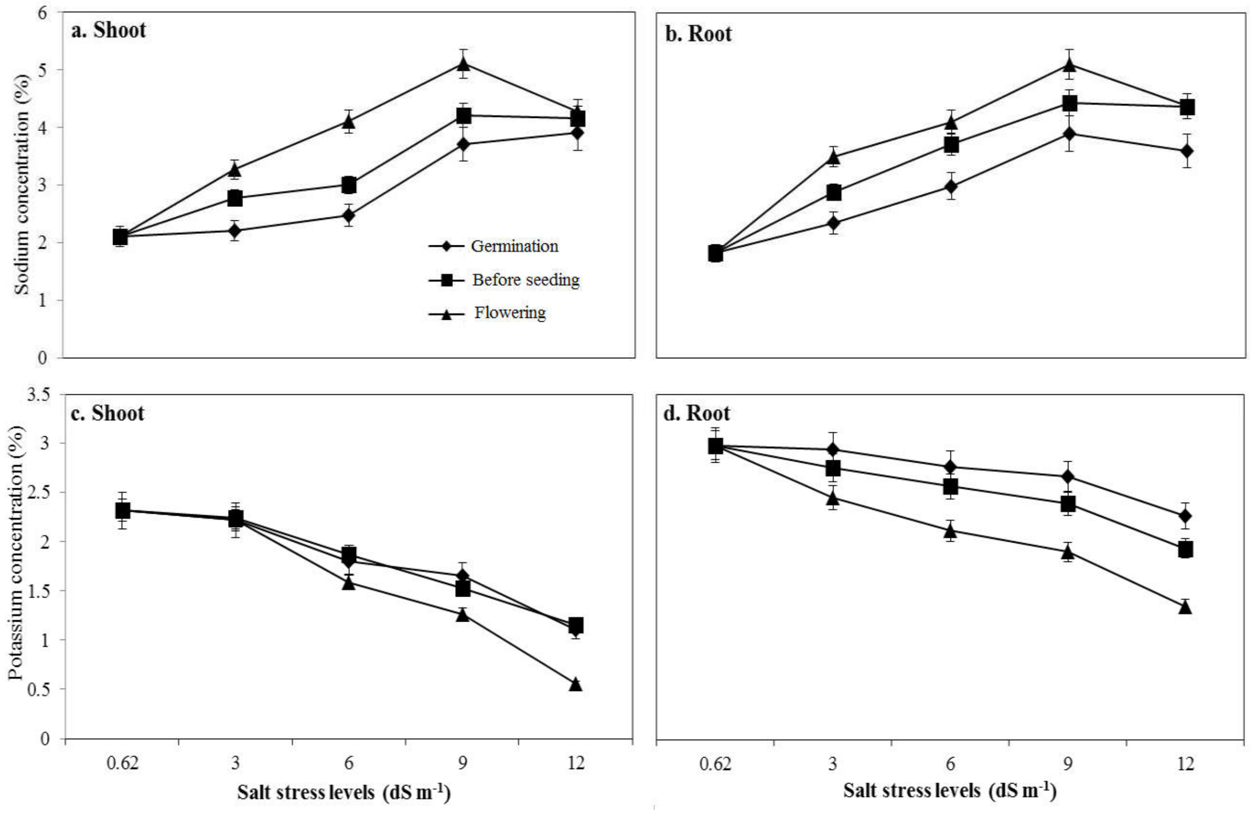

Figure (2): The effect of different levels of salts stress on accumulation of ion in shoots and roots imposed at three pharmacokinetic stages. Bars represent standard errors (±SE)

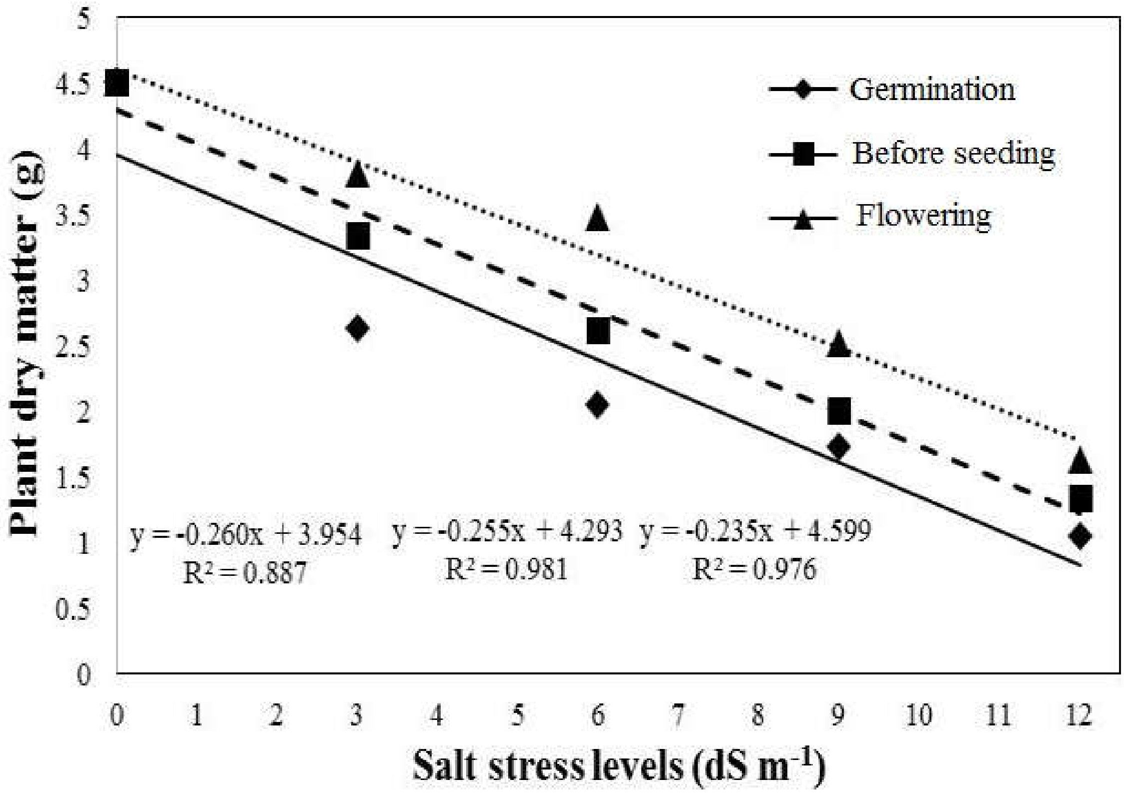

Figure (3): Relationship between different salt stress levels imposed at three phenological stages with plant dry matter (shoot + root)

There was no critical contrast among the three stages at which saltiness stress was forced especially 2 dS m-1 level; in any case, in other salt levels (e.g. 4, 8 and 10 dS m-1), shoot K+ concentration was more noteworthy in plants which were subjected to salt stretch at the flowering (Fig. 2c). The most elevated and the least root K+ concentrations were watched in focused plants when the salt push was forced at flowering and germination stages, separately (Fig. 2d).

Salt push over 3 dS m-1 forced at flowering and over 4 dS m-1 forced at germination and before seeding stages altogether upgraded the action of catalase (CAT) as appeared in Fig. 4a. There was no critical distinction between the pushed and non-stressed plants in terms of CAT exercises especially when saltiness was forced at germination and before seeding stages, be that as it may when salt stretch was forced at flowering, the CAT action was much higher. So on normal, salt push forced at germination and before seeding and flowering caused 28.3%, 31.3% and 45.3% increment in CAT movement, separately.

Although salt stress imposed at any stage enhanced superoxide dismutase (SOD) activity, however, there was no significant difference among the three stages (Fig. 4b). The effect of all salt levels (3, 6, 9 and 12 dS m-1) averaged over three phenological stages showed 128.7%, 151.2%, 175.8 and 201.0% increasing in SOD activity, respectively. All levels of salt stress at flowering and more than dS m-1 at 2- and 6-leaf stages caused enhanced peroxidase (POD) activity (Fig. 4c). At all salinity levels, stressed plants at flowering had greater POD activity than that at the two other stages, so that at 3, 6, and 12 dS m-1 salinity treatments the POD activity was higher by 23.0%, 44.6%, 56.3% and 44.8% in stressed plants at flowering. Salt stress significantly increased shoot and root sodium (Na+) concentration, however, these increasing trends were obtained up to 9 dS m-1, but higher salinity level, i.e. 12 dS m-1 did not significantly change or decrease Na+ concentrations (Fig. 2a and 2b). Salt stress at 6, 9 and 12 dS m-1 enhanced ascorbic peroxidase (ASP) activity only when it was imposed at flowering, however salinity stress imposed at 2- or 6-leaf stage had no significant effect on ASP activity (Fig. 4d). Salt stress at 6, 9 and 12 dS m-1 imposed at flowering caused 20.9%, 28.3% and 31.5% increase in ASP activity, respectively.

In spite of the fact that salt push forced at any organize improved superoxide dismutase (Grass) action, in any case, there was no noteworthy contrast among the three stages (Fig. 4b). The impact of all salt levels (2, 4, 8 and 10 dS m-1) found the middle value of over three phenological stages appeared 128.7%, 151.2%, 175.8 and 201.0% expanding in Turf action, individually. All levels of salt stretch at flowering and more than dS m-1 at germination and before seeding stages caused improved peroxidase (Case) movement (Fig. 4c). At all saltiness levels, pushed plants at flowering had more prominent Case movement than that at the two other stages, so that at 2, 4, and 10 dS m-1 saltiness medicines the Case movement was higher by 23.0%, 44.6%, 56.3% and 44.8% in pushed plants at flowering. Salt stress altogether expanded shoot and root sodium (Na+) concentration, in any case, these expanding patterns were gotten up to 8 dS m-1, but higher saltiness level, i.e. 10 dS m-1 did not essentially alter or diminish Na+ concentrations (Fig. 2a and 2b). Salt stress at 4, 8 and 10 dS m-1 upgraded ascorbic peroxidase (ASP) movement as it were when it was forced at flowering, be that it may saltiness stretch forced at germination or before seeding had no noteworthy impact on ASP movement (Fig. 4d). Salt stress at 4, 8 and 10dS m-1 forced at flowering caused 20.9%, 28.3% and 31.5% increment in ASP action, individually.

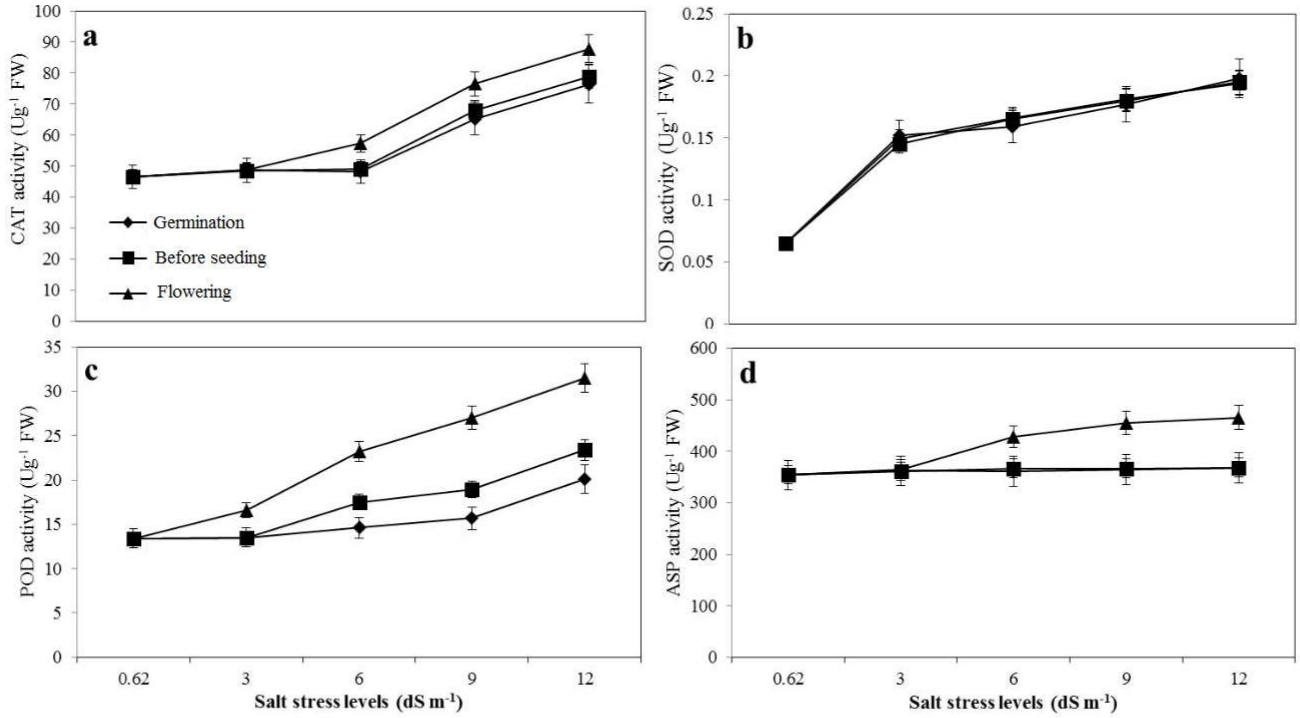

Figure (4): Effect of different salt stress levels imposed at three phenological stages on antioxidant enzymes activities (CAT: catalase, SOD:superoxide dismutase, POD: peroxidase, and ASP: ascorbic peroxidase). Bars represent standard errors (±SE)

Our comes about of decrease in the phenological of *Agropyron desertorum* are in understanding with those of Stephanie et al., (2005), Ellis and Roberts (2006). who detailed a decrease in plant tallness due to saltiness different crops. They too detailed that tall saltiness levels were very compelling in diminishing plant stature in several crops. The decreases in phenological parameters such as plant stature and shoot dry matter may be due to the impact of saltiness on asset productivity, such as water and sustenance. Salt stress decreases the capacity of plants to utilize such assets as water and comes about in a lessening in phenological (Teymori and Jafari, 2007; Yang et al., 2004). At distinctive stages, saltiness has been detailed to decrease the water imbibition by roots that comes about in diminishing osmotic possibilities within the root zone. This change may lead to changes in metabolic exercises and reduction in trim phenological (Senaratna et al., 2003, 2005; Sticher et al., 2007; Zahra, et al., 2010). Higher sodium and lower potassium concentrations in focused plants appeared within the current think about may too be mindful for diminished shoot phenological. Koyro (2006) appeared that the movement of Grass and K+/Na+ proportion were found to be valuable in salt resistance control in grain plants.

Salt stress is detailed to be capable for both restraint and delay in germination and development (Sairam et al., 2002), diminish in water take-up (Sarwa et al., 2013), and improved leaf senescence (Sabra et al., 2012), that could be included for diminished root phenological. A few analysts ascribed diminishments in root phenological to decreased photosynthetic rate and changes in plant metabolic forms, which driven to lower transported absorbs (Qureshi et al., 2005).

The reaction of phenological parameters to salt push medicines appeared that *Agropyron desertorum* was most delicate at early phenological and at afterward arrange it was moderately tolerant. It is contended that salt push at early phenological leads to create powerless seedlings, which may hence abdicate powerless grown-up plants. For illustration, prior Senaratna et al., (2003) for bread and durum wheat, Parida et al., (2005) for maize, Parvaiz, and Satyawati., (2008) for sorghum, Stephanie et al. (2005) for cowpea appeared that all these plants were more delicate to a stress at the seedling stage.

Monovalent particles such as Na+ may have unfavorable impacts on plant biochemical forms (Ashraf et al., 2010). Tall concentrations of Na+ in soil can cause disintegration within the soil structure and may compound the impacts of saltiness by blocking seepage as well as influencing the accessibility of water to the plant as the soil dries (Ashraf & Harris, 2004). Salt push is known to change the particle balance in plant tissues and resultantly, some imperative particles may be viably utilized as critical determination criteria for salt resistance (Ashraf et al., 2010). Without a doubt, K+ concentration is accepted to be an index of saltiness resistance in most edit species. Within the show consider, the most reduced root K+ concentrations were watched in pushed plants when salt stretch was forced at flowering and germination stages, individually. Mittova et al., (2002) detailed that salt stretch resilience was connected with expanded exercises of antioxidant chemicals such as Turf, ASP, and Case.

The part of Turf in rummaging of dynamic oxygen species has been well centered within the writing. It was shown that plants by and large are able to dispense with superoxide (O2−) utilizing Turf, which catalyzes the dismutation of superoxide into hydrogen peroxide and oxygen, and is imperative in anticipating the decrease of metal particles and thus the amalgamation of hydroxyl radicals (Munns et al., 2006). Ashraf and Harris (2004) accepted that Unit and a few other antioxidant chemicals played a pivotal part in salt push resilience. They detailed that salt push caused a impressive increment within the exercises of Case and glutathione reductase within the salt tolerant plants, while the exercises of these chemicals remained unaltered or diminished in salt delicate plants. Besides, it has been famous that Turf might catalyze O2− to hydrogen peroxide and oxygen. Hydrogen peroxide can be disposed of by ASP found within the thylakoid layer (Jaleel et al., 2007). Our comes about almost the capacity of *Agropyron desertorum* to induce recuperated frame saline stretch may too be observed in terms of particle collection and antioxidant chemicals exercises. Ashraf & Harris (2004) in a peer audit noted considerable varieties within the protective mechanisms of antioxidant chemicals such as CAT, Turf, Unit and ASP against activated oxygen species totally different plant species. Hence, advance work is required to set up the common legitimacy of this wonder in saltiness resistance in numerous plants.

4. Conclusion

Salt stress diminished phenological and K+ concentration, and upgraded Na+ concentration and antioxidant proteins exercises. Both shoot and root tissues had moderately comparable reactions. Higher salt push levels, particularly at early phenological had more negative impact on the properties measured. It too was appeared that when salt push was forced at early phenological organize, plants were able to recoup in terms of particle collection and antioxidant proteins. Reaction of phenological parameters to salt stretch at distinctive stages and limit investigation uncovered that *Agropyron desertorum* was a most touchy plant at early phenological, but less delicate at afterward phenological stages.

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