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Combination of Salinity and Sodicity Levels Facilitates Screening of Medicinal Crop Linseed (*Linum Usitatissium*)

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Abstract

Salts lessen germination, delay emergence, and retard seedling growth of linseed (*Linum Usitatissimum L.*). In this research experiment, we designed to find out the effects of (4 dSm-1+ 13.5 (mmol L-1)1/2, 5 dSm-1 + 25 (mmol L-1)1/2 , 5 dSm-1 + 30 (mmol L-1)1/2, 10 dSm-1 + 25 (mmol L-1)1/2 and 10 dSm-1 + 30 (mmol L-1)1/2) on biomass yield of linseed to screen against salinity tolerance using biomass yield characteristic. Highest biomass yield (45.53 gpot-1) was attained by 4 dSm-1+ 13.5 (mmol L-1)1/2 treatment. Biomass yield was decreased as well as the toxicity of salts was increased. Lowest biomass yield (27.75 gpot-1) was produced at 10 dSm-1 + 30 (mmol L-1)1/2. 5 dSm-1 + 25 (mmol L-1)1/2 treatment performed better results i.e. the least reduction % over control (20.25). Salinity- sodicity showed serious effect on the growth reduction from 20.25% to39.05%. This reduction gap was affected by the negative effect of salinity and sodicity on Linseed growth. Salinity- sodicity showed severe impact on the growth reduction from 20.25 to39.05%. Based on the findings, linseed (*Linum usitatissimum L.*) was able to grow the highest at 4 dSm-1+ 13.5 (mmol L-1)1/2 treatment.

Keywords: Linumusitatissimum; Saline- Sodic; Medicinal Value; Biomass Yield

Introduction

Linseed (*Linum usitatissimum L.*) is a cool temperate annual herb with erect stems. Although there are several utilization purposes, it is cultivated commercially for its seed, which is processed into oil and a high protein stock feed after oil extraction Sankari [1-3] and for its fibers, which are made into linen and other cloths El-Nagdy et al. [4]. In addition, linseed varieties with oils suitable for culinary use are available Hosseinian et al. [5]. Seedling establishment is generally slow and seedlings have poor competitive ability. In arid and semi-arid regions where rainfall is insufficient to leach salts out of the root zone, the salinity is a major problem which limits plant growth Khajeh-Hosseini et al. [6], since evaporation tends to exceed rainfall Kaya et al. [7]. Out of 20.2 million hectares of cultivated land in Pakistan, 6.8 million hectares are affected with some degree of salinity Anon [8]. The main approach of testing the linseed growth for salinity tolerance is growing it on the salt affected soils. Several researches on the classification of crop plants for salinity have been performed using various criteria such as reduction in plant growth Bassil and Kaffka [9-11], water stress day index Katerji et al. [12], biochemical activities Johnson et al. [13], ion balance Alian et al. [4,15], and yield reduction Natarajan et al. [16].

Linseed (*Linum usitatissimum L.*) is an important crop produced for natural textile fibre (linen) or oil for industrial application as well as culinary purpose. Recently the market has evolved around linseed as a functional food laden with health promoting properties further highlighting its importance and increased demand. The total world production of linseed reached approximately 2.56 million tons in the year 2014, with Canada (34 %), the Russian Federation (15 %), and China (13 %) being the main producers (FAOSTAT, 2016). In world germplasm collections, there are 46,513 linseed/flax accessions reported (with perhaps 10,000- 15,000 unique accessions), of which L. bienne (the wild progenitor of cultivated flax) is rarely represented (279 accessions only) in gene banks Diederichsen [17]. Linseed germplasm is also represented by cultivars, landraces, wild relatives and other wild ancestral species which breeders can exploit to improve cultivars for future climatic adaptations Heslop-Harrison and Schwarzacher [18] Diederichsen and Fu.

Further, the use of landraces for fibre flax breeding was described by Zhuchenko and Rozhmina [19]. Such studies have proven to be useful tools for efficiently preserving and using flax germplasm collections Diederichsen [17,20,21]. These primary evaluations of flax germplasm collections were followed by numerous secondary evaluations for different characters related to tolerance to biotic and abiotic stress factors Brutch [19,22] with recent focus of germplasm screening on monogenic traits, such as disease resistances Rashid [23]. Some work on the effect of salinity on germination and growth of medicinal plants include Linum usitatissimum, Trigonella foenum–graecum Ashraf et al. [10, 24-30] Ricinus communis Raghavaiah [31]. It appears that little information is available regarding the effect of salinity on the growth and productivity of medicinal plants.

Lepidium sativum L., *Linum usitatissimum L*., Plantago ovata Forssk and Trigonella foenum-graecum L. have been evaluated and proved to be moderately salt tolerant at germination and seedling growth stage Muhammad & Hussain [32]. Supplies of good quality water are falling short of demand for intensive irrigated agriculture in many arid and semi-arid countries due to increased pressures to produce more for the growing population as well as competition from urban, industrial and environmental sectors. Therefore, available freshwater supplies need to be used more efficiently. In addition, reliance on saline waters generated by irrigated agriculture or pumped from aquifers seems inevitable for irrigation Bouwer [33] Qadir et al. The same applies to salt-affected soils, which occur on 831.106 ha Beltra´n and Manzur [34]. Sodicity causes structural problems in soils created by physical processes such as slaking, swelling and dispersion of clay; as well as conditions that may cause surface crusting and hard setting Quirk [35].

Several major irrigation schemes throughout the world have suffered from the problems of salinity Gupta and Abrol [36-38]. Generally, the worst salinity impacts occur where farming communities are relatively poor and face economic difficulties. In severe cases, salinization causes occupational or geographic shifting of the affected communities, with the male population seeking alternate off-farm income opportunities Abdel- [1,40]. As the agricultural use of salt-affected land and saline water resources increases, their sustainable use for food and feed production will become a more serious issue Suarez [41], Wichelns and Oster, 2006. In the future, sustainable agricultural systems using these resources should have good crop production with minimized adverse environmental and ecological impacts Qadir and Oster [42]. Salt-affected soils are reported to comprise 42.3 per cent of the land area of Australia, 21.0 per cent of Asia, 7.6 per cent of South America, 4.6 per cent of Europe, 3.5 per cent of Africa, 0.9 per cent of North America and 0.7 per cent of Central America.

Australia has the world's largest area under salinity which is reported equivalent to about one third of the total area of the continent. Recent estimates indicate that 6.74 million ha (CSSRI, 2006; NBSSLUP, 2006; NRSA, 2006) in India are affected by soil salinity and alkalinity. In the present scenario human use of poor-quality irrigation systems is a major concern for scientists around the world. Therefore, apart from the need for proper irrigation practices a concerted effort to understand the effect of salinity on plants, development of genetically engineered crop varieties and superior tolerant cultivars are essential to combat the world's salinization problems Tester and Davenport [43].

Materials and Methods

A pot study was conducted to evaluate the salt tolerance of Linseed (*Linum usitatissimum L.*) as medicinal plant under different saline and sodic concentrations at green house of Land Resources Research Institute, National Agricultural Research Centre, Islamabad, Pakistan during, 2017. The soil used for the pot experiment was analysed and having 7. 0 pH, 1.8 ECe (dSm-1), 4.9 SAR (mmol L-1)1/2, 22.5 Saturation Percentage (%), 0.33 O.M. (%), 7.0 Available P (mg Kg-1) and 95.9 Extractable K (mg Kg-1). Considering the pre- sowing soil analysis the ECe (Electrical conductivity) and SAR (Sodium Absorption Ratio) was artificially developed with salts of NaCl, Na_2 SO_4, $CaCl_2$ and $MgSO_4$ using Quadratic Equation.10 Kg soil was used to fill each pot. 10 seeds of Linseed (*Linum usitatissimum L.*) as medicinal plant were sown in each pot. Fertilizer was applied @60-50-40 NPK Kg ha-1. Treatments were (4 dSm-1+ 13.5 (mmol L-1)1/2, 5 dSm-1 + 25 (mmol L-1)1/2, 5 dSm-1 + 30 (mmol L-1)1/2, 10dSm-1 + 25 (mmol L-1)1/2, 10dSm-1 + 25 (mmol L-1)1/2 and 10 dSm-1 + 30 (mmol L-1)1/2). Completely randomized deign was applied with three repeats. Data on biomass yield were collected. Collected data were statistically analysed and means were compared by LSD at 5 % Montgomery [44].

Results and Discussions

Salinity adversely reduces the overall productivity of plants including crops by inducing numerous abnormal morphological, physiological and biochemical changes that cause delayed germination, high seedling mortality, poor crop stand, stunted growth and lower yields. So Biosaline agriculture (utilization of these salt- affected lands without disturbing present condition) is an economical approach. Therefore, a pot study was designed to evaluate the salt tolerance of Linseed (*Linum usitatissimum L.*) at various salt concentrations. Significant difference was found among treatments on biomass yield (Table 1). Highest biomass yield (45.53 gpot-1) was attained by 4 dSm-1+ 13.5 (mmol L-1)1/2 treatment. Biomass yield was decreased as well as the toxicity of salts was increased. Lowest biomass yield (27.75 gpot-1) was produced at 10 dSm-1 + 30 (mmol L-1)1/2. Germination and seedling emergence may be influenced by temperature, sowing depth and seedbed conditions like available moisture and salinity Couture et al. [45]; Kurt and Bozkurt [2]. Salinity leads to delayed germination and emergence, low seedling survival, irregular crop stand and lower yield due to abnormal morphological, physiological and biochemical changes Munns [15]; Muhammad and Hussain [31].

Table 1 also explored the % decrease in biomass yield over control. 5 dSm-1 + 25 (mmol L-1)1/2 treatment performed better results i.e. the least reduction % over control (20.25). Salinity-sodicity showed serious effect on the growth reduction from 20.25 to39.05%. This huge fissure was impacted by the negative effect of salinity cum sodicity on Linseed (*Linum usitatissimum L.*) growth. Such problems affect water and air movement, plant-available water holding capacity, root penetration, runoff, erosion and tillage and sowing operations. In addition, imbalances in plant-available nutrients in both saline and sodic soils affect plant growth Qadir and Schubert [46-50].

Table 1: Effect of various salinity and sodicity levels on biomass yield of Linseed (*Linum usitatissium*) as medicinal crop.

Treatments	Biomass Yield (gpot-1)	% Decrease Over Control
ECe= 4 dSm^{-1}+ SAR=13.5 (mmol $L^{-1})^{1/2}$	45.53a	-------
ECe= 5 dSm^{-1} + SAR=25 (mmol $L^{-1}/)^{1/2}$	36.31ab	20.25
ECe= 5 dSm^{-1} + SAR= 30 (mmol $L^{-1})^{1/2}$	33.60bc	26.20
ECe= 10dSm^{-1} + SAR=25 (mmol $L^{-1})^{1/2}$	32.29c	26.88
ECe= 10 dSm^{-1} + SAR= 30 (mmol $L^{-1})^{1/2}$	27.75d	39.05
LSD at 5%	5.31	

Conclusion

Based on the findings, Linseed (*Linum usitatissimum L.*) was able to how more salt tolerance at 4 dSm-1+ 13.5 (mmol L-1)1/2 treatment [51-56]. Therefore, Linseed (*Linum usitatissimum L.*) is suggested to be cultivated in soil salinity farmlands.

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