Research Article

Salt stress impacts on seed germination and seedling growth of *Brassica napus* L.

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Abstract

Crop plant germination and growth adversely affected through salt stress. Canola seed germination and seedling growth in saline condition was evaluated in a laboratory experiment. In sterilized petri plates seeds of two canola varieties (Bulbul 2000 and Rainbow) were sown. Saline condition was employed through sodium chloride solutions (50 mM, 75 mM, 100 mM, 125 mM and 150 mM) and distilled water control was sustained for comparison. Canola seed germination and seedling growth related attribute data were recorded. Results show that canola varieties were statistically significant ($P < 0.005$) responses to saline conditions. Sodium chloride concentration gradual increase reduces canola seed final germination percentage, germination index, mean daily germination and seedling vigor index in both varieties. However, the high salt level (100, 125, 150 mm) significantly reduces germination parameters of seeds of Bulbul 2000. High salt levels significantly affect the root length, shoot length, fresh, and dry weight and total chlorophyll content. Rainbow show better germination and seedling growth in high salt levels. Therefore, they possibly will tolerate moderate levels of salt.

Key words: Salt stress; Canola; Seedling growth; Chlorophyll content.

Introduction

Abiotic stresses adversely affect the growth and yield of crop plants. Crop plants yield subsequently depends upon early seedling growth stages those most likely to more sensitive to abiotic stress conditions [1]. Abiotic stress is the primary factor for crop loss and globally 50 % reduction in the standard yields [2]. Salt stress is major abiotic stresses that adversely influence plant growth and development. Salinity induces negative effects on germination parameter and seedling growth depending upon the plant species. Crop plants seed germination and early seedling growth are

the stages more susceptible to high salt concentrations [3, 4]. Scientists' findings show that in saline environment ionic and osmotic effects disturbed plant germination process. Canola (*Brassica napus* L.) stands third after soybean and palm among oil crops all over the world. It produces as much as 14.7% of vegetable edible oil with high content of unsaturated fatty acids [5]. Canola is most important oil seed crop in Pakistan. Salt stress induced oxidative stress, which might be a reason for the germination percentage reduction [6]. Canola is moderately salt tolerant oil seed crop but canola crop growth increasing in

past decades. This increase in canola plantation is needed to improve salt tolerance in canola crop. In Pakistan problem of salt stress is in irrigated agriculture where drainage is insufficient and almost 10 million ha area is badly affected through high salt concentrations [7]. This information is essential to suggest a suitable crop cultivar for saline soil and capability of crop plants to withstand and grow in salt affected soil is an immense achievement in agriculture [8]. The objective of the present study is to identify the impact of salt stress on different canola varieties at germination stage.

Materials and Methods

A laboratory experiment was carried out in plant physiology lab of department of botany at PMAS-Arid Agriculture University Rawalpindi to study the effect of salt stress on germination and seedling growth attributes of seeds of canola (Bulbul 2000 and Rainbow). Seeds of each variety were surface sterilized in a sodium hypochlorite (1 %) solution for 10 min and then washed twice with distilled water. After seed sterilization, Petri plates containing double layer filter paper were moistened and ten seeds of each variety were soaked in these Petri plates and then kept in an incubator (40% relative humidity) at 25°C. Salt conditions were created by using aqueous sodium chloride solutions, for this point analytical grade NaCl dissolved in distilled water and prepare 50 mM, 75 mM, 100 mM, 125 mM and 150 mM concentration solution. A distilled water control runs for evaluation purpose. Each treatment was replicated three times and germination rate were measured daily. Seeds were considered to be germinated when radical length exceeded 5 mm [9].

Germination percentage calculated by using the following formula.

Germination % age = $\frac{\text{Total seeds germinated}}{\text{Total no of seeds planted}} \times 100$

Germination index was calculated using following formula [10]

Germination Index = n/d ; where n = no of seedlings emerged on day and d = days after planting.

Mean Daily Germination was calculated through [11].

MDG = $\frac{\text{Final germination percentage}}{\text{number of days to final germination}}$.

Seedling vigor index was calculated using this equation [12]

S. V. I = Seedling length (cm) x germination % age

Where; germination % age = $\frac{\text{Total seeds germinated}}{\text{Total no of seeds planted}} \times 100$. After 12 day of sowing from each treatment three seedlings were randomly selected used to measure root and shoot length. Digital balance was used to record seedling fresh and dry weight and seedlings were oven dried at 70°C for 48 h for dry weight. Total chlorophyll was recorded for each treatment [13]. For statistical analysis Statistics 8.1 program was used.

Results and Discussion

High sodium chloride levels in soil harmfully influence germination parameters of the canola cultivars. In different germination attributes significant ($p \leq 0.05$) difference were observed between all salt levels and canola genotypes. Furthermore, canola varieties show different reactions to all salt levels as significant interaction ($p \leq 0.05$) among factors. The germination percentage decreased with increasing salt levels (Figure 1), although germination establishment delayed in canola varieties. In Bulbul 2000 considerable impediment in germination was observed at higher salt level 150 mM. Germination index (Figure 2) and Mean daily germination (Figure 3) was observed that showed variation among both genotypes. As the salt level increase GP MDG and GI rate decreased.

Figure 1. Effect of salt stress on seed germination of canola cultivars

Figure 2. Effect of salt stress on germination index of canola cultivars

Figure 3. Effect of salt stress on mean daily germination of canola cultivars

Figure 4. Effect of salt stress on seedling vigour index of canola cultivars

Figure 5. Effect of salt stress on shoot length of canola cultivars seedlings

Figure 6. Effect of salt stress on root length of canola cultivars seedlings

Figure 7. Effect of salt stress on fresh weight of canola cultivars seedlings

Figure 8. Effect of salt stress on dry weight of canola cultivars seedlings

Figure 9. Effect of salt stress on total chlorophyll content of canola cultivars

At higher salt levels GP, MDG and GI was suppressed by 2, 3 and 4 days of seed germination in Bulbul 2000 as compared to control (Figure 1, 2 & 3). However Rainbow shows better growth at higher salt. Similarly, Seedling vigour index (SVI) of both canola cultivars was observed at different salt levels (Figure 4). Saline conditions impaired seed germination, as a result the establishment of plant decreased. The harmful effect of salt stress on germination parameter of different plants has been studied by a number of scientists [14, 15]. AOAC, [16] reported that reduction in germination percentage in saline conditions due to the combined effect of the osmotic and toxic effect of high salt levels [17]. Karamursel et al., [18] reported that high salt accumulation in inter and intracellular space drastically decrease the

germination percentage primarily due to changes in water relations. Seed germination delay in high salt levels may be due to embryo damage by sodium, chloride ions, inhibition of seed, water uptake and exosmosis [19]. In seedling vigor index (SVI) obvious decrease was observed, seedling vigor index decreased strangely with increasing the salt level than the control. Salt tolerant canola genotypes show sodium and chloride compartmentalization at the organ and organelle level as compared salt-sensitive ones [3]. In this study both varieties were appeared to more sensitive to higher salt levels (100, 125 and 150 mM) than low concentration of salt. They depict better aptitude to deal with high salt levels. High salt levels gradually reduce seedling growth so that a harmful association was

found among seedling growth and salt stress (Figure 5, 6, 7, 8 & 9). Canola genotype interaction with different salt levels was significant ($p \leq 0.05$). In all seedling growth parameters considerable differences were recorded between salt levels and canola varieties. Increasing salt levels subdued the shoot length of both varieties over control. Root length shows considerable increase with increasing salt levels. Root and shoot lengths are mainly significant attributes in saline condition because roots play important role in water absorption and minerals. Shoot provide support and supply nutrients, minerals and food for the rest of the plant. Therefore, root and shoot parameters gave main evidence about the plants response to salinity [20]. As the sodium chloride level increased their gradual reduction in fresh and dry weight of wheat seedling was recorded (Figure 7 & 8). In total chlorophyll content differences between canola varieties and salt level being statistically significant ($p \leq 0.05$) and comparable trend was recorded by other authors [21]. Plants seedling growth stages are very sensitive from salt stress because salinity alters plant water relation and ionic stress. A marked decline in total chlorophyll recorded in both cultivars and maximum in Bulbul 2000. Salt stress is known to cause decrease to chlorophyll content in canola and degradation of chlorophyll due to elimination of phytol caused by enhanced activity of chlorophyllase [22, 23]. Salt stress is responsible to generate oxidative stress resulting to alter cell ultra-structures [24, 25]. In present research Bulbul 2000 comparatively appear salt susceptible as compared to rainbow.

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