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Original Research Paper

Influence of Salinity Stress on Germination and Early Seedling Growth of Coriander (*Coriandrum Sativum L.*) Cultivars

Botany

KEYWORDS : Salinity, coriander, Seed Germination and Seedling Growth

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ABSTRACT

The present study was carried out to investigate salinity tolerance of three cultivars of coriander (PD-21, Pant-Haritima and Kalmi) on the basis of seed germination and seedling growth. Salinity is an important land degradation problem for limiting plant growth and agriculture productivity in many areas of the world. The seedlings were raised in plastic pots filled with sand at the room temperature. These plastic pots were treated with NaCl solutions of different concentration viz. 25, 50, 75 and 100 mM. Distilled water served as control. All sets were managed in triplicates. Seed germination, shoot/root length, fresh and dry weights of shoot and root and total seedling dry weights were determined as growth parameters. The rate of seed germination decreased in all cultivars with increasing levels of salinity from 25 to 100 mM. The analyzed data showed that P.D-21 and Kalmi were found to be highly salt tolerant and moderately salt tolerant respectively in term of germination %, shoot/root length, fresh weight of shoot/root and dry weight of shoot and root with respect to salinity. Conversely, Pant Haritma was sensitive to salinity in terms of the above parameters studied.

INTRODUCTION

Salinity is of the most dangerous environmental factors limiting plant growth and productivity. Salt stress changes the morphological, physiological and biochemical responses of plant (Amirjani, 2010). The adverse effects of salt stress appear on the entire plant at almost every stage of growth including germination, seedling development, vegetative and reproductive stages. Salinity in a given land depends upon the various factors like amount of evaporation (leading to increase in salt concentration), or the amount of precipitation (leading to decrease in salt concentration). Salinity affects plant physiology through changes of water status in cells. Salinity stress may curtail or promote nutrient uptake by plant species affecting the mobility of a nutrient within the plant or by increasing the nutrient requirement by plants in the cells. About 23% of the world's cultivated lands is saline and 37% is sodic (Khan and Duke, 2001).

Salinity stress inhibits the growth of plants at early seedling and developed seedling stage (Ferdose et al., 2009). Salinity stress is associated mainly with two types of stresses: osmotic stress and / or ion toxicity (Eisa et al., 2012). Osmotic effect of salts on plants is a result of lowering of the soil water potential due to increasing solute concentration in the root zone. Osmotic effect contributes to reduce growth rates, change in leaf colour, and development characteristics such as root / shoot ratio and maturity rate.

High ion-concentration may disturb membrane integrity and function. The high Na^+ concentration in saline water potential in the rooting zone which in turn decreases water permeability in to plant tissue (Koyro et al., 2011). Ion toxicity occurs when salt accumulates to toxic concentration in leaves. Sodium chloride (NaCl) reduced all the parameters including : seed germination, number of leaves per plant plant length, roots number, root length and percentage of survivals, with a significant differences among all treatments. So, increasing NaCl concentration leads to more reduction in seed germination percentage and plant growth rate also. It leads to decreasing in the percentage of survivals while the shoot tip necrosis is increased by increasing concentration. Na exclusion ability is significantly correlated with salinity resistance in plants (Ferdose et al., 2009).

Seed germination is first critical and the most sensitive stage in the life cycles of plants (Ahmed, 2009). Salinity adversely affects germination by decreasing the osmotic potential of the soil solution to such a point that it retards or prevents the intake of water (Zekri, 1993). Under saline condition, germination and plumule length of oat decreased with increasing salinity levels (Tiwari et al., 2000). Excessive salinity reduces productivity of many crops including most vegetables (Pena and Hughes, 2007). According to Begum et al., (2010) germination of seeds depends on the utilization of reserved food material of the seed. According to Navaz et al., (2010) salt stress reduced the ability of plants to absorb water which leads to reduction in growth. Salinity results in delayed germination, high rate of seeding mortality, stunted growth and reduced yield (Muhammad and Hussain, 2010). According to Sarker et al. (2014) salinity stress significantly decreased germination and growth parameters of seedlings of four vegetable crops (radish, cabbage, mustard and water spinach). Salinity is a constraint to the sustainable agricultural production. Increasing salinity was found to inhibit growth, height, and total of leaf area of rice from vegetative to generative stages (Hariadi et al., 2015).

Coriander (Coriandrum sativum) which belongs to family Apiaceae (Umbelliferae), is a fast growing annual herb which possesses nutritional and medicinal properties, besides, it is one of the most commonly used spices. The first medicinal uses of the plant were reported by the ancient Egyptians. The plant is native of the Mediterranean region and is extensively grown in Europe, Moroeeo, India and South America. In India, coriander is cultivated in Rajasthan, Madhya Pradesh, Uttar Pradesh and southern states like Andhra Pradesh, Karnataka, and Tamil Nadu. In India, coriander is known as 'dhania' in Hindi language. Coriander seeds and leaves are used as common food flavoring agents both sweet and savory dishes, especially in Europe and India. It helps to remove toxic mineral residue, such as mercury and lead and excretes them in the urine or faeces (Leena et al., 2012). Both leaves and seeds of the plant are used for medicinal purpose. Oil of coriander is used in medicine and in flavoring beverage , such as gin, whisky and various liqueurs.

It is a tropical crop and can be grown throughout the year (except very hot season i.e. March-May) for leaf purpose, but for higher grain yield it has to be grown in specific season. A dry and cold weather free from frost especially during flowering and fruit setting stage favours good grain production. Coriander grows in sandy –loamy, fertile and humus–rich soil in between October to May month. It performs well at a temperature range of 20-250C and soil pH is of 6.0-6.7. In general, coriander is known as moderately tolerant to salinity, the effect appears mainly during germination and plant growth (Elouer and Hannachi, 2013). In this context, the objective of this work is to study the germination and seedling growth of coriander under salt stress condition.

Materials and Methods

The aim of this study was to detect the effect of salinity stress on seed germination and early seedling growth of Coriander (Coriandrum sativum) and to evaluate its tolerance to various salinity levels. The Seeds of three cultivars viz. PD-21, Pant Haritma and Kalmi were procured from G. B. Pant University of Agriculture and Technology, Pant Nagar (Uttrakhand). Sand culture method was applied for this study. Before starting the experiment, the sand which was used for seed germination, washed with water for removing impurities from it. After that this sand was sterilized in hot air oven at 600C temperature for 36 hours. Each plastic pot was filled with 200 gm sand. Consequently, solutions of different concentration (25, 50, 75 and 100 mM) were prepared by dissolving NaCl salt in distilled water.

Now three-three pots were irrigated with 100 ml of each of saline water separately and distilled water was used as control. Healthy and uniform sized seeds were sterilized with 0.01% HgCl2 for a minute and washed thoroughly in distilled water. Twenty seeds were sown in the depth of 2cm in each plastic pot. The experiment was set up in randomly block designed triplicates at room temperature (280 C in day and 180 C at night). The amount of water evaporated was also compensated by adding suitable quantity of water to respective pots. After four days seeds were start to germinate. Control seeds were considered as having germinated when radicle protruded to a length of 1 mm. These salinity concentrations were continued for ten days from seed germination until plants collecting. After ten days data were recorded including percentage of seed germination, root and shoot length, fresh weight of roots and shoots. The dry weight of roots and shoots were measured after drying in hot air oven at 600C temperature for 46 hours. The data analysis of variance is done by SAS statistical programs. The treatment means compared using the Duncon test 0.05 probability level.

Result and Discussion

Germination: Seed germination is one of the most salt–sensitive plant growth stages and is severely inhibited with increasing salinity (Bouda and Haddioui 2011). Data on germination percentage under saline condition in all the varieties have shown in figure -1. Germination percentage decreases significantly when salinity levels increase from 25 to 100 mM. In the present study, germination was not count at higher salinity level (100 mM). The maximum reduction in germination percentage was recorded in cultivar Kalmi (22.22-65.67%) followed by Pant Haritma (16.67-55.56%). The cultivar PD-21 showed minimum reduction (17.65-47.06%) at 25, 50 and 75 mM when it was compared with control set. These results are similar with the findings of Fredj et al. (2013) who reported the reduction in germination percentage of coriander when salinity levels increased. Similar results were observed by various researchers in fenugreek (Ratankar and Rai, 2013), in sunflower (Turhan and Ayaz 2004), barley (Kadri et al., 2009) and spinach (Keshavarzi et al., 2011). This germination reduction can be attributed to prevention of water uptake created by the salinity condition . This can also be due to the toxic effects of Na and Cl ions on germination process (Khajeh-Hossini et al., 2003).

Root and shoot length: Root and shoot lengths are the most important parameters for studying salt tolerance as roots are in direct contact with soil. Figure-2 showed that, the root length and as well as shoot length decreases with increasing concentration of salt. At 25 to 75 mM salinity levels, 27.50-70.00% reductions in root length and 17.95-70.51% reductions in shoot length were recorded in Kalmi followed by Pant Haritma 20.59-61.76% and 14.29-61.43% respectively. The cultivar P D-21 showed minimum reduction (10.67-52.00%) at these levels of salinity when it was compared with control set.

These results are agreements with the findings of Ratnakar and Rai (2013) who reported that effects of salinity on early seedling growth of fenugreek. Similar findings are recorded by Assadi (2009) in fenugreek, Jaleel (2008) in Catharanthus roseus and Foolad (1996) in tomato, Naseer, (2001) in barley for root length, Ghanbari et al., (2013) in basil for shoot length and Mensah et al., (2006) in groundnut and Afkari (2010) in sunflower for number of leaves . Keshavarzi et al., (2011) suggested that salinity leads to reduce water uptake which interferes with cell division and differentiation thereby affecting the root length and shoot length. This decrease of root length may be due to NaCl toxicity and disproportion in nutrient absorption by the seedlings (Bybordi and Tabatabaei 2009).

Shoot and root fresh weight: It is cleared from the figure-3.1 and 3.2 that shoot and root fresh weights have significantly decreased with increasing NaCl concentration. Abbass and Latif , 2005 have also found a trend in fresh weight and dry weight of jute seedlings under NaCl stress. Salinity stress significantly affected root and shoot fresh weight as the salt concentration increased. Reduction in shoot fresh weight 23.53-64.71% and root fresh weight 26-68% was recorded in cultivar Kalmi followed by Pant Haritma 21-60% and 22-64% respectively. The cultivar PD-21 showed minimum reduction 15.38-51.28% in shoot fresh weight and 20.00-57.78% in root fresh weight at 25, 50 and 75 mM when it was compared with control. The decrement was related to the concentrations of NaCl. Our result are agreements with the findings of Okcu et al., 2005 (Pisum sativum), Cicek and Cakirlar, 2002 (maize) Farhoudi and Tafti, 2011 (soyabean), Khan et al., 2009 (wheat), Keshavarzi, 2011(savory), Abbaspour, 2010 (carthamus), Banakar and Ranjbar, 2010(pistachio) and Zhani et al., 2012a (pepper).

Shoot and root dry weight: Reduction in dry weights is relatively dependent on the decrease in shoot length and root length (Atak et al.2006). Dadkhah and Grrifiths (2006) attributed such a decrease in dry weight to greater reduction in uptake and utilization of mineral nutrients by plants under salt stress. Under increasing stress level shoot and root dry weight significantly decreased in all 3 cultivars. Reduction in shoot dry weight 30.28-73.48% and root dry weight 32.35 -76.47% and was recorded in Kalmi followed by Pant Haritma 25.91-66.84% and 28.95-68.42% and respectively. The minimum reduction of shoot dry weight 17.64-56.56 root dry weight 20.93-58.14% was recorded in PD-21 at 25, 50 and 75mM when it was compared with control. A decrease in dry and fresh weight in maize seeding under NaCl salinity observed by (Chaum and Kirdmanee, 2009). According to them salinity leads to water deficit in plants thereby causing a decrease in fresh weight and dry weight. This findings are agreements with those obtained by Pessarakli and Kopec, 2009 (ryegrass), Turan et al., 2009 (maize), Ratnakar and Rai, 2013 (fenugreek).

Total seedling dry weight: Data on effect of salinity on dry weight of total seedling indicate a gradual decrease in both root and shoot dry weight in NaCl stressed plants. The total seedling dry weights of all cultivars were differently decreased with increasing concentration of NaCl. 18.26% reduction in total seeding dry weight was recorded in Kalmi followed by Pant Haritma 26.47%. The cultivar PD-21 showed minimum reduction 30.62-73.96% in total seeding dry weight at 25 to 75mM when it was compared with control. This result are agreements with the findings of Degar (2004) in Salvadora persica, Jaleel (2008) in Withania somnifera, Afzal et al., (2005) Triticum aestivum, Jamil et al., (2006) in sugarbeet, cabbage, amaranth, and pak-choi and Asfaw (2011) in Sorghum biolor L. Moench. Ashraf et al., (2002) reported that the reduction in seedling fresh and dry weight is due to decreasing water uptake by seedling in salt stress presence. Mohamedin et al., (2006) have also been reported that salinity induced water deficit hence the reduced plant growth. Increased drought stress level reduced radicle length and seedling dry weight in canola cultivars (Mohamaddi and Amir, 2010).

Conclusion

On the basis of present study it can be concluded that Coriander (Coriandrum sativum) is sensitive to NaCl salinity. Increasing concentrations of NaCl salinity in growth medium adversely affected the percentage germination, delayed the process of germination. Salinity stress at germination and early growth stages is associated with osmotic stress and ion toxicity rather than oxidative stress which inhibit the plant growth rate and weight of plant.

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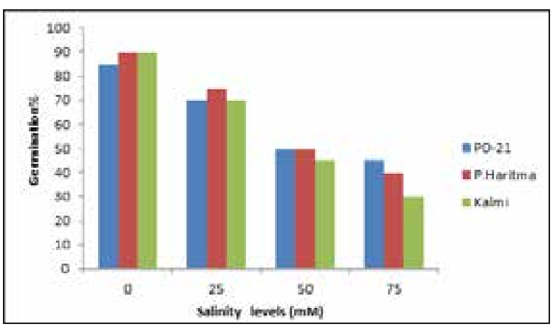

Fig. 1. Effect of NaCl salinity on germination percentage of three coriander cultivars.

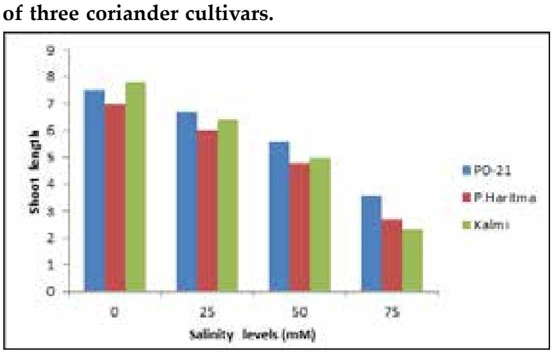

Fig -2.1: Effect of NaCl salinity on shoot length of three coriander cultivars.

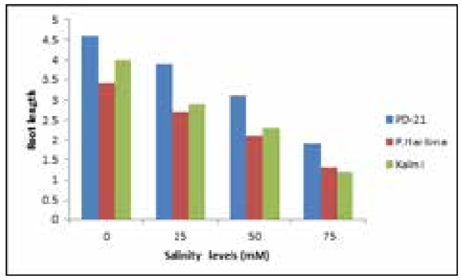

Fig- 2.2: Effect of NaCl salinity on root length of three coriander cultivars.

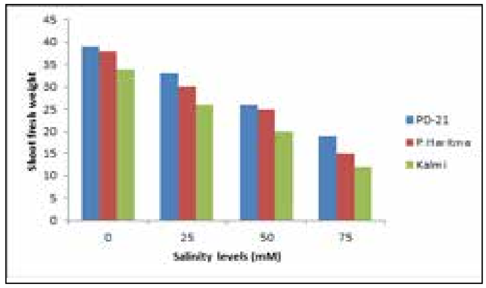

Fig-3.1: Effect of NaCl salinity on shoot fresh weight of three coriander cultivars.

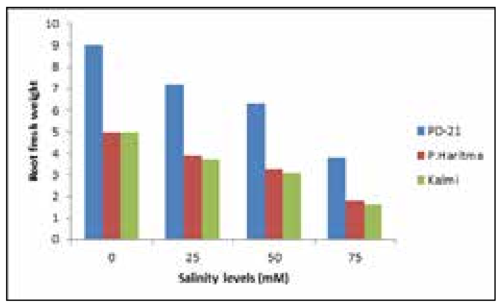

Fig-3.2 : Effect of NaCl salinity on root fresh weight of three coriander cultivars.

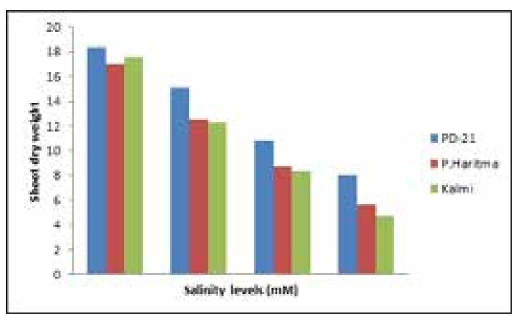

Fig- 4.1: Effect of NaCl salinity on shoot dry weight of three coriander cultivars.

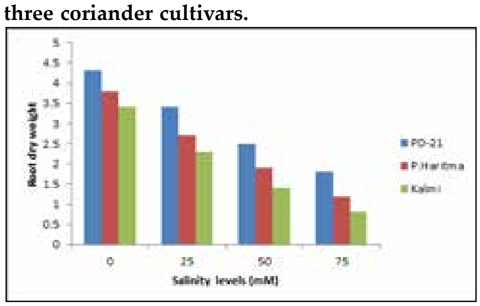

Fig-4.2: Effect of NaCl salinity on root dry weight of three coriander cultivars.

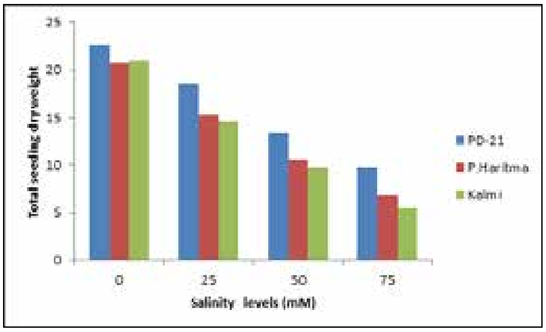

Fig-5: Effect of NaCl salinity on total seeding dry weight of three coriander cultivars.

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