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Original Research Article

GENETIC EVALUATION FOR MORPHOLOGICAL TRAITS OF *CORIANDRUM SATIVUM* GROWN UNDER SALT STRESS

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Abstract: *The Coriandrum is most important among the herb which is used as an ingredient in daily human food. It contains a good amount of antioxidants and health improving ingredients that save human body cells from diseases. It is very sensitive for abiotic environmental stress conditions involving drought, heat, and salt stress as important stress conditions. For this purpose, a study was planned to conduct in the greenhouse of the Institute of Molecular Biology and Biotechnology, University of Lahore to determine the effects of salt stress on Coriandrum seedling growth. For our study we have selected four Coriandrum varieties viz., GAMZE, EAGLE, SUPER XO, and PAK-ORG. The results revealed that there were significant differences among the treatments of NaCl concentrations, Coriandrum genotypes, and the interactions among the Coriandrum genotypes and salt concentrations applied. The average Coriandrum seedling length was recorded as 23.021±1.2026cm while root length was recorded as 22.0128±1.0027cm. The genotype GAMZE showed higher root and shoot length which indicated that GAMZE was a higher salt-tolerant genotype and may be used as a salt-tolerant genotype to improve yield per plant in Coriandrum. The genotype EAGLE has shown poor performance for all of the studied traits which indicated that it was a salt-sensitive Coriandrum genotype. The genetic advance and heritability were found higher for all of the studied traits. The significant correlation between shoot length and root length indicated that the genotypes grow longer roots under stress conditions to increase the shoot length of plants while survive under stressful environmental conditions. The selection of Coriandrum genotype on the basis of root length and shoot length may be useful to improve slat stress tolerance in Coriandrum genotypes for higher seed and green plant biomass yield.*

Keywords: *Coriandrum sativum*, salt stress, genetic advance, heritability, seedling traits, root length, shoot length

Introduction

Dhaniya consist of dried ripe fruit of *Coriandrum sativum* Linn Umbeliferae (Evans, 2002), a Slender, glabrous, branched, cultivated all over Pakistan, giving characteristic aroma when rubbed. It is annual herb originating from the Mediterranean (Mir, 1992; Rondon et al., 2011; Vaidya and Gogte, 2000). The whole plant and especially the unripe fruit, is characterized by a strong disagreeable odour, wherever the name coriander (from the Greek k'opis, a bug) (Gruenwalded, 2004). In Pakistan the *Coriandrum* is grown or cultivated around whole year times in each of the year as autumn as well as spring seasons of country. With an active involvement for multinationals in the country, the growing or cultivation of *Coriandrum* has been improved or increased as compared with previous years. However, the climatic as well as the soil conditions in Pakistan has been most responsive and adaptive for *Coriandrum* seed and green production however the yield is still very low in Pakistan as compared with other *Coriandrum* growing countries of the world (Aissaoui et al., 2008; Ali et al., 2008; Bilal et al., 2020). The crop protection and it management plays an important role in the improvement of grain yield and production under every type of environmental conditions. The management inputs are included as the improved seed varieties, irrigation, the planting pattern, crop sowing times, the use of fertilizers and crop plant population play an effective and major role in enhancement of crop plant and grain yield under any type of environmental condition (Eguale et al., 2007; Handa and Kaul, 1996). The *Coriandrum* crop plant is generally cultivated or grown under the irrigated field conditions of Pakistan. The water has been shortening due to shortage or less of rain falls, the water has been becoming scarce throughout the whole country which is causing salt stress. The water limitations and salt stresses have also adverse effects on other crop plants like other crops (Kansal et al., 2011; Matasyoh et al., 2009).

The significant losses of *Coriandrum* seed yield have been projected because of drought which is increasing with the global climate changes in the major *Coriandrum* producing areas of the world. The

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majority of the *Coriandrum* has been grown under the irrigated conditions of Pakistan (Mir, 1992; Ramadan and Mörsel, 2002). The *Coriandrum* plant suffers due to salt and drought stress up to 40-80% in yield loss. The salt has been considered one of the major factors which affect plant growth as well as the seed yield of *Coriandrum*. There has been a need for recognizing a suitable and executive technique for *Coriandrum* cultivation which can resist salt and drought stress environmental conditions (Ramadan and Mörsel, 2002; Silva et al., 2011). The *Coriandrum* has higher water demands which can give higher grain production even when the water, mineral and other soil nutrients have become sufficient in amount and avail to plants easily, the *Coriandrum* plant is also very sensitive (Pharmacopoeia, 2005) for salt and water deficit of moisture stress environment along with other stress environments like cold, heat, salt and alkaline conditions (Pharmacopoeia, 2005; Saeed and Tariq, 2007).

Materials and methods

Coriandrum is herb plant which is grown throughout whole world for its use in food, salad and other herbal byproducts. *Coriandrum* is very sensitive to abiotic or environmental stress conditions involving drought, heat, cold and salt stress as important stress conditions. For this purpose a study was planned to conduct in greenhouse of IMBB (Institute of Molecular Biology and Biotechnology), The University of Lahore, Lahore to estimate effects of salt stress on *Coriandrum* seedling growth. For our study we have selected three *Coriandrum* varieties viz., GAMZE, EV-097Q, SUPER XO and PAK-ORG. Seed from selected *Coriandrum* genotype was used to grow in 54 pots, filled with 2kg pure washed sand. The sand was mixed with 500mg/kg of NaCl in each of the pot except of the control pots for *Coriandrum* sowing. The seed of each variety were sown in triplicate pots with all irrigation requirements in equal manners. To carry out our research work we have used following sets for treatment of NaCl: T0. Control or no any salt treatment, T_1 0.2Molar NaCl, T_2 0.4Molar NaCl, T_3 0.6Molar NaCl, T_4 0.8Molar NaCl and T_5 1Molar NaCl. The treatment of salt or NaCl was applied after the germination of *Coriandrum* seeds and data was recorded for various seedling traits. The treatment was applied and again data was recorded after one week of salt application. The data recorded for two times from two weeks was pooled to carried analysis of variance and all pairwaise comparisons for *Coriandrum* varieties and treatments of salt. Data was recorded for various morphological traits including, roots per plant, root length, shoot length, shoot water contents and root water contents. The recorded data which was statistically analyzed through using analysis of variance techniques through using SPSS23.1 software.

Results and discussions

The results form table 1 revealed that there was significant differences for all studied traits among the treatments of NaCl concentrations (0.2Molar, 0.4Molar, 0.6Molar, 0.8Molar and 1Molar) along with control and *Coriandrum* genotypes used for research evaluation and the interactions among the *Coriandrum* genotypes and salt concentrations applied. The results also indicated that there was lower coefficient of variation (ranging from 0.35% to 0.99%) recorded for all studied traits of *Coriandrum* under effects of various salt concentrations which indicated that the consistency of results was higher and predications may be useful for selecting *Coriandrum* under salt stress to use as response variable. The heritability wa found higher for root water contents (93.245%) followed by root length (92.882%), shoot water contents (90.234%), shoot length (89.2315) and roots per plant (88.089%). The higher heritability indicated that the selection of *Coriandrum* genotypes may useful to produce hybrids or composite varieties of *Coriandrum* for improving yield under salt stress conditions. The genetic advance was found relative higher for all of the studied traits which revealed that the selection of *Coriandrum* genotypes may be useful to produce synthetic varieties for improved yield under slat stress conditions. The average length of shoot in *Coriandrum* genotypes was recorded as 23.021±1.2026cm under all salt concentration applications. The higher shoot length under salt concentration indicated that the *Coriandrum* genotypes showed tolerance against salt stress and tends to improve plant growth and development even under salt stress environment (Rahman et al., 2009; Ramadan et al., 2003; Singletary, 2016). The results from all pairwise comparison revealed that there was higher shoot length of *Coriandrum* seedlings under the treatment of 0.6Molar NaCl (25.140cm) followed by 0.2Molar NaCl (24.08cm) and 0.4Molar NaCl (23.037cm) while lowest length of shoot in *Coriandrum* genotypes which was found under the application of 1Molar NaCl (21.173cm) concentration. The higher shoot length under lower NaCl concentrations indicated that there were litter effects due to salt applications on growth as well as development of seedlings while with the increase in the concentration of NaCl application the seedling length was decreased which showed the adverse

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effects of salt applications on *Coriandrum* seedling growth. The lowest under higher 1Molar NaCl concentration indicated that the application of higher concentration caused more damages in the seedling to reduce growth and development (Mandal and Mandal, 2015; Msaada et al., 2007; Ovais et al., 2018).

Table 1. Analysis of variance of *Coriandrum* traits morphological under different salt concentrations

Source	DF	Shoot length	Root length	Roots per plant	Shoot water contents	Root water contents
Replication	1	11.4309ns	9.0828ns	9.00ns	10.0238ns	12.00ns
Genotypes	3	3.0467*	7.6075*	22.6342*	33.4521*	3.8611*
Treatments	5	22.8233*	25.9515*	27.9255*	45.0832*	21.7500*
Genotypes × Treatment	15	7.6033*	1.6475*	23.1908*	26.2421*	3.9278*
Error	23	0.00002	0.00001	0.00001	0.0002	0.00001
Grand mean		23.021	22.0128	9.5617	84.905	79.508
Standard Error		1.2026	2.0135	0.3452	3.5012	3.0054
Coefficient of variation		0.82	0.62	0.99	0.50	0.35
Heritability (h^2b.s)		89.231	92.882	88.089	90.234	93.245
Genetic advance		18.237	13.254	17.204	16.242	18.254

*= significant at 5% probability level, ns = non-significant

Table 1a. All-Pairwise Comparisons Test of morphological traits under different salt treatments

Treatments	Shoot length	Root length	Roots per plant	Shoot water contents	Root water contents
T_0 control	21.207D	21.380 D	9.390 B	85.146 AB	79.393 B
T_1 0.2Molar NaCl	24.080B	22.080 C	9.323 B	85.104 AB	80.010 A
T_2 0.4Molar NaCl	23.037C	19.800 F	10.423 A	84.551 B	79.173 B
T_3 0.6Molar NaCl	25.140A	24.933 B	9.423 B	85.443 A	79.484 B
T_4 0.8Molar NaCl	21.240D	20.733 E	9.423 B	84.621 B	79.520 B
T_5 1Molar NaCl	21.173D	26.727 A	9.387 B	84.566 B	79.469 B

Table 1b: All-Pairwise Comparisons Test for *Coriandrum* genotypes under different salt treatments

Genotypes	Shoot length	Root length	Roots per plant	Shoot water contents	Root water contents
SUPER XO	21.957 C	22.417 C	9.4456 B	85.624 A	80.683 A
PAK-ORG	22.741 B	2 22.593 B	9.4939 B	83.885 C	78.896 B
GAMZE	23.241 A	22.817 A	9.7456 A	85.206 B	78.946 B
EAGLE	20.13 D	21.134 D	8.8721 C	82.133 D	77.214 D

The average length of root in *Coriandrum* genotypes was recorded as 22.0128±1.0027cm under all salt concentration applications (Table 1). The higher length of root under salt concentration showed that *Coriandrum* or *Coriandrum* genotypes showed tolerance against salt stress and tends to improve plant growth and development even under salt stress environment (Gruenwalded, 2004; Ikeura and Kobayashi, 2015; Pandey et al., 2011). The results from all pairwise comparison revealed that there was higher root length of *Coriandrum* seedlings under the treatment of 1Molar NaCl (26.727cm) followed by 0.6Molar NaCl (24.933cm) and 0.2Molar NaCl (22.080cm) while lowest length of roots in *Coriandrum* genotypes was found under the application of 0.4Molar NaCl (19.800cm) concentration. The higher length of roots under high NaCl concentrations indicated that there were litter effectiveness due to salt applications on the growth and development of seedlings while with the decrease in the concentration of NaCl application the length of roots was decreased which showed negative effects due to salt applications on *Coriandrum* seedling growth (Table 1a). The lowest under 0.4Molar NaCl concentration indicated that the application of lower concentration caused more damages in the seedling to reduce growth and development (Coşkuner and Karababa, 2007; Diederichsen, 1996; Eguale et al., 2007).

The average roots/plant of *Coriandrum* genotypes was recorded as 9.5617±0.3452 under all salt concentration applications (Table 1). The higher number of roots per plant under salt concentration indicated that the *Coriandrum* genotypes showed tolerance against salt stress and tends to improve plant growth and development even under salt stress

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environment (Kansal et al., 2011; Laribi et al., 2015; Panngom et al., 2018). The results from all pairwise comparison revealed that there was higher number of roots per plant of *Coriandrum* seedlings under the treatment of 0.4Molar NaCl (10.423) followed by 0.6Molar NaCl (9.423) and 0.8Molar NaCl (9.423) while lowest roots/plant of *Coriandrum* genotypes was found under the application of 0.2Molar NaCl (9.323) concentration. The higher roots/plant of *Coriandrum* under high NaCl concentrations indicated that there were litter effects of salt applications on the growth and development of seedlings while with the decrease in the concentration of NaCl application the roots/plant of *Coriandrum* was decreased which showed the adverse effects of salt applications on *Coriandrum* seedling growth (Table 1a). The lowest under 0.2Molar NaCl concentration indicated that the application of lower concentration caused more damages in the seedling to reduce growth and development (Matloup et al., 2017; Rebey et al., 2019; Sankaranarayanan et al., 2012; Sen et al., 2008). The average shoot water content of *Coriandrum* genotypes was recorded as 84.905±3.5012% under all salt concentration applications. The higher shoot water content under salt concentration indicated that the *Coriandrum* genotypes showed tolerance against salt stress and tends to improve plant growth and development even under salt stress environment (Godara et al., 2014; Hnamte et al., 2013; Malhotra et al., 2006). The results from all pairwise comparison revealed that there was higher shoot water contents in *Coriandrum* seedlings under the treatment of 0.6Molar NaCl (85.443%) followed by control (85.146%) and 0.2Molar NaCl (85.104%) while lowest shoot water contents of *Coriandrum* genotypes was found under the application of 0.4Molar NaCl treatment (84.551%) concentration. The higher shoot water content under high NaCl concentrations indicated that there were litter effects for salt applications on the growth and development of seedlings while low NaCl treatment the root dry weight was decreased which showed the adverse effects of salt applications on *Coriandrum* seedling growth. The low NaCl treatment indicated that the application of low treatment caused more damages in the seedling to reduce growth and development (Rondon et al., 2011; Sahu et al., 2014).

The average root water content of *Coriandrum* genotypes was recorded as 79.508±3.0054% under all salt concentration applications (Table 1). The higher root water content under salt concentration indicated that the *coriandrum* genotypes showed tolerance against salt stress and tends to improve plant growth and development even under salt stress environment (Dadiga et al., 2015; Jamali, 2012; Khan and Parveen, 2018; Mehta et al., 2011; Singh, 2013). The results from all pairwise comparison revealed that there was higher root water contents in *coriandrum* seedlings under the treatment of 0.2Molar NaCl (80.010%) followed by 0.8Molar NaCl (79.520%) while lowest root water contents of *Coriandrum* genotypes was found under the application of 0.4Molar NaCl treatment (79.173%) concentration (Table 1a). The higher root water content under low NaCl concentrations indicated that there were litter effects of salt applications on the growth and development of seedlings while high NaCl treatment the root dry weight was decreased which showed the adverse effects of salt applications on *Coriandrum* seedling growth. High NaCl treatment indicated that the application of high treatment caused more damages in the seedling to reduce growth and development (Abdollahi et al., 2016; Dash et al., 2019; Mohammadipour and Souri, 2019; Singh, 2015).

The results showed that the variety GAMZE showed higher roots per plant, root water contents, shoot water contents, root and shoot length which indicated that GAMZE was higher salt tolerant genotype and may be used as salt tolerant genotype to improve yield per plant in *Coriandrum*. The genotype EAGLE has shown poor performance for all of the studied traits which indicated that it was salt sensitive *Coriandrum* genotype (Table 1b).

Table 2. Survival percentage of *Coriandrum* genotypes under different salt treatments

Treatments	GAMZE	EAGLE	PAK-ORG	SUPER XO
T_0 control	100	100	100	100
T_1 0.2Molar NaCl	89.34	78.43	81.23	82.35
T_2 0.4Molar NaCl	83.85	72.35	80.90	80.25
T_3 0.6Molar NaCl	81.20	70.23	82.45	78.54
T_4 0.8Molar NaCl	78.09	67.98	78.82	79.32
T_5 1Molar NaCl	79.04	62.20	77.09	78.23

The results from table 2 indicated that the genotype GAMZE showed higher survival rate percentage under all of the salt stress conditions as compared with other genotypes while the genotype EAGLE

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showed lower survival rate. It was also found that the survival rate was decreased in all of the genotypes with increased in salt stress effects. The decrease in survival indicated that the salt stress caused harmful effects on *Coriandrum* genotypes while the genotype GAMZE showed relatively higher survival rate which revealed that it may be used as salt tolerance *Coriandrum* genotype (Mazhar et al., 2020; Shafique, 2020; Zubair et al., 2016). The results from table 3 indicated that there was a significant and positive correlation of shoot length with root length, roots per plant and shoot water contents. The significant correlation between shoot length and root length indicated that the genotypes grow longer roots under stress conditions to increase the shoot length of plants while survive under stressful environmental conditions. The selection of *Coriandrum* genotype on the basis of root length and shoot length may be useful to improve slat stress tolerance in *Coriandrum* genotypes for higher seed and green plant biomass yield (Ali et al., 2013; Ali et al., 2016; Ali et al., 2014).

Table 3. Correlation for morphological traits of *Coriandrum* genotypes under different salt treatments

Traits	Shoot length	Root length	Roots per plant	Shoot water contents
Root length	0.4258*			
Roots per plant	0.3712*	0.5623*		
Shoot water contents	0.4622*	-0.3482*	0.0023	
Root water contents	0.2381	0.4526*	0.3284*	0.5291*

*= significant at 5% probability level

Conflict of interest

The authors declared absence of conflict of interest.

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