Genotypic Variability in Salinity Tolerance of Some Vegetable Crop Species at Germination and Seedling Stage

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Abstract

Using a novel semi-hydroponic technique it was assessed that highly significant differences were found among all genotypes with respect to seedling parameters studied. In all vegetable crops, in general, significant differences were found among genotype, NaCl - concentration and interaction between genotypes & NaCl - concentration with respect to emergence (%), emergence index, shoot length & root length. High r^2 and low CV (%) indicates the reliability of the technique. Emergence was highly correlated with shoot length, and Root length showing the contribution of shoot length and root length to salinity tolerance in different vegetable crops. With increasing salinity, there was increase in root length in salinity tolerant lines but there was corresponding decrease in root length in susceptible ones. Salinity tolerant genotypes was selected in okra at 0.1 M NaCl: 7025, 7033 and 703. Salinity tolerant genotypes was selected in tomato at 0.1 M NaCl: 132, 113, 125, 126 and 12, also in chilli at 0.1 M NaCl.

1. Introduction

It is well known that vegetable crops are grown under high input situation salinity is not a great problem but occasionally farmers irrigate water their crops with brackish-saline water which may affect seedling growth. Therefore, salinity tolerant genotypes could do better.

Vegetables are sources of minerals and vitamins for human diet. With increasing population there an increasing demand of vegetables throughout the world urging a great necessity for increasing the production of vegetables. But the productivity of vegetable is affected due to various abiotic stress factors such as drought, salinity and low nutrient conditions. Soil salinity is becoming a serious problem throughout the world. Alarge area of the cultivable land is being converted into saline soils due to indiscriminate use chloride and sulphate containing fertilizers to build up of these ions in the soil profile (Maiti et al., 2004). Very little information is available on research on salinity in vegetables (Shannon and Grieve, 1999). Several studies have revealed that salinity affects germination and seedling growth in vegetable crops (Schmidhalter and Saladino, 1990; Crucci et al., 2003). Maiti et al. (2004) reported significant variability to salinity tolerance among some vegetable crop species. Among them celery showed higher level of tolerance followed by cabbage, beet leaves, green tomato. Salinity affected the quality and productivity of vegetables (Yo and Shaw, 1990; Singh and Mangal, 1991; Pascale and Barberi, 1995; Sharma et al., 2001). It is reported that at certain concentrations, saline water might be utilized to irrigate vegetable crops (Kowaski and Pailada, 1995). Maiti et al. (2007) reported variability in salinity tolerance and osmotic stress among vgetable crop species. Brinjal showed higher level of tolerance to salinity. Okra showed highest level of tolerance to salinity. Genotypic variability in salinity tolerance at the seedling stress has been reported among tomato genotypes (Maiti et al., 2007).

It is well known that vegetable crops are grown under high input situation salinity is not a great problem but occasionally farmers irrigate water their crops with brackish-saline water which may affect seedling growth. Therefore, salinity tolerant genotypes could do better under such conditions.

2. Materials and Methods

Different experiments were conducted with different vegetable crop species for salinity tolerance using a novel hydroponic technique.

Expt. 1: Screening of fifteen okra genotypes for salinity tolerance

15 Okra genotypes were screened for salinity tolerance at seedling stage by using semi-hydroponic technique. The technique is explained below:

The genotypes were grown in plastic pots using coco peat in room temperature and artificial light was provided to maintain light up to 14 days. Room temperature was about 27°C. A novel technique has been developed for this purpose. The technique involved consists of sowing the seeds at a depth of 2 cm in a plastic pot (hight 85 mm, diameter 80 mm) filled with coco peat (neutral delignified coir fibres) and then applying water or required saline concentration up to two thirds of the pot. Twenty seeds were sown in each pot in the upper coco peat layer at 2 cm depth which receive water/solution by capillarity.

Semi-hydroponic technique for salinity tolerance

We apply the solution only one time, say water, or saline solution up to the termination of the experiment (14 days after sowing). To protect seeds from fungal attack, seeds were treated with Thiram solution (5 %, p/v) for 5 minutes before sowing. Seeds were sown in each pot under control (distilled water) along with 0.1 M NaCl or at higher salinity level up to 0.15 M NaCl as per specific experiment. Each of the treatments was replicated thrice for all the genotypes. This technique simulates a semi-hydroponic system where the upper layers of coco peat medium receive water/or saline solution only by capillary movement, while the roots are immersed in saturated lower coco peat medium During capillary movement there is free flow of oxygen owing to constant evapo-transpiration. Speed of emergence (emergence index) was calculated by daily taking number of emergence up to 14 days. Observations were taken by taking 14 days old seedlings. Data were taken on average emergence percentage, shoot length (cm), root length (cm) on 14th day. The same procedure and the same variables are taken in all the experiments. The main objective of the present study is to determine the efficacy of this new technique on different sets of vegetable crops for tolerance to NaCl-salinity. In the following figures are represented the response of okra genotypes for salinity tolerance at different concentrations of salinity with respect to different seedling parameters showing large variability among genotypes.

Different varieties (commercial hybrids) of different field crops were evaluated for comparative level of salinity using semi-hydroponic technique at 0.1 M NaCl and 0.15 M NaCl.

Expt. 2: Screening of 24 tomato genotypes for salinity tolerance

Twenty four tomato genotypes were screened for tolerance to salinity using the above system described.

Expt 3: Screening of 13 chili genotypes for salinity tolerance

Thirteen chili genotypes were screened for tolerance to salinity using the above system described.

1. Results and discussion

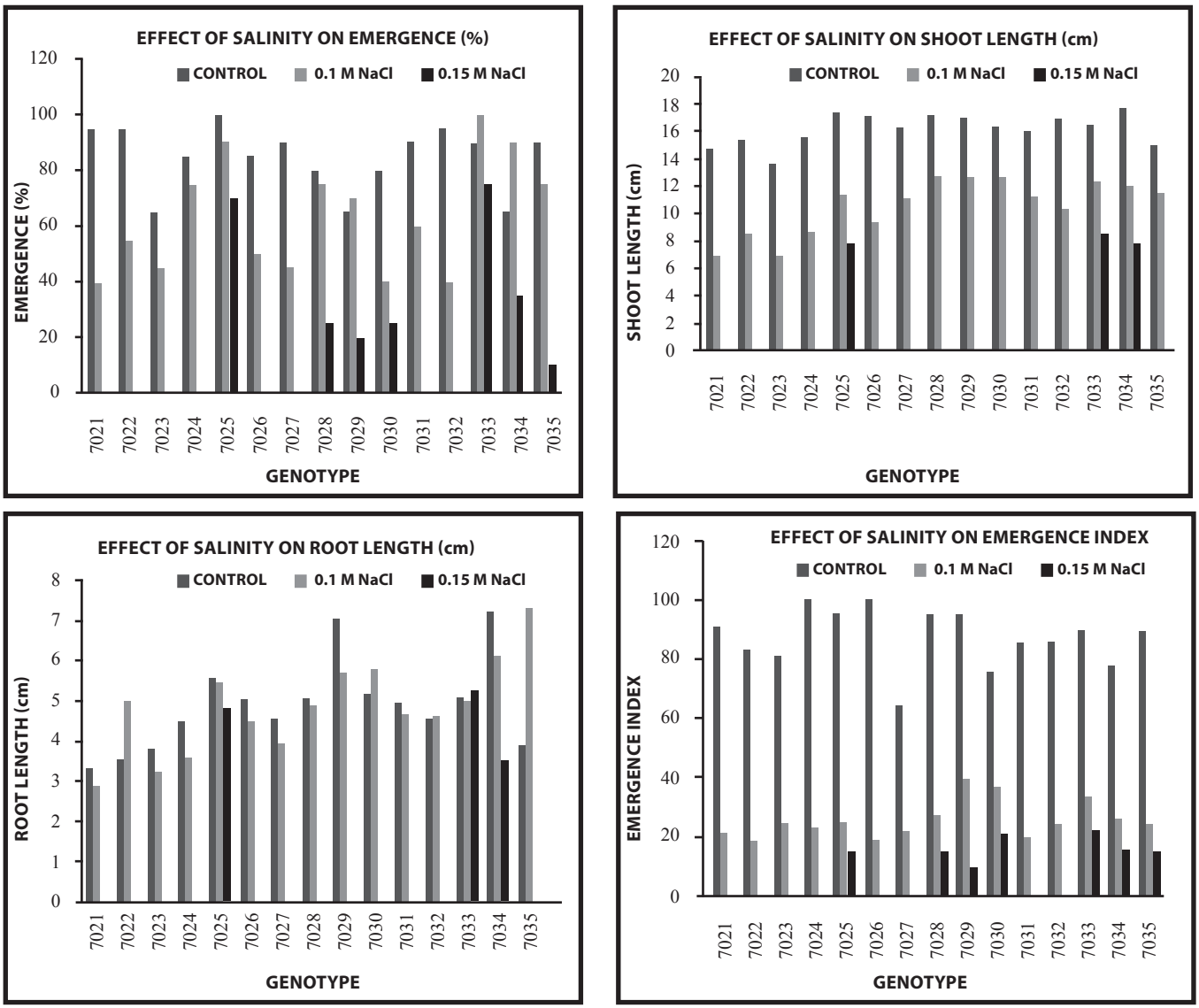


Figure 1: Mean values of emergence (%), shoot length, root length and emergence index.

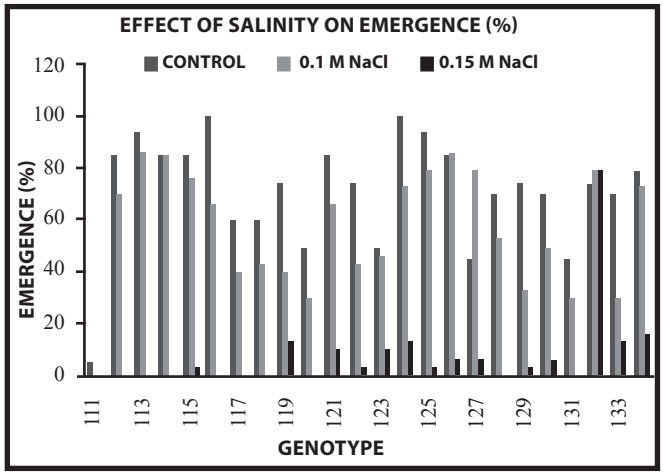
Table 1: Effect of different salinity levels on okra									
Experimental conditions	Source of variation	Variable							
		Emergence (%)		Shoot length (cm)		Root length (cm)		Speed of emergence	
		MS	F	MS	F	MS	F	MS	F
Control, 0.1 & 0.15 M NaCl (13 genotypes)	Genotype (g)	1313.0	4.8***	17.5	19.2***	6.9	9.6***	194.8	2.3*
	NaCl	35524.4	129.9***	1609.9	1774.5***	157.1	219.8***	52521.8	643.8***
	G * NaCl	532.8	1.9*	5.5	6.0***	2.8	3.8***	115.7	1.4 NS
	Error	273.3		0.9		0.7		81.6	
	Mean	55.1		8.8		3.5		40.0	
	r^2	0.791		0.978		0.878		0.937	
	CV (%)	30.0		10.8		23.8		22.6	
NS: Not Significant; p >0.05; *<0.05; **p<0.01; ***p<0.001									

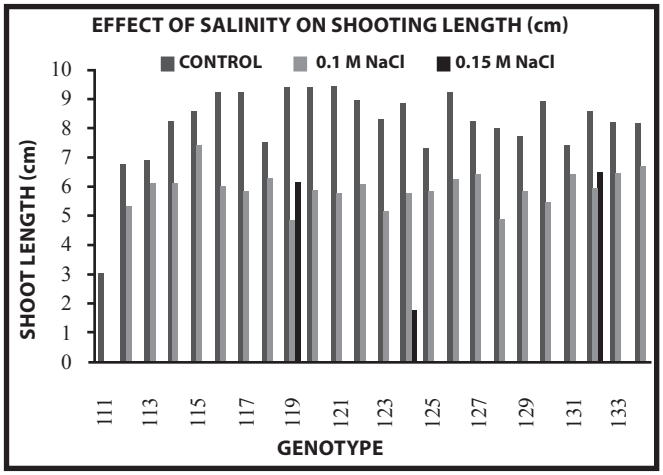
Expt. 1: Screening of fifteen okra genotypes for salinity tolerance

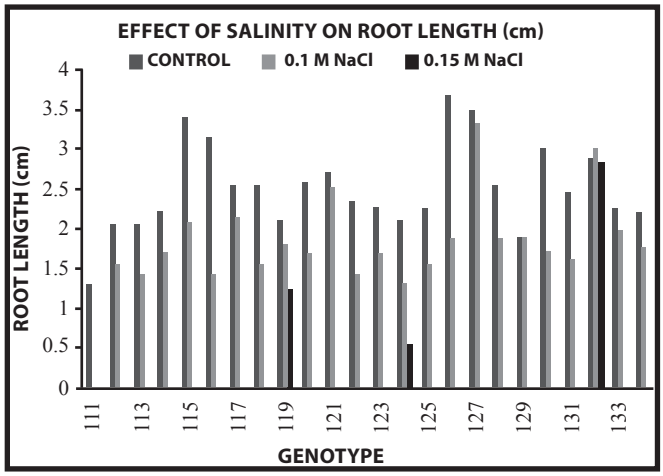
From the mean values it is observed that salinity reduces the emergence (%), shoot length and speed of emergence. Some tolerant genotypes showing increased root length under low saline concentration (0.1 M NaCl), these are 7022, 7030, 7034 and 7035. Genotypes 7025, 7033 and 7034 have above 80 % emergence in 0.1 M NaCl.

Calculated mean squares (MS) and F values from the statistical analysis corresponding to data of 13 okra genotypes subjected to 0.1 & 0.15 M NaCl concentrations. Mean, adjusted coefficient of determination (r^2), and coefficient of variation (CV, %) values are provided.

It is observed that significant differences were observed among genotypes and NaCl-concentration with respect to shoot length and root length. High r^2 and moderate to low







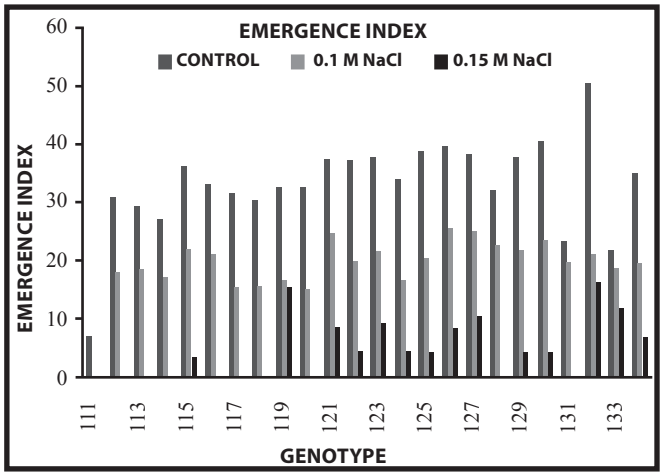
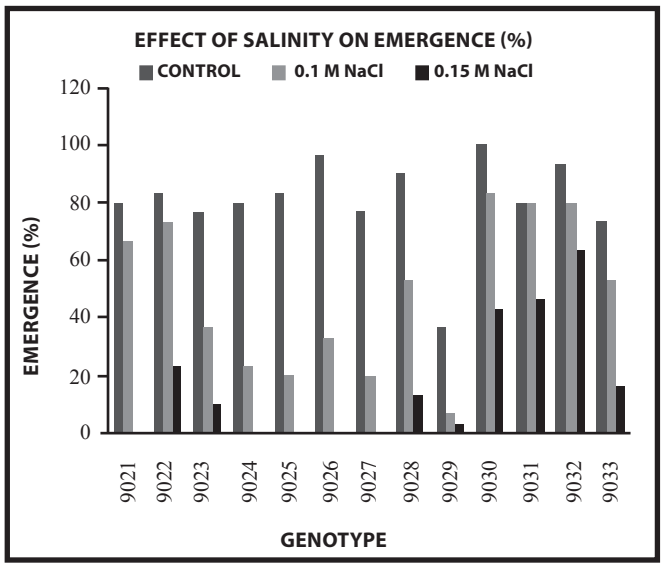
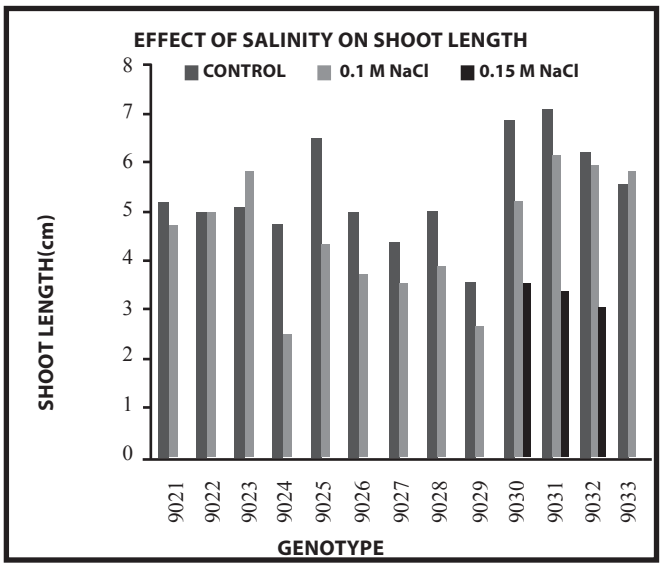
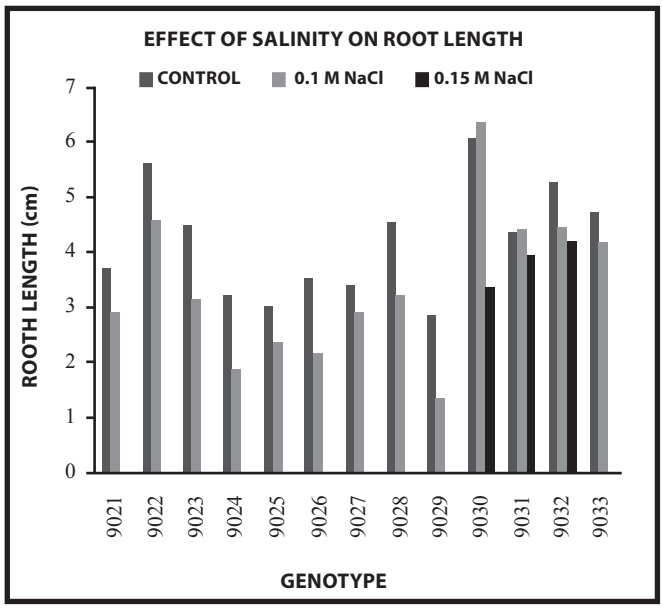


Table 2: Effect of different salinity levels on tomato									
Experimental conditions	Source of variation	Variable							
		Emergence (%)		Shoot length (cm)		Root length (cm)		Speed of emergence	
		MS	F	MS	F	MS	F	MS	F
Control, 0.1 & 0.15 M NaCl (24 genotypes)	Genotype (g)	1914.5	9.8^{***}	8.6	15.2^{***}	1.5	4.8^{***}	204.0	9.9^{***}
	NaCl	70396.3	395.5^{***}	916.5	1607.2^{***}	86.9	271.3^{***}	11831.6	576.2^{***}
	G * NaCl	686.3	3.5^{***}	4.9	8.6^{***}	0.6	1.9^{**}	49.9	2.4^{***}
	Error	195.8		0.57		0.3		20.5	
	Mean	45.3		4.8		1.5		18.9	
	r^2	0.844		0.953		0.781		0.880	
	CV (%)	30.9		15.7		37.9		23.9	
NS: Not Significant; p >0.05; *<0.05; $^{**}p$<0.01; $^{***}p$<0.001									







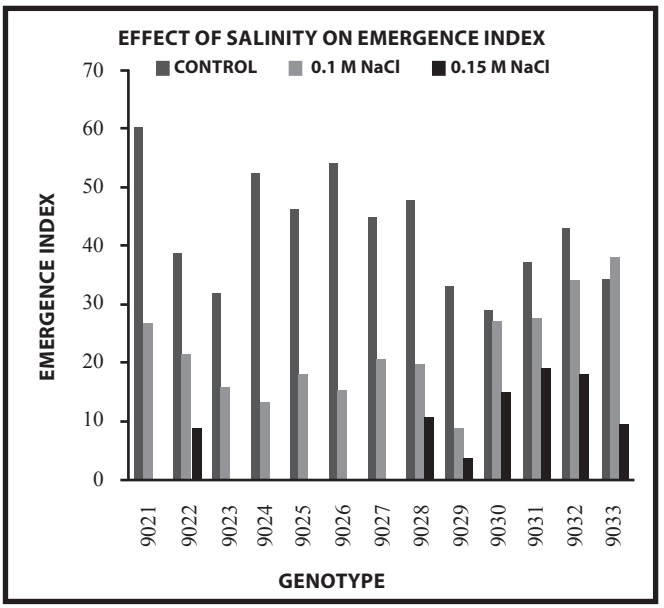
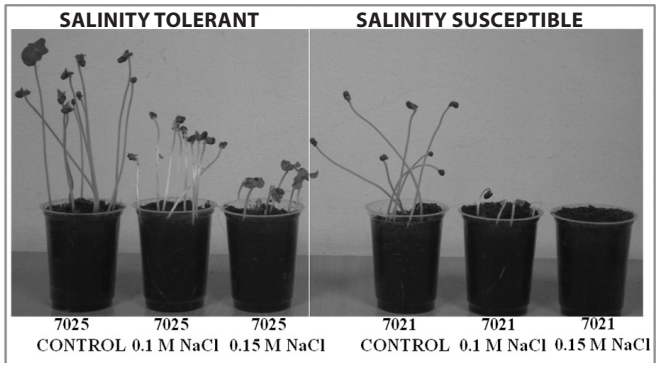
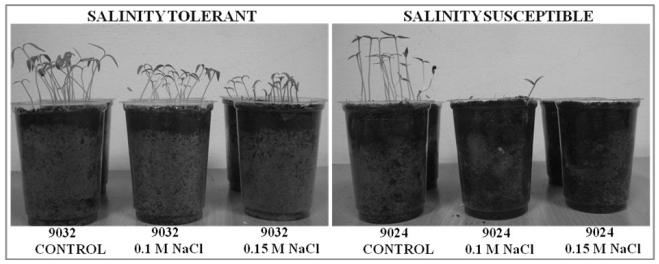


Table 3: Effect of different salinity levels on chilli									
Experimental conditions	Source of variation	Variable							
		Emergence (%)		Shoot length (cm)		Root length (cm)		Speed of emergence	
		MS	F	MS	F	MS	F	MS	F
Control, 0.1 & 0.15 M NaCl (13 genotypes)	Genotype (g)	3033.0	10.0^{***}	10.7	21.1^{***}	13.4	4.8^{***}	204.4	2.8^{***}
	NaCl	39746.2	131.4^{***}	239.6	469.9^{***}	116.4	271.3^{***}	12822.0	174.2^{***}
	G * NaCl	600.8	2.0^{***}	1.7	3.4^{***}	2.0	1.9^{**}	218.7	3.0^{***}
	Error	302.6		0.5		0.7		73.6	
	Mean	48.7		3.6		2.8		23.7	
	r^2	0.772		0.914		0.829		0.782	
	CV (%)	35.7		19.9		30.4		36.1	
NS: Not Significant; p >0.05; *<0.05; $^{**}p$<0.01; $^{***}p$<0.001									





CV (%) indicting the reliability of the technique. Emergence was highly correlated with shoot length (r=0.846* p<0.01), root length (r=0.775* p<0.01) and speed of emergence r. (p<0.01) =701*. The Selected salinity tolerant genotypes at 0.1 M NaCl are 7025, 7033 and 7034.

Expt. 2: screening of 24 tomato genotypes for salinity tolerance at seedling stage

Conclusion: from the mean values it is observed that salinity reduces the emergence (%), shoot length and speed of emergence. Genotypes 113, 125,126, 132 and 134 are showing above 80 % emergence in 0.1 M NaCl.

Calculated mean squares (MS) and F values from the statistical analysis corresponding to data of 24 Tomato genotypes subjected to 0.1 & 0.15 M NaCl concentrations. Mean, adjusted coefficient of determination (r^2), and coefficient of variation (CV, %) values are provided.

NS Not Significant p>0.05; * <0.05; **p<.01; ***p<.001

It is observed that significant differences were observed among genotypes and NaCl-concentration with respect to emergence, shoot length, root length and speed of emergence. High r^2 and low CV (%) indicting the reliability of the technique. Emergence was highly correlated with shoot length (r=0.838* p<0.01), root length (r=0.769* p<0.01) and speed of emergence [r (p<0.01)=.780*]. Selected salinity tolerant genotypes at 0.1 M NaCl are 132, 113, 125, 126 and 127.

Expt. 3: screening of 13 chilli genotype for salinity tolerance

13 chilli genotypes were screened for salinity tolerance at seedling stage by using semi-hydroponic technique. Mean values of different variables:

Calculated mean squares (MS) and F values from the statistical analysis corresponding to data of 13 Chilli genotypes subjected to 0.1 & 0.15 M NaCl concentrations. Mean, adjusted coefficient of determination (r^2), and coefficient of variation (CV, %) values are provided.

NS Not Significant p>0.05; * <0.05; **p<.01; ***p<.001

It is observed that significant differences were observed among genotypes and NaCl-concentration with respect to shoot length root length and speed of emergence. High r^2 and low CV (%) indicting the reliability of the technique. Emergence was highly correlated with shoot length (r=0.800* p<0.01), root length (r=0.816* p<0.01) and speed of emergence [r(p<0.01)=0.753*].

Selected salinity tolerant genotypes at 0.1 M NaCl: 9022, 9030, 9031 and 9032

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