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RESEARCH ARTICLE

EVALUATION OF SODIUM CHLORIDE STRESS TOLERANCE IN FINGER MILLET (ELEUSINE CORACANA L.) CULTIVARS BY OBSERVING MORPHOLOGICAL CHARACTERS.

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Abstract

Saline soils are unproductive. Plant growth and yield are highly effected by salinity. This may overcome by cultivating salt tolerant varieties. The aim of this study is to figure out, salt tolerant and salt sensitive cultivars of finger millet. In this study 12 cultivars of finger millet (*Eleusine coracana* L.) seeds were grown at different NaCl concentrations. Germination percentage, root length, shoot length and dry weight of the seedlings were assessed using different concentrations of NaCl. Based on the growth parameters, VR-1076 was confirmed as salt tolerant cultivar and VR-988 was confirmed as salt susceptible cultivar.

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Introduction:-

Finger millet (Eleusine coracana L.) is an annual herbaceous plant, widely grown as a cereal crop in arid and semiarid areas in Africa and Asia. Abiotic pressures like salt stress limit the crop growth and yield; also limit the land available for farming. It is thus needed to understand, how plants respond to adverse conditions. By studying the effects of environmental stresses, tolerance in plants may be understood (Joseph *et al*., 2010).

High concentration of soluble salts in the soil moisture of root zone is referred to as salinity in agricultural soils. These concentrations of soluble salts through their high osmotic pressures reduce plant growth by restricting the uptake of water by the roots. As the absorption of nutritional ions is restricted, plant growth is affected (Tester and Davenport, 2003).

Salinity creates two major threats to plant growth: osmotic and ionic stress (Flowers and Colmer, 2008). Salinity stress alters different physiological and metabolic processes of plants. The responses of these changes are often accompanied by a variety of symptoms such as the decrease in leaf area, increase in leaf thickness and succulence, abscission of leaves, necrosis of root and shoot and decrease of internode lengths (Gucci and Tattini, 1997; Kozlowski, 1997; Parida and Das, 2005). More recently, climate change has shown a trend that leads to differences in rainfall patterns, temperature extremes and soil composition changes, including salinization (Versules *et al*., 2006). The main aim of this work is to find out NaCl tolerant and NaCl sensitive cultivars of finger millet at the seedling stage.

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Materials and methods:-

For the collected, twelve cultivars of finger millet salt tolerance activity test was conducted with NaCl. In this assay germination of the seeds, shoot length, root length and dry weight were calculated. For salt tolerance activity 10 different NaCl salt concentrations i.e. 500, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500 and 5000 ppm were used. Initially 20 seeds from each cultivar were taken and sowed in different pots with mentioned concentration of NaCl. After that enough water was added to all the samples. Along with these different salt concentrations one control pot was seeded with 20 seeds for all cultivars. After 48 hours, germination percentage was calculated and tabulated. After incubation, germination percentage, root length, shoot length and dry weight were measured and recorded. According to the result resistant and susceptible cultivars were characterised.

Result Analysis and Discussion:-

In the present study, the effect of NaCl stress on morphological characteristics such as percentage of germination, root length, shoot length and dry weight of seedlings in 12 different cultivars of finger millet were investigated. There was a large range of variation in germination percentage under NaCl stress conditions. From the table-1 it is inferred that as the NaCl concentration increased, the germination percentage declined. The highest NaCl concentration used in this experiment was 5000 ppm, only one cultivar i.e. VR-1076 showed germination (figure 1), six cultivars VR-1101, VR-900, VR-847, VR-708, VR-1099 and PR-202 showed germination up to 3500 ppm, four cultivars VR-762,VR-1117,VR-936,GPU-67 showed germination up to 3000 ppm, cultivar VR-998 showed germination up to 2500 ppm. Similar results were reported in mungbean (Mahajan and Tuteja, 2005; Mahadavi and Sanavy, 2007), rice (Lee *et al*., 1998), durum wheat (Tekalign Mamo *et al*., 1996). The effect is more pronounced at higher salinity levels.

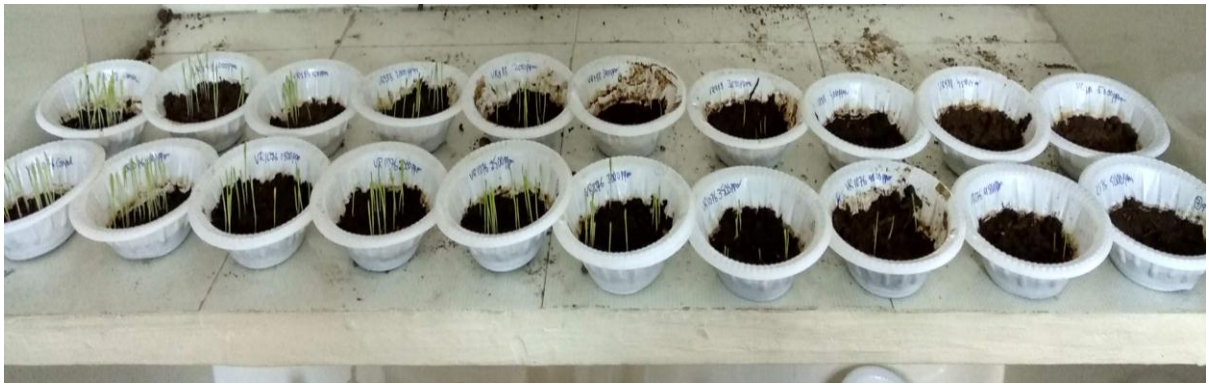

Figure 1:-Figure showing that germination of susceptible cultivar with different salt concentrations in first lane and germination of tolerant cultivar with different salt concentrations in second lane.

Table 1:-Effect of NaCl stress on seed germination in different cultivars of finger millet

Cultivars	Salt (NaCl) concentrations used (PPM)										
	control	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
VR-762	85 %	85 %	70 %	55 %	50 %	35 %	15 %	0	0	0	0
VR-1101	80 %	75 %	75 %	50 %	35 %	25 %	15 %	10 %	0	0	0
VR-900	100 %	75 %	70 %	50 %	35 %	25 %	25 %	15 %	0	0	0
VR-988	85 %	60%	45%	35%	25%	5%	0	0	0	0	0
VR-1076	85 %	85 %	75 %	65 %	50 %	50 %	45 %	40 %	30 %	30 %	25 %
VR-847	75 %	75 %	70 %	70 %	55 %	50 %	40 %	20 %	0	0	0
VR-1117	80 %	75 %	75 %	55 %	40 %	20 %	20 %	0	0	0	0
VR-936	75 %	75 %	55 %	50 %	45 %	45 %	25 %	0	0	0	0
VR-708	80 %	80 %	75 %	70 %	50 %	50 %	30 %	20 %	0	0	0
VR-1099	80 %	80 %	70 %	50 %	40 %	25 %	20 %	10 %	0	0	0
GPU-67	80 %	75 %	55 %	40 %	35 %	25 %	15 %	0	0	0	0
PR-202	75 %	75 %	65 %	55 %	50 %	40 %	40 %	25 %	0	0	0

Table2:-Effect of NaCl stress on root length in different cultivars of finger millet

Cultivars	Root length (Cm)										
	control	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
VR-762	2.51	2.39	1.72	1.07	0.27	0.22	0.22	0	0	0	0
VR-1101	2.48	2.41	1.96	1.32	0.48	0.42	0.34	0.25	0	0	0
VR-900	3.28	2.83	2.05	1.07	0.78	0.56	0.48	0.37	0	0	0
VR-988	2.38	1.89	1.45	1.02	0.69	0.38	0	0	0	0	0
VR-1076	2.45	2.14	1.64	1.07	0.5	0.43	0.4	0.35	0.31	0.26	0.22
VR-847	2.1	1.57	1.05	0.85	0.58	0.41	0.4	0.33	0	0	0
VR-1117	2.7	2.03	1.39	1.01	0.75	0.65	0.43	0	0	0	0
VR-936	1.85	1.06	0.85	0.47	0.39	0.33	0.31	0	0	0	0
VR-708	2.41	2.02	1.65	0.92	0.5	0.42	0.40	0.32	0	0	0
VR-1099	2.41	2.01	1.66	1.1	0.73	0.48	0.39	0.33	0	0	0
GPU-67	2.45	2.12	1.5	1.04	0.64	0.42	0.39	0	0	0	0
PR-202	1.98	1.3	1.02	0.96	0.76	0.51	0.32	0.30	0	0	0

The seedling root lengths of various cultivars were recorded in table-2. The highest root length was found in VR-900 (3.28 cm), followed by VR-1117 (2.7cm), VR-762 (2.51 cm), VR-1101 (2.48 cm), VR-1076, GPU-67 (2.45 cm), VR-708, VR-1099 (2.41 cm), VR-988 (2.38 cm), VR-847 (2.1 cm), PR-202 (1.98 cm), VR-936 (1.85 cm). Significant decrease in root length with increase in NaCl concentration was observed.

Table3:-Effect of NaCl stress on shoot length in different cultivars of finger millet

Cultivars	shoot length (Cm)										
	Control	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
VR-762	3.55	3.48	2.81	2.16	1.36	0.98	0.47	0	0	0	0
VR-1101	3.52	3.5	3.05	2.41	1.57	1.16	0.55	0.4	0	0	0
VR-900	4.32	3.92	3.14	2.16	1.06	0.82	0.51	0.33	0	0	0
VR-988	3.42	2.13	1.27	0.83	0.39	0.33	0	0	0	0	0
VR-1076	3.49	3.23	2.73	2.16	1.59	1.32	1.14	0.99	0.48	0.4	0.31
VR-847	3.14	2.66	2.14	1.39	1.17	0.85	0.48	0.33	0	0	0
VR-1117	3.74	3.12	2.48	2.10	1.84	1.13	0.77	0	0	0	0
VR-936	2.89	2.15	1.48	1.19	0.95	0.48	0.25	0	0	0	0
VR-708	3.45	3.11	2.74	2.01	1.59	1.10	0.72	0.3	0	0	0
VR-1099	3.45	3.10	2.75	2.19	1.82	1.14	0.59	0.33	0	0	0
GPU-67	3.49	3.21	2.59	2.13	1.73	1.31	0.84	0	0	0	0
PR-202	3.02	2.39	2.11	1.74	1.13	0.95	0.34	0.22	0	0	0

The highest shoot length was observed in cultivar VR-900 (4.32 cm), followed by cultivars VR-1117 (3.74 cm),VR-762 (3.55 cm), VR-1101 (3.52 cm), VR-1076 (3.49 cm), GPU-67 (3.49 cm), VR-708 (3.45 cm), VR-1099 (3.45 cm), VR-988 (3.42 cm), VR-847 (3.14 cm), PR-202(3.02 cm) and least growth was observed in cultivar VR-936 (2.89 cm) under unstressed condition. Increasing salinity levels decreased the shoot lengths. Except one cultivar i.e. VR-1076, remaining cultivars failed to germinate at highest concentration (5000ppm) of NaCl. The shoot length observed at 5000 ppm in cultivar VR-1076 is 0.31 cm, it is less than 10% of control. As NaCl concentration is increased the shoot length was found to be decreased in all cultivars.

Table3:-Effect of NaCl on dry weight in different cultivars of finger millet

Cultivars	Dry weight (mg)										
	Control	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
VR-762	45	43	41	34	30	23	18	0	0	0	0
VR-1101	48	45	45	40	35	53	25	20	0	0	0
VR-900	41	41	37	33	30	28	25	22	0	0	0
VR-988	48	41	31	28	22	20	0	0	0	0	0
VR-1076	53	50	50	45	43	38	35	32	27	23	20
VR-847	53	52	50	45	42	32	27	20	0	0	0

VR-1117	45	45	43	42	36	33	21	0	0	0	0
VR-936	51	51	45	41	35	26	22	0	0	0	0
VR-708	42	40	40	36	30	25	25	20	0	0	0
VR-1099	47	45	43	40	37	30	28	28	0	0	0
GPU-67	42	40	40	34	28	28	25	0	0	0	0
PR-202	40	38	33	29	26	26	22	20	0	0	0

From the table-4 it was observed that with increasing NaCl levels all the cultivars showed decreased quantities of dry weights. Highest dry weight was recorded in VR-1076 and VR-847 (53 mg) followed by VR-936 (51 mg), VR-1101, VR-988 (48 mg), VR-1099 (47 mg), VR-762, VR-1117 (45 mg), VR-708, GPU-67 (42 mg), VR-900 (41 mg), PR-202 (40 mg).

Similar results were obtained by Kaliappan et al., (1967), Panigarh et al., (1978), Onkware (1993) and Anantaraju (2001) while screening finger millet genotypes for salt tolerance at seedling stage.

Salt stress inhibited the seed germination, root length and shoot length. The results help in studying the effect of NaCl stress on plants (Jamil and Rha, 2004).Unbalanced nutrient uptake by seedlings is due to toxic effects $Na^+$and Cl^- ions present in the salt might be the reason for reduction in seedling growth. Decreased water uptake by roots might affect the growth of roots and shoot (Werner and Finkelstein, 1995). The findings of the study are in accord with the findings of Demir and Arif (2003) who reported that the root growth was more adversely affected compared to shoot growth by salinity. Hussain and Rehman (1997) also reported that the roots of seedlings were more sensitive than shoots.

The results obtained in this study deal with the salt tolerance of different cultivars at seedling stage. The tolerance observed in the cultivar VR-1076, at NaCl concentration 5000 ppm and cultivars VR-1101, VR-900, VR-847, VR-708, VR-1099 and PR-202 at NaCl concentration 3500 ppm may or may not be conferred at the adult stage. Nevertheless, tolerance observed at the seedling stage is of great importance because it has been emphasised by many workers that the screening of cultivars for salt tolerance at vegetative stage of plants has considerable value in determining the ultimate tolerance of the species (Akbar and Yabuno, 1974; Asraf and McNeilly, 1987).

Conclusion:-

Based on the germination percentage, root length, shoot length and dry weight, it was observed that cultivars VR-1076, VR-1101, VR-900, VR-847, VR-708, VR-1099, PR-202 were found to be salt tolerant cultivars and cultivar VR-988 was very much sensitive to NaCl. The salt tolerance levels observed in different cultivars of finger millet studied in laboratory may have a considerable value, the cultivars which were observed to grow at salinity levels 3500 ppm-5000 ppm VR-1076, VR-1101, VR-900, VR-847, VR-708, VR-1099, PR-202 need to be tested in field experiments for the conformation.

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