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Effect of Codex-551 on germination and seedling growth of wheat (*Triticumaestivum*) crop in saline-alkaline black soil

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Abstract

Saline alkaline-black cotton soil can affect seed germination and plant growth. The high concentration of soluble salts can lead to problem of hindered germination and shunted growth with low seedlings. In present study, the germination of wheat (*Triticumaestivum*) under the salt stress and soil treated conditions with different Codex-551concentrations of (10 ppm up to 100 ppm) was studied under laboratory conditions. Lowest germination (1 ± 0.44) was observed in control after 24 hours while highest (15.2 ± 1.81) germination was observed in 60 ppm. Seed germination up to (20 ± 3.03) was observed in the treatment of codex-551 with 60 ppm concentration after 48 hours while the least germination (6 ± 0.92) was observed in control consisted of saline-alkaline black cotton soil without any treatment. After 7 days in control the lowest 1.6 cm root length and 1.9 cm shoot length was observed while in 60 ppm, highest root length up to 4.1 cm and shoot length up to 6.3 cm was observed. After 15 days lowest root length (2.5 cm) and shoot length (3.7 cm) was observed in control while highest root length observed was 5.6 cm andshoot length was 11.7 cm in 60 ppm

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Introduction

Vermitechnology the United Nations Environment Program (UNEP) estimated that 20% of the total agricultural and 50% of the available cropland in the world is salt stressed or salt affected (Flowers and Yeo, 1995). Soil salinity imposes a serious environmental problem, affects vegetation cover and the

availability of animal feed limiting the availability of grasses in arid and semiarid regions (El-Kharbotly *et al.*, 2003). Salt stress unfavorably affects the plant growth and reduces the productivity during all developmental stages of crops. It has been reported(Epstein *et al.*, 1980) that soil salinity decreases the seed germination process, retards plant development and reduces crop yield (Shokohifard *et al.* 1989). Salt affected soils occupy wide regions that are scattered all over the world and account to about 954 millions of hectares, particularly in arid and semi-arid regions. Salt stress is one of the most serious limiting factors for crop growth and production in these regions. About 23 % of the world's cultivable agricultural lands are saline and 37 % are sodic. These soils are affected with high concentrations of sodium (Na^+) salts and represent a different set of problems which cannot be so easily rectified. The saline soil has an EC value more than 4 ds m^{-1} and exchangeable sodium percentage (ESP) more than 13%. Soils with high in sodium salts contents have decreased rates of water penetration and infiltrations problems due to the dispersion of clay particles within these soils (Amezketa and Aragues, 1995).

Germination is the most critical period for a crop subjected to salinity. Germination failures under saline soils are often the results of high salt concentrations in the seed planting zone because of upward movement of soil solution and subsequent evaporation at the soil surface (Bernstein 1974).These salts interfere with seed germination and crop establishment (Fowler 1991). Seed germination has been reported to decline with increasing salinity levels (Steppuhn and Wall, 1999). The reduction in osmotic potential of the growth medium is the primary causeof the adverse effects of salinity on plant growth and survival, both the directly and indirectly. The high concentration of specific ions in soil can cause disorders in mineral nutrition in the plants. For examples, high sodium concentrations may cause deficiencies of other elements, like potassium and calcium. The high levels of sulfate and chloride can diminish the rate of nitrate absorption in plants. Specific ions such as sodium and chloride have toxic effect on plants. They reduce the growth or cause damage to cells and membranes. The nutritional deficiencies and toxicities of plants are characterized by necrosis that results in tip burning or marginal scorch, chlorosis which results in turning the leaves yellow in color, and abscission which results in premature dropping of leaves..

Material and methods

Study area and soil sampling

The soil sample was collected from Sharnapur, District Aurangabad. The upper layer (25cm) of saline soil sample was collected. The soil sample was collected in polythene bags. These saline soil samples were analyzed for physico-

chemical parameters for the comparative study, the pH, electrical conductivity, sodium, potassium, moisture, total alkalinity etc. Garden soil was collected from Botanical garden of Dr. B. A. M. University, Aurangabad and characterized for same physico-chemical parameters using standard methods (Trivedy and Goel, 2000; P. K. Guptta, 2002). The wheat seeds of variety- MACS. 3125 were procured from local market for the present study.

Nature of Codex-551

The Codex-551 is the synonym of phosphono butane tri carboxylic acid and abbreviated as PBTC. Its chemical formula is $C_7H_{11}O_9P$ and molecular weight is 270. It is colorless or light pale yellow liquid having specific gravity 1.3^{+}-0.01 at 25°C. The pH of 1% solution is less than 2 due to active acidic nature. It has wide applications in cooling water treatment, boiler water treatment; Codex-551 was investigated as soil amendment for saline soil reclamation.

Experimental method

The experimental work was carried out under laboratory conditions. The healthy seeds were selected, sterilized with 0.05 N $HgCl_2$ and seeds were germinated in Petri plats. Total of 20 seeds were kept for germination in each sterilized Petri plate with all sets in triplicate. At the bottom of each Petri plate wet filter paper were placed and 20 seeds of wheat were arranged on it. The papers were replaced every two days to prevent accumulation of salts (Rehman et al. 1996). A set of control without any treatment was arranged for comparison with only saline soil suspension. Treatments were (11) control i.e., there was no addition any chemicals only saline soil suspension (Abdurrahman Hanay *et al*., 2004) and sets 1 to 10 were treated with different ppm concentrations viz. 10ppm, 20ppm, 30ppm, 40ppm, 50ppm, 60ppm, 70ppm, 80ppm, 90ppm, 100ppm concentrations were prepared. The seeds were considered to have germinated, when the emerging radical elongated to 1mm. Shoot and root length (cm), and seedling fresh and dry weight mg/plant were measured on the 7th and 15th day. Germination percentage of seeds was observed and recorded after 24 hours and 48 hours. Dry weights were measured after drying samples at 70°C for 48 hours in an oven (Bohm, 1979). Germination was recorded.

Results and Discussion

The Physico-chemical parameters of saline alkaline-black cotton soil were studied. Salinity indicator parameters, electrical conductivity and exchangeable sodium values of soil were determined 4.19ds/m and 13.5 mg/kg respectively.

Sr. No.	Properties	Average values
1	pH	10.2
2	Electric conductivity	4.19 ds/m.
3	Total alkalinity	30 g/lit.
4	Exchangeable sodium	13.5 mg/kg.
5	chloride	17.4 g/lit.

Table 1: Physico-chemical properties if saline alkaline-black cotton soil

Sr. No.	Treatments Conc. Of Codex-551	Mean ±SD After 24 hr.	Mean ±SD After 48 hr.
1	10 ppm	4.08±0.83	10.8±1.33
2	20 ppm	6±1.00	13.00±1.51
3	30 ppm	8.2±1.14	14.03±1.80
4	40 ppm	9.1±1.30	14.07±2.05
5	50 ppm	12.00±1.48	16.01±2.34
6	60 ppm	15.3±1.81	20.00±3.03
7	70 ppm	13.5±1.67	19.02±2.77
8	80 ppm	12.8±1.58	17.00±2.38
9	90 ppm	11.01±1.44	13.08±1.78
10	100 ppm	10.6±1.37	13.02±1.71
11	Control	1±0.44	06±0.92

Table 2: Effect of Codex-551 on seed germination of wheat.

Treatments Conc. Of Codex-551	Root Length after 7 days in (cm)	Shoot length 7 days (mg)	Fresh weight after 7 days (mg)	Dry weight after 7 days (mg)
10 ppm	2.9	3.7	0.133	0.034
20 ppm	3	4.4	0.174	0.041
30 ppm	3.4	4.10	0.197	0.050
40 ppm	3.6	5.1	0.204	0.053
50 ppm	3.8	5.6	0.223	0.057
60 ppm	4.1	6.3	0.247	0.065
70 ppm	3.11	5.9	0.239	0.060
80 ppm	3.7	4.5	0.200	0.054
90 ppm	3.5	4.2	0.184	0.047
100 ppm	2.8	3	0.161	0.039
Control	1.6	1.9	0.097	0.024

Table 3: Effect of Codex-551 on root, shoot length, fresh weight and dry weight after 7 days.

Codex-551 was used for the treatment of saline soil. Ten different concentrations at ranging from 10 ppm to 100 ppm were used for the treatment of saline soil. Lowest germination (1 ± 0.44) was observed in control after 24 hours while highest (15.2 ± 1.81) germination was observed in 60 ppm. Seed germination up to (20 ± 3.03) was observed in the treatment of codex-551 with 60 ppm concentration after 48 hours while the least germination (6 ± 0.92) was observed in control consisted of saline-alkaline black cotton soil without any treatment.

The treatment of codex-551 was 10 ppm concentration. The root length and shoot length observed were after 7 days 2.9 cm and 3.7 cm. The sixth set treated with 60 ppm concentration. The highest root length up to 4.1 cm and shoot length up to 6.3 cm was observed in after 7 days. It is observed that the root length and shoot length were increasing with treatment concentration maximum at 70 ppm and were decreasing there after indicating the toxic effect. The lowest root length 1.6 cm and shoot length 1.9 cm after 7 days was observed in saline soil without any treatment.

The treatment of codex-551 was found beneficial at lower and moderate concentration and reflected through the increase in fresh weight and dry weight per plant. With its 10 ppm concentration, the total fresh weight of wheat crop observed was 0.247 gm and dry weight was 0.065 gm per plant 7 days. In the sixth set (60 ppm concentration) had maximum total fresh weight (0.419 gm per plant) and maximum dry weight (0.107 gm per plant) after 15 day. In saline soil (Control) without any treatment it was observed the lowest total fresh weight of wheat crop 0.097 gm and dry weight 0.024 gm was after 7 days respectively.

Treatments Conc. Of Codex-551	Root length15 days (mg)	Shoot length15 days (mg)	Fresh weight after 15 days (mg)	Dry weight after 15 days (mg)
10 ppm	3.7	6.11	0.257	0.065
20 ppm	4.3	7.1	0.270	0.070
30 ppm	4.5	7.8	0.316	0.081
40 ppm	4.6	8.3	0.368	0.094
50 ppm	4.9	9.10	0.391	0.100
60 ppm	5.6	11.7	0.430	0.110
70 ppm	5.1	11.5	0.419	0.107
80 ppm	4.4	7.9	0.388	0.098
90 ppm	4.1	7.2	0.354	0.090
100 ppm	3.10	5.6	0.245	0.062
Control	2.5	3.7	0.162	0.041

Table 4: Effect of Codex-551 on root, shoot length, fresh weight and dry weight after 15 days.

The treatment of codex - 551 with 10 ppm concentration the root length per plant was 3.7 cm and shoot length was 6.11 cm per plant after 15 days. The sixth set treated with 60 ppm concentration the root length highest was (5.6 cm) and shoot length was also highest (11.7 cm) after 15 days. It observed that the overall root length and shoot length was decreasing after the treatment with 60 ppm concentration indicating the toxic effect or hindering effect evidenced by reduced the root and shoot length respectively. In saline soil (Control) without any treatment the lowest root length (2.5 cm) and shoot length (3.7 cm) was noticed after 15 days.

The treatment of codex-551 with 10 ppm concentration the total fresh weight of wheat crop 0.257 gm per plant and dry weight was 0.065 gm after 15 days which is lowest among the all treatments except control. In the sixth set (60 ppm concentration) had maximum total fresh weight (0.419 gm per plant) and maximum dry weight (0.107 gm per plant) after 15 days respectively. The minimum total fresh weight per plant (0.162 gm) and minimum dry weight (0.041 gm) was observed in saline soil (Control) without any treatment after 15 days which clearly suggests that the Codex-551 reduces the toxicity in saline alkaline-black cotton soil.

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