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Effect of salt stress on different germination and growth of *Oryza sativa*

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Abstract: *Oryza sativa* is a major crop plant cultivated on a large scale to supply the demand of food requirement of ever increasing population. In the present study seeds of rice plant were germinated onto soil treated with different concentration of three salts (NaCl, $PbNO_3$, $CuSO_4$) and their effect was germination rate and other growth parameters of plant. It was found that the plant responded well to the salt stress and in case of NaCl the plant showed the maximum growth followed by $PbNO_3$ and then $CuSO_4$. On an average reduced growth in terms of shoot length, root length, dry and fresh weight was obtained on most of the concentrations of these salt as compared to results obtained in control. However, onto NaCl concentration of 0.005M and 0.01 better growth was attained as compared to control. After certain period of time the plants become pale yellow in colour from green. Also black colour was observed at the tips of the rice plants treated with $PbNO_3$. Phytochemical screening of these plants was also done which showed the presence of steroids, terpenoids, tannins, flavonoids, alkaloids, and sugar in most of treatments, however on some concentration some of the phytocompounds were found to be reduced or absent.

Keywords: *Oryza sativa*, salt stress, germination, plant growth

INTRODUCTION

Rice is the seed of the grass species Oryza sativa (Asian rice). As a cereal grain, it is the most widely consumed staple food in large part of the world (Yang *et al* 2013) especially in Asia. It is the agricultural commodity with the third-highest worldwide production (Dogara AM and Jumare AI, 2014). Rice, a monocot, is normally grown as an annual plant, although in tropical areas it can also survive as a perennial. However, rice can be grown practically anywhere, even on a steep hill or mountain area with the use of water-controlling terrace systems. Rice contributes to human nutrition up to 20% of the calories consumed worldwide. Asia, with 145 millions ha yielding more than 650 million tonnes, is the main world rice producer accounting for 90% of the total (Dogara AM and Jumare AI, 2014). Abiotic stresses often prevent the achievements of optimum yields, limiting the attainance of the maximum potential of growth (Basu *et al* 2002, Almeida *et al* 2016).

Rice requires slightly more water to produce than other grains. Temperature rise is another concern for rice cultivation (Jaeil and Taikan 2012). It has been reported that, as a result of rising temperatures during the later years of the 20th century, the rice yield growth rate has decreased in many parts of Asia, compared to what would have been observed had the temperature and solar radiation trends not occurred. High water vapour content (in humid tropics) subjects unusual stress which favours the spread of fungal and bacterial diseases. Light wind transports CO_2 to the leaf canopy but strong wind causes severe damage and may lead to sterility (due to pollen dehydration, spikelet sterility, and abortive endosperms). Hence, abiotic stress such as drought, salinity, high or low temperatures, intense light, low nutrient availability, mineral deficiency, heavy metals, and mechanical injury, all represent a serious threat to sustainable rice production. Among them, drought and salinity (Horie *et al* 2012) are the two main causes of yield loss worldwide (Alam *et al* 2004). However plants do exhibit ability to tolerate stress (Munns and Tester 2008). Stress tolerance varies from species to species. The present study was conducted to analyse the effect of different salt on germination and growth of *O. staiva*.

MATERIALS AND METHOD

Seeds of rice (*Oryza sativa*) plants procured from local market and authenticated by Dr. Manjul Dhiman, Head department of Botany, KL DAV PG College, Roorkee. Solution of different salts (NaCl, $PbNO_3$ and $CuSO_4$) were prepared in varying concentration (0.001M, 0.005M,0.01M and 0.05M). Each solution was given a specific code (Table 1) and were utilized as test sample in the present study. Distilled water was utilized as control.

An independent experiment was setup for each test sample. Around 30 seeds of rice were germinated in separate pots. Each pot was irrigated with a specific test solution. Similar garden soil was utilized for all experiments. Each experiment was repeated atleast thrice. Seeds were allowed to germinate. Observations were recorded at an interval of about 3 to 4 days. Average shoot length, root length, fresh weight, dry weight was calculated for plants grown on each concentration and control. For fresh weight, the complete plants were excised and weighed on electric balance in gms. To find out dry weight, the plants were completely dried in incubator at temperature of about 50°C and then weighed in gms. Different extract prepared were subjected to phytochemical screening to detect any variation in the nature and type of phytochemial compound produced by the plants grown on different concentrations of different salts (Sass1940).

Table 1: Different treatments utilized in the present study:

I.	**Control (C)**			
	Distilled water			
II.	**Sodium chloride (NaCl)**			
Conc. (Molar)	0.001	0.005	0.01	0.05
Code	N1	N2	N3	N4
III.	**Lead nitrate ($PbNO_3$)**			
Conc. (Molar)	0.001	0.005	0.01	0.05
Code	P1	P2	P3	P4
IV.	**Copper sulphate ($CuSO_4$)**			
Conc. (Molar)	0.001	0.005	0.01	0.05
Code	C1	C2	C3	C4

RESULT AND DISCUSSION

Germination rate of seeds sown in control and various salt concentrations (C, N1, N2, N3, N4, P1, P2, P3, P4, C1, C2, C3, C4) was expressed in terms of percentage germination (Fig. 1) and it was found that in control about 92% germination was achieved. Onto 0.001M NaCl germination rate was found to be 88%, however at the concentration of 0.005M NaCl about 90% seeds geriminated. While the germination rate at the concentrations 0.01M and 0.05M NaCl were found to be 55% & 44% respectively. While in case of $CuSO_4$ the rate of germination was found to be minimum at the concentration 0.05 M that is 54% followed 68% at the concentration 0.01 M and it was found that the rate of germination was maximum (in $CuSO_4$) at the concentration 0.005 that is 70% followed by the concentration 0.005 M that onto which 65% seeds germinated. On a comparative note $CuSO_4$ affected the germination rate most among all the three salts. In case of $PbNO_3$ the rate of germination was found to be minimum at the concentration 0.05M that is only 55%. While onto concentration 0.001M rate of germination was found to be 66.66%. Maximum rate of germination was observed at the concentrations 0.005 M that is 70%.

Initially all the rice plants grown on different salt concentration were dark green in colour but with the increasing concentration of salts plants eventually turned pale yellow in colour and plants become thin (Fig. 4) . In case of NaCl the plants treated with concentration of 0.005M maximum growth was obtained as compared to all other salt concentrations. In case of lead nitrate the maximum growth was reported at the concentration 0.01M concentration onto which an average of shoot length of 14.2cm was obtained (Fig. 2). While at the concentration 0.005M the shoot length was found to minimum, also after certain growth time the tips of plants turned black and growth slowed down. Plant grown in soil irrigated with water containing different concentration of $CuSO_4$ also exhibited effect of salt on growth in terms of shoot length of plants when compared to shoot length of control plants. The plants obtained were very much thin and pale yellow coloured as compared to lush green plants obtained in control. Moreover this paleness could be observed at an early stage of growth indicating adverse effect of $CuSO_4$ on growth of rice plants. In a study conducted by wang *et al* (2011) response of rice plant to salt and alkali stress was evaluated and it was reported that alkali stress has more profound effect than salt stress. Both root and shoot growth detoriated in plants under salt and alkali stress. In the study conducted by Pattanagul and Thitisaksakul (2008) response of rice plant to salt stress was evaluated and decrease in leaf related water content along with reduction in fresh in dry weight was reported. Jamil *et al* (2012) also conducted a study on effect of salt stress on rice plant and in their study salt stress was found to negatively effect growth of rice plant. They reported decrease in germination rate, seedling growth and protein content. In the same study rice plant under stress were also found to accumulate sodium and potassium ion.

Similarly root length of plant grow in all the salt concentration was also analyzed (Fig. 3). Twenty plants from each concentration were obtained and their average root length was calculated. In control the average root length was found to be about 5.4 cm in plant grown in soil irrigated with the different concentration of NaCl varying result were obtained. Average root length of about 5.8 cm was obtained among the plant treated with 0.001M NaCl concentration. however plant treated with 0.005M NaCl concentration exhibit an average root length of about 6cm or further increasing the concentration of NaCl treatment to 0.01 average root length was found to be 4.8cm, however average root length again increased upto 5.7cm in the plants treated with 0.05M NaCl. These results indicate that plant of *O.sativa* have an inherent ability to tolerate salt (NaCl) stress. In an another study conducted by Rao *et al* 2008 they have also reported salinity tolerance ability of rice plants. When the root length of plant treated with different concentration of $PbNO_3$ was analyzed it was observed that irrespective of concentration of $PbNO_3$ (low or high) plant exhibit comparatively low growth in term of root length as compared to control plant onto 0.001m $PbNO_3$ concentration average root length was 4.3 as compared to 5.4 in control .on increasing the concentration of $PbNO_3$ to 0.005M average root length decrease to 3.2. However contrary to expected trend onto 0.01m concentration average root length was found to be 4cm and onto 0.05M $PbNO_3$ treatment average root length was about 3.9 cm. Among different salt treatment $CuSO_4$ was found to exert maximum effect on to root growth. Among plant treated with 0.001M $CuSO_4$ average root length was found to be 3.5 cm. There was little or no change in average root length on increasing concentration of $CuSO_4$ to 0.005M as an average root length of 3.6 cm was obtained on further increasing concentration of $CuSO_4$ to 0.01M. Average root length decreased to 3cm and average root length of 2.5 cm was obtained as in plant treated with 0.05M $CuSO_4$. Beside effect on germination rate, shoot and root length effect of salt treatment was also observed on fresh and dry weight of plants. 20 days old plants grown in control exhibited a fresh weight of 3.8 gms with a dry weight of 1.2 gm. Onto NaCl concentration of 0.005M fresh weight was 2.9 gms and dry weight was 1 gm. When concentration of NaCl was increased to 0.05M, fresh and dry weight reduced to 2.2 and 0.8 respectively. Similarly fresh weight and dry weight reduced to 2.5 and o.6 onto 0.005M concentration of $CuSO_4$, on further increasing the concentration of $CuSO_4$ to 0.05M fresh and dry weight was 2 and 0.5 gms. Plants grown in soil irrigated with different concentrations $PbNO_3$ also exhibited reduced fresh and dry weight as compared to that of control. Onto.0.05M $PbNO_3$ fresh and dry weight was 1.9 and 0.8 gms respectively. Organic extracts prepared from plants grown on different concentration of various salts were analyzed to detect the presence of different phytocompounds (phytochemical screening) and it was found that plants grown on most of the concentrations of salts showed the presence of terpenoids, steroids, alkaloid, flavanoid, tannins.

CONCLUSION

The present study indicates that presence of salts in soil have direct influence on growth of rice plant. With increasing concentration the growth of plant is adversely effected which will eventually affect productivity. However to a certain extent *O. sativa* also exhibits inherent resistance to salinity with specific reference to NaCl stress.

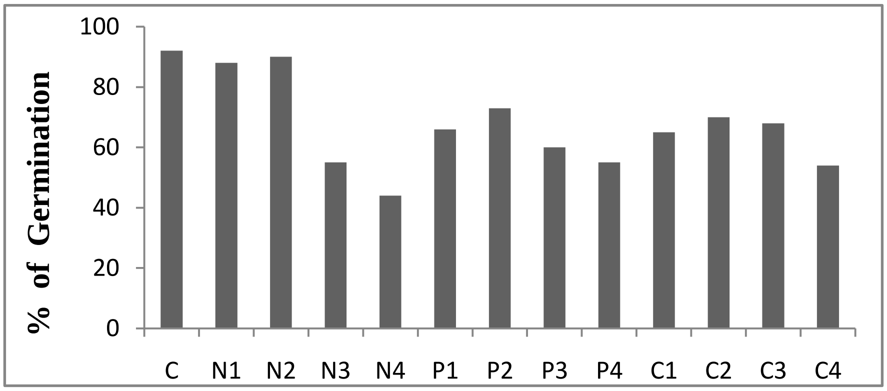


Fig.1: Effect of different concentration of NaCl, $PbNO_3$ and $CuSO_4$ on germination rate of *O. sativa*.

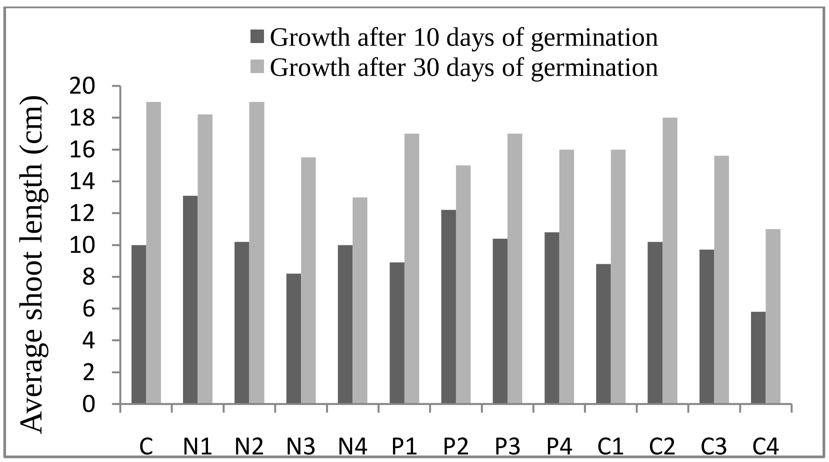


Fig.2: Effect of different concentration of NaCl, $PbNO_3$ and $CuSO_4$ on shoot length of *O. sativa.*

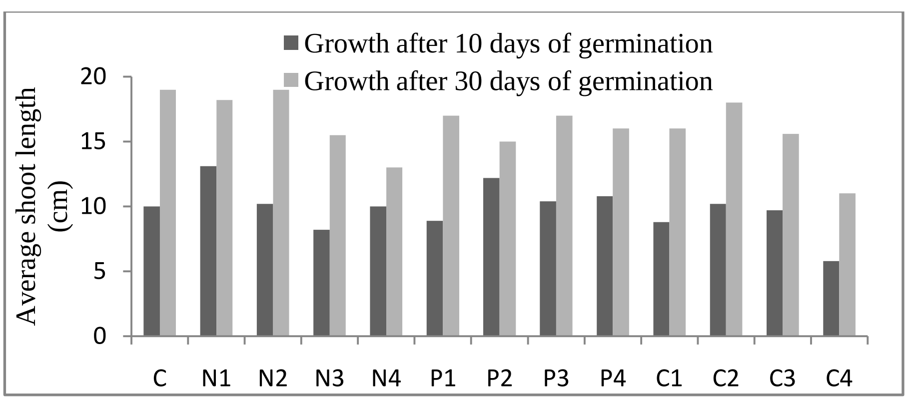
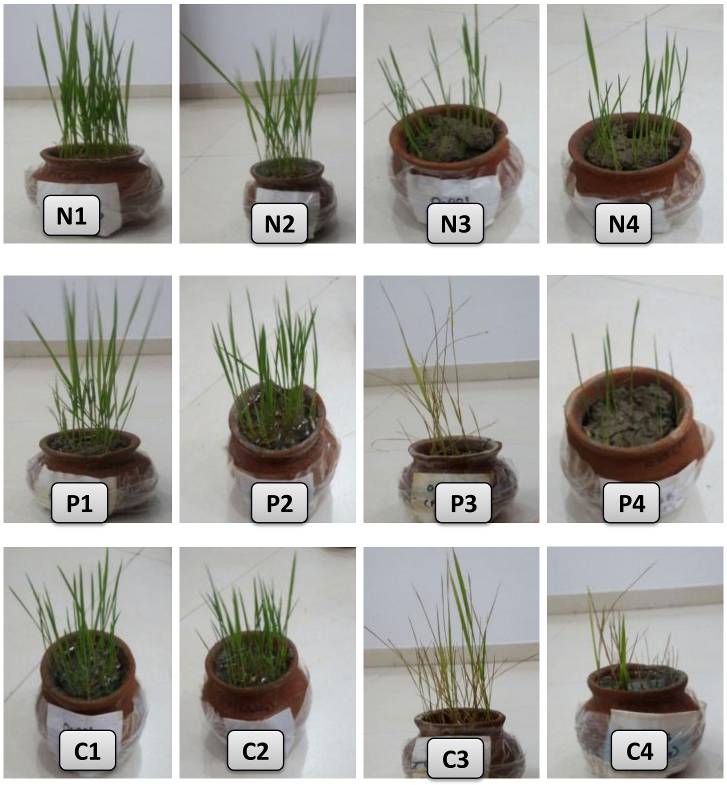


Fig.3: Effect of different concentration of NaCl, $PbNO_3$ and $CuSO_4$ on root length of *O. sativa*.



N1 (0.001M NaCl), N2 (0.005M NaCl), N3 (0.01M NaCl), N4 (0.05M NaCl); P1 (0.001M $PbNO_3$), P2 (0.005M $PbNO_3$), P3 (0.01M $PbNO_3$), P4 (0.05M $PbNO_3$); C1 (0.001M $CuSO_4$), C2 (0.005M $CuSO_4$), C3 (0.01M $CuSO_4$), C4 (0.05M $CuSO_4$)

Fig. 4: One month old plant grown on different salt concentrations

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