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EFFECT OF LIGHT AND TEMPERATURE ON SEEDLINGS RAISED UNDER SODIUM CHLORIDE SALINITY

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Abstract

The growth of wheat (*Triticum aestivum* L) jute (*Corchorus capsularis* L) and maize (*Zea mays* L.) cultured on the control and saline (NaCl) media were studied in dark and light. Sodium chloride showed an inhibitory effect on the growth of seedlings and this effect was enhanced with increase in light intensity and temperature.

Introduction

The effect of light and temperature on plants have been studied during last two decades and the most direct approach has been to record the changes in the growth components of the plants (Friend *et al,* 1962; Friend, 1969; Mac Dowall, 1973 a,b). However, few attempts have been made to explore the effect of light and temperature on plants raised under saline conditions (Meire *et al,* 1971; Nieman & Poulsen, 1971). When plants were subjected to discontinuous salinity during day and night separately, no significant effect were observed (Meire *et al,* 1971). When plants were exposed to continuous salinity no growth depression in dark grown plants were recorded, however, increase in light intensity reduced the growth substantially (Nieman & Poulsen, 1971). Keeping these observations in mind, the differential effects of light, temperature and salinity on the growth of wheat, jute and maize seedlings was studied.

Materials and Methods

Seeds of *Triticum aestivum* L. (cv. Pak-70), *Zea mays* Linn., (cv. Akber) and *Corchorus capsularis* Lam., (cv. D-145) were surface sterilized for three minutes with 0.2% mercuric chloride solution and washed with distilled water. Seeds were germinated in four inch diameter sterilized Petri plates containing three layer of tissue paper with 3 ml of test solution. Half-strength Hoagland solution (pH 6.0) was used and this was considered as the solution at zero atmosphere. Desired osmotic potential of the test solution was obtained by adding sodium chloride in Hoagland solution. Three Petri plates each containing 10 seeds were used for each treatment. The Petri plates were kept in a growth chamber maintained at 70 ± 2°F with 10 h of 6k lux of white flourescent light supplemented with incandescent lamps. The relative humidity ranged from 60 to 70%.

Seeds were subjected to 1, 3 and 5 atm of continuous NaCl-salinity to observe the differential effect of NaCl on the growth of jute and wheat seedlings. Petri plates were held at 70, 80 and 90 ± 2°F separately with or without 10 h of 6k lux of light intensity and increase in length of seedlings were recorded after 96 h. Effect of light and salinity on the growth of maize seedlings was also studied. Seeds were grown in 9 cm diameter Petri plates containing 200g of sandy loam irrigated with 40 ml of test solution with or without 6 atm NaCl. Light of 6 and 8k lux were provided separately in the same growth chamber by altering the distance between light source and Petri plates at 70 ± 2°F. After 15 days of treatments, shoot length were measured.

Results

Effects of NaCl and light on the growth of maize shoots were studied. Seeds were grown in Petri plates containing sandy loam irrigated with NaCl-solution (4 atm) and kept in dark and light in a growth chamber maintained at 70 ± 2°F. The light intensities provided were 6 and 8k lux at the surface of the plant. After 15 days of treatment; shoot length was recorded. The results presented in Table 1 indicates that increase in light intensity from 6 - 8k lux supressed the elongation of maize shoots by 47 and 58% respectively. However, when, NaCl was included in the growth medium light further supressed the elongation of shoot, as compared to salt-treated plants in complete darkness. The individual effect of salinity and light on growth supression of shoots were significant, whereas, the interactive effect of light and salinity was not significant.

TABLE 1. Effect of light intensities on the growth of NaCl-treated maize seedlings after 15 days of treatment.

Salinity	Light intensity (Lux)	Shoot length (cm)	% over dark control	% over non-saline control
- NaCl	0	15.50 ±2.83	100	100
		**		
–NaCl	6000	8.18 ±0.09	52.70	100
		**		
–NaCl	8000	6.55 ±0.96	42.10	100
4 atm NaCl	0	9.20 ±0.46	100	59.30
		**		
4 atm NaCl	6000	2.41 ±0.31	26.00	29.46
		**		
4 atm NaCl	8000	1.85 ±0.08	20.00	28.24

Level of significance: * $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$

TABLE 2. Interactive effects of NaCl, Temperature and Light on the growth of jute seedling after 96 hours

	70°F								80°F							
	Dark				Light				Dark				Light			
	Atm (NaCl)				Atm (NaCl)				Atm (NaCl)				Atm (NaCl)			
	0	1	3	5	0	1	3	5	0	1	3	5	0	1	3	5
Hypocotyl length (mm)	32.50	28.23 n.s.	18.63 **	2.80 ***	22.20	20.50 *	12.90 ***	5.55 ***	46.06	36.35 **	35.43 ***	19.36 ***	30.56	32.10 n.s.	22.26 **	8.89 ***
Standard error	±1.36	±1.66	±1.75	±2.12	±0.21	±0.81	±1.10	±0.63	±0.35	±3.19	±-.52	±0.55	±0.26	±1.36	±2.53	±0.90
Percent over control	100	85.80	56.60	8.50	100	92.30	58.10	24.90	100	78.90	76.90	42.30	100	105.30	72.80	29.09
Root leng-length (mm)	23.60	24.50 n.s.	19.93 ***	5.00 ***	31.60	27.90 *	18.86 **	11.43 ***	24.20	33.40 *	29.05 *	16.88 **	22.93	30.06 **	28.30 ***	15.93 ***
Standard error	±0.44	±0.93	±1.01	±0.90	±1.64	±1.51	±0.66	±1.19	±1.21	±0.73	±2.82	±0.79	±2.80	±1.37	±4.80	±0.52
Percent over control	100	103.80	75.90	21.18	100	88.29	59.69	36.17	100	138.10	120.40	69.70	100	131.09	123.40	69.47

Level of significance:
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$
n.s non-significant

TABLE 3. Intreactive effects of NaCl, Temperature and Light on the growth of wheat seedling after 96 hours

	70°F								80°F							
	Dark				Light				Dark				Light			
	Atm (NaCl)				Atm (NaCl)				Atm (NaCl)				Atm (NaCl)			
	0	1	3	5	0	1	3	5	0	1	3	5	0	1	3	5
Hypocotyl length (mm)	29.66	28.76 n.s.	10.35 ***	6.50 ***	33.86	29.50 *	23.10 **	14.23 ***	39.06	36.26 n.s.	35.00 *	21.93 **	49.13	49.16 n.s.	38.70 *	25.93 **
Standard error	±0.61	±1.27	±0.18	±0.61	±0.59	±1.27	±0.20	±0.15	±0.77	±3.84	±0.36	±3.02	±1.43	±1.36	±.136	±0.68
Percent over control	100	98.97	35.62	22.37	100	87.12	60.20	42.02	100	92.83	89.61	56.14	100	100.60	78.77	52.78
Root length (mm)	39.50	36.13 *	19.56 ***	15.60 ***	41.36	34.80 *	35.70 *	24.36 ***	77.83	71.90 n.s.	65.76 n.s.	31.50 *	63.70	70.40 n.s.	59.00 n.s.	26.50 *
Standard error	±0.35	±2.10	±0.90	±0.36	±0.41	±3.30	±0.46	±0.89	±4.90	±3.80	±4.70	±2.30	±4.30	±1.10	±1.10	±1.50
Percent over control	100	91.46	49.52	39.49	100	85.55	85.70	58.52	100	92.38	84.48	40.47	100	110.52	92.62	41.60

Level of Significance:

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$
n.s. non-significant

Effect of sodium chloride-salinity, temperature and light on the growth of jute seedlings is presented in Table 2 shows progressive decrease in hypocotyl length of NaCl-treated jute plants observed in light as well as in dark at both the temperatures (70 and 80 ± 2°F). The supression of hypoctyl length induced by 3 and 5 atm NaCl at 70 ± 2°F was higher than 80 ± 2°F. The effect of salinity on root growth was more adverse at 70 ± 2°F as compared to 80 ± 2°F. At 70 ± 2°F both in light and dark a progressive decrease in growth was recorded, whereas, at 80 ± 2°F NaCl at low concentration (1 and 3 atm) stimulated the growth significantly both in light and dark. However, 5 atm NaCl depressed the growth significantly.

Effect of sodium chloride, temperature and light on the growth of wheat seedlings is presented in Table 3. A progressive decrease in shoot and root length were observed in light as well as in dark at either temperatures (70 & 80 ± 2°F). As regards the temperature, growth depression either in shoot or roots length were higher at 70 ± 2°F.

Discussion

Salinity affected both light and dark dependent growth of young seedlings of wheat, jute and maize. Nieman & Poulsen (1971) reported that sodium chloride has no effect on dark grown bean shoots. The present study, however, clearly indicated that sodium chloride significantly supressed the growth ($P < 0.001$) of dark grown shoots of wheat (78% over control); Jute (92% over control) and maize (60% over control) at 70 ± 2°F. Another set of the plants which were raised in 10h photoperiod, as compared to dark grown plants revealed further increased growth reduction induced by sodium chloride salinity as also observed by Nieman & Poulsen (1971).

The mechanism involved in the interactive effect of salt and light is not very well understood. Chlorophylls appears to be a likely target in light grown plants as salt affect their development (Nieman & Poulsen, 1971), their response to light (De Mar *et al,* 1967) and also the light dependent protein and nucleic acid synthesis (Nieman & Poulsen, 1971). Recent reports implicates that environmental factors such as light, temperature and salinity may affect the endogenous level of growth regulators. Temperature, light and salinity was found to decrease the level of growth promoters (Lip & Roth-Ben – Jerano, 1969; Friend *et al* 1969; Itai & Vaadia, 1971; Naqvi & Ansari, 1974; Reiel *et al,* 1974) but these increase the amount of inhibitors (Yun-Te & Canvin, 1967; Mizrahi, *et al,* 1970; Zir *et al,* 1973; Khan *et al,* 1976).

It may, therefore, be concluded that the environmental factors such as light and temperature regulate plant growth under saline conditions. There appears to be a sound basis for considering a hormonal explanation for the differential effects of salt, light and temperature on plant growth.

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