

KINETICS OF AUXIN TRANSPORT UNDER SALT STRESS*

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Abstract

Studies were carried out where the effect of salt stress on maize seedling growth and auxin transport was determined. As the salt stress increased (0.0, 0.4 and 1.0%) the percent germination remained unaffected while the shoot growth of maize seedlings significantly decreased. Studies on ^{14}C -IAA transport kinetics through maize coleoptile segments revealed that increase in salt stress had no influence on various parameters.

Introduction

Plants require soluble salt constituents (certain mineral elements) for normal growth but excessive concentrations of these salts i.e. salinity retards plant growth. The adverse effect of salt stress on glycophytes is positively correlated with increase in salinity until plant growth ceases completely. Studies from various physiological aspects have been carried out (Mass & Nieman, 1978; Wainwright, 1980; Greenway & Munns, 1980) but our understanding of the hormonal physiology is very much limited (Naqvi, 1978). In the absence of such knowledge it is not possible to integrate the available physiological data to explore measures for improving plant growth under saline conditions. Keeping this objective in mind studies were carried out to elucidate the effect of salt stress on the kinetics of ^{14}C -IAA transport.

Material and Methods

Kernels of *Zea mays* L. (cv. Neelan) were washed in running tap water and soaked for 3 hr in 0.0 (distilled water) 0.4 and 1.0% NaCl solutions and planted in plastic pots containing sand saturated with the above solutions. Fifty kernels per pot were planted and appropriately covered to minimize evaporation. The seedlings were raised in complete darkness for 120 h when shoot length and germination percentage was recorded. Seedlings for transport determinations were raised in an identical manner except that 52 h after planting they were exposed overnight to red light to suppress mesocotyle growth.

Indol-3yl-acetic acid-2- ^{14}C (sp. act. 2GB_q/mM, Amersham, England) was incor-

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porated in 1.5% agar donor blocks at a concentration of 0.4 mg/l. The manufacturer's analysis of the supplied auxin indicated a purity greater than 98 percent by thin-layer chromatographic analysis.

Segments 8.0 mm long were excised from 96 h old coleoptiles (35-40 mm) commencing 1-2 mm below the tip and the leaf was pushed out. One agar block containing ^{14}C -IAA (donor) was mounted on the apical cut surface and the basal cut end was placed on a plain agar block (receiver). Thus each assembly consisted of one coleoptile segment with its donor and receiver blocks in normal vertical orientation. At the end of every 0.5 h four assemblies were dismantled and components pooled separately and placed in three vials containing Naqvi's scintillant. The radioactivity in each component was then assayed, after overnight in a refrigerator, in a liquid scintillation spectrometer (Intertechnique SL-30).

The temperature throughout was maintained between 28-30°C and only green safe-light was used during manipulations and transport determinations. The data represents an average of experiments repeated three times. Statistical evaluation of the data was made by the analysis of variance.

Results and Discussion

Germination percentage of seedlings raised under salt stress conditions was not appreciably affected upto the highest salt concentration tested (Table 1). However, shoot length of these seedlings was adversely affected with increase in salt stress given through the growth media. Compared with control, increase in salt stress to 0.4% reduced growth by 20% and further increase to 1.0% reduced it by 63% per cent (Table 1).

Table 1. Effect of salt stress on germination and shoot growth in *Zea mays* (cv. Neelam).

Treatment	Germination (%)	Shoot	
		Length (cm)	Inhibition (%)
Control	98	12.47 ± 0.53	—
0.4% NaCl	90	9.05 ± 0.63	19.52
1.0% NaCl	92	4.56 ± 0.58	62.61

LSD 5% = 0.61; 1% = 0.37

The transport kinetics, determined by using coleoptile segments from the above

treatments, show that there was no material difference in the amounts of ^{14}C -IAA absorbed or the portion of that transported out of the segments at various time intervals (Table 2).

Table 2. Salt stress effect on ^{14}C -IAA transport through *Zea mays* (cv. Neelam) coleoptile segments.

Treatment	(Time Hr.)			
	0.5	.10	1.5	2.0
^{14}C -IAA absorbed (% of applied)				
Control	10.38	20.82	31.89	42.60
0.4% NaCl	10.29	20.23	30.13	42.46
1.0% NaCl	9.98	21.30	30.43	42.98
^{14}C -IAA translocated (% of absorbed)				
Control	4.98	34.58	47.96	53.94
0.4% NaCl	4.74	34.82	49.41	53.65
0.1% NaCl	4.63	34.80	47.95	52.02

Analysing radioactivity from the transport experiments at various time intervals, by linear regression method ($Y=a+bx$), we observe (Table 3) that the time intercepts of the receiving system are not materially different. The x-axis was intercepted at 0.49 (Control), 0.51 (0.4%) and 0.48 (1.0%) hours. The velocities calculated from these intercepts are thus 16.33, 17.78 and 16.67 mm/h, respectively. The slope of the line indicating the amount of auxin moving per unit time (transport intensities) shows no material difference. Similarly the density of auxin present i.e. cpm/unit length of the tissue is also not affected by increase in salt stress.

Table 3. Salt stress effect on various transport parameters estimated by linear regression method ($Y=a+bx$).

Transport Parameters	Control	0.4%	1.0%
Velocity	16.33	17.78	16.67
Intensity	1138	1149	1152
Density	69.44	72.56	69.25

Data presented (Table 1) indicate that increase in salt stress caused a significant reduction in shoot growth without materially affecting the germination percentage. The stunted growth of the shoot can be explained on the basis of a reduction in the amount of diffusible auxin obtained under salt (Naqvi & Ansari, 1974) and or water stress conditions (Hartung & Witt, 1968). However, the reduction in diffusible auxin itself could only be either due to a reduction in transport kinetics, or inhibition of its synthesis, or by its enhanced destruction.

Detailed analyses of the effect of salt stress on various parameters of ^{14}C -IAA revealed that the treatment did not influence auxin transport in otherwise stunted shoots. These observations thus corroborate the earlier report with a different *Zea mays* cultivar where only total transport, at a fixed time of 90 minutes, was determined in coleoptile segments obtained from seedlings raised in presence of 0.4% NaCl and Na_2SO_4 salts (Naqvi, 1972).

The physiological significance of the present studies showing an absence of salt stress effect on auxin transport in the presence of an effect on growth and on diffusible auxin (Naqvi & Ansari, 1974) is worth discussing. It is known that auxin transport is adversely affected by water (Kaldewey *et al.*, 1968) and osmotic stress (Sheldrake, 1979) and thus can explain the reduction in diffusible auxin obtained (Hartung & Whitt, 1968) under water stress conditions. But our observations of a reduction in diffusible auxin under salt stress condition (Naqvi & Ansari, 1974) can not be explained on similar basis. Therefore, the present studies indicate that in the range of concentrations tested the depression in growth and reduction in diffusible auxin was due to ionic effect *per se* and not due to water or osmotic stress caused by the salts used. The cause of reduction in the diffusible auxin observed in our earlier studies needs investigation.

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