BRIEF COMMUNICATION

Role of abscisic acid in regulation of wheat seedling growth under salinity stress

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Abstract

Growth of wheat seedlings (*Triticum aestivum* L. cv. Mehran-89), in hydroponic culture, was affected by abscisic acid (ABA*). Using salinity stress and exogenous ABA application (10^{-6} M) to enhance endogenous ABA level, the growth of roots was more suppressed than the growth of shoots. On the other hand, norflurazon, which inhibits ABA biosynthesis, reduced only the growth of shoots.

Additional key words: NaCl, norflurazon, *Triticum aestivum* L.

Living organisms have built-in regulatory mechanisms by which they transduce stress perception into intracellular events which regulate plant growth and development. Abscisic acid (ABA) generally increases under stress conditions and has been considered to be the prime candidate as the stress transducer (*e.g.* Naqvi 1995). This hormone reduces shoot growth and maintains (Saab *et al.* 1990, 1992, Sharp *et al.* 1993, 1994), inhibits (Kuzmanoff and Evans 1981, Biddington and Dearman 1982, Carcellar and Fraschina 1989, Robertson *et al.* 1990, Thangaraj *et al.* 1990, Creelman *et al.* 1990, Leskovar and Cantliffe 1992, Mian *et al.* 1993, Malibari 1993, Misra 1994, Khan *et al.* 1995) or has no effect (Robertson *et al.* 1990, Leskovar and Cantliffe 1992) on root growth. Considering this property we studied the effect of ABA on wheat seedling growth. We used treatments with ABA as well as salinity to raise endogenous ABA level, and norflurazon (NF), to obtain ABA deficient wheat seedlings.

Wheat (*Triticum aestivum* L. cv. Mehran-89) seeds were surface sterilized, for 10 min, with 5 % sodium hypochlorite, thoroughly washed with distilled water and

Received 14 June 1996, *accepted* 3 September 1996.
Acknowledgements: We thank Mr. K.H. Tahir for statistical analysis and Mr. Zahid Pervez for secretarial work.
*the author recommended abbreviation AbA as more logical.

imbibed overnight. Thirty imbibed seeds were planted on moulded plastic sieves in a glass-jar with sufficient 1/10 Hoagland solution (control) and as and when required supplemented with the treatment solutions to touch the net (Naqvi *et al.* 1994). Seedlings were raised in a growth cabinet maintained at 25/20 °C day/night temperature and 12-h photoperiod (irradiance 22 W m^{-2}). Treatment solutions consisted of various concentrations of exogenous ABA (10^{-10} to 10^{-5}; *Sigma*, St. Louis, USA), NaCl (0.13 M) or NF (3.3×10^{-5} M; *Zorial*, Sandoz, Pakistan) and the seedlings were harvested 7 or 8 d after planting (DAP). Shoot and the longest root lengths, root and shoot dry mass (d.m.; oven drying at 70 °C for 48 h), and root length/shoot dry mass ratio were determined. The experiments were performed in triplicate, in a randomized manner, and repeated three times. Data were subjected to *ANOVA* and Duncan's multiple range test.

When wheat seedlings were raised in the presence of ABA (10^{-10} to 10^{-5} M, 7 DAP), germination was not affected but significant reduction of shoot growth at 10^{-6} M and root growth at still lower concentration (10^{-7} M) was observed (Table 1). The lower concentrations did not affect these two parameters but the higher concentration (10^{-5} M), without affecting germination, completely inhibited the growth of both the organs.

Table 1. Effect of increasing concentrations of ABA on wheat seedlings growth (7 DAP). Means not followed by the same letter in vertical columns differ significantly ($P > 0.05$).

ABA [M]	Length [cm] shoot	root	Dry mass [mg] shoot	root	Root/shoot [cm mg^{-1}]
Control	10.70 a	12.58 a	0.24 a	0.20 a	52.42
10^{-10}	11.16 a	12.21 a	0.24 a	0.19 a	50.88
10^{-9}	10.58 a	11.81 a	0.25 a	0.19 a	47.24
10^{-8}	10.98 a	11.36 a	0.25 a	0.18 a	45.44
10^{-7}	10.63 a	9.75 b	0.24 a	0.18 a	40.63
10^{-6}	7.11 b	6.26 c	0.16 b	0.15 b	39.13

Table 2. Effect of NaCl (0.13 M), ABA (10^{-6} M) and NF (3.3×10^{-5} M) on growth parameters of wheat seedlings (8 DAP). Means not followed by the same letter in vertical columns differ significantly ($P > 0.05$).

	Length [cm] shoot	root	Dry mass [mg] shoot	root	Growth rate [mm h^{-1}] shoot	root
Control	14.06 a	13.48 a	0.31 a	0.19 a	0.98	0.94
NaCl	8.25 c	3.93 c	0.21 c	0.11 c	0.58	0.27
ABA	11.79 b	9.12 b	0.26 b	0.15 b	0.82	0.63
NF	11.95 b	12.33 a	0.21 c	0.19 a	0.83	0.85
NF + NaCl	8.54 c	4.48 c	0.23 c	0.12 c	0.59	0.31

The effect of treatments on the growth of shoot and the root (8 DAP), are quite evident (Table 2). After allowing 48 h for germination, the relative rate of elongation was 0.98 mm h^{-1} for shoot and 0.94 mm h^{-1} for the root in the control seedlings. Inhibition of ABA biosynthesis with NF, reduced the relative shoot growth to 0.83 mm h^{-1} but did not affect the root growth; salinity and ABA significantly reduced the growth rate of both the organs. The dry mass accumulation also reflects similar trend. Root-shoot ratio indicates that seedlings raised under NF required longer roots to feed one unit shoot dry mass while in all other treatments shorter roots were required. In the treatment NaCl + ABA, shoot and root elongation was severely affected and could not be reasonably measured.

Our results clearly indicate that ABA reduces root growth, both in terms of length as well as in the accumulation of fresh and dry mass, more than it affects the shoot growth. Salinity stress also reduces the growth parameters of these two organs differentially: reducing root growth comparatively more than the shoot growth. Osmotic stress of similar magnitude (PEG-6000; -0.6 MPa) also reduced the shoot and root growth, but to a lesser extent (data not presented). However, treatment with NF reduced shoot but did not significantly affect the root elongation.

On the other hand, in maize seedlings shoot elongation was inhibited and root elongation was almost maintained under accumulation of endogenous ABA due to water stress or after exogenous application (Saab *et al.* 1990, Sharp *et al.* 1993, 1994).

Our results are in agreement with many others who have either used soil (Thangaraj *et al.* 1990, Leskover and Cantliffe 1992, Mian *et al.* 1993, Misra 1994), hydroponic (Kuzmanoff and Evans 1981, Biddington and Dearman 1982, Carcellar and Fraschina 1989, Malibari 1993, Khan *et al.* 1995) or aeroponic (Robertson *et al.* 1990) culture systems to raise seedlings or mature plants.

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