en los trazados electroforéticos las actividades alfa de las beta amilásicas, teniendo en cuenta que tanto las características de los granos de cereales como los comportamientos industriales de los productos que se pueden obtener de ellos se encuentran relacionados con las amilasas.

Resumen

Se determinó la actividad de alfa y beta amilasa en extracto de semillas de trigo maduras en diferentes estados de germinación. En semillas maduras la mayoría de la actividad fue de beta amilasa; el contenido de alfa amilasa aumentó durante la germinación, hasta el sexto día. En discos de electroforéticos en poliacrilamida con colorantes específicos se encontró dos bandas de rápido movimiento en semillas maduras y siete bandas adicionales en los extractos de plántulas germinadas.

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Plant growth and born uptake by *Lycopersicon esculentum* and *L. cheesmanii* f. minor.

Resumen. Plantas de dos cultivares de tomate (*Lycopersicon esculentum*) y de una especie silvestre (*L. cheesmanii* f. minor) fueron cultivados durante tres semanas en soluciones nutritivas con niveles de boro de 0.5 a 11 ppm para los cultivares comerciales y de 0.5 a 32 ppm, para la especie silvestre.

El peso seco de raíces de los cultivares fue menor con 2 y 3 ppm de B que a mayores o menores concentraciones de este elemento. Síntomas visuales de toxicidad de B, bordes necróticos de hojas maduras, completamente expandidas, fueron evidentes con concentraciones de 2 ó más ppm de B. Las plantas se volvieron necróticas con 11 ppm de B

En el caso de la especie silvestre los más altos valores de peso seco de la planta fueron obtenidos con niveles de 2 y 5 ppm de B. A la concentración de 5 ppm B se observó una ligera necrosis del borde de las hojas maduras acentuándose ésta conforme se incrementaba la concentración de B en la solución.

Las plantas sobrevivieron niveles de 32 ppm B si bien presentaban una necrosis severa en el follaje.

Tanto para la especie cultivada como para la especie silvestre la más alta concentración de B se obtuvo en hojas maduras; valores intermedios fueron encontrados en hojas jóvenes en desarrollo, mientras que las menores concentraciones fueron halladas en raíces.

Debido a que la especie silvestre sobrevivió a niveles de B mucho mayores que las formas cultivadas se considera que posee una gran tolerancia al B. Esta tolerancia al B. evidentemente tiene una base genética. Algún mecanismo desconocido que limita parcialmente la absorción o el transporte del B hacia las hojas de *L. cheesmanii* parece estar implicado en esta tolerancia.

Means of altering the salt content of soils and waters to improve crop production have dealt almost exclusively with manipulating the mineral substrate (4). Another method has been selecting strains of crops tolerant to saline conditions (4). Genetic adaptation as a means to circumvent soil problems has also been utilized (9). Information regarding the genetic control of mineral uptake, transport, and metabolism by plants has been reviewed by Epstein (3).

Boron is at varying concentrations in saline soils, and B toxicity presents an important natural nutritional excess in many subtropical areas (1). Soils formed under limited rainfall often contain B at concentrations toxic to plants. Boron may often also be introduced by irrigation water. Regulation of soil available B is difficult because the range between deficient and toxic levels in plants is rather narrow (3). Although considerable information on the effects of B on plants has been accumulated, its physiological role is still not well understood (6). Tomato has been reported to be semitolerant to B (10).

Ir is the purpose of this study to evaluate the growth and B uptake of seedlings of a cultivated and wild species of tomato subjected to increasing concentrations of B in culture solution. Two short-term experiments were conducted concurrently utilizing two cultivars of tomato *L. esculentum* Mill., and ecotype (C. M. Rick accession no. LA 1401) of the wild species, *L. cheesmanii* f. minor (Hook) Mull. The wild species was selected because its natural habitat is near the sea in the Galapagos Islands and it is very salt-tolerant (8).

Materials and methods

Seeds of the two cultivars, VF-145-B7379 and UC 82 A, were germinated on cheesecloth saturated with half-strength Hoagland's solution including B at 0.5 ppm, in a greenhouse environment. Ten days after germination, three seedling of each of the cultivars were transferred into one-liter nutrient culture containers with B at concentrations of 0.5, 1, 2, 3, 5 and 11 ppm.

Seeds of the wild species were germinated in petri dishes containing moistened filter paper in a germination chamber at 25°C. The seeds were treated prior to germination with 2.6% NaOCl (1/2 strength household bleach) for 45 minutes to enhance germination (7). Because the seedlings of the wild species were much smaller and more difficult to handle than those of the cultivars, sprouted seedlings were planted in nutrient saturated vermiculite in plastic containers and allowed to grow to a larger size. After three weeks growth two plants were then transferred to one-liter nutrient cultures with B concentrations at 0.5, 2, 5, 11, 22, and 32 ppm. Higher concentrations of B were used than for the cultivated varieties because the threshold B value for toxicity of the wild species was unknown.

Boric acid was used as the source of B. Solutions containing B were applied two days following transfer of seedlings into individual one-liter containers. Germination of the wild species was started in advance of the cultivars so that all seedlings would be ready for B treatment at the same time.

Solutions were changed once a week and continuously aerated. A complete randomized design, with three replications per treatment, was utilized. Changes in plant growth were observed and plants harvested three weeks after growth in the B solutions. After thorough rinsing several times with distilled water, each plant was divided into three parts: young expanding leaves (those at the two first nodes from the apex), mature fully-expanded leaves (those below the first two young leaves), and roots. Tissue was dried at 70°C for 48 h and then analyzed for B (2).

Results and discussion

Since there were differences in the time of seedling development prior to placement into solution culture containing varying levels of B, direct comparison of growth between the two species was not made. The growth of the two cultivars of *L. esculentum* was essentially the same at each level of B.

Growth response of *L. esculentum*. Growth for three weeks did not differ at B concentrations be-

tween 1 and 3 ppm (Table 1). At 0.5 and at 5.0 ppm B shoot elongation was not as vigorous and root dry weight increased. This was reflected in changes in shoot to root ratio from a high of 7.3 at 2 ppm B to a low of 5.5 and 4.8 at 0.5 and 5 ppm B respectively. Plants grown at 11 ppm B became necrotic and varied widely in dry weight and hence this data was not included in the tables.

No discernible leaf discoloration appeared on plants grown at 0.5 and 1.0 ppm B during the course of this study. By the second week edges of a few of the older leaves showed mild necrosis on plants at concentrations of 2 to 5 ppm B. Older leaves on plants at 5 ppm B were severely necrotic by the third week. All leaves on plants at 11 ppm B were showing necrotic tissue by the end of the first week. During the second week the necrosis spread and intensified, and the plants were virtually dead by the third week.

Growth response of *L. cheesmanii*. Best growth of plants occurred at B concentrations ranging from 0.5 to 5 ppm, (Table 2). At B concentrations of 11 ppm and higher growth declined. In contrast to the growth pattern of *L. esculentum*, the dry weight yield of both shoot and root declined as the concentration of B increased above 5 ppm. The shoot to root ratio remained fairly constant and did not fluctuate as widely as noted for *L. esculentum* (Table 1).

Table 1. Influence of nutrient culture boron concentration upon the growth of *Lycopersicon esculentum* (U.C. 82A)[z].

Boron (ppm)	Shoot length (cm)	Plant dry weight			Shoot/Root ratio
		Total (g)	Shoot (g)	Root (g)	
0.5	19.0ab	5.9a	5.0a	0.9a	5.5
1	21.8a	5.4a	4.7a	0.7ab	6.7
2	21.0a	5.0a	4.4a	0.6b	7.3
3	20.6ab	4.7a	4.1a	0.6b	6.8
5	17.0b	5.2a	4.3a	0.9a	4.8

z Each value is an average of 9 plants after 3 weeks growth in nutrient solution. Values with similar letters are not significantly different at 5% by the Duncan multiple range test

Table 2. Influence of nutrient culture boron concentration upon the growth of *Lycopersion cheesmanii*[z].

Boron (ppm)	Shoot length (cm)	Plant dry weight			Shoot/Root ratio
		Total (g)	Shoot (g)	Root (g)	
0.5	21.7b	13.2ab	10.2ab	3.0ab	3.4
2	23.3ab	14.2a	10.9a	3.3a	3.3
5	24.3a	14.2a	10.9a	3.2ab	3.4
11	15.7c	12.2b	9.3bc	2.9bc	3.2
22	8.7d	10.6c	8.1cd	2.6cd	3.1
32	8.7d	10.1c	7.7d	2.4d	3.2

z Each value is an average of 6 plants after 3 weeks growth in nutrient solution. Values with similar letters are not significantly different at 5% by the Duncan multiple range test

Leaf edges of older leaves were slightly necrotic on plants at 5 ppm B by the third week. The necrosis of leaf tissue intensified as the B concentration increased, yet plants at 32 ppm B were not totally necrotic at harvest.

Plant boron concentration. Examination of B concentration in various plant parts after three weeks growth (Figure 1) revealed that for both *L. esculentum* and *L. cheesmanii*, root tissue contained the lowest B, fully mature expanded leaves the highest B, and young expanding leaves intermediate concentrations of B.

The concentration of B in mature leaves of *L. esculentum* increased more rapidly in plants grown at solution concentrations above 2 ppm B than in mature leaves of *L. cheesmanii*. This response was less noticeable in root or young leaf tissue. The B concentration in mature leaves of *L. cheesmanii* grown at 11 ppm B was about a third to one-half that found in mature leaves of *L. esculentum* grown at corresponding concentrations of B.

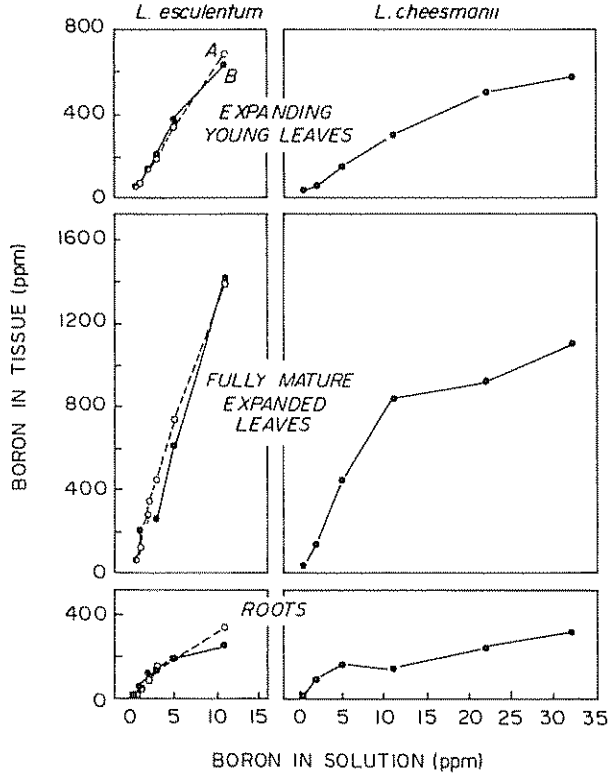

Fig. 1. Boron content on dry weight basis of root and leaf tissue of tomato plants grown for three weeks in nutrient solution containing B. *L. esculentum* A = FV – 145 – B7879 and B = UC 82A.

From the growth responses and the visual symptoms of necrosis exhibited, it is apparent that plants of the wild species, *L. cheesmanii*, was more tolerant to B than are those of the commercial cultivars of *L. esculentum* used in this study. The development of severe toxicity symptoms at 5 ppm B and complete necrosis of plants at 11 ppm B by both cultivars of *L. esculentum* after three weeks exposure to B (Table 1, Figure 1) is in contrast to the response of "Bonney Best", an inbred strain of tomato, reported by Parks *et al* (5). They found fruit bearing plants at 30.5 ppm B, with leaflet tissue containing 1351 ppm B. Their growth response seems to more closely resemble that response found with *L. cheesmanii* at 32 ppm B (Table 2, Figure 1). This would suggest that the presently available high yielding cultivars of tomato lost some of their tolerance and/or adaptability to levels of B above 2 ppm during the process of selections of earlier breeding lines. The partial exclusion of B from leaf tissue and accumulation in root tissue in *L. cheesmanii* may not be the same mechanism of tolerance as reported for sodium (8). Differences in B concentration in leaf tissue of *L. esculentum* and *L. cheesmanii* may be attributable in part to a change to a lower rate of B absorption by *L. cheesmanii* as the external source of B in the culture media increases. The mechanism for B tolerance is obscure, but some mechanism partially limiting absorption or transport of B seems to be involved. The tolerance to B apparently has a genetic basis, and further investigation into the physiological and genetic factors that govern the tolerance and sensitivity of tomatoes to B is needed.

Summary

Plants of two cultivars of tomato *Lycopersicon esculentum* and of a wild species, *L. cheesmanii* f. minor were grown for three weeks in nutrient solutions containing boron from 0.5 to 11 ppm for commercial cultivars and from 0.5 to 32 ppm for the wild species.

For the cultivars, root dry weight was lower at 2 and 3 ppm than at higher or lower concentrations of B. Visual symptoms of B toxicity, necrotic leaf edges of fully mature expanded leaves, were evident at and above 2 ppm B. Plants were necrotic at 11 ppm B. For the wild species highest plant dry weight was found at 2 and 5 ppm B. Some necrosis of leaf edges of fully developed leaves occurred at 5 ppm B and necrosis increased in severity with increasing concentration of B. Plants still viable, but with severely necrotic foliage, were present at 32 ppm B.

In both the cultivated and wild species the highest concentration of B was present in fully expanded leaves, least in roots, and intermediate in young ex-

panding leaves. Because the wild species could survive at levels of B much higher than the cultivated forms, it is considered to have significant tolerance to B. Such tolerance evidently has a genetic basis. Some unknown mechanism, partially limiting the absorption or transport of B to the leaves of *L. cheesmanii* is implicated in the tolerance.

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Diagnose foliar na cana-de-açúcar. X. Efeito da quantidade de chuva nos teores foliares de macronutrientes na cana-planta e na cana-soca.

Summary. This paper deals with the effect of rainfall before the sampling date on the composition of the + 3 leaf of the sugar-cane plant. By analysing data found in the literature the increase in the percentage of macronutrients due to 200 mm of rain which fell 2 months before sampling was estimated. In the case of the cane/plant the following values were obtained: P = 0.016 to 0.034% (depending of the type of soil); K = 0.071%; Mg = 0.0194 to 0.0388%. For the first ratoon crop the increase in leaf content was estimated to be: N = 0.17%; P = 0.02%; Mg = 0.027%; S = 0.055%

O teor de nutrientes na folha, determinado parse avaliar o estado nutricional da planta ou a necessidade de adubos da cultura, obedece à equação

Fenótipo = Genótipo x Meio;

em aoutras palavras: a composição mineral (fenótipo) é o produto da interação entre as características genéticas da planta e as condições do meio (3) Condições do meio significa principalmente características do solo e do clima