MORPHOLOGY OF CROWN – THE OVERWINTERING ORGAN OF WINTER WHEAT SEEDLING

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ABSTRACT

During eight days of hardening of the ten-day old winter wheat seedlings neither the shape nor crown morphology changed. Such observation considered seedlings of four cultivars differing in frost resistance.

KEY WORDS: *Triticum aestivum* L., frost hardening, crown, morphology

INTRODUCTION

The importance of cereal crowns in frost survival is unquestionable; plants often lose leaves and roots during winter frosts, but new analogical organs may regrow only if crowns are at least partially intact (Pauli 1960, Tanino and McKersie 1985). Our previous experiment showed that the crowns of ten-day old winter wheat seedlings are able to become hardened, i.e. to achieve a higher level of frost resistance during growth for 8 days at temperature above $0^{o}C$ (Rybka 1989). It was interesting to look closer into the crown morphology of winter wheat seedlings of different frost resistance at the first-leaf stage of growth.

MATERIAL AND METHODS

The crowns of two frost resistant (Mironovska 808 and Odesska 16) and two frost sensitive (San Pastore and Super X) wheat cultivars were examined. The seedlings were grown in climatic chambers (type KTLK 1250, Germany). The day/night temperature regime was $18^{o}/14^{o}C$, relative humidity 70/80% and a 16 h photoperiod, with light intensity of 120 W m^{-2}. Ten days old seedlings were transferred for hardening to $+2^{o}C$ at continuous light reduced to 1/3 for 8 days, as described previously (Rybka, 1989, 1990). The crowns, i.e. the low part of the seedling stem, about two millimeter long, with detached roots and leaves were collected at the tenth day of growth (control = not hardened) and at the eighth day of low temperature treatment (hardened seedlings). The crowns were fixed in CRAF (Randolph's chromo-acetic-formalin) and embedded in paraffin. Longitudinal and transverse 10 μm thick sections were stained with hematoxylin (Ehrlich), mounted in Canada balsam and photographed using the Nikon Labophot microscope.

RESULTS AND DISCUSSION

Figure 1 presents a fragment of a typical ten-day old wheat seedling, i.e. the stage at which the seedlings were exposed to the hardening regime. The crown region has been marked.

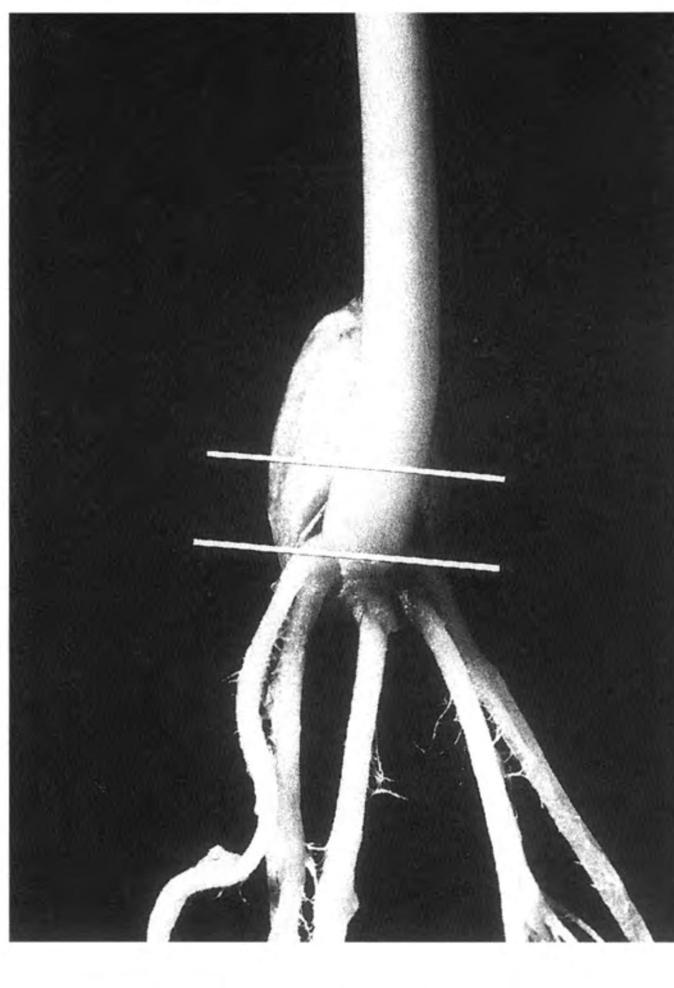

Fig. 1. Basal fragment of a ten-day old seedling of winter wheat. Lines indicate the crown region. Magnification 7.3 x.

The general growth characteristics of the control and the eight-day cold treated seedlings (plant height, fresh and dry weight of leaves and roots and the leaf area) are given at Table 1. The hardened plants practically do not grow under hardening conditions.

TABLE 1. The biometrical parameters of winter wheat seedlings of four cultivars differing in frost resistance.

	Frost resistant		Frost sensitive	
	M 808	O 16	SP	SX
Shoots:				
fresh weight (mg)				
non-hardened	130±9	133±5	138±7	118±12
hardened	130±11	118±5	150±6	112±8
dry weight (mg)				
non-hardened	16±2	17±2	17±2	14±2
hardened	16±2	14±3	19±1	14±1
Roots:				
dry weight (mg)				
non-hardened	67±5	68±1	79±10	88±2
hardened	63±2	69±1	76±9	90±2
Leaves:				
length of the first leaf (mm)				
non-hardened	145±3	153±4	151±3	110±4
hardened	141±7	148±1	151±6	103±6
length of the second leaf (mm)				
non-hardened	94±5	80±4	79±2	55±6
hardened	94±7	64±5	85±6	57±8
area of the first leaf (mm^2)				
non-hardened	244±8	289±21	304±40	233±31
hardened	304±28	336±21	402±1	203±13
area of the second leaf (mm^2)				
non-hardened	82±9	62±11	73±10	62±8
hardened	97±1	52±4	86±8	61±7

The values represent the mean of two experiments (n=40 in each) with ± SD.

Microphotography of a typical longitudinal section of the crown's central zone is shown in Fig. 2. Since all the crown microscopic sections of wheat seedlings, irrespective of the cultivar and temperature treatment (18°C or 2°C) were the same, the picture refers to the crowns of both hardened and not hardened plants of either cultivar.

The coleoptile tissues (C), young leaves (L) and leaf primordia (LP) surrounding the shoot apex (A) are visible. In all crowns three to four tiller primordia (TP) were placed between the successive leaves. Not all tiller primordia are visible on the photograph since some of them are located off the cutting surface. The shoot apexes of the investigated seedlings did not show any symptoms of transition to the generative phase of growth. A very similar picture of rye crowns at a comparable stadium of growth was presented by Rovenska (1973).

A typical transverse section of a wheat crown is shown in Fig. 3. Crowns were cut near the base of the roots, and root primordia (RP) are clearly visible. Similarly as it was observed for longitudinal sections, the transverse sections of crowns from different cultivars did not differ neither in shape nor diameter; the root primordia, 2 to 3 in number in each crown of four cultivars, could be easily recognized.

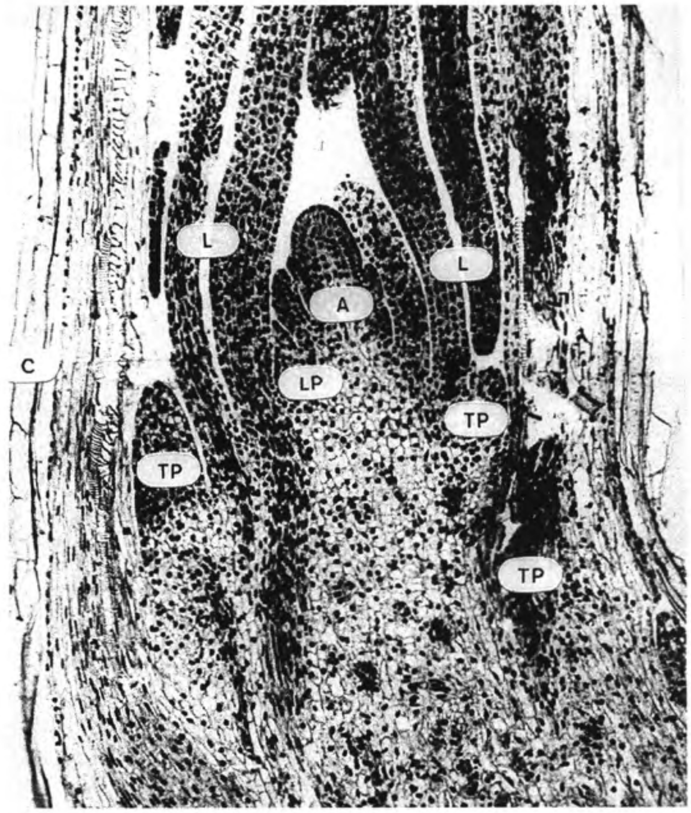

Fig. 2. Longitudinal section of crown of a ten-day old winter wheat seedling. Magnification 100 x.
C – coleoptile; L – leaves; LP – leaf primordia;
TP – tiller primordia; A – apex

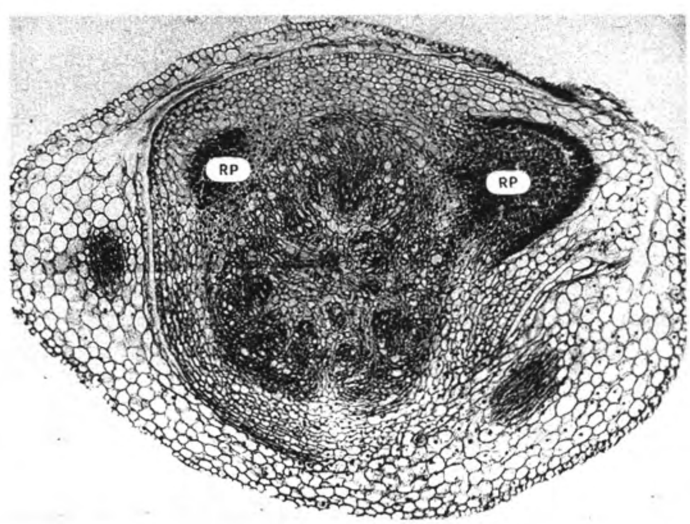

Fig. 3. Transverse section of basal part of crown. Magnification 100 x.
RP – root primordia

The data presented show that a ten-day growth at 18°C/14°C is a period long enough for the differentiation of tiller and root primordia, but eight days of low temperature treatment of the seedlings did not cause any detectable changes in size, structure and number of the developing crown elements, although frost resistance of the seedlings increased. This suggests that the achievement of frost resistance during as short a time as eight days of hardening should be ascribed to the metabolic and/or ultrastructural changes within the crown cells (Levitt 1980, Sakai and Larcher 1987, Rybka 1989, 1990, 1993).

From the agricultural point of view the most important for frost survival is the development of primordia of roots and shoots which determine plant regrowth. These structures, especially root primordia, should be investigated more closely.

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MORFOLOGIA PĄKU SZCZYTOWEGO – ORGANU PRZEZIMOWANIA SIEWEK PSZENICY

STRESZCZENIE

W czasie ośmiodniowej jaryzacji dziesięciodniowych siewek pszenicy nie stwierdzono żadnych zmian w kształcie i morfologii pąków szczytowych. Obserwacja ta dotyczy siewek czterech kultywarów o różnej odporności na mróz.

SŁOWA KLUCZOWE: jaryzacja, pąk szczytowy, morfologia