

## ABSCISIC ACID LEVELS IN MAIZE SEEDLINGS UNDER FIELD CONDITIONS DURING COLD PERIODS IN SPRING<sup>1</sup>

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### Introduction

Investigations performed with maize seedlings grown in a growth chamber have shown that under chilling conditions (0–10°C) abscisic acid (ABA) accumulates in maize seedlings. This accumulation has been found to be faster and greater in chilling tolerant genotypes than in sensitive ones [CAPELL, DÖRFFLING 1993; JANOWIAK, DÖRFFLING 1996]. On the basis of these results the hypothesis was developed that chilling tolerance (CT) in maize is related to the ability for fast and pronounced formation and accumulation of ABA as a protective agent against chilling injury. This hypothesis has been controversially discussed and reinvestigated in recent literature [RISTIC et al. 1998; JANOWIAK et al. 2002]. The aim of the presented research was to test this hypothesis during natural cold weather periods under field conditions at two sites differing in climatic conditions: Cracow and Hamburg.

### Material and methods

#### Plant material and growth conditions

The investigations were performed with two chilling tolerant (17, Z7) and two sensitive (Co151, Penjalinan) maize inbreds. The experiments were carried out under field conditions at two sites differing in climatic conditions: Cracow (more continental climate) and Hamburg (maritime climate). Seeds were sown at an early sowing time in pots and exposed to natural conditions.

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**Measurements of ABA level and water content**

At the third leaf stage of seedlings, ABA content in the middle part of the third leaf was measured by enzyme linked immunosorbent assay (ELISA), according to the protocol of WALKER-SIMMONS [1987]. Additionally, the water content of the third leaf and of the whole upper part of seedlings were determined. These measurements were performed during normal spring conditions (control) as well as during (or directly after) cold (2–8°C) weather periods lasting a few days, or after chilling treatment of field-grown seedlings in a growth room at 4°C.

**Statistical evaluation**

A fully randomised experimental design was used. The data are mean values of at least nine replicates. Least statistical differences (LSD) were calculated at the level of error probability 5% ( $p < 0.05$ ) and are presented in the figures.

**Results and conclusions**

Chilling treatment of field-grown plants induced accumulation of ABA in tolerant inbreds (F7, Z7) already during the first treatment day (Fig. 1). In the

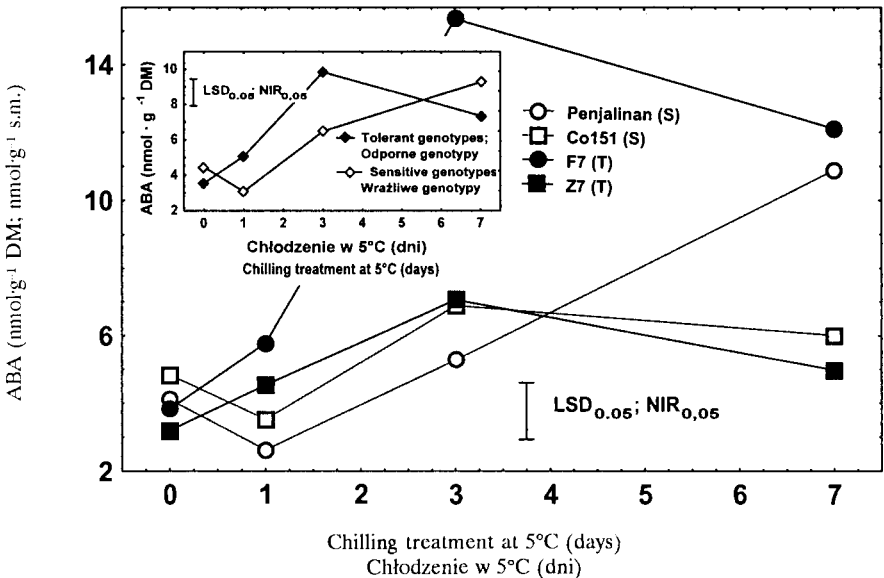


Fig. 1. Abscisic acid (ABA) content during chilling treatment at 5°C of field-grown maize seedlings of two chilling sensitive inbred lines (S) and two tolerant ones (T). Field experiment in Hamburg

Rys. 1. Poziom kwasu abscysynowego (ABA) podczas chłodzenia w 5°C u wyhodowanych w warunkach polowych siewek dwóch wrażliwych (S) i dwóch odpornych (T) linii wsobnych kukurydzy. Eksperyment polowy w Hamburgu. Inset pokazuje średni poziom ABA dla odpornych i wrażliwych linii wsobnych kukurydzy

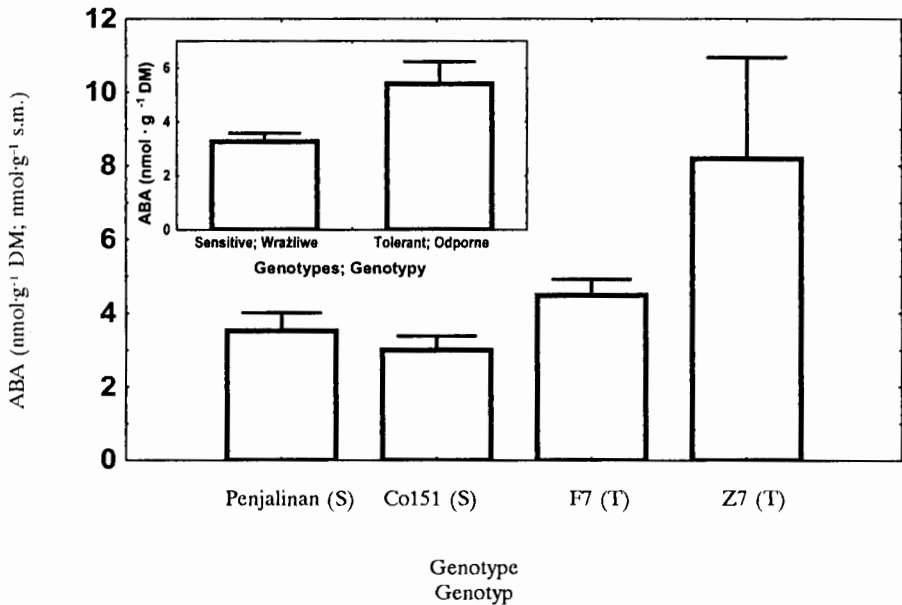


Fig. 2. Leaf ABA content in seedlings of two chilling sensitive (S) and two tolerant (T) maize inbred lines after long chill wave under field conditions. Field experiment in Cracow. ABA measurements were made after 10 days of chilling period (6/12°C day/night)

Rys. 2. Poziom ABA w liściach siewek dwóch wrażliwych na chłód (S) oraz dwóch odpornych (T) linii wsobnych kukurydzy podczas długich okresów chłodu w warunkach polowych. Eksperyment polowy w Krakowie. Pomiary ABA wykonano po 10 dniach chłodu (6/12°C dzień/ noc). Inset pokazuje średni poziom ABA dla odpornych i wrażliwych linii wsobnych kukurydzy

sensitive inbreds (Co 151, Penjalinan) a transient decrease in ABA level during the first treatment day was observed. Further chilling of seedlings caused ABA accumulation in all inbreds investigated. The ABA accumulation up to the 3rd day of treatment was significantly higher in the tolerant inbreds than in the sensitive ones (Fig. 1, inset). During a long-term exposure of maize seedlings to chill waves under field conditions, a higher ABA level in the tolerant genotypes than in the sensitive ones was observed (Fig. 2). There was no relationship between ABA level and chilling-induced water deficit under field conditions because the tolerant genotypes showed a higher water content than the sensitive ones (Fig. 3). Accumulation of ABA in maize seedlings under field conditions during naturally occurring chill waves in both experimental sites confirms earlier studies performed under growth room conditions about the importance of ABA accumulation during chilling exposure for CT in maize. Additionally, the results indicate that the ABA accumulation induced by low temperature is not directly related to chilling-induced water deficit.

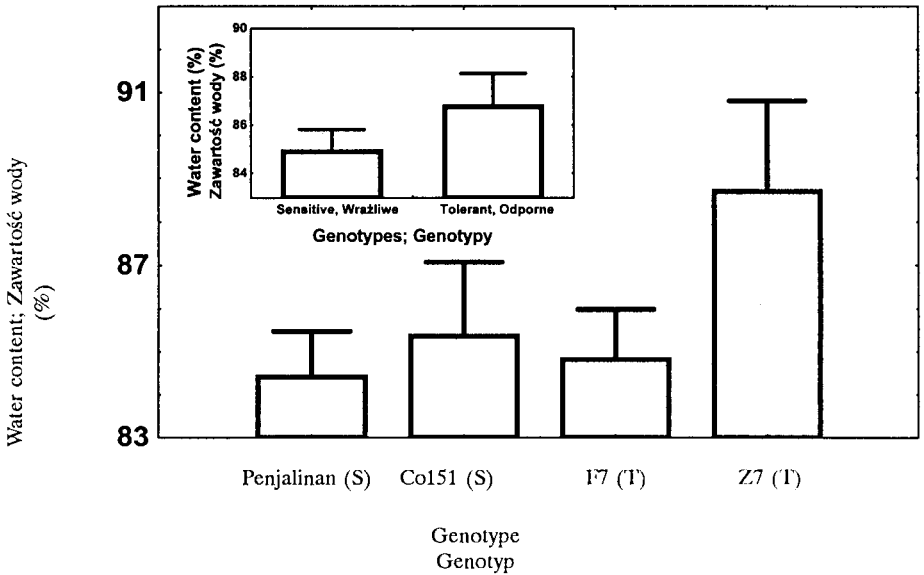


Fig. 3. Water content of the third leaf in seedlings of two chilling sensitive (S) and two tolerant (T) maize inbred lines after long chill wave under field conditions. Field experiment in Cracow. Measurements were made after 10 days of chilling period (6/12°C day/night)

Rys. 3. Zawartość wody w trzecim liściu siewek dwóch wrażliwych na chłód (S) oraz dwóch odpornych (T) linii wsobnych kukurydzy podczas długich okresów chłodu w warunkach polowych. Eksperyment polowy w Krakowie. Pomiary wykonano po 10 dniach chłodu (6/12°C dzień/ noc). Inset pokazuje średnią zawartość wody dla odpornych i wrażliwych linii wsobnych kukurydzy

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Key words: abscisic acid, chilling tolerance, maize

### Summary

Laboratory studies have showed higher ABA accumulation in seedlings of the chilling tolerant genotypes than in the sensitive ones during low temperature exposure. On the basis of these results the hypothesis was developed that chilling tolerance (CT) in maize is related to the ability for fast and pronounced formation and accumulation of ABA as a protective agent against chilling injury. Presented in the paper measurements of ABA levels in maize seedlings under complex field conditions during natural spring cold waves at two sites of Europe confirmed the results from growth rooms. The chilling tolerant maize lines accumulated under field conditions more ABA than the sensitive ones during spring cold periods. Moreover, the data from field conditions show that the ABA accumulation induced by low temperature is not directly related to chilling-induced water deficit.

### POZIOM KWASU ABCYSYNOWEGO U SIEWEK KUKURYDZY W WARUNKACH POŁOWYCH PODCZAS WIOSENNYCH OKRESÓW CHŁODU

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Słowa kluczowe: odporność na chłód, kukurydza, kwas abscysynowy

### Streszczenie

Badania w warunkach komór wzrostowych wykazały wyższą akumulację kwasu abscysynowego (ABA) w warunkach chłodu u siewek genotypów kukurydzy odpornych na chłód w porównaniu z wrażliwymi. Na podstawie tych wyników postawiono hipotezę, że odporność na chłód u siewek kukurydzy powiązana jest ze zdolnością do szybkiej syntezy i akumulacji ABA jako czynnika ochronnego przeciw uszkodzeniu roślin chłodem. Prezentowane w niniejszej pracy pomiary poziomu ABA u siewek kukurydzy w warunkach polowych podczas naturalnych okresów zimna, wczesną wiosną, w dwóch stanowiskach Europy potwierdzają wyniki otrzymane w komorach wzrostowych. Podczas wiosennych okresów chłodu linie odporne na chłód akumulowały w warunkach polowych istotnie więcej ABA niż wrażliwe. Ponadto, dane z badań polowych wykazują, że poziom akumulacji ABA w warunkach chłodu jest niezależny od indukowanego chłodem deficytu wody u roślin.

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