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The usefulness of selected physiological indicators for evaluation of the sensitivity of maize to drought stress as dependent on potassium supply

ABSTRCT

Maize is becoming one of the main crops in Poland. Maize is virtually the only one C_4 type plant which has a small specific water consumption, but great water demands related to its productivity. Successful maize cultivation seems to be more determined by periodic shortages of water called water stresses than the total amount of rainfall during growing season. This fact combined with a small number of the literature was the basic of this research.

The purpose of the study was to determine the effect of short-term drought stresses on the values of selected physiological parameters, yield, and yield components of maize plants dependent on potassium supply.

The pot experiments were conducted in greenhouse at Grabów Experimental Station IUNG-PIB between years 2013 and 2015. The experiments with single maize plant were conducted in 9-kilogram pots. A four-factorial experiment was established in 5 replications in complete randomization design. The first factor were two maize cultivars for different use (Jawor – grain, Sumaris – silage), the second factor was soil moisture at 3 levels: control and two stresses at 6-7 leaves stage BBCH 16-17 (S1) and at tasseling stage BBCH 51-53 (S2), the third factor was potassium availability in soil, low (K0), high (K1), very high (K2) and the fourth factor was the date of physiological indicator measurements, before the introduction of S1 stress, after S1 stress, after S2 stress and three weeks after the end of S2 stress. On each date of measurements, the following indices were determined by *in vivo* methods: gas exchange (LI-6400 Portable Photosynthesis System), chlorophyll fluorescence (Handy PEA chlorophyll Fluorimeter), chlorophyll and flavonoid content (Dualex 4), SPAD index (Hydro-N-tester), leaf temperature (Fluke 572 IR thermometer), potassium concentration in the sap (K+ Cardy meter). After harvest yield and yield components and potassium content in the dry matter by XRF method were determined.

As a result of the research, the following conclusions were drawn:

- A three-week drought stress from 6-7 leaves stage (BBCH 16-17) causes a decrease of maize biomass yield by about 40% and grain yield by about 50%. Drought stress from tasseling stage (BBCH 51-53) causes yield declines by 34% and 42% respectively.

- The grain yield decrease of grain maize cultivar was the result of the decrease of the number of grains per cob, while the weight of thousand grains was not changed. Silage maize cultivar responds to the drought stress by a reduction of grain share in the final yield and thus deterioration of the silage value.
- The effects of drought stress can be predicted on the basis of physiological indicators measured *in vivo*. These indices can be arranged in series: stomatal conductance > transpiration rate > photosynthesis rate > Performance Index > chlorophyll content > SPAD index > potassium concentration in the sap > flavonoid content > Nitrogen Balance Index > leaf temperature> maximum quantum efficiency of photosystem II photochemistry, in accordance with the decreasing sensitivity to drought stress.
- The only physiological indicator responding to potassium supply of maize was potassium concentration in the sap. A sufficient concentration, as determined by hand-held ionometer, is 200 ppm K+.
- In this research conditions, with 125 mg K_2O abundance per kilogram of soil, there was no interaction between increasing potassium fertilization and maize plant tolerance to drought stress.