31 Monograph. Danyte V. Potassium status of winter wheat and maize depending on nitrogen fertilization

Abstract (Summary)

Potassium is one of the most abundant nutrients in plant tissues and can be found both in cytoplasm and in vacuole. The main cytoplasm function of the potassium is providing the correct ionic environment for metabolic processes. Potassium salts in vacuole (plant water tissue or plant sap) are involved in the generation of cell turgor. Notwithstanding from its localisation, potassium is not a constituents in organic substances and appears exclusively in ionic form that can be easily "squeezed" out of the plant's body. For this reason, it has for some time been argued that the content of this element should be measured and expressed in terms of tissue water rather than plant dry matter. The prerequisite for using potassium concentration in tissue water as the plant test is the simple quantitative, and reliable method of its estimation, possibly *in situ.* Hand held ion meters (e.g. Cardy Ion Meter) developed in the last decade offers new opportunities for quick field diagnosis of potassium deficiency based on the plant sap squeezed out from leaves. Of particular interests are the relation between nitrogen and potassium because both elements play a decisive role in the plant's physiological processes and are highly mobile within the plant. It might therefore be assumed that there is a close link between N and K uptake particularly when the growth rate of crop is close to the optimum. The above considerations resulted in the establishment of the following objectives of this author's research:

- to adapt the Cardy Ion Meter for routine analysis of K concentrations in the tissue water of field grown crops,
- to compare potassium content in dry matter and concentrations in tissue water of winter wheat and maize plants differing in supply of nitrogen,
- to find the relation between the accumulation of potassium and nitrogen in the whole vegetation period of the two mentioned crops.

The research was held over the years 2005-2007, and was made in field experiments localised in the Experimental Station Grabów, close to Puławy. Two-factorial permanent field experiments have been carried out since 1980 in four-crop rotations: winter wheat - maize - spring cereals - winter rape, and all crops grown in each year. In the split-block experiment, the first factor in the years 2005-2007 was fertilization with potassium (without potassium K_0 and with optimal rate of potassium K_{opt}) and the second one six rates of nitrogen fertilizers. The samples of winter wheat (C_3 plant) were collected in intervals of seven - ten days since

the beginning of shooting (Feekes phase 30-31), and the samples of maize (C_4 plant) in similar intervals since its eight leaves unfolded (phase 18-19). The sample were divided into two parts: one was dried, grounded and analysed for dry matter and potassium in dry matter K_{DM} content and another one was cut into small pieces, frozen and after de-frosting analysed for potassium concentration in plant tissue water K_{sap} (by means of spectrometer and ion-meter). Altogether about 2500 plant samples have been analysed for both forms of potassium, including the samples taken in 2003-2004 from the farmer's field for calibration the ion-meter.

The most important findings of this research were as follows:

- critical potassium content K_{DM} and to a less extent, potassium concentration K_{sap}, particularly in winter wheat, which depends significantly on the plant nitrogen status. In winter wheat plants optimally supplied with nitrogen critical potassium content was in the range of 3.2-3.5% in DM and critical concentration in the range of 7000-10000 mg dm^{-3} of plant sap. Corresponding figures for maize leaves and maize whole plants were in the range of 2.0-2.-5% in DM and 5000-7000 mg K dm^{-3} of plant sap,
- for winter wheat potassium concentration in tissue water is a better measure of plants K status then the content of potassium in dry matter. The K concentration is less dependent on nitrogen fertilization and sampling time and hence has a more universal character throughout the crop growth and management practices,
- for maize both potassium content in dry matter and concentration in tissue water are comparable measures of plants K status. However, analysis of leaves (youngest, fully developed) provides unreliable results due to a high mobility of potassium in the plant's body. Analysis of the whole aboveground maize matter, however more reliable, encounters serious sampling problems,
- the concept of dilution curve developed for nitrogen is applicable to potassium as well. The dilution curves for both elements expressed in percent of dry matter seem to be closely interrelated and the critical content of potassium is proportional to the critical content of nitrogen,

Handy ion-meter (Cardy Meter) is a very good tool for the estimation of potassium concentration in plant tissue water. The analysis can be performed *in situ*, but after dilution of the plant sap. Freezing the plant samples before analysis is a recommended procedure in routine research.