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Monograph, Potassium in Soil and Plants ,Editor Fotyma M.

Fotyma M. Forms and tests of available potassium in soils

Abstract

In the years 2003 – 2008 two series of investigations on the content of potassium forms (so called total, fixed, exchangeable, available and water soluble) in soils, have been carried on in soil samples collected by Agrochemical Laboratories all over Poland. The content of all K forms except the water soluble one increased from light to heavy soils and were higher in the upper soil horizon. However, the share of potassium forms in the so called total potassium decreased from light to heavy soils. The content of all potassium forms was highly correlated and the highest correlations were found between exchangeable and available as well as between available and water soluble potassium. Taking water soluble potassium form as a reference one the new critical values for available potassium have been proposed. In comparison to the officially accepted available potassium classes, the new critical values are higher for light soils and lower for the heavy ones. In cooperation with neighboring countries the soil tests for available potassium have been compared on the same set of soil samples. In 10 Central-Eastern European countries altogether 4 methods of soils testing is applied (CAL, DL, AL and Mehlich(III)). Calibration values for these methods differ considerably and so differ the fertilizer recommendation based on soil testing.

Key words : forms of potassium in soil of Poland, total potassium, fixed potassium, exchangeable potassium, available potassium, water soluble potassium

Grzebisz W., Szczepaniak W., Gaj R., Barłóg P., Przygocka-Cyna.K. Field forming functions of potassium and magnesium fertilizers ln a course of a plant crop growth

Abstract

Crop yield depends on the degree of effect of nutrients on dynamics of dry matter accumulation expressed as quantitative response of yield structure elements. Yield forming functions of potassium and magnesium are different due to their differentiated time-growth effect. Potassium is critical to crop plants during the elongation phase of growth and dynamics of magnesium accumulation coincides with dry matter accumulation and shows maximum uptake at the end of vegetation. However, both nutrients are responsive for nitrogen economy of high yielding crops. The best example are cereals, which respond to supply of nitrogen over the whole growing season, however showing at heading, when final structure of yields

components is established, strong dependence on both elements supply. The yield forming effect of magnesium fertilization reveals its deep influence on final yield, but mainly under conditions of low supply of nitrogen. Sugar beet yielding response to N and mg interaction is the best example of this phenomenon.

Key words: potassium, magnesium, elements of yield structure, nitrogen economy

Grzebisz W., Muzolf R., Szczepaniak R., Barłóg P. Effect of artificially imposed water shortage against a background of potassium supply on dry matter, nitrogen and potassium accumulation by winter wheat

Abstract

A response of winter wheat to different water supply under background of two levels of potassium supply was tested during three consecutive growing seasons in a static field experiment established in 1990. The experimental design consisted of two potassium rates (0, 100 kg $K_2O \cdot ha^{-1}$) and three water levels: 1) control (natural water conditions), 2) sprinkled (water content at the level of 70% of water holding capacity - WHC) and 3) artificially simulated drought (2 x 21 days – 1st imposed at the beginning of shooting and repeated again at the beginning of flowering). Both experimental factors affected, independently of each other wheat grain yield (variety *Kobra*), but showing seasonal variability. The results revealed that, in the course of the growing season the most sensitive stage of wheat development to the imposed experimental conditions was the milk stage of grain growth. At that particular stage, the most decisive nutritional factor for final grain yields was potassium economy of the flag and the third leaf. Year-to-year variability of potassium amounts in these two leaves was in position to explain 75% and 69% of the grain yield variability, respectively. Therefore, potassium nutritional characteristics of wheat during grain filling period of wheat are of potential value for final grain yield prognosis.

***Key words*:** water, potassium, critical stage of development, grain yield, winter wheat

Grzebisz W., Fotyma M. Recommendations and use of potassium fertilizers in Central Eastern Europe(CEE)

Abstract

During the last 17 years (i.e. 1988-2004), yields of the main crops (cereals) in the Central-Eastern Europe (CEE) countries have undergone a significant decline. This was

basically attributed to changes related to the shift from a planned to a free market economy, which in turn led to a rise of prices of the means of plant production, including fertilisers among other inputs. A study was conducted in selected countries of the CEE which revealed that the decline in crop yields in the last 17 years was strongly related to potassium (K) soil fertility status. For example, referring to the average yields of winter wheat for the period 1988-91, it was found that the quantitative yield decline reached 1.0 t grain per ha. The greatest drop in yield occurred in the period 1990-93, i.e. 3 or 4 years after cessation of high K use. At present, the lower but stable level of yields is a permanent feature of agriculture in Czech Republic, Poland and also in Bulgaria and Romania, but a linear decrease still occurs in Hungary and Slovak Republic.

This study has also revealed that in most CEE countries the original concept of build up and maintenance of soil K reserves remains in force in spite of the growing gap between recommended and applied potassium rate. Therefore new strategies of more sustainable K management are required in order to increase the availability of soil potassium reserves and utilisation coefficients of potassium applied in fertilisers. Two concepts are suggested (i) a refinement of soil K test in relation to the most sensitive crop in the rotation (ii) an enhancement of the accessibility of subsoil K reserves to crop plants.

It was also found that the CEE region is not uniform with respect to soil K supply potential. Poland is naturally poor in potassium resources, due to the different origin of the main soil types. Therefore any kind of K management strategy must take into account the regional or even local (field scale level) soil potential for K supply and the use of crops in the rotation which can exploit soil and fertiliser potassium resources.

Key words : potassium fertilization, crops yield, systems of K fertilization

Igras J., Kopiński J. Potassium management in Poland and in conterminous countries

Abstract

The paper presents the basic indicators that affect the management of potassium in agriculture in Poland and in selected European countries. The consumption of potassium fertilizer in compare to nitrate and phosphorous fertilizer consumption, and potassium balance were showed. Balance of this component was developed by the method on the field surface. The regional variation of potassium content in soil in Poland in voivodeship system was presented.

Key words: Potassium fertiliser consumption, potassium balance, potassium content in soil

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Johnston A.E. Potassium, magnesium and soil fertility: Long term experimental evidence

Abstract

The developing root system of arable crops early in the growing season explores only a very limited volume of soil to take up nutrients. It is essential that this soil contains sufficient readily plant-available potassium (K) during the early stages of growth if the crop is to achieve its economic optimum yield. This is illustrated by the very different pattern of daily uptake of K by spring barley grown on two similar soils but with different amounts of available K and the effects of this on final grain yield. The total amount of K taken up by crops usually exceeds that of nitrogen (N) and with an ample supply of K, crops use N fertilisers more efficiently. The roots of grass crops are efficient in searching soil for nutrients but grass that yields well can remove 800-900 kg K·ha per year. Consequently soils growing grass must also have an adequate supply of readily plant-available K if this demand is to be met. In farming systems where grass and arable crops are grown alternately (ley-arable systems), if the large amounts of K taken off in grass and other ley crops are not replaced, the amount of plant-available K in soil can decline to such an extent that the yields of following arable crops are decreased, and examples are given here. It is possible to determine a critical level of readily plant-available K in soil for crops, farming systems and soil types; examples are given as are ways of maintaining the critical level once it has been achieved. This relies on estimating K balances and periodically analysing soil.

A conceptual framework to describe soil K is presented in which soil K is considered to exist in four pools related to the availability of the K to plants. These pools are: soil solution K, exchangeable K, fixed K and lattice K and the K in these pools is immediately available, readily available, less readily (slowly) available and very slowly available, respectively, for plant uptake. The evidence presented shows that K can transfer reversibly between the first three pools. When K fertiliser is applied to a soil, some K remains in the soil solution and some rapidly transfers to the exchangeable and fixed K pools. As plant roots take up K from the soil solution it is replaced by K in the exchangeable and fixed K pools. It appears that in a 'steady state' situation, there is an equilibrium between exchangeable and fixed K. At equilibrium the amount of K in each pool depends on the number of exchange sites available for holding K and this is related to the amount and type of clay minerals.

A new approach to estimating K use efficiency is presented. Using soil analysis to manage the use of K in crop production is discussed.

Kocoń A. Physiological and agronomical principles of evaluation plants potassium nutritional status.

Abstract

This review deals with a physiological and agronomical role of potassium and methods of evaluation of plants K nutrition status. Most of the place in the paper was spent on methods currently used in agriculture but also on a new method of evaluation of plants potassium nutrition status which has not been fully researched and verified, that is on the method in which potassium nutrition status is determined from the potassium level in the plant sap. While considering plants potassium nutrition status one should not ignore a role of nitrogen in plant metabolism and linear dependence among K and N and among critical concentration of K and N, which may be used to evaluate plants potassium nutrition status.
Key words: potassium, plants nutrition status, critical concentration

Milford G.F.J.,Johnston A.E. Potassium and nitrogen interactions in crop production

Abstract

The potassium (K) status of the soil has a considerable influence on crop uptake and response to nitrogen (N). Yield response to applied fertiliser N is decreased by low concentrations of exchangeable K in the soil. The basis of this interaction is explored using historical and current data from Rothamsted Research's experiments at Rothamsted, Saxmundham, Woburn and Broom's Barn on spring barley, winter wheat, potatoes, sugar beet, mangels and grass. It is argued that the agronomic responses derive from the physiologically interacting effects of N and K on tissue hydration and consequential osmotic adjustments in shoot tissues.

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Romheld V., Kirkby E.A. Management functions in crop nutrition and yield

Abstract

The essential requirement for magnesium (Mg) and its basic biochemical and physiological functions in plant metabolism have been understood for many years. Despite this understanding, however, in comparison with the other major nutrients not a great deal of attention has been given to Mg in crop nutrition. With some justification therefore Mg has been described as the almost forgotten mineral nutrient. There is now increasing evidence of the occurrence of Mg deficient symptoms in crop plants and the consequent need for Mg fertilisation for the improvement of yields and crop quality. Magnesium uptake by plants can be low particularly on acid sandy soils poor in Mg as a consequence of the competitive effect of other cations including potassium (K^+), ammonium (NH_4^+) and aluminium (Al^{3+}). Plants poorly supplied in Mg have low root to shoot ratios making them less well able to acquire nutrients and water. The need for Mg in the phloem loading process means that in inadequately supplied plants the transport of photosynthates can be impaired and thus too the quality of grains, fruits and tubers. Adequate amounts of Mg are therefore particularly required during the period of reproductive growth. This is particularly important under conditions when Mg acquisition for the soil can be impaired as under drought, or high K supply or on low pH soils. A lack of Mg also disturbs nitrogen (N) metabolism so that crops low in Mg are unable to make optimal use of N fertilisers, which is of significance both to crop production and the environment. More evidence is forthcoming of the mitigating effect of higher Mg concentrations in the plant on various environmental stresses including light, heat and drought, stresses which are likely to take on even more importance with the increasing weather extremes caused by global climate change. From the physiological principles involved, six areas of research in field crop production are considered in relation to the strategic use of Mg fertilisers for the benefit of farmers.