POTASSIUM FERTILIZATION INFLUENCE UPON VEGETABLE YIELD QUALITY AND SOIL FERTILITY PROTECTION

INFLUENTA FERTILIZARII CU POTASIU ASUPRA CALITATII PRODUCTIEI VEGETALE SI PROTECTIEI FERTILITATII SOLULUI

RADULOV ISIDORA*, MILAN PAVLOVIC, SALA F*, BERBECEA ADINA*.**

Universitatea de Stiinte Agricole si Medicina Veterinara a Banatului Timisoara

****Tehnicki Fakultet „Mihajlo Pupin" Zrenjanin - Serbia***

Abstract: *Like nitrogen and phosphorus, potassium is major nutrition`s element contributing to large, steady and high quality crops. Crops need potassium and nitrogen in fairly comparable amounts however everyday agriculture stands proof to a lack of balance in the intake of these nutrients to the detriment of the potassium.*

The potassium used in fertilizers, especially in developing countries, is much below the amount of the potassium in the crops. By way of consequence the amount of the potassium in the soil diminishes and so does soil fertility.

Rezumat: *Potasiul, la fel ca azotul si fosforul, este unul din elementele principale ale nutritiei, contribuind la obtinerea de recolte ridicate calitativ si cantitativ. Desi plantele de cultura necesita potasiul si azotul in cantitati relativ egale, practica agricola uzuala arata un dezechilibru intre cei doi nutrienti, in defavoarea potasiului. Cantitatile de potasiu aplicate prin ingrasaminte, mai ales in tarile in curs de dezvoltare, sunt mult sub cantitatea de potasiu extrasa cu recolta. Ca urmare are loc scaderea continutului de potasiu al solului, cu consecinte asupra fertilitatii acestuia.*

Key words*: potassium, fertilizers, yield quality, soil fertility*

Cuvinte cheie*: potasiu, ingrasaminte, calitatea recoltelor, fertilitatea solului*

INTODUCTION

Three major challenges will confront future agricultural production: a continuously growing global population needs more food, i.e. it requires higher production; increasing urbanization demands more food in general and more meat, vegetables and fruits in particular, i.e. more diverse diet and thus a diverse crop spectrum; higher purchasing power of the urban population will ask for better quality (KRAUSS, 2002).

Most of the increase in crop production has to come from higher yields and less due to area extension because land reserves to cultivate crops are almost exhausted. To the contrary, loss of land for urbanization, industrial purpose and civic needs will continue, leaving less land for crop production. The global per capita availability of land will further decrease from currently 0.24 ha to 0.17 ha within the next 20 years.

Assuming that the global area with cereals remains fairly constant at around 700 million ha, it would imply that the global cereal yield has to be increased from currently 3 t/ha to almost 5 t/ha within the next 20 years to match the expected demand (IFC, 2003).

In general, there is a fairly good relationship between fertilizer use and crop yield, because 35-40% of the yield increase can be attributed to fertilizer. Numerous field trials of FAO and the fertilizer industry showed that with one kg fertilizer, grain yield of cereals increased by about 10 kg/ha. However, fertilizer use went out of balance with respect to the ratio between the applied nutrients and the balance between input by fertilizers and nutrient output by crops. This refers in particular to potassium.

DISCUSSION

Considering the global fertilizer use, it shows that use of N is steadily increasing. In contrast, P and K use in particular lags seriously behind. In consequence, the NK ratio depreciated from 1:0.4 in the early eighties to currently 1:0.27. On the other hand, a good crop absorbs about 100-200 kg/ha N, 40-80 kg/ha P_2O_5 and 100-400 kg/ha K_2O (KRAUSS, 2001). This means that plants take up potassium in the same or even higher quantity than nitrogen.

For decades, farmers in these areas have assumed that potassium levels were adequate. Their focus in nutrient management has been on nitrogen and phosphorus. But years of neglect has mined soils down to yield-limiting levels of potassium in many areas. Farmers in these regions now have in additional nutrient to worry about- a nutrient they have traditionally not had to manage (MAGEN, 2006).

Higher and quality yields mean higher nutrient turnover or, if unreplaced, higher nutrient loss. Farmers are conscious of the need to replace nitrogen and phosphate but potassium is often forgotten even though plants need this element in the same quantities as they need nitrogen. For example, for cauliflower and tomatoes, the ratio of nitrogen:potassium uptake is 1:1.4, for potatoes and apples it is 1:1.8.When mineral nitrogen fertilizer is applied, but potassium is not, the imbalance is reflected in disappointing yields and poor quality of product.

The potassium used in fertilizers, especially in developing countries, is much bellow the amount of potassium in the crops. By way of consequence the amount of potassium in the soil diminishes and so does the soil fertility. Furthermore an unbalanced fertilization means poor efficiency of the fertilizers especially in the case of the nitrogen which is likely to volatilize. The negative effects of the unbalanced fertilization on the environment and the soil sustainability will only add to the farmers dwindling income as a result of a limited use of the potential of the culture.

Farmers neglect potash because they fail to understand the functions of potassium in plant and its behaviour in soils. In soils potassium is found in four main pools, namely structural potassium, slowly exchangeable potassium, exchangeable potassium and soil solution potassium. Routine soil tests usually consider only partially the availability of soil potassium because is difficult to examine other K pools. Therefore response prediction based on routine soil test values can be as often wrong as right. More research is needed for better understanding the underlying processes in order to develop more reliable and precise fertilizer recommendation.

All fractions are interrelated through exchange processes. Soil K removed from solution through plant uptake or leaching is replenished with K desorbed from the exchange sites. Adding K with fertilizers initiates the reverse process, namely absorption of K.

The nutrient requirement of a good crop is considerable, the daily uptake varies around 5, 0.5 and 5 kg/ha for N, P and K, respectively. To provide 5 kg K per ha and day by diffusion to the roots, the required K concentration in the soil solution should range in moist soils from around 100 μM in light soils to 200 μM in heavy soils. The drier the soil and the less dense the root system, the higher is the needed K concentration.

Potassium effect on yield quality might be more protein (for cereals), higher feeding value (for forages), improved drought tolerance, decrease the incidence of pests and diseases, greater consumer acceptance (for vegetables and fruits) (BORLAN, 2001). The profits from the investment in K can originate from: improvement in total yield; better crop quality; lower cost per unit of production; disease resistance; stress tolerance; more effective use of other nutrients, especially nitrogen; improves membranes turgescence and structure, which leads to higher mechanical resistance; increase free sugar content and improves organic acids synthesis; improves colour and increase dry matter content.

Unfortunately, due to lack of knowledge, farmers seldom relate stagnating yields, poor crop quality and high susceptibility stress to imbalance in nutrition and hidden K deficiency.

Many field experiences shows that balanced potassium fertilization has positive influence on crop quality. Crops with high potassium content also have better looks. Balanced fertilization means crops with no disease or pests, which lead to hygienic products. And at last, higher yields obtained after balanced fertilization, mean lower residual nitrogen ($N\text{-}NO_3^-$) content in soil and through this can prevent environment pollution.

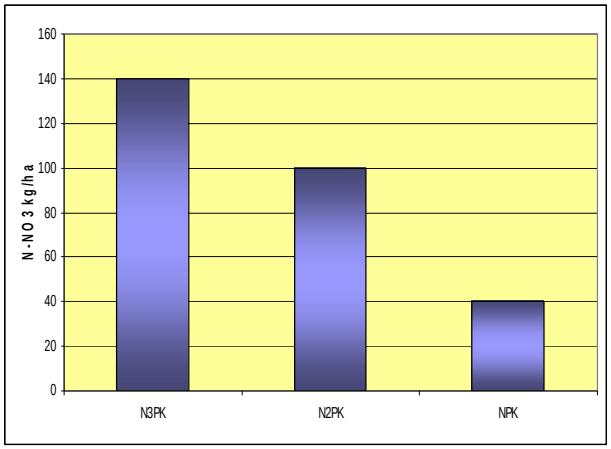


Figure.1 Residual nitrate in subsoil after harvest of cabbage as affected by fertilization practice (KRAUSS, 1999)

The benefit of balanced fertilization on crop yield results from more recent trials of the International Potash Institute (IPI) in Central/Eastern Europe shows:

- Up to 36% higher potato yields in Poland with balanced fertilization including NPK+S+Mg compared to NP (DITSCHAR, 2005).

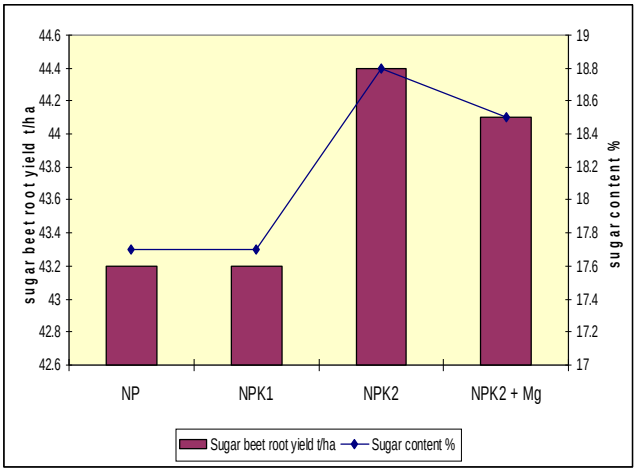
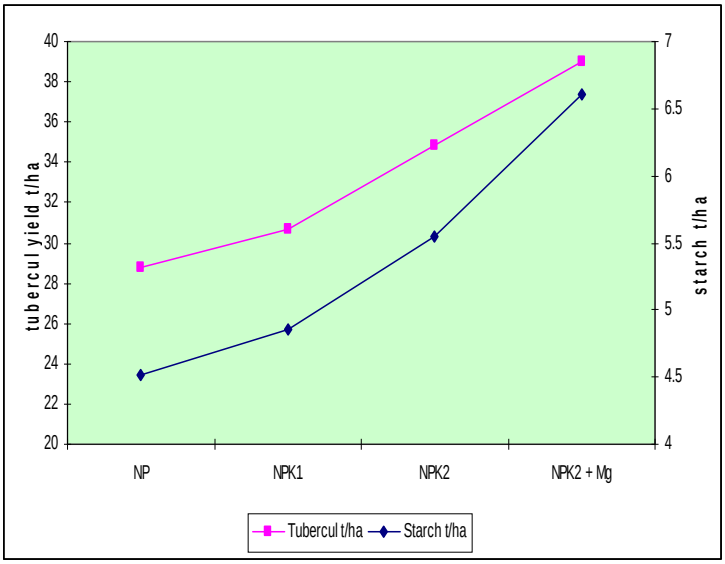


Figure.2 Sugar beet root yield and sugar content obtained in Hungary after balanced fertilization (KRAUSS, 2001)

- 8% higher beet and up to 17% higher sugar yield in Czech Rep. with NPK+S+Mg and 18% higher beet and 20% higher sugar yield in Hungary
- 29% higher yield of beans and 11% higher yield of potato tubers in Bulgaria.
- 51% higher wheat yield in Russia with NPK (KRAUSS, 2002).
- In Russia, applying adequate potash to cabbage increased yield by 20t/ha to 90.8t/ha and improved vitamin C content by 12%. Cabbage stored during 4 months showed a substantial loss of weight, 35%, and serious incidence of spot necrosis when unbalanced fertilized with NP only. In contrast, balanced fertilization improved weight loss (27%) and reduced considerably incidence of spot necrosis. After 4 months, cabbages also had a rather favourable K:N ratio of 1.18, whereas the cabbage at NP control contained substantially more nitrate , K:N=0.49. Comparable results were also found in carrots and red beet.



Fgure.3 Potato yield and starch content obtained in Poland after balanced fertilization (KRAUSS, 2001)

Research in Australia found that comparing nitrogen, phosphorus, and potassium deficiencies, it was a shortage of potassium that most severely affected root growth. Within four days after seeding there were fewer root numbers on potassium –deficient plants. After three weeks, the potassium-deficient plants had half the seminal roots compared to the nitrogen – or phosphorus-deficient plants. And at 30 days after seeding, the potassium –deficient plants still had no nodal roots, while the nitrogen and phosphorus-deficient plant did. (BRUULSEMA , 2001).

Researches made at International Potash Institute in Central Europe(Czech Republic, Poland, Slovakia, Hungary, Romania, Serbia and Bulgaria) showed that fifteen years ago it was difficult to show any effect of potassium, because most of the soils were rich in K as the result of heavy potash applications made in previous years. However, after 1990, because of the hardship brought about by economic changes, farmers in the region stopped applying potassium completely and it did not take long until soil reserves were greatly depleted and field trials were clearly demonstrating the need for potash.

Experiences made by IPI in Romania (Livada, 2004-2007) in a classical crop rotation with maize, sunflower, spring barley and winter wheat was the basis for this trial. The NP treatment resulted in decline of total cereal units of 8.6-13.2 %, grater loss than that with the omission of P (the NK plot).(POPP, 2007).

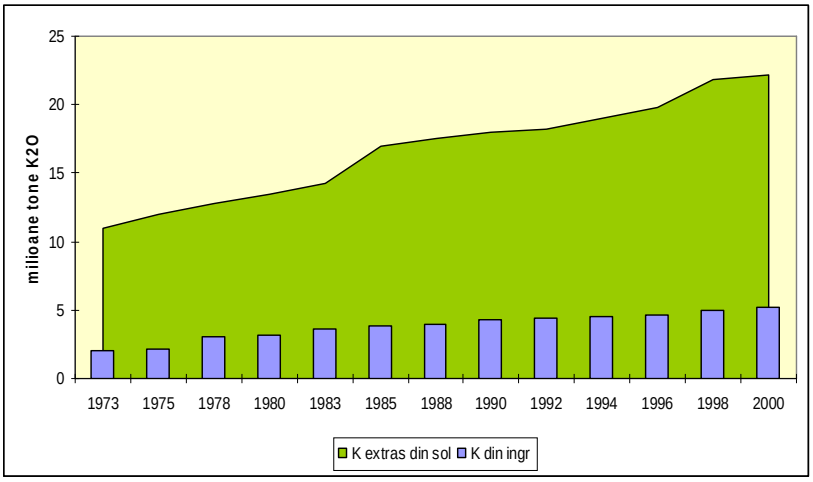


Figure.4. Dependenta dintre potasiul extras cu recolta si potasiul aplicat prin ingrasaminte (IFC NO.7, 2002),

Potassium is essential for plant and animal life wherein it has many vital nutritional roles. In plants, potassium and nitrogen are the two elements required in greatest amounts, while in animals and humans, potassium is the third most abundant element, after calcium and phosphorus. Without sufficient plant and animal intake of potassium, life as we know it would cease. Human and other animals at top of food chain depend upon plants for much of their nutritional needs. Many soils lack sufficient quantities of available potassium for satisfactory yield and quality of crops. For this reason available soil potassium levels are commonly supplemented by potash fertilization to improve the potassium nutrition of plants, high yielding crop species and varieties.

Soil fertility management involve the use of potassium in proper relationship to inputs of other macronutrients such as nitrogen, phosphorus and sulphur. Without adequate potassium, the full potential benefits of investments in the other major fertilizer nutrients, and soil irrigation are at risk. Potassium encourages more efficient nutrient utilization by plants, which in turn contributes to higher benefits, improved ecological conditions and sustainable agriculture.

Based on current demographic development and continuous urbanization, quality crop production is a must, equally is consumed either fresh or processed. Balanced fertilization supports this demand by regulating the metabolic processes in yield formation. Ultimately it is not only the consumer who will benefit; it is also the farmer through higher income. Balanced fertilization also assists in resources conservation and environment protection.

CONCLUSION

1. The potassium used in fertilizers, especially in developing countries, is much bellow the amount of potassium in the crops. By way of consequence the amount of potassium in the soil diminishes and so does the soil fertility.

2. Unfortunately, due to lack of knowledge, farmers seldom relate stagnating yields, poor crop quality and high susceptibility stress to imbalance in nutrition and hidden K deficiency.
3. Soil fertility management involve the use of potassium in proper relationship to inputs of other macronutrients such as nitrogen, phosphorus and sulphur. Potassium encourages more efficient nutrient utilization by plants, which in turn contributes to higher benefits, improved ecological conditions and sustainable agriculture.
4. The profits from the investment in K can originate from: improvement in total yield; better crop quality; lower cost per unit of production; disease resistance; stress tolerance; more effective use of other nutrients, especially nitrogen.

LITERATURE:

1. BORLAN Z. – *Potasiul, nutrient indispensabil pentru producția şi calitatea legumelor,* International Potash Institute, Basel Elveția, 2001
2. BRUULSEMA T.W. – *Functional food components: a role for mineral nutrients?* Better crops 84 (2) pg. 6-7, 2001
3. DITSCHAR B., IVANOVA SVETLANA - *The effect of K on yield quality of selected Solanaceae*, The first International Symposium on Sustainable Agriculture for Subtropical regions Changsha, People`s Republic of China 23-25 Nov. 2005
4. KRAUSS A - *Potassium, an integral part for sustained soil fertility and efficient crop production*, 2nd International AUP-IPBA-IPI Workshop, Poznan - Sielinko, Polonia, Iunie 2002
5. KRAUSS A. – *Potassium effects on yield quality,* Potafos Symposium on K in Brasilian Agriculture, Sao Pedro, Brazil, 22-24 sept. 2002
6. KRAUSS A. – *Quality production at balanced fertilization : the key for competitive marketing of crops* , Role of fertilizers in sustainable agriculture, Suceava Romania, 21-22 august 2000
7. MAGEN H. – *Balanced crop nutrition: fertilizing for crop and food quality*, IFA Agriculture Conference – Optimizing Resource Use Efficiency for Sustainable Intensification of Agriculture, Kunming China, 28 Feb.- 2 March 2006
8. POPP T. – *IPI field experiments in Central Europe –an overview on 15 years of activity*, e-ifc no.14, Decembrie 2007
9. RADULOV ISIDORA, M. GOIAN – *Potasiul in agricultura si nutritie,* Ed. Solness, Timisoara, 2004
10. *** - *…on impact of K on quality*, International Fertilizer Corespondent, No.7, pg. 5-6,2002
11. *** - *K rules, ok?,* International Fertilizer Corespondent, No.8, pg. 1-2,2003