CHANGES IN SOIL POTASSIUM CONTENT AFTER MINERAL FERTILIZATION

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Abstract:

Potassium is one of essential macronutrients for plant nutrition. Of the primary plants nutrients, the potassium is known regarding to its influence on the production in general and in particular on the quality of the harvest. To achieve high and good quality yields, potassium fertilization is a factor of utmost importance. Unfortunately in agriculture are used large quantities of nitrogen at the expense of potassium, causing an imbalance because the amount of potassium that is extracted with the yield is much higher than the one that is returned to the soil as fertilizer. This draws decreased soil fertility in terms of a reduced nutrient content. From field experiment soil samples were taken by depth of 0-20 cm for testing. Analysis were made in Soil Science Laboratory of Agricultural Faculty. Potassium was extract in ammonium acetat –lactat solution, and content determination was made by emission with atomic absorption spectrophotometer Varian 220 FAAS, at wave length of 766 nm. pH was determined in water extract 1:2.5. Ammonia is extracted from the soil with a solution of potassium sulphate (K_2SO_4) 0,1n, soil solution ratio being 1:3 and it is been colorimetrical dosed with Nessler's reagent. Potassium availability for plants is governed by the transfer between four main pools in the soil: native, fixed, exchangeable and soluble. The main contributors to K supply to plants are exchangeable and soluble forms. When K^+ is removed from the solution by plant uptake or leaching, the soil solution is rapidly replenished by K^+ from exchangeable sites, whereas the fixed clay replenishes the exchangeable sites slowly by a diffusion controlled process. Usually average values of state insurance of assimilable potassium in the arable layer of chernozem cambic, are between 150-200 ppm, which corresponds to a medium and good insurance in this macroelement. There is a reduction in the potassium content of the soil at low pH values. As the pH is close to the neutral values, soil content of assimilable K increases.

***Key words**: potassium, soil, fertilization, ammonium*

INTRODUCTION

Potassium is one of essential macronutrients for plant nutrition. It is located in tissue with high biological activity and is found almost exclusively in the form of ion. The average content of potassium in plants is 10 mg /g (NEAMȚU, CÂMPEANU AND SOCACIU, 1995 QUOTE RADULOV ISIDORA ȘI GOIAN M., 2004).

Potassium plays an important role in the synthesis, transport and storage of glucides, participates in the process of photosynthesis and respiration, positive influence fluid regime of plants, reducing transpiration, increases plant resistance to frost and drought, pests and diseases attack.

Of the primary plants nutrients, the potassium is known regarding to its influence on the production in general and in particular on the quality of the harvest. Influence of potassium on the quality of plant products is stronger than any nutrient (RADULOV ISIDORA AND GOIAN M., 2004).

The soil potassium exists as poorly soluble and therefore difficult to reach the plants, as well as in water-soluble form that is available to the plant. The ratio of these forms is influenced by the nature of the mineral, the proportion of clay and pH.

The total content of potassium (including forms difficult to access and easily available for plant) in soils from Romania is contained on average between 1.25 and 1.90% K (1.5 to 2.3 K2O) (VELICICA DAVIDESCU, D. DAVIDESCU 1979). Soils with high amounts of potassium are rich in clay and reddish brown, chernozems leachates and the lowest amounts are found in podzols, basified soils and soils with light texture.

Plants readily absorb the potassium dissolved in the soil water. As soon as the potassium concentration in soil water drops, more is released into this solution from the K attached to the clay minerals. The K^+ attached to the exchange sites on the clay minerals is more readily available for plant growth than the K^+ trapped between the layers of the clay minerals.

Following the above we can say that to achieve high and good quality yields, potassium fertilization is a factor of utmost importance.

Unfortunately in agriculture are used large quantities of nitrogen at the expense of potassium, causing an imbalance because the amount of potassium that is extracted with the yield is much higher than the one that is returned to the soil as fertilizer. This draws decreased soil fertility in terms of a reduced nutrient content.

The potassium content of soil originated in rocks that was formed. It is passed from primary minerals (feldspar, mica) in secondary minerals (kaolinite, illite, chlorite, montomorilonit, vermiculite) after performing the process of alteration and chemical disaggregation and the action of organisms.

Potassium from soils can be grouped into the following categories: unavailable potassium, slowly available potassium, readily available potassium.

There are a limited number of fertilizer materials that can be used to supply K when needed. These materials are listed in Table 1.

Table 1.

Common fertilizer sources of K (GEORGE REHM AND MICHAEL SCHMITT, 2002)

Material	*Chemical formula*	*K_2O content %*
Potassium chloride	KCl	60
Potassium-magnesium sulphate	K_2SO_4-$2MgSO_4$	20
Potassium nitrate	KNO_3	44
Potassium sulphate	K_2SO_4	50

Table 2.

Amounts of potassium used for main crops

CROPS	*Specific consumption 1000kg*	*Quantities applied per hectare*
Wheat	19-37 kg K_2O	60-80 kg/ha
Corn	23-36 kg K_2O	70-130 kg/ha
Sunflower	3,8-16,5 kg K_2O	60-80 kg/ha
Rape	40-50 kg K_2O	60-80 kg/ha

MATERIAL AND METHOD

Testing the effect of mineral fertilizers:

1. control (unfertilized)
2. 54.0.0 (54 $kgN \cdot ha^{-1}$),
3. 81.0.0 (81 $kgN \cdot ha^{-1}$),
4. 81.15.0 (81 $kgN \cdot ha^{-1}$ si 15 $kgP_2O_5 \cdot ha^{-1}$),
5. 81.20.40 (81 $kgN \cdot ha^{-1}$, 20 $kgP_2O_5 \cdot ha^{-1}$ şi 40 $kgK_2O \cdot ha^{-1}$),
6. 81.27.27 (81 $kgN \cdot ha^{-1}$, 27 $kgP_2O_5 \cdot ha^{-1}$ şi 27 $kgK_2O \cdot ha^{-1}$),
7. 122.30.60 (122 $kgN \cdot ha^{-1}$, 30 $kgP_2O_5 \cdot ha^{-1}$ şi 60 $kgK_2O \cdot ha^{-1}$).

Nitrogen was applied in the form of ammonium nitrate (33.5% N). Complex fertilizers were applied in the form of 20.20.0, 15.15.15 and 14.10.20.

From field experiment soil samples were taken by depth of 0-20 cm for testing. Analisis were made in Soil Science Laboratory of Agricultural Faculty. Potassium was extract in ammonium acetat –lactat solution, and content determination was made by emission with atomic absorption spectrophotometer Varian 220 FAAS, at wave length of 766 nm. pH was determined in water extract 1:2.5.

Ammonia is extracted from the soil with a solution of potassium sulphate (K2SO4) 0,1n, soil solution ratio being 1:3 and it is been colorimetrical dosed with Nessler's reagent.

RESULTS AND DISCUSSION

Potassium availability for plants is governed by the transfer between four main pools in the soil: native, fixed, exchangeable and soluble (RÖMHELD AND KIRKBY, 2010). The main contributors to K supply to plants are exchangeable and soluble forms. When K^+ is removed from the solution by plant uptake or leaching, the soil solution is rapidly replenished by K^+ from exchangeable sites, whereas the fixed clay replenishes the exchangeable sites slowly by a diffusion controlled process (BAR TAL, 2011). Usually average values of state insurance of assimilable potassium in the arable layer of chernozem cambic, are between 150-200 ppm, which corresponds to a medium and good insurance in this macroelement.

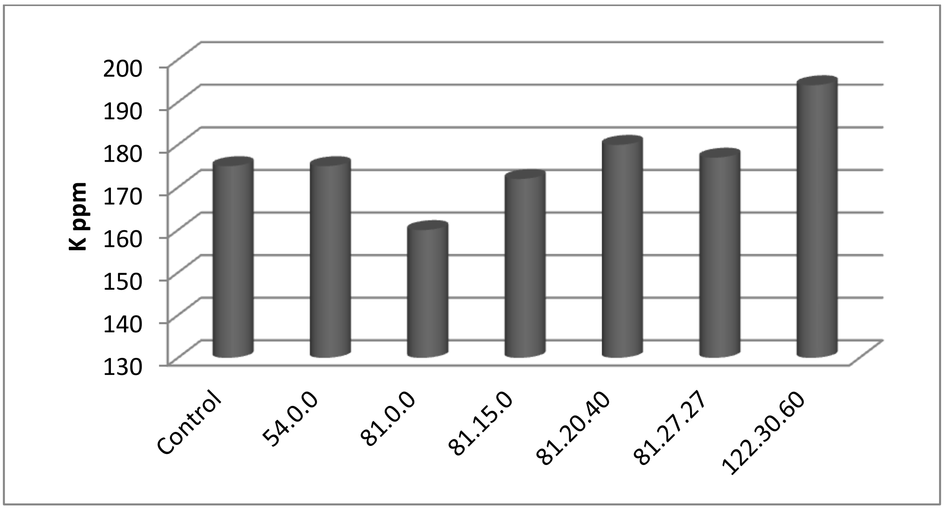

Fig.1 Assimilable potassium content of the soil after mineral fertilization

Potassium content of the soil increases with from 1 to 18 ppm relative to the control, the highest values are determined in variants of the most potassic fertilizer applied doses. In the case of fertilization with only 81 kg N / ha occurs a reduction in the amount of potassium determined by analysis, probably due to consumption by plants and its retention in the soil colloidal complex.

Soil K status influences K uptake by plant roots. The amount of K in the soil depends on soil type, production level, retention or removal of crop residues and the input of K as fertilizer or as a component of irrigation water. Imbalance in fertilizer application, especially N fertilizers with no K, is very common (BAR TAL 2011).

Potassium levels increase with higher pH levels, so acidic soils, which have lower pH levels, tend to have less potassium content than alkaline soils.

Table 3

Potassium content and soil pH values after mineral fertilization

Variant	pH	K ppm
Control	6,53	175
54.0.0	6,45	175
81.0.0	6,39	160
81.15.0	6,48	172
81.20.40	6,73	180
81.27.27	6,67	177
122.30.60	6,81	194

The average values of pH increase in variants in which the complex fertilizer was applied to the nitrogen, phosphorus and potassium. The decrease in pH values after the application of nitrogen fertilizers can be explained by the fact that this nutrient has been applied in the form of ammonium nitrate (Table 1).

There is a reduction in the potassium content of the soil at low pH values. As the pH is close to the neutral values, soil content of assimilable K increases.

Numerous published data indicate that K^+ and NH_4^+ are attracted by the same exchange sites with similar affinity. A slight preference for K^+ over NH_4^+ has been demonstrated in laboratory exchange isotherms (CHUNG AND ZASOSKI, 1994). The concentration of NH_4^+ in the soil solution has a strong and direct impact on the distribution of K^+ between the soil solution and the exchange complex and vice versa.

Ammonia form of nitrogen can be absorbed and retained by soil colloidal material. In the case of soil where were placed experiences, soil with a high cation exchange capacity, the possibility of retaining the N-NH_4^+ is high. The of reversibility cations retention processes is important in plant nutrition and fertilizer application. If the plants adsorb from soil solution a particular species of cations, the balance of the solution with the solid phase is restored to the soil solution by moving a part of the cation of the same species, existing in the state of adsorption. The mobility of exchange between cations adsorbed and the cations contained in the soil solution ensures the nutrients to the plants (RADULOV AND GOIAN, 2004).

Table 4

Potassium ammonium antagonism influenced by mineral fertilization

Variant	K ppm	NH_4^+ ppm
Control	175	0.95
54.0.0	175	8.9
81.0.0	160	10.57
81.15.0	172	7.47
81.20.40	180	5.55
81.27.27	177	6.87
122.30.60	194	4.72

The potassium ion compared to the ammonium ion show an antagonistic action. If is in soil solution fixed potassium and ammonium ions, ammonium ions prevents the release of potassium (loosening) and conversely, if ammonia is entered between the layers prevents penetration between layers and fixation of potassium. Plants need of potassium becomes even greater, as in the soil solution are larger amounts of NH_4^+ ion (Goian, 2000).

In the case of mineral fertilization on the same agrofond of phosphorus and potassium is observed a decrease of potassium content and the increase in the content of ammoniacal nitrogen with increasing the dose. A soil well supplied with potassium, if is fertilize excessively with nitrogen appears deficient in potassium, nitrogen fertilization must be accompanied by the potassium fertilization. N-NH_4^+ values decrease along with the increase doses of phosphorus and potassium, against to K.

CONCLUSIONS

- To achieve high and good quality yields, potassium fertilization is a factor of utmost importance.
- Usually average values of state insurance of assimilable potassium in the arable layer of chernozem cambic, are between 150-200 ppm, which corresponds to a medium and good insurance in this macroelement.
- Unfortunately in agriculture are used large quantities of nitrogen at the expense of potassium, causing an imbalance because the amount of potassium that is extracted with the yield is much higher than the one that is returned to the soil as fertilizer.
- There is a reduction in the potassium content of the soil at low pH values. As the pH is close to the neutral values, soil content of asimilable K increases.
- In the case of fertilization with only 81 kg N / ha occurs a reduction in the amount of potassium determined by analysis, probably due to consumption by plants and its retention in the soil colloidal complex.

- In the case of mineral fertilization on the same level of phosphorus and potassium is observed a decrease of potassium content and the increase in the content of ammonium content as the dose rises.

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