

Rapid monitoring of Ca and K in plants by X-ray fluorescence spectrometry method

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Abstract Literature contains numerous data on the distribution of minerals in soil and plants from spontaneous flora or cultivated in different geographical areas, as well as a series of mineral analysis techniques. The aim of this study was to determine the concentrations in K and Ca of *Cirsium arvense*, *Agropyron repens* and *Medicago sativa* using x-ray fluorescence spectrometry. This study was conducted on a cambic chernozem, in seven location in Dumbravita (Timis County) area. The tested plants accumulated Ca and K differently. The mineral content of whole plants are expressed on a dry matter basis. In *Cirsium arvense* and *Medicago sativa* total calcium content is higher than total potassium content but in *Agropyron repens* the ratio is reversed. The average values of the content of Ca (mg/kg d.w.) has a downward trend: *Cirsium arvense* > *Medicago sativa* > *Agropyron repens*. The trend for K (mg/kg d.w.) is: *Medicago sativa* > *Agropyron repens* > *Cirsium arvense*. Comparing our results, obtained by using x-ray fluorescence spectrometry with literature, the values are similar, so we consider that this method can be used for a rapid monitoring of the mineral contents in forages, but it is necessary to make other researches in future on this theme.

Key words

Cirsium arvense, *Medicago sativa*, *Agropyron repens*, elemental analysis

Literature contains numerous data on the distribution of minerals in soil and plants from spontaneous flora or cultivated in different geographical areas, as well as a series of mineral analysis techniques [2,3,7,10].

There are a lot of studies about the importance of calcium and potassium for humans and animals. Minerals play major role in the development and maintenance of the skeletal system and perform many other physiologic functions. The health benefits of potassium include relief from stroke, blood pressure, heart and kidney disorders, anxiety and stress, as well as enhanced muscle strength, metabolism, water balance, electrolytic functions, and nervous system [1, 11]. Nearly 99% of the calcium in the body is found in the skeleton, while 80% of the phosphorus is in bones and teeth. The remaining Ca is extracellular and plays a role in nerve conduction, muscle contraction, blood clotting and immune system activation [5]. Potassium (K) is essential for human and animal life. Potassium is involved in many body functions and is required for proper muscle development. Adequate K is also important for good heart function [4].

The literature show that minerals such as magnesium, manganese, copper, zinc, boron, cobalt and selenium were often significantly higher in species such as chicory, narrow-leaved plantain, dandelion, broad-leaved dock (*Rumex obtusifolius*), Californian thistle (*Cirsium arvense*) and hairy buttercup (*Ranunculus*

sardous) than the perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*) components of the sward [8].

The aim of this study was to determine the concentrations in K and Ca of *Cirsium arvense*, *Agropyron repens* and *Medicago sativa*, by using x-ray fluorescence spectrometry.

Seven location in Dumbravita (Timis County) area were taken into our study. The forages were harvested in autumn 2014.

Analysis by atomic fluorescence X-ray is a modern method of determination of mineral elements, for environmental samples, geological, biological (solid and liquid), without processing [1].

Material and Methods

This study was conducted on a cambic chernozem, in seven location in Dumbravita (Timis County) area. The forages were harvested in October 2014.

The collected samples of plants were washed with double distilled water. The samples of whole plants were oven dried at 80°C to constant weight, than they ground and packed in polyethylene bags of 10 grams.

The spectral fluorescence ray X (FRX) analyzer is NITON XL3t GOLD+ model, with basic features: tube miniaturized X-ray, anode silver, X-ray. Measurements

were carried out by applying the measurement window of the device directly on the surface of the polyethylene bags of samples.

The levels of Ca and K, expressed as ppm (mg/kg dry weight), were read directly from the screen of the device.

Results and Discussions

The experimental data obtained for Ca and K (mg/kg d.w.) in the tested plants and detected by using atomic fluorescence X-ray are shown in Figures 1, 2 and 3. The results are expressed as mg/kg dry weight.

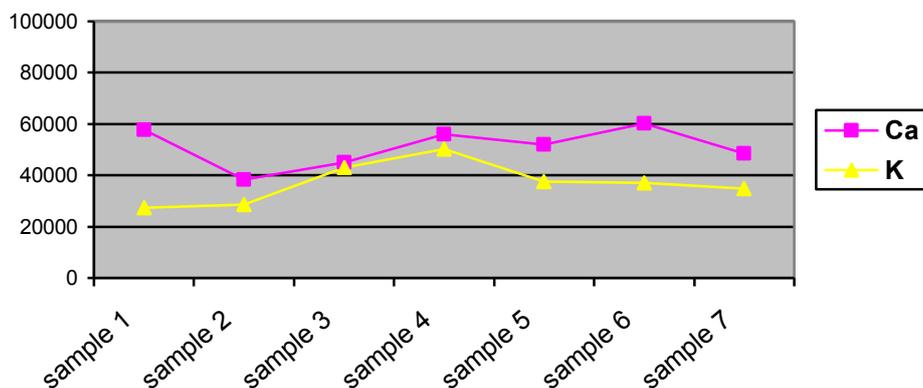


Fig.1. Ca and K(mg/kg d.w.) in *Cirsium arvense*

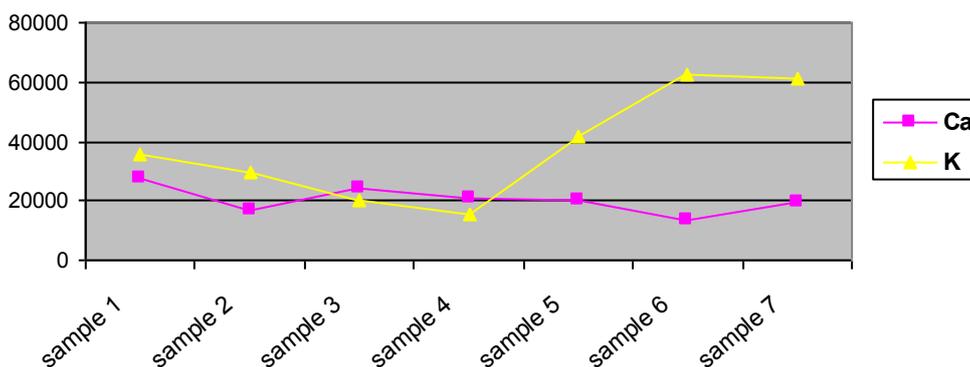


Fig 2. Ca and K(mg/kg d.w.) in *Agropyron repens*

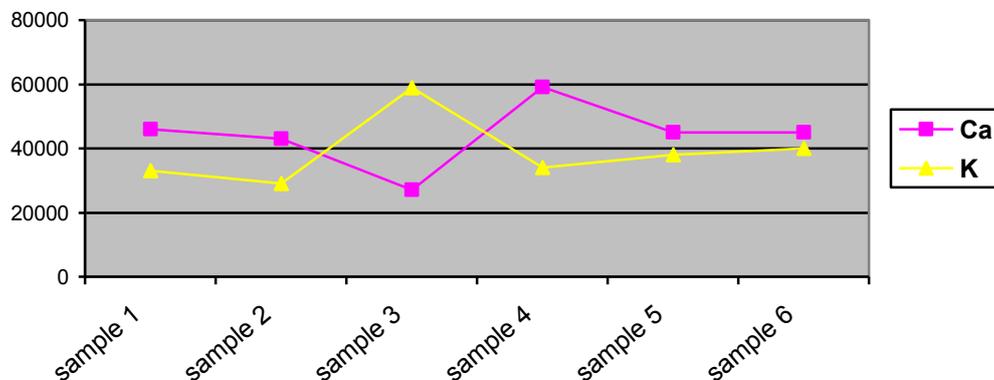


Fig 3. Ca and K (mg/kg d.w.) in *Medicago sativa*

Analysing the Figure 4, we see that the tested plants accumulated Ca and K in their tissues differently. In

Cirsium arvense and *Medicago sativa* total calcium content (mg/kg d.w.) is higher than total potassium

content (mg/kg d.w.), but in *Agropyron repens* the ratio is reversed.

Comparing the average values of the content of Ca (mg/kg d.w.) in the three plants studied, it has a downward trend: *Cirsium arvense* > *Medicago sativa* > *Agropyron repens*.

Regarding the average values of the content of K(mg/kg dw) in the studied plants, they are relative similar, with the downward trend *Medicago sativa*> *Agropyron repens*> *Cirsium arvense*.

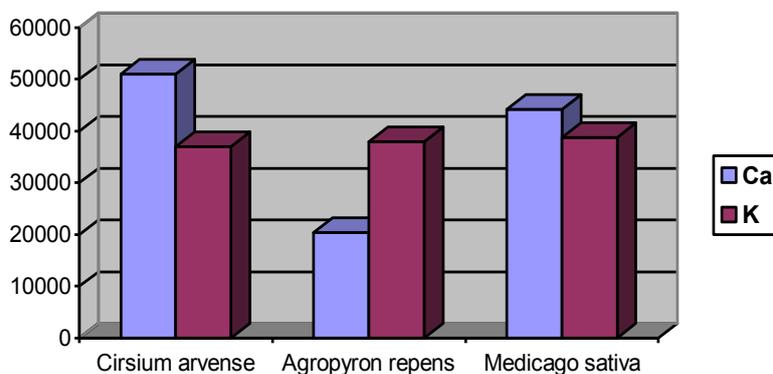


Fig 4. Mean values of Ca and K(mg/kg d.w.) in studied plants

In *Cirsium arvense* and *Medicago sativa* total calcium content(mg/kg d.w.) is higher than total potassium content, but in *Agropyron repens* the ratio is reversed. Comparing our results, obtained by using x-ray fluorescence spectrometry with literature, we observed that regarding K, the values are similar, but for Ca, our values are higher.

Conclusions

The tested plants accumulated Ca and K differently. In *Cirsium arvense* and *Medicago sativa* total calcium content is higher than total potassium content but in *Agropyron repens* the ratio is reversed.

The average values of the content of Ca (mg/kg dw) in the studied plants, has a downward trend: *Cirsium arvense*> *Medicago sativa*> *Agropyron repens*.

The trend for the average values of the content of K(mg/kg dw) is: *Medicago sativa*> *Agropyron repens*> *Cirsium arvense*.

Comparing our results, obtained by using x-ray fluorescence spectrometry with literature, our values are similar, so we consider that this method can be used for a rapid monitoring of the mineral contents in forages, but it is necessary to make other researches in future on this theme.

References

1. Alda S., Alda Liana Maria, Cristea T., Gogoasa I., Negrea P., Danci M., Gergen I. , 2015- Researches regarding rubidium content in soil and plants using analysis by atomic fluorescence X-ray, Journal of

Horticulture, Forestry and Biotechnology, 19(1), 126-129;

2.Borcean I., David G., Nita Simona, Borcean A., Baghina N., Nita L., 2008 - A study on the possible prevention of environmental pollution with mining wastes from copper mines through agricultural valorisation-8th International Symposium on Metal Elements in Environment, Medicine and Biology, Timisoara, ISBN 978-973-620-437-1, ISSN 1583-4204;

3. Bordean Despina Maria, Borozan Aurica Breica., Pirvulescu Luminita, Iancu T., Popescu Roxana, Filimon Nicoleta, Moigradean Diana, Gergen I. , 2013- Enrichment of soils: plaque or aid?, International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & mining Ecology Management, 1, 361;

4. Cârciu G., Alda S., Cristea T., Drăgunescu Anca, Turc Alina, Molnar L., 2015- Influence of pre-emergent crop on weeding rate and crop in winter barley, Journal of Horticulture, Forestry and Biotechnology, 19(1), 176-180;

5.Dragoescu C., Petrescu I., Lazar A., Danci O., Danci M., 2008- Studies concerning the in vitro callusogenesis at alfalfa (*Medicago sativa*) genotypes. Research Journal of Agricultural Science,40(3), 25-28;

6. Li G., Fan S. , 1995- Direct determination of 25 elements in dry powdered plant materials by X-ray fluorescence spectrometry, Journal of Geochemical Exploration, 55(1), 75-80;

7. Gogoasa I., Jurca Violeta, Alda Liana Maria, Velciov Ariana, Rada Maria, Alda S., Sirbulescu Claudia, Bordean Despina Maria, Gergen I. , 2013-

Mineral Content of Some Medicinal Herbs, Journal of Horticulture, Forestry and Biotechnology, Volume 17(4), 65- 67;

8. Harrington, K. C., Thatcher, A., Kemp, P. D. , 2006- Mineral composition and nutritive value of some common pasture weeds, New Zealand Plant Protection, 59, 261;

9. Manea, D. N., Cârciu, G., Lăzureanu, A., Alda, S., 2007 - *Cirsium arvense* (L.) Scop- An unwanted presence in winter wheat crops, Research Journal of Agricultural Science, 39(1), 387-392;

10. Niță L., Mircov V. D., Mihuț Casiana, Niță Simona, Dancea L., 2010-The soil cover Aranca plain in relation with the environmental and anthropic

factors, Research Journal of Agricultural Science, 42(3), 265-270;

11. Popescu Sofia, Velciov Ariana, Pirvulescu Luminita, Sirbulescu Claudia, Darlea Auruta Bordean Despina Maria, 2013- Dietary factors in calcium oxalate urolithiasis, International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & mining Ecology Management, 129;

12. <https://www.ipni.net/ppiweb/.../98-3p32.pdf>;

13. <http://www.orffa.com/site/products-minerals-trace-elements-uk>;

14. <http://igrow.org/livestock/beef/importance-of-calcium-and-phosphorus-in-the-ruminant-diet>;

15. <https://www.organicfacts.net/health-benefits/minerals/health-benefits-of-potassium.html>.