Contribution to characterization of some cereals from Dobrogea region

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Abstract The purpose of this study is to present original results about nitrogen, phosphorus and potassium distribution in straw cereal grains from Dobrogea region depending on the soils characteristics. In order to achieve this aim, studies on the nutrients content in soils from small farms located in Mereni, Independenta and Lumina (Constanta County) together with nitrogen, phosphorus and potassium content in grains of different cereals cultivated on the above mentioned soils have been done. Samples of soils, barley, wheat and rye grains have been collected; for the preparation of cereals and soils samples and their chemical characterization standard protocols were followed. Nitrogen was determined by acidimetric titration, phosphorus using molecular absorption spectrometry and potassium by atomic emission spectrometry.
Nutrients concentrations in cereal grains and soils have been found in accordance with the means reported values of occurrence. The nutrients transfer coefficients from soil to cereal grains generally increase in the order: nitrogen (8-15), potassium (15-66), phosphorus (76-250) in all studied sampling sites with some exceptions depending probably on the specific equilibrium involved in the nutrients absorption by roots.

Keywords: soils, barley, wheat, rye, nitrogen, phosphorus, potassium, molecular spectrometry

1. Introduction

Cereals represent one of the nutritional sources for humans and livestock. In the natural form (as in whole grain), they are a rich source of vitamins, minerals, carbohydrates, fats, oils and proteins.

Phosphorus (P) together with nitrogen (N) is essential parts of photosynthesis process. It is involved in the transformation of solar energy into chemical energy, proper plant maturation, withstands stress, rapid growth, blooming and root growth and formation of all oils, sugars, starches, etc. Phosphorus often comes from fertilizer, bone meal and superphosphate [1].

Potassium (K) is absorbed by plants in larger amounts than any other mineral element, except calcium, and is provided by soil minerals, organic materials and fertilizer. It's involved in proteins formation, photosynthesis, proper fruit quality and reduction of diseases [2, 3].

The aim of the present work is to evaluate nutrients concentrations in some straw cereal grains (barley, rye and wheat) from small farms located in Mereni, Independenta and Lumina (Constanta County) in order to report their transfer from the above mentioned soils.

2. Experimental

2.1. Materials and reagents

Analytical grade chemicals have been used: HCl 37%, HNO_3 > 69%, hydrogen peroxide 30%, $HClO_4$ 60%, H_2SO_4 97%, ammonium vanadate, ammonium molibdate, lactic acid, purchased from Merck and Fluka.

In order to determine phosphorus concentration, in cereal grains the colouring reagent was used, containing equal volumes of ammonium vanadate 0.25%, ammonium molybdate 5% and diluted HNO_3 (1:2). In strong acid medium, phosphoric acid forms

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with the colouring reagent a yellow, stable heteropoliacid.

Phosphorus in soil samples was analysed using molybdenum blue method.

2.2. Sampling and sample preparation

Samples of **barley, wheat and rye grains** have been collected in duplicate from three small farms located in Mereni, Independenta and Lumina (Constanta County), 18 samples in total, during the spring of 2010.

In order to determine nutrients concentrations 0.2 g of sample (previously dried) was mineralized with 5.5 mL mixture of sulfuric acid and perchloric acid (12.5:1v/v). After full mineralization, the sample was cooled and than added distilled water to a final volume of 100 mL.

For phosphorus measurement in cereal grains, in 100 mL calibrated flask, 10 mL of sample solution was added, 50 mL distilled water, and 10 mL colouring reagent; the flask was filled with distilled water to the final volume and the obtained solution was kept 2 hours before the absorbance measurement.

From the same sampling sites, two profiles of **soil samples** (0-20 cm and 20-40cm) have been collected in duplicate and dried in air.

Soil solutions have been obtained by extraction of 10g soil samples with 50 mL ammonium acetate lactate (AAL) solution at pH 3.75. The suspension was mixed 2 hours and then filtered.

For mobile phosphorus determination in soils, in 100mL calibrated flask 10 mL of soil solution was added, 50 mL distilled water, 1mL H_2SO_4 97%, 1 mL ammonium molybdate solution 50g/L in H_2SO_4 5N and 1 mL ascorbic acid 10%. After 10 minutes the flask was filled up with distilled water.

For nitrogen measurement, 10 mL of both types of sample solutions (cereal grains and soils) have been distilled using Parnas Wagner device and then the obtained distillate was titrated with sulfuric acid 0.2N.

2.3. Analytical instrumentation

The concentrations of phosphorus have been measured by molecular absorption spectrometry. Phosphorus in cereal grains was measured at 436 nm and in soil at 715 nm using Cintra 404 spectrometer. Potassium concentrations have been determined by atomic emission spectrometry using a Sherwood 707 flame photometer. For all determinations calibration curves have been previously plotted. The calibration curves for P in cereal grains was linear in 0 – 1400 mg/L range (correlation coefficient 0.9983), for P in soils was linear between 0.1- 3.0 mg/L (correlation coefficient 0.9971) and for K in 0–500 mg/L range (correlation coefficient 0.9998).

3. Results and Discussions

3.1. Nutrients concentrations in cereals and soil

The mean value of the nitrogen in the studied cereal grains was 1.56%, of phosphorus 0.41% and of K 0.67% (expressed as percentage in dry mass) (**Tables 1, 2 and 3**). To be noticed that the mean nitrogen concentrations increase in the order: barley (1.55%), rye (1.57%) and wheat (1.58%), phosphorus concentrations increase as follows: rye (0.33%), wheat (0.42%) and barley (0.48%) and the mean of potassium concentrations increase in the order: wheat (0.42%), barley (0.78%) and rye (0.80%).

Table 1. Nutrients occurrence in cereal grains from Independenta sampling site

Cereal	Mean concentration, %		
	N	**P**	**K**
Barley	1.52	0.50	0.75
Rye	1.61	0.33	0.98
Wheat	1.45	0.45	0.51

Table 2. Nutrients occurrence in cereal grains from Mereni sampling site

Cereal	Mean concentration, %		
	N	**P**	**K**
Barley	1.42	0.46	0.88
Rye	1.49	0.32	0.85
Wheat	1.58	0.42	0.36

The nitrogen, phosphorus and potassium concentrations in investigated soils are presented in **Table 4**.

Table 3. Nutrients occurrence in cereal grains from Lumina sampling site

Cereal	Mean concentration, %		
	N	**P**	**K**
Barley	1.71	0.48	0.71
Rye	1.62	0.35	0.59
Wheat	1.72	0.41	0.40

Table 4. Nutrients occurrence in studied soils

Sampling site	Mean concentration		
	N, %	P, mg/kg	K, mg/kg
Independenta	0.12-0.15	20-22.3	114-144
Mereni	0.16-0.17	48.81-62.16	192-238
Lumina	0.12-0.13	31.67-45.24	117-170

Nitrogen and phosphorus concentrations in cereal grains and soils have been in good accordance with those reported in scientific literature (**Table 5**) [1, 4-7].

Table 5. Nutrients mean occurrence in grain cereals and soils reported in scientific studies

Sample	Mean concentration, UM		
	N	**P**	**K**
Barley	1.3-1.8%	0.35-0.44%	0.41-0.58%
Rye	1.4-1.7%	0.35-0.48%	0.41-0.58%
Wheat	1.5-2.5%	0.30-0.48%	0.33-0.66%
Soil	0.01-0.38%	4 -72 mg/kg	40-300mg/kg

Nutrients concentration in cereal grains depend on their available amounts in soils. Potassium concentration determined in our study was higher than the mean reported values in barley and rye samples, and similar in wheat grains.

3.2. Nutrients transfer from soils to cereals

In order to compare the nutrient transfer in cereal grains from soils, the transfer coefficients (TC) have been calculated as the rapport between the nutrient concentrations in cereal grains versus nutrient concentration in the corresponding soil.

Nitrogen transfer coefficients (**Fig.1**) are in the range 8 – 15 for all cereal grains and all sampling sites; the minimum TC values occur in Mereni and the maximum in Lumina sampling sites (except for rye), but the variation is not too large.

Soil phosphorus is often considered one of the most limiting nutrients for plant productivity [8]. Uptake of phosphorus by plant roots is highly dependent on the concentration gradient of this element in soil solution. The uptake of P by plants leads to depletion of soil solution P and a consequent net release of phosphorus from soil solid to liquid phase [9].

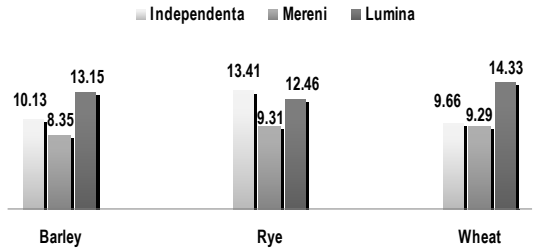

Fig. 1. Comparative data regarding nitrogen transfer coefficients from soil to different cereal grains

Phosphorus transfer coefficients (**Fig.2**) are the highest between the studied nutrients, having variation in 80-250 range, more than 10 times higher than nitrogen. TC for phosphorus depends on the cereal type but the main limiting factor is the soil: it can be observed that soils from Independenta sampling site contain the lowest mobile P concentration explaining the TC values.

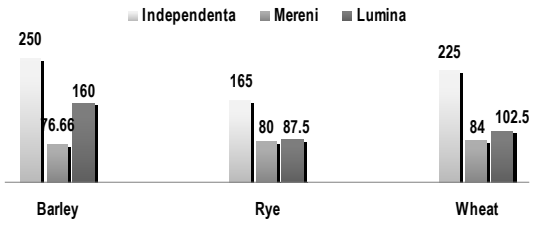

Fig. 2. Comparative data regarding phosphorus transfer coefficients from soil to different cereal grains

Potassium TC values (**Fig.3**) vary from 15 to 70 with one exception (225 for TC in rye grains from Independenta sampling site).

The minimum potassium TC occurs for wheat grains (15-37). In grains of rye and barley TC have slightly increasing shapes.

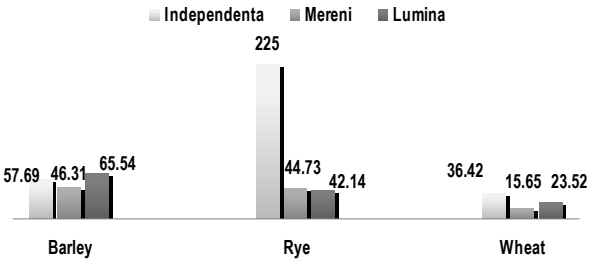

Fig. 3 Comparative data regarding potassium transfer coefficients from soil to different cereal grains

4. Conclusions

Studies on the nutrients content in soils and barley, rye and wheat grains from small farms located in Mereni, Independenta and Lumina (Constanta County) followed by transfer coefficients from soil to plants calculation have been done.

The mineral nutrients, absorbed from soil as dissociated or exchangeable ions are uptake in variable amounts in barley, rye and wheat grains.

Positive correlation between mineral nutrients from soil and their amount in plants is observed.

Nutrients concentration in the studied cereals grains depend on the location and cereal type.

The nutrients transfer coefficients from soil to cereal grains generally increase in the order: nitrogen (8-15), potassium (15-66) and phosphorus (76-250) with some exceptions depending probably on the specific equilibrium involved in the nutrients absorption by roots.

Nitrogen and phosphorus are transferred in similar rates in all studied cereal grains but potassium has different transfer coefficients which increase in the order: wheat, rye and barley.

The minimum transfer coefficients are observed generally in cereals cultivated in Mereni sampling site that means is necessary to improve the local soil characteristics in order to increase the nutrients transfer.

5. References

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