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RESEARCH ON THE CHEMICAL PROPERTIES OF THE SOIL ACCORDING TO SOME AGRICULTURAL PRACTICES APPLIED TO THE SORGUM GRAIN CROP

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Abstract

Sorghum, due to its high drought resistance, has become more common in many parts of the world. The article presents the results of the changes generated, by the two factors studied (Factor A - sowing density with three graduations and Factor B - mineral fertilization, with nitrogen and phosphorus with five graduations) and by their interaction, in some soil characteristics from an experimental field organized by A.R.D.S. Secuieni, where grain sorghum was cultivated. In order to assess the influence of fertilization and plant density, 45 soil samples were collected from the experimental field and analyzed. From the analysis of laboratory tests and statistical data processing, results statistically significant changes soil reaction, manganese and mobile iron contents under the influence of the interaction of the two experimental factors studied: sowing density and level of fertilization. The other soil quality indicators have no changed statistically significant under the influence of the tested technological factors however, showing slight increasing trends of the N, P, K contents in soil as a result of the applied fertilization treatments.

Key words*: grain sorghum, soil, plant density, fertilization, chemical characteristics.*

INTRODUCTION

The climate evolution towards heating and aridization for the 2001-2050 period of time in the Balkan area, where Romania is also found, compels to a reconsideration of the sorghum as: alimentary cereal (beads used in the formula for composite flours destined for gluteic and agluteic panification, the sweet juice extracted from the body, used for making syrup, vinegar and other alimentary products) (Revathi et al., 2011), fodder plant (under the shape of green mass, hay, silo), technical plant (stationary and textile celluloses, plastic material), the industry of construction materials and the handicraft industry (brushes of domestic and industrial use, brooms, nettings) (Antohe, 2007; Pochișcanu et al., 2015, 2016, 2017; Oprea et al., 2020).
Sorghum (*Sorghum bicolor* L. Moench) is one of the 5 major cultivated species in the world and can be used as feed, food, sugar or ethanol production (Almodares et al., 2007, 2008, 2011; Buah et al., 2012).
Planting space is closely related to yield density that affects crop production per unit of land area. Sharifi et al. (2009) explain that higher space density promotes competition among plants in absorbing nutrients.
Furthermore, fertilize the soil with compound fertilizer (nitrogen, phosphorus, and potassium), particularly nitrogen is vital for plant growth because it promotes shoot elongation, tillering regeneration, leaf to stem ratio, succulency, and palatability of fodder crop (Choudhary& Phrabu, 2016).
Several works observed improvement of sorghum biomass and protein content by increasing nitrogen (Sher et al., 2012; Cameron et al., 2013; Astuti et al., 2019).

MATERIALS AND METHODS

This paper presents data from the experimental field from Agricultural Research-Development Station (A.R.D.S.) Secuieni, located on the second terrace of Siret, on a typical cambic faeoziom (chernozem) soil type, being characterized by normal supply with mobile phosphorus (P_2O_5 – 39 ppm), and mobile potassium (K_2O – 161 ppm), moderately supplied in nitrogen (soil nitrogen index: 2.1), slightly acidic (pH: 6.29) and slightly fertile (humus content 2.3%).

The experiment was of the two-factor A×B type with: Factor A – sowing density with three gradations: a_1 – 20 grains/m^2, a_2– 25 grains/m^2 and a_3 – 30 grains/m^2 and Factor B – nitrogen and phosphorus fertilization with five gradations: b_1 – unfertilized, b_2 – $N_{75}P_{80}$, b_3 – $N_{75}P_{80}$ + Biostimulatory, b_4 – $N_{150}P_{80}$, and b_5 – $N_{150}P_{80}$ + Biostimulatory and the interaction between these two factors. The analysis of the results of the laboratory tests and the statistical processing of the data, allowed us to highlight the effects of the applied technological factors on the soil quality indicators.

From the experimental field, 45 soil samples were collected, which were conditioned and chemically analyzed.

The determinations carried out on the soil samples concerned:

- Soil reaction (pH);
- Organic carbon content (Corg);
- Nitrogen content ($N_{kjeldahl}$);
- Accessible phosphorus content (P_{AL});
- Accessible potassium content (K_{AL});
- Content of microelements in forms accessible (Cu, Zn, Mn and Fe).

RESULTS AND DISCUSSIONS

In our study, the changes produced by factor A (sowing plant density) with the three gradations and by factor B (nitrogen and phosphorus fertilization) with the five gradations on the main properties of the soil and heavy metals in the soil are presented.

Figure 1 shows that the influence of factor A (sowing plant density) on the soil reaction has no statistical changes, with a slight increase in acidity in variant a_2. The supply of soil with humus, nitrogen, mobile phosphorus and mobile potassium has no significant changes in any of the three variants. The humus content is low (2.16-2.21%), the total nitrogen has low values between 0.130 and 0.144%. The soil supply with mobile P is high in variant a1 and a_3 and very high in a_2 (148 mg·kg^{-1}), and mobile K has average values without statistical changes.

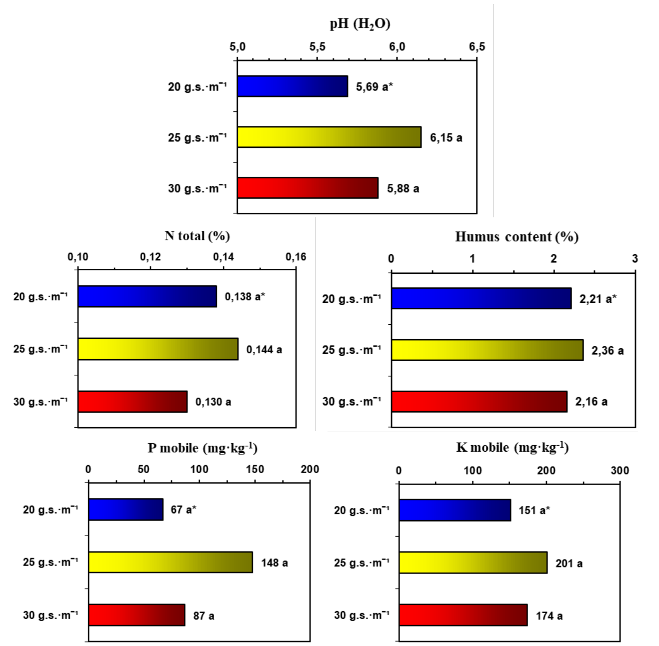
Figure 2 shows the influence of factor B on the chemical properties of the soil, without statistical changes. The soil reaction is slightly acidic between 5.80 to b_2 and 5.99 to b_3, the humus content values are low to medium, and the total nitrogen content is low between 0.137-0.139%. The supply of mobile phosphorus is very high, with lower values in the control variant, and mobile potassium has average values between 164-190 mg·kg^{-1}.

The density of seeds at sowing on the concentration of heavy metals (Cu, Mn and Fe) in the soil extractable form in DTPA did not produce statistical changes. The Zn content, the extractable form in DTPA increases significantly in variant a_2 compared to a_1 (20 grains/m^2) are shown in Figure 3.

Figure 4 shows the influence of factor B (fertilization level) on the concentration of heavy metals in the soil, the extractable form in DTPA (Cu, Zn, Mn and Fe) where no significant changes are observed.

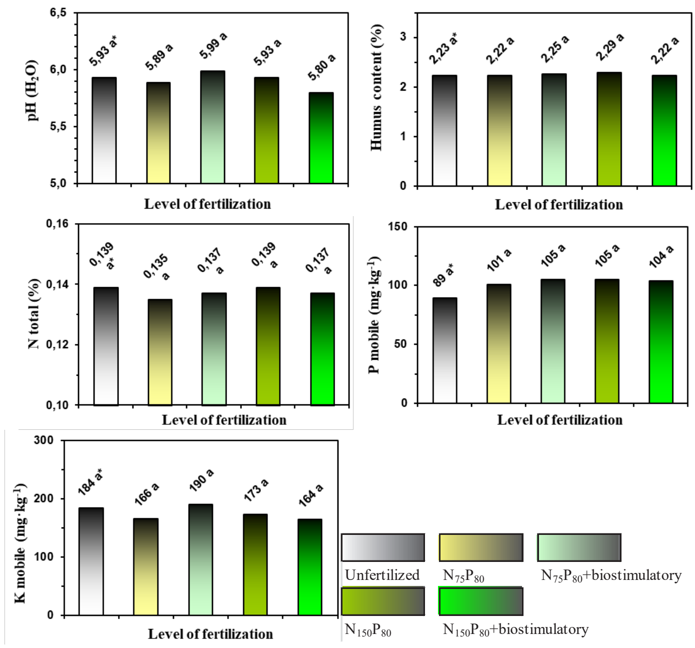
Table 1 shows the statistical significances of the Fisher test established by variant analysis method to highlight the changes produced by the two factors studied and their interaction on soil characteristics from the experience organized to establishing technological parameters with high efficiency on sorghum grains.

It is noted that only the soil reaction, manganese and mobile iron content in the soil underwent statistically assured changes under the influence of the interaction of the two experimental factors studied (sowing density and nitrogen fertilization). Other indicators of soil quality and nutrition of sorghum plants did not change statistically significantly under the influence of applied technological links.



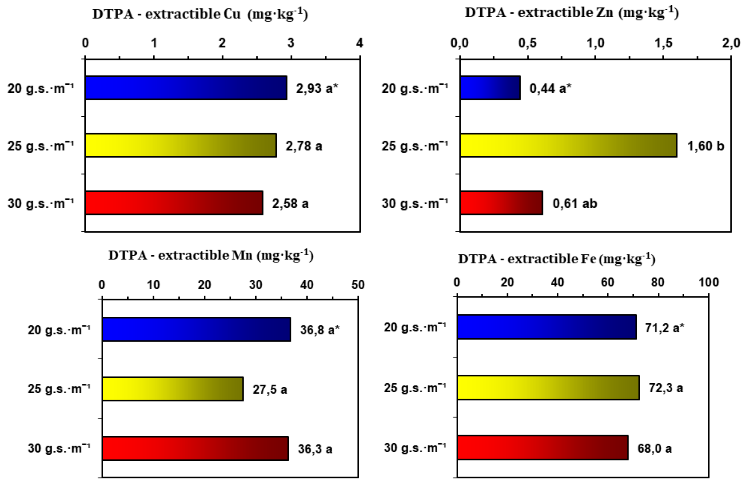
*Values followed by the same letter (a, b, c) are not significantly different at the 5% level according to the Tukey's honestly significant differences (HSD) test.

Figure 1. The effects of factor A (plant density) on the pH value and the contents of humus, nitrogen, mobile phosphorus and mobile potassium in soil, in the experience field cultivated with sorghum grains (0-20 cm, A.R.D.S. Secuieni, 2019)



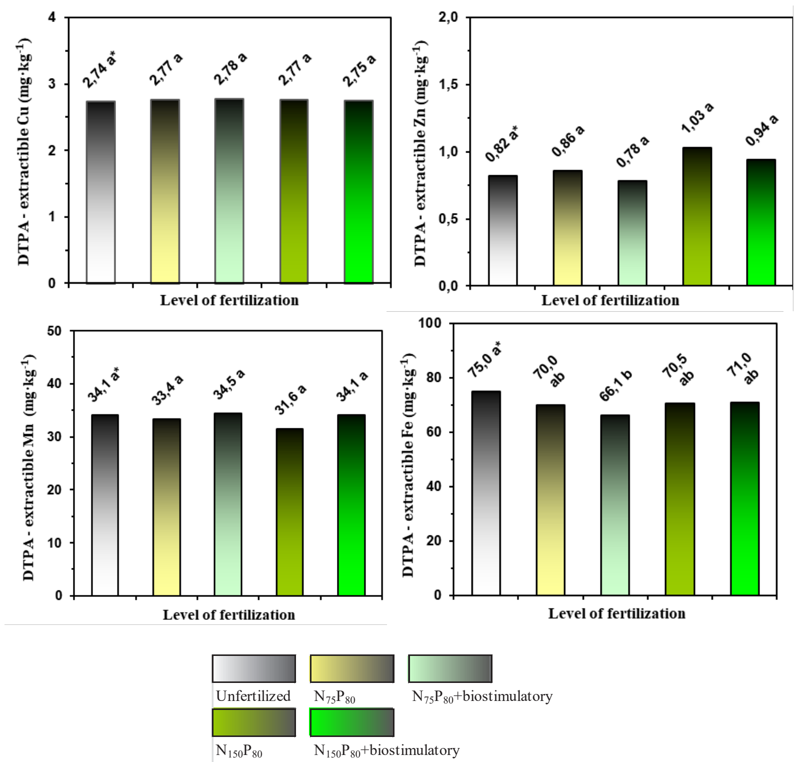
*Values followed by the same letter (a, b, c) are not significantly different at the 5% level according to the Tukey's honestly significant differences (HSD) test.

Figure 2. The effects of factor B (fertilization level) on the pH value and the contents of humus, nitrogen, mobile phosphorus and mobile potassium in soil, in the experience field cultivated with sorghum grains (0-20 cm, A.R.D.S. Secuieni, 2019)



*Values followed by the same letter (a, b, c) are not significantly different at the 5% level according to the Tukey's honestly significant differences (HSD) test.

Figure 3. The effects of factor A (plant density) on the contents of copper, zinc, manganese and iron in soil - extractible forms in DTPA, in the experience field cultivated with sorghum grains (0-20 cm, A.R.D.S. Secuieni, 2019)



*Values followed by the same letter (a, b, c) are not significantly different at the 5% level according to the Tukey's honestly significant differences (HSD) test.

Figure 4. The effects of factor B (fertilization level) on the contents of copper, zinc, manganese and iron in soil - extractible forms in DTPA, in the experience field cultivated with sorghum grains (0-20 cm, A.R.D.S. Secuieni, 2019)

Table 1. Statistical significance of the Fisher test established by variant analysis method to highlight the changes produced by two factors studied and thein interaction on some soil characteristics from the experience field organized establishing technological parameters with high efficiency on sorghum grains

Caracteristics in 0-20 cm soil layer	Source of variation		
	Factor A	Factor B	Interaction AxB
pH	NS	NS	★
Humus contents	NS	NS	NS
Nitrogen contents	NS	NS	NS
Phosphorus mobile	NS	NS	NS
Potassium mobile	NS	NS	NS
Cu in soil – extractibile forms in DTPA	NS	NS	NS
Zn in soil – extractibile forms in DTPA	NS	NS	NS
Mn in soil – extractibile forms in DTPA	NS	NS	★★
Fe in soil – extractibile forms in DTPA	NS	NS	★

NS	Non-significant (p > 0,05)	★★	Very significant effect (0,001 < p ≤ 0,01)
★	Significant effect (0,01 < p ≤ 0,05)	★★★	Extremely significant effect (p ≤ 0,001)

Factorul A – Plant density *Factorul B – Fertilization level*

CONCLUSIONS

The main findings of this study note are that only the soil reaction, manganese and mobile iron content in the soil underwent statistically assured changes under the influence of the interaction of the two experimental factors studied: sowing density (Factor A) and nitrogen fertilization (Factor B). The other soil quality indicators have no changed statistically significant under the influence of the tested technological factors however, showing slight increasing trends of the N, P, K contents in soil as a result of the applied fertilization treatments.

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