# RESEARCH ON THE INFLUENCE OF FERTILIZATIONS ON THE NUTRITIONAL QUALITY OF GRAIN SORGHUM IN THE CONDITIONS OF SANDY SOILS IN SOUTHERN OLTENIA

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## ABSTRACT

Research conducted at SCDCPN Dăbuleni in the period 2018-2019, regarding the influence of the fertilization system on the nutritional quality of grain sorghum, has revealed different results, due to both the applied fertilization and the climatic conditions of the study period. The most balanced biochemical composition of sorghum beans was obtained in the fertilized variant with N150P80 K80 + biostimulatory (ALBIT-40 ml / ha) (11.72% humidity, 13.50% protein, 906.39 kg / ha protein, 6714kg / ha grain production, 3.53% fat, 87 kg / hl hectolitric mass, 29g mass of 1000 grains). The amount of protein expressed as a percentage increased with the increase of the production but insignificant, and the quantity of protein expressed in kg / ha increased with the increase of the distinct grain production significantly. Regarding the influence of the study years, the best results were obtained in the climatic conditions of the year 2018, which was characterized by maximum average temperatures of 26.6 0C, in the summer months and with significant precipitations during the period May-July (106.6-195.2mm).

## INTRODUCTION

Under the current conditions of climate drying, the identification of agricultural practices with the potential to mitigate the impact of climate change on the security of agricultural production is gaining more and more interest. In this context, the orientation towards drought-resistant crops is emerging as an alternative solution. Sorghum is one of the crops with high adaptability to slightly favorable ecological conditions (poor soils, arid climate), due to its high capacity to efficiently harness natural resources and increased tolerance to drought. The importance of sorghum culture is given by its role or as an alternative to corn cultivation, against the background of multiple uses: in animal feed (USA and Australia), in food (India, China, Central America), in the food and light industry (starch production, of ethyl alcohol, beer) (Oprea Cristina Andreea, 2018).

Having a good ability to efficiently exploit natural resources, sorghum produces high yields under ecological conditions not favorable to other cereals (Antohe I. et al., 1981). In Romania research has sought to determine the production potential of hybrid grain sorghum (Sorghum bicolor (L.) Moench var. Eusorghum) in terms of recovery of the climatic restrictive conditions (T. Muresan, 1961, Antohe I., 2007, Mt. Gh., 2011, Drăghici I., 2016), and the obtained results varied under the influence of the experimentation factors (fertilization,

rotation, water regime, sowing distance, density).

New in Europe, but used for a long time in Africa and Asia, sorghum is a cereal that is cooked like rice or quinoa. May be included in the composition of beer or other alcoholic beverages. At present, Europe is discovering its taste and dietary virtues. Nutritionally, it is rich in protein, iron, vitamin B6, etc. Energizing, rich in antioxidants, gluten-free, therefore free from allergic dangers, it is also a source of dietary fiber and potassium. The nutritional quality of grain sorghum is influenced by the variety, the cultivation technology (fertilization), as well as by the climatic conditions in the crop area. Numerous researches have shown the influence of fertilization on the quality of the grains.

Kaufman R.C. et al., 2013, showed that the protein content increased as the nitrogen rate increased. Similar results have also been reported (Fageria et al. 2002, Amal G. Ahmed et al., 2007, Torbatinejad, N.M., et al., 200, D. Coclea et al., 2013). The amount of protein in sorghum grains is often negatively correlated with grain production (Pale S., et al., 2010).

Sorghum has low requirements for nutrient requirements, because it has a well-developed root system that allows it to extract all the nutrients it needs from the soil. Sorghum needs small amounts of phosphorus and potassium, the need being: 20-60 kg / ha active substance. The nitrogen requirement is slightly higher, but lower than maize namely 50-80 kg s.a./ha (Simona Pochiscanu, 1918).

## MATERIAL AND METHOD

The researches were carried out at the Development Research Station for Plant Culture on Dăbuleni Sands in the period 2018-2019. At the Armonik hybrid, different fertilization variants with chemical fertilizers and in combination with the biostimulatory ALBIT in the amount of 40ml / ha were tested.

The variants studied were:

a1- Unfertilized;

a2 - N80P80K80;

a3 - N80P80K80 + biostimulatory (ALBIT-40 ml / ha): when sorghum has 6 - 8 leaves;

a4 - N150P80K80;

a5 - N150P80 K80 + biostimulatory(ALBIT-40 ml / ha): when sorghum has 6 - 8 leaves.

The location of the experience was randomized, in three repetitions. The sorghum samples were collected at the harvesting maturity, and the following determinations were performed in the laboratory:

- determined protein content (%) - Perten method;
- determined humidity (%) - Perten method;
- determined fat (%) - Perten method;
- determined the hectolitric mass MH (kg / hl) - with the hectolitric balance;
- determined the mass of 1000 grains MMB (g) - by weighing 1000 grains on the electronic balance type KERN;
- production (kg / ha) - weighing of the beans on the plants of each variant and extrapolated to the hectare.

Leaf samples were collected during the vegetation period of sorghum plants to determine the state of supply of plants in macroelements (N.P.K). The content of nitrogen, phosphorus and potassium was determined by the following methods:

- total nitrogen - Kjeldahl method;
- total phosphorus - colorimetric method;
- total potassium - the method of dosing by flame emission photometry.

## RESULTS OBTAINED

The experience was located on sandy soil with a low total nitrogen

content (0.05-0.07%), medium supplied in extractable phosphorus (23-34ppm) and poorly supplied in exchangeable potassium (23-34ppm). The amount of organic matter in the soil was reduced (0.29-0.47%) and the soil reaction was weakly acidic (6.01-1.39).

Determinations were made regarding the macroelement content of sorghum leaves in the intense growth phase of plants. The obtained results are presented in table 1.

Nitrogen is the main element that enters into the composition of plant tissues of amino acids, alkaloids and chlorophyll. Without nitrogen the plant cannot grow because it enters the structure of proteins without which the tissues of the plant cannot form. In the absence of nitrogen or a deficient supply with this element, the plants remain small, have a small foliage surface and therefore have a low assimilation capacity. The nitrogen content of the plant was between 2.16% in the unfertilized version and 2.90% in the fertilized version with N150P80 K80 + biostimulatory (ALBIT-40 ml / ha):. The values increase with the increase of the administered nitrogen dose, but the results indicate a reduced state of plant supply, compared to the literature data. The total phosphorus content of the plants was between 0.66% in the unfertilized version and 0.81% in the fertilized variant with N150P80 K80 + biostimulatory (ALBIT-40 ml / ha). The obtained results show an optimum phosphorus supply status, and the content increases with increasing fertilizer doses, and the highest values were determined in the variants where treatments were performed with the biostimulator ALBIT-40 ml/ha (0.74-0.81%). The absorption of the nutrients from the soil and of the fertilizers in plants increases with: N (24-25%), P (26-40%), K (9-20%) following treatments with the product ALBIT.

The potassium content of the leaves was quite low (0.72% in the unfertilized version and 1.22% in the fertilized version with N80P80K80, and the optimum values are in the 3-4% range. Potassium deficiency may occur primarily on potassium-poor soils, especially under conditions of low temperatures, which contribute to the reduction of potassium absorption.

*Table 1*

**Supply status of sorghum plants for nitrogen, phosphorus and potassium beans depending on the fertilization system**

| Variant | Total nitrogen **(%)** | Total phosphorus **(%)** | Total potassium **(%)** |
|---|---|---|---|
| $a_{1-}$ Unfertilized; | 2.16 | 0.66 | 0.72 |
| $a_2$ – $N_{80}P_{80}K_{80}$ | 2.70 | 0.69 | 1.22 |
| $a_3$ – $N_{80}P_{80}K_{80}$ + biostimulatory (ALBIT-40 ml/ha) | 2.66 | 0.74 | 1.16 |
| $a_4$ – $N_{150}P_{80}K_{80}$ | 2.50 | 0.70 | 0.86 |
| $a_5$ – $N_{150}P_{80}K_{80}$+ biostimulatory (ALBIT-40 ml/ha) | 2.90 | 0.81 | 0.78 |
| Optimum supply area | **3.5-5.0** | **0.30-0.50** | **3.0-4.0** |

Excess humidity and soil state reduce potassium absorption, favoring the deficiency phenomenon. Fertilization with high doses of nitrogen, in the absence of potassium application, can have negative effects on potassium nutrition, through harvest increases, and in some species and as a result of the negative N-K interaction.

The duration of the periods and phases of seed formation and maturity, as well as their character, is determined not only by the biological particularities of the species, varieties, but to a large extent, and by the pedoclimatic conditions of the year, the region, which reflects on the quality of the seeds, influences their physical qualities, their capacity sowed. Providing water and optimum temperature, as well as nutrition elements, contributes to increasing the duration of the seed formation period. Such conditions favor the formation of seeds in which large amounts of organic substances accumulate, weight increases, their surface becomes smooth, red or yellow. As a rule, these seeds have high seeding qualities and high production qualities.

The application of fertilizers in different doses, to the sorghum culture, the Armonik hybrid, influenced both the grain production and its quality traits. The results obtained are presented in table 2. Grain moisture is an important indicator of quality appreciation. The optimum humidity of the grains when harvesting is 14%, and in the variants taken into consideration the humidity of the grains was between 11.27% and 11.75%, below the maximum limit of 14% as provided by the specialized literature. The amount of protein in sorghum beans was between 10.67% in the unfertilized version and 13.50% in the fertilized variant with N150P80K80 + biostimulatory (ALBIT-40 ml / ha): when sorghum has 6-8 leaves.

*Table 2*

**Nutritional quality of grain sorghum by fertilization system**

| Variant | Moisture (%) | Protein | | Production (Kg/ha) | Fat (%) | HM* (kg/hl) | MTG* (g) |
|---|---|---|---|---|---|---|---|
| | | (%) | (Kg/ha) | | | | |
| $a_{1-}$ Unfertilized; | 11.27 | 10.67 | 437.47 | 4101 | 3.50 | 83 | 27 |
| $a_2$ – $N_{80}P_{80}K_{80}$ | 11.65 | 12.23 | 613.21 | 5014 | 3.65 | 84 | 27 |
| $a_3$ – $N_{80}P_{80}K_{80}$ + biostimulatory (ALBIT-40 ml/ha): | 11.48 | 11.47 | 649.55 | 5663 | 3.82 | 86 | 28 |
| $a_4$ – $N_{150}P_{80}K_{80}$ | 11.75 | 12.94 | 817.16 | 6315 | 3.57 | 86 | 28 |
| $a_5$ – $N_{150}P_{80}K_{80}$+ biostimulatory (ALBIT-40 ml/ha): | 11.72 | 13.50 | 906.39 | 6714 | 3.53 | 87 | 29 |

MTG* - mass of a thousand grains
HM* - hectolitic mass

Similar results were obtained by S. Palé et al., 2010, in the Central Plateau of Burkina Faso, Ouagadougou, which determined in the sorghum grains an amount of protein between 9.5% and 14.5%. The results showed that the physico-chemical properties of sorghum grains were influenced by both the water management technique and the application of fertilizers.

If we compare the amount of protein from grains sorghum to grain production, from the data presented in table 2 we can see an increase of the protein expressed in kg / ha, with the increase of the production and the dose of fertilizers.

The highest amount of protein expressed in kg / ha (906.39kg / ha) was determined in the fertilized variant with N150P80 K80 +biostimulatory (ALBIT-40 ml / ha): when sorghum has 6-8 leaves, the variant was determined and the highest production (6714kg / ha. The amount of fat in sorghum grains was between 3.50% in the unfertilized version and 3.82% in the fertilized version with N80P80K80 + biostimulatory (ALBIT-40 ml / ha): when the sorghum has 6 - 8 leaves. In this variant, the amount of protein expressed as a percentage has the highest values. With increasing the dose of nitrogen decreases both the amount of protein and the amount of fat in sorghum grains.

The role of the biostimulatory ALBIT in ensuring a high productivity of plants in drought conditions is not only conditioned by the induction of the biochemical mechanisms of drought resistance (thermal resistance, water retention capacity), but also by the ability of the preparation to form a more root system. strong. Under the ALBIT action the root formation takes place, the formation of additional secondary roots, facilitating the absorption of nutrients from the soil and increasing the resistance of the plants to drought.

The ALBIT product also has an indirect effect on the plants through the microbial community of the rhizosphere (the area of the soil around the roots of the plant). The absorption of nutrients from the soil and fertilizers in plants increases with: N (24-25%), P (26-40%), K (9-20%). The role of this product is to improve stress resistance especially in drought, burns, pesticide treatment, diseases, pests, chemical soil contamination, soil salinity etc. Acting at the biochemical and cellular level, ALBIT stimulates the growth and development of plants and improves the biometric characteristics of the vegetative growth (germination, root system growth, twinning, time required for phenological phases, etc.) and implicitly increases its production and quality.HM and MTG showed higher values in the fertilized variants, and the best results were obtained in the fertilized variant with N150P80K80, (87 kg / hl HM and 29g MTG).

Between the grain production and the protein content expressed in% and kg / ha were established polynomial correlations given by the second degree equations with significant correlation factor for the amount of protein in kg / ha. (Figure 1).

The amount of protein in percentage increases with the increase of the production but insignificant, and the quantity of protein expressed in kg / ha increases with the increase of the grain production distinctly significant.

Also, between the dose of nitrogen administered and the amount of protein (%) was established a polynomial correlation, given by a second degree equation, with a significant correlation factor (r = 0.95 *). The amount of protein increases with increasing nitrogen dose (Figure 2).

Research by Kaufman RC et al., 2013, showed that the protein content of grains sorghum increased as the nitrogen rate increased.

Diallo Sory, 2012, showed that N application (45 or 90 kg / ha) significantly improved the protein in cereals, but not other quality traits. There are opportunities to improve protein in cereals by managing fertilizers and plant growth.

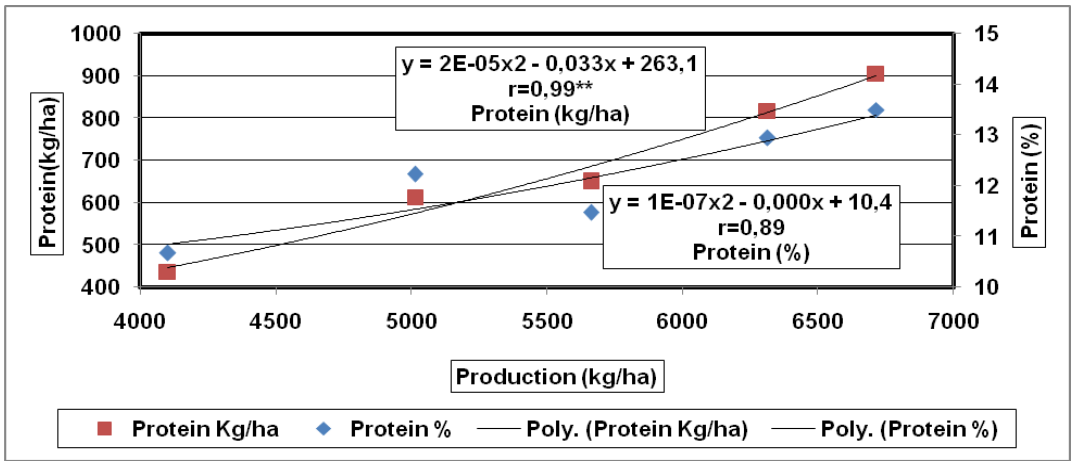


*Figure 1* - **Correlation between grain production and protein content expressed in % and kg / ha**

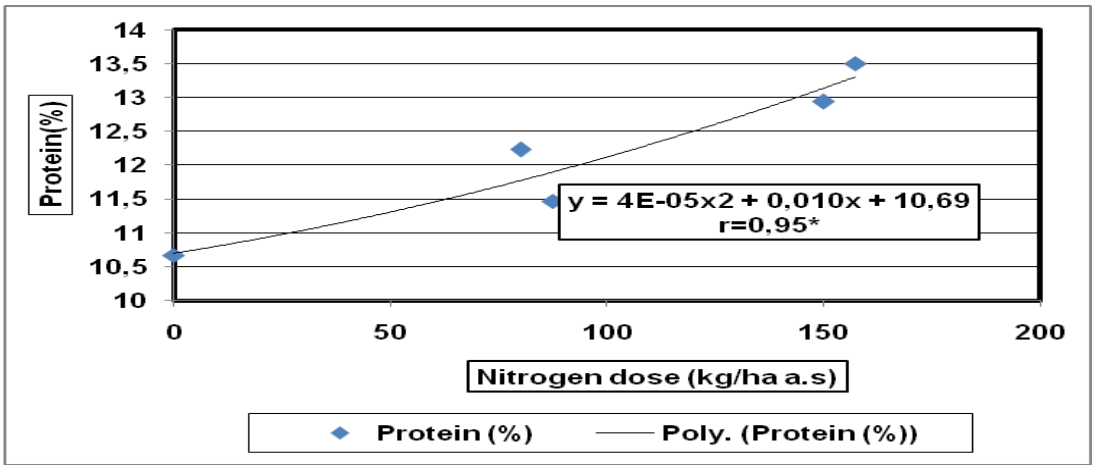


*Figure 2* - **Correlation between the dose of nitrogen fertilizers and the amount of protein (%)**

*Table 3*

**The influence of the years of study on the protein content of grains sorghum, as well as on the production of grains**

| Variant | Protein (%) | | Protein (kg/ha) | | Production (kg/ha) | |
|---|---|---|---|---|---|---|
| | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 |
| $a_1$- Unfertilized; | 9.77 | 9.53 | 431.3 | 360.5 | 4419.5 | 3782.4 |
| $a_2$ – $N_{80}P_{80}K_{80}$ | 13.70 | 12.17 | 796.8 | 530.4 | 5670.7 | 4358.0 |
| $a_3$ – $N_{80}P_{80}K_{80}$ + biostimulatory (ALBIT-40 ml/ha ) | 14.77 | 11.13 | 924.6 | 563.2 | 6260.0 | 5060.1 |
| $a_4$ – $N_{150}P_{80}K_{80}$ | 13.87 | 13.70 | 971.0 | 771.2 | 7000.5 | 5628.77 |
| $a_5$ – $N_{150}P_{80}K_{80}$+ biostimulatory (ALBIT-40 ml/ha) | 14.20 | 14.70 | 1025.0 | 913.0 | 7217.3 | 6211.0 |

## CONCLUSIONS

The results regarding the state of supply of plants in NPK showed a low nitrogen content (2.16% in the unfertilized version and 2.90% in the fertilized variant with N150P80K80 + biostimulatory (ALBIT-40 ml/ha.

The total phosphorus content of plants was between 0.66% in unfertilized variant and 0.81% in fertilized variant with N150P80 K80 + biostimulatory (ALBIT-40 ml / ha): so a state of optimal phosphorus supply, and the content increases with increasing doses of fertilizers, and the highest values were determined in the variants where treatments were performed with the biostimulatory ALBIT-40 ml / ha, (0.74 -0.81%). The potassium content of the leaves was quite low (0.72% in the unfertilized version and 1.22% in the fertilized version with N80P80K80. The optimum values are in the 3-4% range.

The most balanced biochemical composition of grains sorghum was obtained in the fertilized variant with N150P80 K80 + biostimulatory (ALBIT-40 ml / ha): (11.72% moisture, 13.50% protein, 906.39 kg / ha protein, 6714kg / ha grain production, 3.53% fat, 87kg/hl hectolitric mass, 29g mass of one thousand grains).

The amount of protein in percentage increases with the increase of the production but insignificant, and the quantity of protein expressed in kg / ha increases with the increase of the grain production, distinctly significant.

The amount of protein increases with increasing the distinct nitrogen dose significantly.

Regarding the influence of the study years, the best results were obtained in the climatic conditions of the year 2018, which was characterized by maximum average temperatures of 26.6 $^0$C, in the summer months and with significant precipitations during the period May-July (106.6-195.2mm).

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## BIBLIOGRAPHY

1. **Amal, G. Ahmed, Nabila, M. Zaki, M.S. Hassanein**, 2007,*Response of Grain Sorghum to Different Nitrogen Sources,* Research Journal of Agriculture and Biological Sciecnes, 3(6): 1002-1008,
2. **Antohe, I.,** 2007, *Realizări În Ameliorarea Sorgului La Fundulea,* An. I.N.C.D.A. Fundulea, Vol. Lxxv, , Volum Jubiliar Genetica Şi Ameliorarea Plantelor, p. 137-157
3. **Antohe, I., Drăghici, I., Naidin, C.,** 2002 – *Sorghum an alternative crop for south of Ro-mania. In: Drought mitigation and prevention of land desertification*, 22-24 April, 2002, Bled, Slovenia: 112.
4. **Coclea, D., Simona, Niţă, Ioana, Maria, Mateaş,** 2013, *Production potential of grain sorghum (sorghum b.var. Eurosorghum) under the influence of fertilization and hybrids studied,* Research Journal Of Agricultural Science, 45 (4), p.30
5. **Diallo, Sory**, 2012, *Effect of genotypes and nitrogen on grain quality of sorghum*, Department of Agronomy College of Agriculture KANSAS STATE UNIVERSITY Manhattan, Kansas

6. **Drăghici, I.,** 2016, *Assessing the bioenergetically potential of primary and secondary production to the grain sorghum crop. Sustainable exploitation of environmental resources in areas with sandy soils*. Annals of the Research -Development Center for Field Crops on Sandy Soils, DABULENI, volume20th, pag. 82-89, Editura SITECH, Craiova,
7. **Fageria, N. K., Baligar, C., Clark, R. B**., 2002. *Micronutrients in crop production.* Advance Agronomy77: 185-268.
8. **Kaufman, RC, Wilson, JD, Bean, SR, Presley, DR, Blanco-Canqui H, Mikha, M.,** 2013, *Effect of nitrogen fertilization and cover cropping systems on sorghum grain characteristics*, Agric Food Chem. 2013 Jun 19;61(24):5715-9
9. **Matei, Gh.,** 2011. *Research on some technological measures for increasing the yields on grain sorghum cultivated on sandy soils from Tâmbureşti*. Analele Universităţii din Craiova, seria Agricultură-Montanologie Cadastru Vol. XLI 2011/1.
10. **Mureşan, T., Cosmin, O., Sarca, Tr.,** 1961, *Importanta culturii sorgului şi comportarea unor hibrizi încercaţi la Baza experimentală Fundulea în anii 1958-1960*. Probleme agricole, 8: 19-26.
11. **Oprea, C. Cristina, Andreea**, 2018, *Cercetări privind cultura sorgului pentru boabe (Sorghum Bicolor var. Eusorghum) în condițiile din zona de sud-est a României,* Teza de doctorat, USAMV Bucuresti)
12. **Palél, S., S. J. B. Taonda, B. Bougouma, S. C. Mason**, 2010, *Water and fertilizer influence on sorghum grain quality for traditional beer (dolo) production in Burkina Faso,* African Journal of Food Science Vol. 4(11), pp. 723 - 734,
13. **Torbatinejad, N.M., M.R. Chajchee and S.Sharifi**, 2001. *The effect of different levels ofnitrogen on silage qualityofthree sorghumcultivars.* Agricultural Sciences and Technology.,15(2): 75-82
14. **Varvel, G.E.,** 2000, *Crop Rotation and Nitrogen Effects on Normalized Grain Yields in a Long-Term Study*. Agron. J. 92, p. 938-941.