RESEARCHES REGARDING THE INFLUENCE OF FERTILIZATION ON GRAINS YIELD AND QUALITY AT *SORGHUM BICOLOR* L. IN THE PEDOCLIMATIC CONDITIONS FROM THE CENTER OF MOLDOVA

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Abstract

Crop fertilization has beneficial effects on the productivity of sorghum crops although the species does not have high demands on it. This is explained by the fact that the root system of sorghum is well developed and manages to extract nutrients from the soil. Previous experiments show that mineral fertilizers contribute to the production increase with 40%. Under A.R.D.S. Secuieni pedoclimatic conditions, for a five years period (2013 – 2017) the influence of nitrogen and phosphorus fertilizers on the soil production and quality was studied, and the conclusion was that sorghum reacts well to the fertilization with these fertilizers. Significant production increases have been achieved in the variants fertilized with doses starting from 80 kg a.s./ha of nitrogen and phosphorus, and the maximum level was recorded in the variant fertilized with 120 kg a.s./ha of nitrogen and phosphorus. Of the five years of experimentation, the most favorable for sorghum crop was 2013, a year characterized as very warm. This year's average production was high and reached 7397 kg/ha. In each of the five years of experimentation, the maximum yield was achieved in the variants fertilized with 120 kg/ha and its variation ranged between 5506 kg/ha (2015) and 7397 kg/ha (2013). The minimum yield level was recorded each year in the non-fertilized variants, ranging from 3842 kg/ha (2014) to 4517 kg/ha (2017). The highest production increase per 1 kg of active substance fertilizer was obtained each year in the variants fertilized with 40 kg a.s./ha of nitrogen and phosphorus. The nitrogen and phosphorus fertilization has also influenced the grain quality, which had a positive influence on the protein content and a negative influence on the starch content.

Key words: starch, nitrogen, phosphorus, protein, sorghum

Sorghum is a highly adaptable species, being cultivated in the tropical, subtropical and temperate regions of the world. Center of origin it is considered to be the northeastern part of Africa, most likely in the modern regions of Ethiopia and Sudan, where its cultivation as a crop plant began as early as 4000 BC. (Dillon S.L. *et al*, 2007a). In terms of the importance of grain harvesting in the world, sorghum ranks fifth, after wheat, maize, rice and barley (Ejeta and Grenier, 2005; ICRISAT 2015).

Its grains provide human food in Africa and Asia, but in the western hemisphere, the species is mainly grown for animal nutrition (QDAF 2012b). This plant is an important food source for more than 500 million people in 30 African and Asian countries (ICRISAT 2015). In Africa, sorghum is the basis of food security due to its tolerance to drought and its ability to withstand high temperatures and water exploitation (Taylor J.R., 2003). A high variety of foods are prepared from sorghum grains: boiled food (similar to rice), roasting or popcorn (like corn), bread, pancakes, dumplings, cereals for breakfast or couscous or alcoholic and non-alcoholic beverages (FAO 2015). There is an increasing interest in the development of sorghum potential for its use in food and beverages and in western countries, especially as a source of gluten-free food (O'Hara I. *et al*., 2013, Norwood C., 2015). Also, due to its potential and high importance in the production of biofuels, the species is gaining more and more importance in the world (CGIAR 2015).

Research on this species is extensive, however, because in the world the established sorghum crops have different morphological traits and have many uses in food, feed, fiber and building materials, etc. (Dillon S.L. *et al*, 2007b), they need to be intensified. It is known that it is not possible without the application of fertilizers to obtain quantitative and qualitative increases in production to reach the level of requirements.

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For this reason, at A.R.D.S. Secuieni, starting with 2013 we have set up experiences regarding the influence of some technological factors on the yields and quality of sorghum grains. In this paper, we will present the results obtained regarding the fertilization of the crop.

MATERIAL AND METHOD

In the S.C.D.A. Secuieni experimental field, was placed, in the period 2013 - 2017, an monofactorial experience, after the randomized blocks method in three repetitions, the purpose of which was to determine to what extent fertilizers with nitrogen and phosphorus, the production and quality of grain sorghum. Experimental fertilization variants were: N_0P_0, $N_{40}P_{40}$, $N_{80}P_{80}$ and $N_{120}P_{120}$.

The analysis of the sorghum grain was carried out in the laboratory using the NIR DA 7250 apparatus which is in the endowment of the station, where it was determined the protein and starch content.

RESULTS AND DISCUSSIONS

Although the species (sorghum) is not pretentious to soil fertility, the results show that the species reacts very well to fertilizer application, both in terms of production and its quality.

The interpretation of the results was carried out by reporting the yield obtained at the average of the experience (control), given that for the pedoclimatic area in the Center of Moldova there is no recent research, there is no standard fertilization dose. Compared to the control is observed the sorghum positive reaction at high doses, in each of the five years, at the application of the 80 or 120 kg a.s./ha nitrogen and phosphorus doses, production increases were statistically assured. On average, during the experimental period, 2013-2017, the $N_{80}P_{80}$ fertilization variant obtained a distinctly significant production increase, and in the $N_{120}P_{120}$ fertilization variant, the increase was very significant (*table 1*).

Table 1

Obtained yields after the application of fertilizers with nitrogen and phosphorus, 2013 – 2017

Fertilizer variant	Obtained yields (kg/ha)					Media 2013 – 2017 (kg/ha)
	2013	2014	2015	2016	2017	
N_0P_0	4468 ^{ooo}	3842 ^{ooo}	3788 ^{ooo}	3865 ^{ooo}	4517 ^{ooo}	4096 ^{ooo}
$N_{40}P_{40}$	6605 ^{ooo}	4912 ^{ooo}	5047 ^{oo}	5125 ^{o}	5892	5516 ^{oo}
$N_{80}P_{80}$	8547 ***	6235 ***	5950 **	6058 **	6838 **	6726 **
$N_{120}P_{120}$	9969 ***	7343 ***	7240 ***	7308 ***	7494 ***	7871 ***
Media	7397	5581	5506	5509	6185	6036
LSD 5 %	183	266	285	363	411	302
LSD 1 %	226	351	386	517	557	407
LSD 0,1 %	303	503	512	655	744	543

The positive reaction of sorghum at high doses is also reinforced by the values of the coefficient correlation (r) which in each of the five years was statistically assured and interpreted as very significant (*figure 1*).

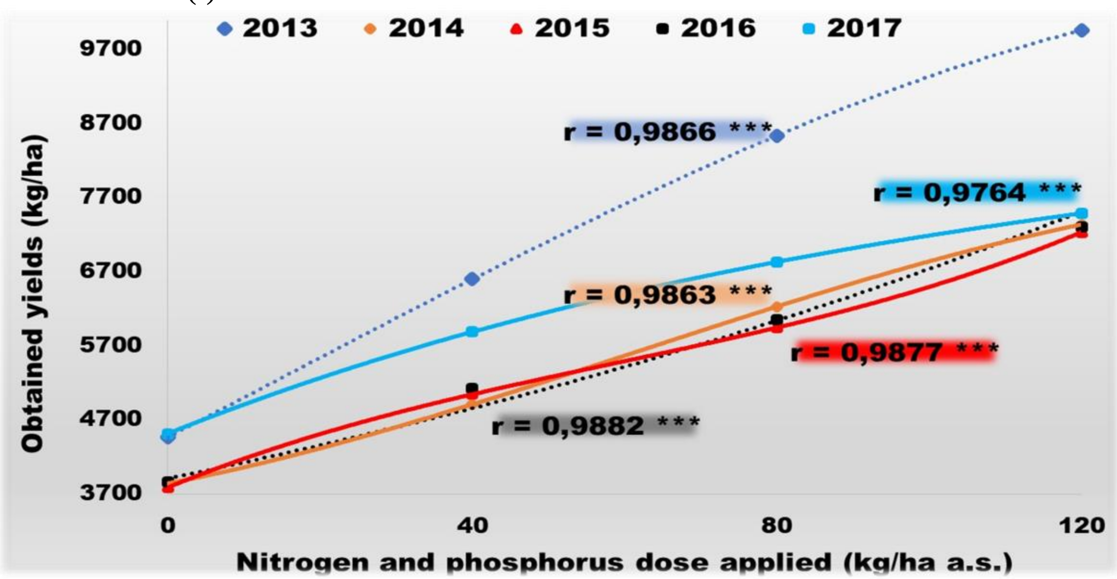

Figure 1 **The correlation between the fertilizer dose with nitrogen and phosphorus applied and the yield of grain produced (2013-2017)**

Although the highest yields are achieved with fertilized variants with 120 kg a.s./ ha of nitrogen and phosphorus, from *table 2* we can see that the highest increase per kilogram of applied fertilizer was carried out each year in fertilized variants with 40 kg a.s./ ha nitrogen and phosphorus. In fertilized variant with this dose, have been achieved 69.0 kg of sorghum grains /1 kg of fertilizer.

Table 2

Increases obtained from sorghum under the influence of applied nitrogen and phosphorus fertilizers

Fertilizer variant	Increases per kg of fertilizer					Average 2013 - 2017
	2013	2014	2015	2016	2017	
N_0P_0	-	-	-	-	-	-
$N_{40}P_{40}$	82.6	61.4	63.1	64.1	73.7	69.0
$N_{80}P_{80}$	53.4	39.0	37.2	37.9	42.7	42.0
$N_{120}P_{120}$	41.5	30.6	30.2	30.5	31.2	32.8

Nitrogen and phosphorus fertilization also had positive effects on protein content, ranging from 11.4 % (unfertilized) to 12.6 % ($N_{120}P_{120}$). Compared with the average of the experience, statistically assured increases were made only in the fertilized variant with 120 kg a.s./ha of nitrogen and phosphorus. In this variant, the increase in protein was interpreted as distinctly significant. As for the starch content, it decreased with the increase in the fertilizer dose. Thus, as in the variant fertilized with 120 kg a.s./ha nitrogen and phosphorus, the difference was negatively distinctly significant (*Table 3*).

Table 3

The influence of fertilization on chemical indicators of sorghum seed

Fertilizer variant	Protein	Significance	Starch	Significance
N_0P_0	11.4	oo	63.3	**
$N_{40}P_{40}$	11.9		62.6	
$N_{80}P_{80}$	12.2		61.6	
$N_{120}P_{120}$	12.6	**	60.8	oo
Media	12.0		62.1	
LSD 5 % LSD 1 % LSD 0,1 %	0.3 0.5 0.8		0.7 1.1 1.6	

Correlation coefficients (r) showed that there are close correlations between fertilization - protein, fertilization - starch, in the first case the coefficient being interpreted as very significant, and in the second case being negative very significant (*Figure 2*).

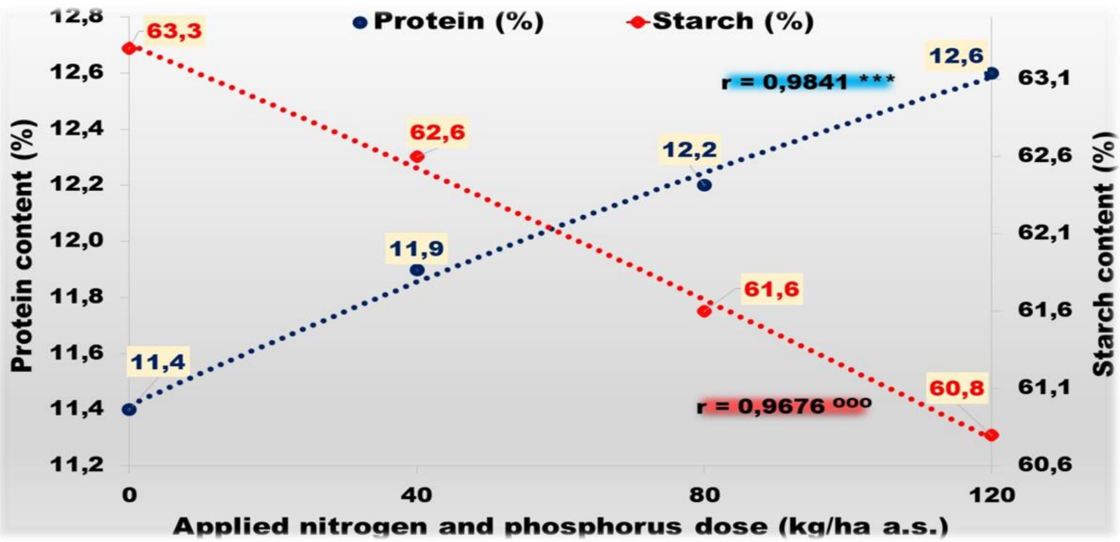

Figure 2 **The correlation between nitrogen and phosphorus fertilization and chemical indices of seed**

CONCLUSIONS

The highest level of yield was registered in each experimental year in variants fertilized with N120P120, and the highest yields increase/ 1 kg a.s. fertilizer with nitrogen and phosphorus in fertilized variants with N40P40. As in the case of grain yields, grain quality has been influenced by the application of nitrogen and phosphorus fertilization. Thus, with the application of fertilizers, the protein content increased and the content in the starch decreased.

We recommend crop cultivation to achieve high productions and high-quality.

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