

## RESEARCH REGARDING THE INFLUENCE OF NITROGEN AND PHOSPHORUS FERTILIZATION ON THE YIELD OF GRAIN SORGHUM HYBRIDS

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### Abstract

The fertilization is an essential technological factor in improving yield. The purpose of this research was to evaluate the effect of fertilization and the answer of grain sorghum hybrids in terms of yield and its components. Research conducted over two agricultural years (2013/2014-2014/2015) was located in the South-Eastern Romania area and was based on a split plot design. The paper presents the results regarding the following tested factors: Factor A- grain sorghum hybrids: Alize, Aquilon, Arack; Factor B - fertilization levels:  $N_0P_0$ ,  $N_{90}P_0$ ,  $N_{90}P_{60}$ ,  $N_{120}P_0$ ,  $N_{120}P_{60}$ . Regarding fertilization, both the use of nitrogen (N) and the fertilization with complex fertilizers (nitrogen and phosphorus) generated the increase of yield and its components with values statistically assured for the three researched hybrids. The average yield was 7.83 t/ha, varying from 5.61 t/ha (Arack hybrid unfertilized) to 9.22 t/ha (Aquilon hybrid fertilized  $N_{120}P_{60}$ ). Hectolitre mass was highly significant influenced by the use of fertilizers, the highest value (80.74 kg/hl) being recorded by the hybrid Arack fertilized  $N_{120}P_{60}$ . The maximum value of a thousand seeds weight was recorded by the hybrid Aquilon fertilized  $N_{120}P_{60}$  (24.15 g) and the lowest value was recorded by the hybrid Alize unfertilized (19.03 g) with variations between +0.95 g (Arack hybrid fertilized  $N_{90}P_0$ ) and +3.56 g (Aquilon hybrid fertilized  $N_{120}P_{60}$ ).

**Key words:** Sorghum, fertilization, grain yield, yield components.

### INTRODUCTION

*Sorghum bicolor* (L.) is well known as a grain with a high capacity of exploiting natural resources (Varvel, 2000; Almondares, 2008; Borghia, 2013). Nevertheless grain sorghum production and yield are highly influenced by the interaction of the plants with environmental factors (Showemimo, 2007) and technological factors. Hydric stress, poor soils and a poor fertilization management are the main limiting factors of the yield (Aleminew, 2015). Water stress at panicle differentiation and during flowering determines the yield reduction, following the decrease in number of seeds by 45% (Tolka, 2013). Lack of nitrogen fertilization determines a yield reduction by nearly 19% (Smith, 1990 cited by Tucker, 2009). Thus, agricultural practices regarding fertilization management are essential in terms of increasing yield. Nitrogen (N) is the main determinant nutrient of yield (Baozhen, 2014; Akdeniz, 2006; Saber-Rezaii, 2009). Long term research (40years) conducted in Western

Kansas highlighted the positive influence of fertilization with different doses of N (up to 225 kg/ha) and P (up to 20 kg/ha) on the grain yield of sorghum. On average, during the 40 years, the grain yield increased by 31%. The highest average yield was recorded for the application of  $N_{180}P_{20}$  (Stewart, 2005). Along with nitrogen (N), phosphorus (P) is important for the development of sorghum plants (Khalili, 2008; Sahrawat, 1999), P fertilization with a dose of 40 kg/ha once every two years satisfying the plant requirements under semi-arid agro-climatic conditions (Sahrawat, 2000). Phosphorus fertilization in irrigated cropping conditions has a positive influence on the yield and its elements (No. of seed/panicle, a thousand seeds weight) (Afshar, 2014).

In Romania, research results underline the fact that sorghum reacts to fertilization rates of  $N_{50-80}$ ,  $P_{30-60}$ ,  $K_{40}$  kg/ha active substance (a.s.) (Sin, 2005 cited by Nica, 2011) and to fertilization doses of  $N_{60-120}$ ,  $P_{60}$ ,  $K_{60}$  kg/ha a.s. (Oprea, 2015). Research conducted on a sandy soil (in Craiova area, at Tâmburești) reveals the

obtaining of better yields under the fertilization with  $N_{160}P_{80}K_{80}$  (Matei, 2011). Other authors (Munteanu L.M. and Tabără V., 2011, 2012) also show the fertilization influence on the yield of grain sorghum cultivated on a brown soil, the maximum yield being obtained for the fertilization with  $N_{240}P_{80}K_{80}$ , respectively 8,214 kg/ha in 2010 and 6,770 kg/ha in 2011.

The purpose of this research was to determine the influence of applying different doses of nitrogen and phosphorus on the grain yield of some sorghum hybrids (*Sorghum bicolor* (L.) Moench, in the field conditions of South-Eastern Romania.

## MATERIALS AND METHODS

The research was conducted over two agricultural years (2013/2014 and 2014/2015) in the South-Eastern area of Romania, in Ilfov County. The experiments were placed at the Experimental Field of Moara Domnească Didactic Farm (44°30' North latitude, 26°13' East longitude, 90 m altitude) on a chromic luvisol with a moderately acidic reaction.

The experimental design was developed in order to study the effect of different fertilization doses of nitrogen and phosphorus over the grain yield of sorghum hybrids. The experiments were based on the split plot method and the tested factors were the following:

- Factor A -grain sorghum hybrids:  $a_1$  - Alize,  $a_2$  - Aquilon,  $a_3$  - Arack;
- Factor B -fertilization treatment with the following graduations:  $b_1$  -  $N_0P_0$ ,  $b_2$  -  $N_{90}P_0$ ,  $b_3$  -  $N_{120}P_0$ ,  $b_4$  -  $N_{90}P_{60}$ ,  $b_5$  -  $N_{120}P_{60}$ .

In the two agricultural years of research the sorghum hybrids were sown at the distance of 70 cm between rows, on the 2<sup>nd</sup> of May 2014 and on the 24<sup>th</sup> of April 2015. The fertilization treatments were applied when preparing the field for sowing and during the vegetative stages, at 36 days after sowing (2013/2014) and 41 days after sowing (2014/2015). Regarding the maintenance of the crop in both years Dual Gold 1.5 l/ha (S-metolachlor 960 g/l) herbicide (pre-emergence) and Dicopur Top 1 l/ha (2.4-D dimethylamine salt 600 g/l) herbicide (after emergence) were used to control weeds, two mechanical hoes were also applied. Pests control (*Tanymecus dilaticollis*) was carried out using Calypso (150 ml/ha).

Normal climatic conditions of the research area, presented in Table 1, are characterized by rainfalls with values of 301 mm and average temperatures of 19.5°C. In the agricultural year 2013/2014, during the plants growing season, rainfalls recorded a value similar to the normal standard of the area (291 mm) but with different distribution. In terms of temperature, the average value during the growing season was 2° C higher compared to the multiannual values. In the agricultural year 2014/2015 the average temperature during sorghum vegetation period recorded values with 2.8° C higher than the normal temperature of the season and 0.8° C higher compared to the same interval in the previous year. Regarding rainfalls, these recorded in the growing season values by approx. 49% lower compared to the normal precipitations values characteristic to the same period (144 mm).

Table 1. Climatic conditions in the agricultural years 2013/2014 and 2014/2015 at Moara Domnească, Ilfov

Month	Temperature (°C)			Rainfall (mm)		
	Year 2013-2014	Year 2014-2015	Normal	Year 2013-2014	Year 2014-2015	Normal
October	14.0	11.8	11.0	81.7	64.2	35.8
November	8.3	6.0	5.3	17.6	49.1	40.6
December	-0.2	1.4	0.4	1.2	84.6	36.7
January	-0.5	-1.5	-3.0	33.2	33.4	30
February	1.2	2.0	-0.9	7.6	21.4	32.1
March	8.9	6.2	4.4	37.3	65	31.6
April	13.4	11.7	11.2	116.0	2	48.1
May	19.3	18.6	16.5	88.0	33.6	67.7
June	19.9	21.0	20.2	113.0	56.8	86.3
July	22.8	25.3	22.1	38.0	5.2	63.1
August	24.1	24.3	21.1	26.2	48.4	50.5
September	21.3	-	17.5	25.8	-	33.6
<b>Avg./Sum</b>	<b>12.7</b>	<b>11.5</b>	<b>10.5</b>	<b>585.6</b>	<b>463.7</b>	<b>556.1</b>
<b>Avg./Sum* May-Sept</b>	<b>21.5</b>	<b>22.3</b>	<b>19.5</b>	<b>291.0</b>	<b>144.0</b>	<b>301.2</b>

\*May-15 Sept (2014); 24 Apr-1 Sept. (2015)

## RESULTS AND DISCUSSIONS

### *Hybrid influence on grain sorghum yield and yield components, Moara Domnească*

Grain yield of sorghum hybrids researched in the field conditions of South - Eastern Romania, in the agricultural years 2013/2014 - 2014/2015 recorded an average value of nearly

7.8 t/ha (Table 2). Under hybrid's influence grain sorghum yield recorded variations from -3.8% to +4.4%, but without being statistically assured. Aquilon hybrid recorded positive yield increases (between 2.3% and 4.6%) compared to Control. Alize and Arack hybrids recorded mainly negative yield variations compared to Control, the average yield being by 2.4% and 0.8% lower. Arack hybrid unfertilized had the minimum yield (5.61 t/ha) and Aquilon hybrid

fertilized N<sub>120</sub>P<sub>60</sub> had the maximum yield of 9.22 t/ha. Compared to Alize, Aquilon hybrid recorded yield increases statistically assured for the fertilization with complex fertilizers (N<sub>90</sub>P<sub>60</sub> and N<sub>120</sub>P<sub>60</sub>) while compared to Arack the yield had a significant variation for the fertilization treatment N<sub>90</sub>P<sub>60</sub>. Yield differences between the hybrids Alize and Arack varied depending of the fertilization treatment from -0.23 t/ha to +0.42 t/ha and were not statistically assured.

Table 2. Hybrid influence on sorghum grain yield (t/ha) (Moara Domneasă, Average 2014-2015)

Variants	Alize (a <sub>1</sub> )		Aquilon (a <sub>2</sub> )		Arack (a <sub>3</sub> )		Average Hybrids			Diff. between hybrids		
	GY (t/ha)	%	GY (t/ha)	%	GY (t/ha)	%	GY (t/ha)	%	Signf.	a <sub>2</sub> -a <sub>1</sub> (t/ha)	a <sub>3</sub> -a <sub>1</sub> (t/ha)	a <sub>3</sub> -a <sub>2</sub> (t/ha)
N <sub>0</sub> P <sub>0</sub> (b <sub>1</sub> )	5.83 ns	100.5	5.98 ns	103.0	5.61 ns	96.6	5.81	100	Ct	0.15 ns	-0.23 ns	-0.37 ns
N <sub>90</sub> P <sub>0</sub> (b <sub>2</sub> )	7.68 ns	98.1	8.09 ns	103.4	7.72 ns	98.6	7.83	100	Ct	0.41 ns	0.04 ns	-0.37 ns
N <sub>120</sub> P <sub>0</sub> (b <sub>3</sub> )	8.02 ns	97.2	8.44 ns	102.3	8.30 ns	100.6	8.26	100	Ct	0.42 ns	0.28 ns	-0.14 ns
N <sub>90</sub> P <sub>60</sub> (b <sub>4</sub> )	8.04 ns	96.8	8.69 ns	104.6	8.18 ns	98.5	8.30	100	Ct	0.65*	0.14 ns	-0.50 o
N <sub>120</sub> P <sub>60</sub> (b <sub>5</sub> )	8.65 ns	96.3	9.22 ns	102.7	9.06 ns	101.0	8.98	100	Ct	0.57*	0.42 ns	-0.16 ns
<b>Avg.</b>	7.64 ns	97.6	8.08 ns	103.2	7.77 ns	99.2	7.83	100	Ct	0.44 ns	0.13 ns	-0.31 ns

LSD 5% = 0.50 t/ha; LSD 1% = 0.70 t/ha; LSD 0.1% = 0.97 t/ha

GY = Grain Yield at STAS humidity (14%); Ct = Control; ns = no significance

Analyzing the hybrids' influence on a thousand seeds weight (TSW, g), data presented in Table 3 show that Aquilon hybrid recorded the highest value of TSW (24.15 g) for the fertilization treatment N<sub>120</sub>P<sub>60</sub>; the minimum value was recorded by Alize hybrid unfertilized (19.03 g). Compared to Control the three hybrids recorded variations of the TSW between -0.85 g (Alize fertilized with N<sub>90</sub>P<sub>60</sub>) and +1.19 g (Aquilon fertilized with N<sub>90</sub>P<sub>0</sub>). Increases of a thousand seeds weight statistically assured compared to Control were recorded by Aquilon hybrid for 4 fertilization

treatments (N<sub>90</sub>P<sub>0</sub>, N<sub>120</sub>P<sub>0</sub>, N<sub>90</sub>P<sub>60</sub>, N<sub>120</sub>P<sub>60</sub>). Also, Aquilon present statistically assured increases of TSW compared to Alize for all the fertilization variants, with values between 1.6 g and 2.01 g. Differences between the hybrids Arack and Aquilon ranged from -0.86 g and -1.62 g, being distinctly significant when fertilizers were used (N<sub>90</sub>P<sub>0</sub>, N<sub>120</sub>P<sub>0</sub>, N<sub>90</sub>P<sub>60</sub>, N<sub>120</sub>P<sub>60</sub>). A thousand seeds weight for the hybrid Arack varied negligible in relation to Alize hybrid, the differences were between +0.20 g. and +0.69 g.

Table 3. Hybrid influence on grain sorghum hybrids' a thousand seeds weight (TSW, g) (Moara Domneasă, Average 2014-2015)

Variants	Alize (a <sub>1</sub> )		Aquilon (a <sub>2</sub> )		Arack (a <sub>3</sub> )		Average Hybrids			Diff. between hybrids		
	TSW (g)	%	TSW (g)	%	TSW (g)	%	TSW (g)	%	Signf.	a <sub>2</sub> -a <sub>1</sub> (g)	a <sub>3</sub> -a <sub>1</sub> (g)	a <sub>3</sub> -a <sub>2</sub> (g)
N <sub>0</sub> P <sub>0</sub> (b <sub>1</sub> )	19.03ns	96.2	20.59 ns	104.1	19.72 ns	99.7	19.78	100	Ct	1.55**	0.69 ns	-0.86 ns
N <sub>90</sub> P <sub>0</sub> (b <sub>2</sub> )	20.26 ns	96.2	22.25*	105.6	20.67 ns	98.1	21.06	100	Ct	1.98***	0.40 ns	-1.58oo
N <sub>120</sub> P <sub>0</sub> (b <sub>3</sub> )	21.65 ns	97.4	23.34*	105.0	21.72 ns	97.7	22.24	100	Ct	1.69***	0.06 ns	-1.62oo
N <sub>90</sub> P <sub>60</sub> (b <sub>4</sub> )	20.69 ns	96.1	22.70*	105.4	21.21 ns	98.5	21.53	100	Ct	2.01***	0.52 ns	-1.49oo
N <sub>120</sub> P <sub>60</sub> (b <sub>5</sub> )	22.54 ns	97.4	24.15*	104.3	22.74 ns	98.3	23.14	100	Ct	1.60**	0.20 ns	-1.40oo
<b>Avg.</b>	20.84 ns	96.7	22.60*	104.9	21.21 ns	98.4	21.55	100	Ct	1.77***	0.38 ns	-1.39oo

LSD 5% = 0.89 gr; LSD 1% = 1.22 gr; LSD 0.1% = 1.65 gr

TSW = a thousand seeds weight; Ct = Control; ns = no significance

The hectolitre mass (HLM) of the grain sorghum hybrids recorded an average value of 78.48 kg/hl (Table 4). Under hybrid's influence the indicator recorded insignificant variations, nevertheless the maximum value of HLM was recorded by Arack fertilized N<sub>120</sub>P<sub>60</sub> (80.74 kg/hl), while Alize unfertilized had the minimum value (73.65 kg/hl). Compared to Control the influence of the three sorghum hybrids on the hectolitre mass is not significant, the indicator recording variation's values from

-0.94 kg/hl (Alize unfertilized) to 0.86 kg/hl (Arack fertilized N<sub>120</sub>P<sub>60</sub>). The hybrids' hectolitre mass differences varied between -0.17 kg/hl and +1.60 kg/hl, being mainly insignificant. A comparison between hybrids' HLM reveals differences statistically assured between Aquilon and Alize, Arack and Alize for the unfertilized variant and also between Arack and Aquilon, when fertilization treatments with N<sub>120</sub>P<sub>0</sub> and N<sub>120</sub>P<sub>60</sub> were applied.

Table 4. Hybrid influence on grain sorghum hybrids' hectolitre mass (HLM kg/hl) (Moara Domnească, Average 2014-2015)

Variants	Alize (a <sub>1</sub> )		Aquilon (a <sub>2</sub> )		Arack (a <sub>3</sub> )		Average Hybrids		Diff. between hybrids			
	HLM (Kg/hl)	%	HLM (Kg/hl)	%	HLM (Kg/hl)	%	HLM (Kg/hl)	%	Signf.	a <sub>2</sub> -a <sub>1</sub> (Kg/hl)	a <sub>3</sub> -a <sub>1</sub> (Kg/hl)	a <sub>3</sub> -a <sub>2</sub> (Kg/hl)
N <sub>0</sub> P <sub>0</sub> (b <sub>1</sub> )	73.65ns	98.7	74.87 ns	100.4	75.25 ns	100.9	74.59	100	Ct	1.21*	1.60**	0.38 ns
N <sub>90</sub> P <sub>0</sub> (b <sub>2</sub> )	78.64 ns	99.6	79.00 ns	100.1	79.22 ns	100.3	78.95	100	Ct	0.36ns	0.58 ns	0.22 ns
N <sub>120</sub> P <sub>0</sub> (b <sub>3</sub> )	79.55 ns	99.6	79.47 ns	99.5	80.47 ns	100.8	79.83	100	Ct	-0.08 ns	0.92 ns	1.00 *
N <sub>90</sub> P <sub>60</sub> (b <sub>4</sub> )	78.93 ns	99.7	79.19 ns	100.0	79.35 ns	100.2	79.16	100	Ct	0.26 ns	0.42 ns	0.16 ns
N <sub>120</sub> P <sub>60</sub> (b <sub>5</sub> )	79.95 ns	100.1	79.77 ns	98.8	80.74 ns	101.1	79.88	100	Ct	-0.17ns	0.79 ns	0.97*
<b>Avg.</b>	78.14 ns	99.6	78.29 ns	99.8	79.01 ns	100.7	78.48	100	Ct	0.32 ns	0.86 ns	0.55 ns

LSD 5% = 0.88 gr; LSD 1% = 1.22 gr; LSD 0.1% = 1.77 gr  
HLM = hectolitre mass; Ct = Control; ns = no significance

### Fertilization influence on grain sorghum yield components, Moara Domnească

Nitrogen and phosphorus fertilization (Table 5) generated an average yield growth from 34.8% to 54.6%, statistically assured compared to Control (that was not fertilized). The positive influence of fertilization on the grain yield was significant for all the hybrids. Nitrogen

fertilization with doses of 90 kg/ha and 120 kg/ha (a.s.) generated significant positive yield increases from 1.85 t/ha (Alize) to 2.70 t/ha (Arack) while N<sub>90</sub>P<sub>60</sub> and N<sub>120</sub>P<sub>60</sub> fertilization treatments generated an yield growth statistically assured with values between 2.21 t/ha (for the hybrid Alize fertilized N<sub>90</sub>P<sub>60</sub>) and 3.45 t/ha (for the hybrid Arack fertilized N<sub>120</sub>P<sub>60</sub>).

Table 5. Fertilization influence on sorghum grain yield (GY t/ha) (Moara Domnească, Average 2014-2015)

Variants	Alize				Aquilon			Arack				Average hybrids				
	GY (t/ha)	%	Diff. (t/ha)	Signf	GY (t/ha)	Diff. (t/ha)	Signf	GY (t/ha)	%	Diff. (t/ha)	Signf	GY (t/ha)	%	Diff. (t/ha)	Signf	
N <sub>0</sub> P <sub>0</sub> (Ct)	5.83	100.0	Ct	-	5.98	100.0	Ct	-	5.61	100.0	Ct	-	5.81	100.0	Ct	-
N <sub>90</sub> P <sub>0</sub>	7.68	131.6	1.85	***	8.09	135.3	2.11	***	7.72	137.6	2.11	***	7.83	134.8	2.02	***
N <sub>120</sub> P <sub>0</sub>	8.02	137.5	2.19	***	8.44	141.2	2.46	***	8.30	148.1	2.70	***	8.26	142.2	2.45	***
N <sub>90</sub> P <sub>60</sub>	8.04	137.8	2.21	***	8.69	145.3	2.71	***	8.18	145.9	2.58	***	8.30	143.0	2.50	***
N <sub>120</sub> P <sub>60</sub>	8.65	148.2	2.81	***	9.22	154.2	3.24	***	9.06	161.6	3.45	***	8.98	154.6	3.17	***
<b>Avg.</b>	7.64	131.0	1.81	***	8.08	135.2	2.10	***	7.77	138.7	2.17	***	7.83	134.9	2.03	***

LSD 5% = 0.61 t/ha; LSD 1% = 0.81 t/ha; LSD 0.1% = 1.06 t/ha  
GY = Grain Yield at STAS humidity (14%); Ct = Control

Considering the influence of nitrogen and phosphorus fertilization treatments on sorghum hybrids' a thousand seeds weight (Table 6), on average this varied between 19.78 g for the unfertilized variant and 23.14 g for the

application of N<sub>120</sub>P<sub>60</sub>. The fertilization treatment N<sub>90</sub>P<sub>0</sub> generated a significant growth of the indicator compared to Control, the application of N<sub>90</sub>P<sub>60</sub> determined a distinctly significant increase and the fertilization with

N<sub>120</sub>P<sub>0</sub> and N<sub>120</sub>P<sub>60</sub> had a very significant positive influence on TSW.

Nitrogen fertilization with a rate of 90 kg/ha active substance generated an increase of the TSW statistically assured for the hybrid Aquilon (+1.66 g), while for the hybrids Alize and Arack the indicator variations were not significant. The treatment with complex fertilizers N<sub>90</sub>P<sub>60</sub> determined a significant

growth of a thousand seeds weight for the hybrids Arack and Alize, with 1.49 g and 1.65 g respectively, compared to the unfertilized variant, and distinctly significant for Aquilon (+2.11 g compared to Control). The use of nitrogen in a dose of 120 kg/ha (a.s.) and the fertilization with N<sub>120</sub>P<sub>60</sub> generated TSW's increases statistically assured compared to Control, for all three tested hybrids.

Table 6. Fertilization influence on grain sorghum a thousand seeds weight (TSW, g) (Moara Domnească, Average 2014-2015)

Variants	Alize				Aquilon				Arack				Average hybrids			
	TSW (g)	%	Diff. (g)	Signf	TSW (g)	%	Diff. (g)	Signf	TSW (g)	%	Diff. (g)	Signf	TSW (g)	%	Diff. (g)	Signf
N <sub>0</sub> P <sub>0</sub> (Ct)	19.03	100.0	Ct	-	20.59	100.0	Ct	-	19.72	100.0	Ct	-	19.78	100.0	Ct	-
N <sub>90</sub> P <sub>0</sub>	20.26	106.5	1.23	ns	22.25	108.1	1.66	*	20.67	104.8	0.95	ns	21.06	106.5	1.28	*
N <sub>120</sub> P <sub>0</sub>	21.65	113.8	2.62	***	23.34	113.4	2.76	***	21.72	110.1	2.00	**	22.24	112.4	2.46	***
N <sub>90</sub> P <sub>60</sub>	20.69	108.7	1.65	*	22.70	110.3	2.11	**	21.21	107.5	1.49	*	21.53	108.9	1.75	**
N <sub>120</sub> P <sub>60</sub>	22.54	118.4	3.51	***	24.15	117.3	3.56	***	22.74	115.3	3.02	***	23.14	117.0	3.36	***
Avg.	20.84	109.5	1.80	**	22.60	109.8	2.02	**	21.21	107.6	1.49	*	21.55	108.9	1.77	**

LSD 5% = 1.25 gr.; LSD 1% = 1.66 gr.; LSD 0.1% = 2.17 gr

TSW = 1,000 seeds weight; Ct = Control; ns = no significance

The use of fertilizers determined increases of the hectolitre mass statistically assured for each of the three researched grain sorghum hybrids (Table 7). The average HLM varied following the application of fertilizers with values between +4.36 kg/hl and +5.29 kg/hl, statistically assured for all the fertilization

treatments. Thus, the application of nitrogen in dose of 90 kg/ha and 120 kg/ha (a.s.) determined the growth of the HLM with values ranging from 3.79 kg/hl to 5.90 kg/hl, and the use of complex fertilizers (N<sub>90</sub>P<sub>60</sub> and N<sub>120</sub>P<sub>60</sub>) generated increases of the indicator from 4.10 kg/hl to +6.30 kg/hl, compared to Control.

Table 7. Fertilization influence on grain sorghum hybrids'hectolitre mass (HLM kg/hl) (Moara Domnească, Average 2014-2015)

Variants	Alize				Aquilon				Arack				Average hybrids			
	HLM Kg/hl	%	Diff. Kg/hl	Signf	HLM Kg/hl	%	Diff. Kg/hl	Signf	HLM Kg/hl	%	Diff. Kg/hl	Signf	HLM Kg/hl	%	Diff. Kg/hl	Signf
N <sub>0</sub> P <sub>0</sub> (Ct)	73.65	100.0	Ct	-	74.87	100.0	Ct	-	75.25	100.0	Ct	-	74.59	100.0		-
N <sub>90</sub> P <sub>0</sub>	78.64	106.8	4.99	***	79.00	105.5	4.13	***	79.22	105.3	3.97	***	78.95	105.8	4.36	***
N <sub>120</sub> P <sub>0</sub>	79.55	108.0	5.90	***	79.47	106.2	4.60	***	80.47	106.9	5.22	***	79.83	107.0	5.24	***
N <sub>90</sub> P <sub>60</sub>	78.93	107.2	5.28	***	79.19	105.8	4.32	***	79.35	105.5	4.10	***	79.16	106.1	4.57	***
N <sub>120</sub> P <sub>60</sub>	79.95	108.5	6.30	***	78.94	105.4	4.08	***	80.74	107.3	5.49	***	79.88	107.1	5.29	***
Avg.	78.14	106.1	4.49	***	78.29	104.6	3.43	***	79.01	105.0	3.76	***	78.48	105.2	3.89	***

LSD 5% = 1.35 kg/hl; LSD 1% = 1.79 kg/hl; LSD 0.1% = 2.35 kg/hl

HM = hectoliter mass; Ct = Control

### Correlation between fertilization and grain yield and yield components

The high positive correlation between fertilizer doses (a.s.) applied to the analyzed sorghum hybrids and their grain yield is supported by a coefficient with the value  $r = 0.9788^{***}$  (very significant positive) (Figure 1). The relationship between grain yield and the

quantity of fertilizers active substance applied is described by a regression line with a positive slope,  $b = 0.0171$ , meaning that for every additional kg of fertilizer active substance applied per ha an increase of 0.017 t/ha in grain yield is expected. The y-intercept of 5.9915 shows that in the absence of fertilization ( $x=0$ ) the expected average grain yield is nearly 5.99 t/ha.

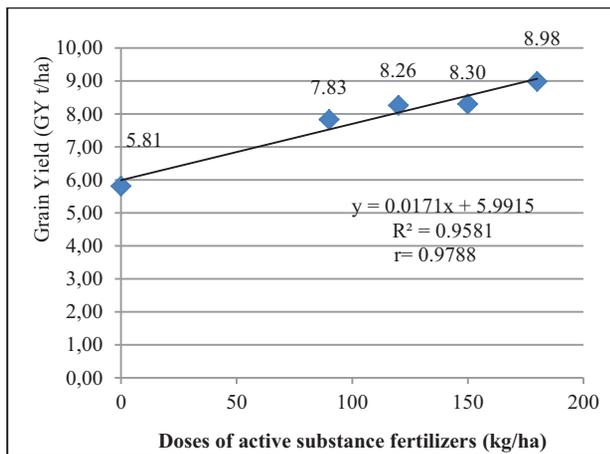


Figure 1. Correlation between the grain yield (GY t/ha) of sorghum hybrids and the doses of active substance fertilizers applied (kg/ha)

The relationship between a thousand seeds weight and the doses of fertilizers (a.s.) is described by a regression line with a positive slope, that allows the association of fertilizers doses (a.s.) to a higher TSW, supported by a high correlation coefficient  $r = 0.9228^{***}$  (Figure 2). The yield indicator's value is mainly influenced (85%) by the quantity of active substance fertilizers applied, while in the lack of fertilization grain sorghum hybrids record an average TSW of nearly 19.73 g.

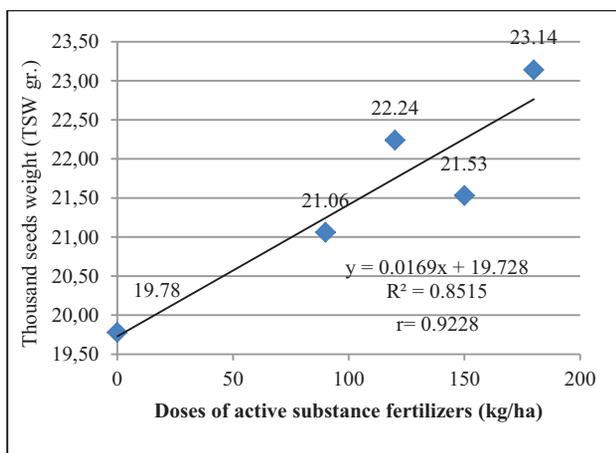


Figure 2. Correlation between a thousand seeds weight (TSW g) of sorghum hybrids and the doses of active substance fertilizers applied (kg/ha)

The influence of the doses of active substance fertilizers on the hectolitre mass of sorghum hybrids (Figure 3) is supported by a correlation coefficient with the value  $r=0.9113^{***}$ . R square ( $R^2=0.8304$ ) shows that the increase of the hectolitre mass, for the three researched

hybrids, is due in a proportion of 83% to the doses of active substance fertilizers applied. The positive slope of the regression line shows that an increase of the hectoliter mass by 0.0292 kg/hl is expected for every additional kg of fertilizer active substance applied per ha. Much more, in the absence of fertilization the average HLM of grain sorghum hybrids was approx. 75.33 kg/hl.

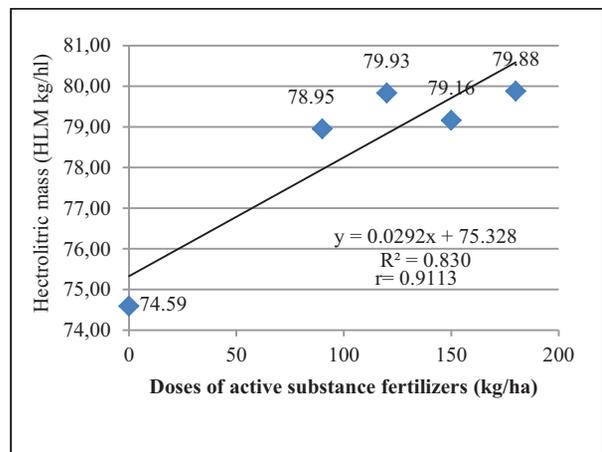


Figure 3. Correlation between hectolitre mass (HLM kg/hl) of sorghum hybrids and the doses of active substance fertilizers applied (kg/ha)

## CONCLUSIONS

In the field conditions of South-Eastern Romania, corresponding to the agricultural years 2013/2014 - 2014/2015, research results regarding the influence of fertilization and hybrid on grain sorghum yield and its components conducted to the following conclusions:

- Under the hybrid influence the average grain yield varied between 7.64 t/ha for Alize and 8.08 t/ha for Aquilon.
- Aquilon hybrid had the highest value of a thousand seeds weight (24.15 g), recording significant increases of the indicator compared both to Alize and Arack; the lowest value of the indicator was recorded by the hybrid Alize (19.03 g).
- The average hectolitre mass of the researched hybrids had a value of 78.48 kg/hl, the highest value was recorded by the hybrid Arack (79.01 kg/hl) and the lowest value by the hybrid Alize (78.14 kg/hl).
- Under the hybrid influence the hectolitre mass recorded variations from -0.17 kg/hl to +1.60 kg/hl, with differences statistically assured between the hybrids

- Aquilon and Alize, Arackand Alize, Arackand Aquilon.
- Nitrogen fertilization with rates of 90 kg/ha and 120 kg/ha (a.s.) determined yield increases between 1.85 t/ha (Alize) and 2.70 t/ha (Arack).
  - Under the influence of different fertilization treatments sorghum hybrids recorded TSW's increases statistically assured with values between 1.66 g and 2.76 g and HLM's increases with values from 3.79 kg/hl and 5.90 kg/hl.
  - The application of complex fertilizers like  $N_{90}P_{60}$  and  $N_{120}P_{60}$  had a strongly significant positive influence on the grain yield of three researched hybrids, with average increases of 2.5 and 3.17 t/ha. Under the fertilization with  $N_{90}P_{60}$  the average TSW increased by 1.75 g and HLM recorded a variation of +4.57 kg/hl.  $N_{120}P_{60}$  fertilization generated TWS's and HLM's growth statistically assured with values of 3.36 g and 5.29 kg/hl respectively.

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