

THE INFLUENCE OF TILLAGE SYSTEM AND FERTILIZATION ON TWINNING AND THE OBTAINING OF PRODUCTIVE SIBLINGS IN THE GRAIN SORGHUM IN THE CONDITIONS OF SĂRĂȚENI, IALOMIȚA

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Abstract

The lack of precipitation puts more and more emphasis on the cultivation technology of the agricultural land, for which it is necessary to adapt the cultivation technology according to the climatic changes. Sorghum can be a substitute for corn when conditions do not allow its cultivation. The number and quality of the productive brothers obtained in the sorghum culture depends a lot on the pedoclimatic conditions, but also on the technology applied in the culture. Our research aimed to evaluate the twinning potential of sorghum under the conditions of South-East Romania (Sărățeni Locality, Ialomița County), analyzing the interaction between different variants of the basic soil work and some fertilization funds based on nitrogen, phosphorus and foliar fertilizers. In this way, it will be possible to establish the optimal variants for stimulating twinning, but also obtaining productive brothers who have reached maturity. The results of the three years of research show that they were different in terms of precipitation, 2021 being a year with high precipitation and 2022-2023, two years with a water deficit, so that the influence of climatic conditions on twinning can be observed. The deeper the loosening of the soil was, the higher the twinning was, tillage by scarification at 35 cm and at 45 cm excelled at all four fertilizations, thus having the highest growth rates of the number of productive siblings in sorghum culture. The most favorable combination of technological factors that ensured a maximum twinning yield in 2022 of 3.6 productive brothers per plant, was represented by tillage by scarifying at 35 cm and a fertilization of $N_{100}+P_{50}+Foliar$ (Borocal).

Key words: *Sorghum bicolor L., soil tillage, fertilization, twinning, productive siblings.*

INTRODUCTION

Sorghum is the fifth most produced cereal crop after maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.) and barley (*Hordeum vulgare* L.) globally (FAOSAT).

It is a staple food crop in Africa and Asia and a vital source of industrial feedstock for the manufacture of feed, bioethanol and syrup (Hossain et al., 2022).

Sorghum is not pretentious to the preceding plant, succeeding even in monoculture. It is not recommended to cultivate it in repeated culture because it leads to a sharp impoverishment of the soil in the main nutritional elements. Water stress, poor soils and reduced fertilization are the main yield-limiting factors (Aleminew, 2015). The reduced requirements for the preceding plant are explained by its ability to take both water and nutrients from the soil. Fertilization is an essential technological factor in improving yield (Oprea et al., 2016). Fertilization with nitrogen and phosphorus has a positive influence

on the number of shoots/ha, but large sowing plots cause their number to decrease (Pochiscanu, 2015). In favorable humidity conditions, sorghum reacts favorably to nitrogen fertilization both in terms of yield and protein content, and in dry areas phosphorus has a positive effect (Coclea et al., 2013). Along with the deeper cultivation of the soil, the height of the sorghum plants also increases, regardless of the way in which it was fertilized (Bănică, 2023).

Research on the influence of culture technology on twinning, carried out under different conditions, shows that it reacts favorably to mineral fertilization (Oprea et al., 2017). Sorghum requires well-drained and deep fertile soils. This will improve root growth and expansion for better absorption of moisture into the soil, the best soil pH being 5.4-8.4. (<https://www.yara.co>). In this context, the objective of the research carried out and provided in the paper is to take into account the main technological elements that influence the formation of productive

brothers in the culture of sorghum for grains: the basic work of the soil and fertilization with a view to an optimal level of yield in correlation with the conditions from the town of Sărățeni, Ialomița county.

MATERIALS AND METHODS

The researches were carried out in the town of Sărățeni-Ialomița county (44°38'11"N 26°55'41"E) between the years 2020-2023 within the Bănică Ion Individual Enterprise on a cambic chernozem.

The rainfall regime was high in 2021, with a total of 673.6 mm, thus favoring obtaining a

high production through the high number of siblings reaching maturity. Both at sowing and in the twinning phases, there was an amount of precipitation above normal. During the period of vegetative development of plants (May-August), 283.4 mm were recorded in 2021, and 96 mm in 2022, the difference between the two years being 184 mm (Table 1).

The year 2023 was an average year between the two years, accumulating 177 mm.

The average monthly temperature for the period of vegetative growth is 20.4°C, and the average for the period 2020-2023 is 21.5°C, which shows us that the studied area is consistent with global warming.

Table 1. Climatic conditions during sorghum plant's vegetative period at Sărățeni-Ialomița

	Temperature (°C)				Rainfall (mm)			
	Normal (1981-2010)	2020-2021	2021-2022	2022-2023	Normal (1981-2010)	2020-2021	2021-2022	2022-2023
May	17.6	17.0	17.8	16.8	50.5	36.0	15.0	43.6
Jun	21.4	20.7	22.7	21.1	71.2	175.0	26.0	42.6
July	23.2	24.9	25.5	25.7	61.9	33.0	31.0	46.2
August	22.6	23.6	24.8	25.9	46.8	36.0	24.0	32.4
September	17.3	16.8	17.2	21.5	47.8	3.4	0.0	12.2
Avg./Sum	20.4	20.6	21.6	22.4	278.2	283.4	96	177

The experiment was placed in randomized blocks, in 3 repetitions with the analyzed factors: Factor A - basic soil work with graduations: a₁ - Plow at 25 cm; a₂ - Scarified at 35 cm; a₃ - Scarified at 45 cm; a₄ - Disc 10 cm; and factor B - fertilizations with graduations: b₁ - N₀P₀ (Control); b₂ - N₁₀₀P₀; b₃ - N₁₀₀P₅₀; b₄ - N₁₀₀P₅₀ + Foliar; b₅ - Borocal 1.5 l/ha (Foliar). The biological material studied was the hybrid ES Abanus, a simple hybrid with white grains, excellent vigor at the start of vegetation with a compact panicle and very good tolerance to drought and shaking.

It shows high tolerance to *Fusarium*, the plant size is small with very good resistance to falling. Tillage and fertilization were applied according to the graduations.

The predecessor plant was corn.

Chemical fertilizers were administered before sowing, and foliar fertilization was applied to the vegetation.

Sowing was carried out at a density of 230.000 grains/ha, and after sowing pre-emergent herbicide was used with the herbicide Dual Gold 960 EC in a dose of 1.2 l/ha.

RESULTS AND DISCUSSIONS

The influence of fertilization and tillage on the initial number of siblings

The ability to twin is a hereditary characteristic, but it varies a lot depending on the vegetation and climatic conditions, at the same time it is an important element of productivity. In the research carried out, the fertilizations applied in the sorghum culture stimulated twinning regardless of the method of tillage, with increases between 0.3 brothers (Foliar - Borocal 1.5 l/ha - Plow 25 cm) and 2.3 brothers (b₄ - N₁₀₀P₅₀ - a₂ - Scarified 35 cm) (Table 2). The most pronounced twinning was obtained by applying a fertilization based on N₁₀₀P₅₀ and loosening the soil at 35 cm. The nitrogen deficiency delays the growth of the plants, thus reducing the number of siblings. Foliar fertilizations resulted in reduced twinning, the minimum was 1.7 brothers per plant in the variant where the soil was tilled and 2.1 brothers per plant, where the soil benefited from a scarification at 45 cm superficial work with the disc, the twinning manifested itself in an excellent way with a number of 2.8 siblings per

plant in the variants fertilized with $N_{100}P_0$ and 3.4 siblings in the variants with $N_{100}P_{50}$. Tilling the soil scarification at 35 and 45 cm favored twinning in the sorghum culture, compared to the control plowed at 25 cm

compared to which there was a difference of 0.6 and 0.9 brothers per plant in the agrofund $N_{100}P_{50} + \text{Foliar}$, with an average of 3.8 and 3.5 brothers (Table 3).

Table 2. The influence of agrofund and tillage on the initial number of siblings (2021-2023 average)

Variant	$b_1 - N_0P_0$			$b_2 - N_{100}P_0$			$b_3 - N_{100}P_{50}$			$b_4 - N_{100}P_{50} + \text{Foliar}$			$b_5 - \text{Foliar (Borocal 1.5 l/ha)}$		
	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.
a_1 - Plow 25 cm	1.4	100	C	2.3	164.2	0.9	2.6	185.7	1.2	2.9	207.1	1.5	1.9	135.7	0.3
a_2 - Scarified 35 cm	1.4	100	C	3.	214.2	1.6	3.1	221.4	1.7	3.8	271.4	2.4	2.1	150	0.7
a_3 - Scarified 45 cm	1.5	100	C	2.7	180	1.3	2.9	193.3	1.4	3.5	233.3	2	2.1	140	0.6
a_4 - Disc 10 cm	1.1	100	C	2.8	254.5	1.7	2.8	254.5	1.7	3.4	309	2.3	1.7	154.5	0.6

Table 3. The influence of the basic soil work on the initial number of brothers by different types of fertilization (2021-2023)

Variant	$b_1 - N_0P_0$			$b_2 - N_{100}P_0$			$b_3 - N_{100}P_{50}$			$b_4 - N_{100}P_{50} + \text{Foliar}$			$b_5 - \text{Foliar (Borocal 1.5 l/ha)}$		
	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.
a_1 - Plow 25 cm	1.4	100	Ct	2.3	100	Ct	2.6	100	Ct	2.9	100	Ct	1.9	100	Ct
a_2 - Scarified 35 cm	1.4	100	0	3.	130.4	0.7	3.1	119.21	1.7	3.8	131	0.9	2.1	110.51	0.2
a_3 - Scarified 45 cm	1.5	107.1	0.1	2.7	117.3	0.4	2.9	111.5	0.3	3.5	120.6	0.6	2.1	10.5	0.2
a_4 - Disc 10 cm	1.1	78.5	-0.3	2.8	121.7	0.6	2.8	107.6	0.2	3.4	117.2	0.5	1.7	89.4	-0.2

The influence of fertilization and tillage on the number of productive brothers

Even if sorghum had a high capacity for twinning, not all the siblings that appeared in the first phases of vegetation reached maturity and were productive. The dynamic increase in the number of panicles was not as pronounced as that of the number of siblings per plant. In the case of the variants without fertilization, regardless of the method of tillage, the maximum number of siblings that reached maturity was 0.4 (Scarified 35 cm).

Fertilization based on $N_{100}P_{50}$ influenced the twinning productivity with a minimum of 1.1 panicles when the soil was worked superficially by discus and a maximum of 2 productive brothers by scarification at 45 cm of the land. Fertilizations based on foliar fertilizers were above the non-fertilized controls, but with the lowest values among all the fertilization options. The maximum number was recorded by tilling the soil at 35 cm: 0.6 productive brothers (Table.4).

Table 4. The influence of the agrofund and tillage on the number of productive brothers (2021-2023 average)

Variant	$b_1 - N_0P_0$			$b_2 - N_{100}P_0$			$b_3 - N_{100}P_{50}$			$b_4 - N_{100}P_{50} + \text{Foliar}$			$b_5 - \text{Foliar (Borocal 1.5 l/ha)}$		
	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.
a_1 - Plow 25 cm	0.3	100	C	1.1	366.6	0.8	1.4	466.6	1.1	1.6	533.3	1.3	0.5	166.6	0.2
a_2 - Scarified 35 cm	0.4	100	C	1.6	400	1.2	1.9	475	1.5	2.1	525	1.7	0.6	150	0.2
a_3 - Scarified 45 cm	0.3	100	C	1.6	533.3	1.3	2	666.6	1.7	2.1	700	1.8	0.4	133.3	0.1
a_4 - Disc 12 cm	0.2	100	C	0.9	450	1.2	1.1	550	0.9	1.2	600	1	0.3	150	0.1

Analyzing the soil tillage, with the deeper loosening, the number of productive panicles per plant was continuously increasing. Fertilization with nitrogen, phosphorus, foliar fertilizers, together with scarification at 45 cm of the land brought the highest increase of productive brothers - 0.6 brothers.

The variant with the best yield in terms of productive brothers reaching maturity was the scarification of the land at 45 cm along with a fertilization with $N_{100}P_{50} + \text{Foliar}$, thus obtaining 2.1 productive brothers on average per plant (Table 5).

Table 5. The influence of fertilization and tillage on the number of productive brothers (2021-2023 average)

Variant	b ₁ - N ₀ P ₀			b ₂ - N ₁₀₀ P ₀			b ₃ - N ₁₀₀ P ₅₀			b ₄ - N ₁₀₀ P ₅₀ + Foliar			b ₅ - Foliar (Borocal 1.5 l/ha)		
	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.	No.	%	Dif.
a ₁ - Plow 25 cm	0.3	100	Ct	1.1	100	Ct	1.4	100	Ct	1.6	100	Ct	0.5	100	Ct
a ₂ - Scarified 35 cm	0.4	133.31	0.1	1.6	145.4	0.5	1.9	135.7	0.5	2.1	131.2	0.5	0.6	120	0.1
a ₃ - Scarified 45 cm	0.3	100	0	1.6	145.4	0.5	2	142.8	0.6	2.1	131.2	0.5	0.4	80	-0.1
a ₄ - Disc 10 cm	0.2	66.6	-0.1	0.9	81.8	-0.2	1.1	78.5	-0.3	1.2	75	-0.4	0.3	60	-0.2

The influence of fertilization and tillage on the height of the productive brothers

At the time of the sorghum harvest, after the completion of the vegetative growth, depending on the agrofund applied, the height of the productive brothers from the sorghum culture was between 70.1 cm in the unfertilized version - discussed and 92.4 cm in the foliar fertilized version - scarified at 45 cm. The application of fertilizers determined the obtaining of more vigorous brothers, thus influencing their productivity (Table 6).

The biggest differences compared to the non-fertilized variants were brought by the application of nitrogen + phosphorus + foliar

fertilizations, the largest being 10.8 cm for the Disc 10 cm + N₁₀₀P₅₀ + Foliar variant. Through the application of phosphorus-based fertilizers, progressive values were recorded for all soil works, but they were best utilized in the case of deep works - scarified at 35 and 45 cm (81.1 cm and 84.7 cm).

Fertilization with N₁₀₀P₀ brought differences of up to 5.1 cm (Scarified 45 cm), but the superficial processing did not positively capitalize this agrofund compared to the plowed control. In the case of foliar fertilizers, the height of the brothers was not constant, values between 72.1 (a₄ - Disc 10 cm) and 82.4 cm (Scarified 45 cm) were recorded.

Table 6. The influence of fertilization on the height of the productive brothers in different tillage systems

Variant	b ₁ - N ₀ P ₀			b ₂ - N ₁₀₀ P ₀			b ₃ - N ₁₀₀ P ₅₀			b ₄ - N ₁₀₀ P ₅₀ +Foliar			b ₅ - Foliar (Borocal 1.5 l/ha)		
	cm	%	Dif.	cm	%	Dif.	cm	%	Dif.	cm	%	Dif.	cm	%	Dif.
a ₁ - Plow 25 cm	74.6	100	C	77.7	104.1	3.1	79.5	106.5	4.9	80.4	107.7	5.8	79.8	106.9	5.2
a ₂ - Scarified 35 cm	75.6	100	C	78.6	104.2	3	81.1	107.7	5.6	82.9	110	7.3	80.9	107	5.3
a ₃ -Scarified 45 cm	82.1	100	C	82.8	100.8	0.7	84.7	103	2.5	88.8	97	6.6	82.4	100.3	0.3
a ₄ - Disc 12	70.1	100	C	72.1	107.7	2	77.8	111	7.7	79.7	96.4	10.8	72.1	102.7	3.5

The deeper the tillage, the higher the height of the productive brothers, regardless of the agrofund applied. Scarification of the soil at 45 cm brought the biggest differences compared to the Plowed control at 25 cm: 8.4 cm (N₁₀₀P₅₀ + Foliar) (Table 7).

The superficial work of the soil brought negative differences compared to the work by ploughing, regardless of fertilization, with values between -1.7 cm (N₁₀₀P₅₀) and -7.7 cm (Foliar Borocal 1.5 l/ha).

Table 7. The influence of tillage on the height of the productive brothers by different types of fertilization (2021-2023)

Variant	b ₁ - N ₀ P ₀			b ₂ - N ₁₀₀ P ₀			b ₃ - N ₁₀₀ P ₅₀			b ₄ - N ₁₀₀ P ₅₀ + Foliar			b ₅ - Foliar (Borocal 1.5 l/ha)		
	cm	%	Dif.	cm	%	Dif.	cm	%	Dif.	cm	%	Dif.	cm	%	Dif.
a ₁ - Plow 25 cm	74.6	100	C	77.7	100	Ct	79.5	100	Ct	80.4	100	Ct	79.8	100	Ct
a ₂ - Scarified 35 cm	75.6	101.3	1	78.6	101.1	0.9	81.1	102	1.6	82.9	103	2.5	80.9	101.3	0.1
a ₃ - Scarified 45 cm	82.1	110	7.5	82.8	106.5	5.1	84.7	106.5	5.2	88.8	110.4	8.4	82.4	103.6	2.6
a ₄ - Disc 10 cm	70.1	93.9	-4.5	72.1	92.7	-5.6	77.8	97.8	-1.7	79.7	99.1	-0.7	72.1	90.3	-7.7

CONCLUSIONS

Following the research carried out, the following more important conclusions can be

synthesized regarding the influence of tillage systems and fertilization in grain sorghum culture regarding twinning:

Under the conditions of a cambic chernoziom from the Sărățeni-Ialomița area, the highest height of the productive brothers in a sorghum crop was obtained in the variants fertilized with foliar fertilizers 92.4 cm together with tillage by scarification at 45 cm.

The most pronounced twinning was obtained by applying a fertilization based on N₁₀₀P₅₀ + Foliar and loosening the soil at 35 cm: 3.8 siblings. The variant with the best yield in terms of productive brothers reaching maturity was the scarification of the land at 45 cm along with a fertilization with N₁₀₀P₅₀ + Foliar, thus obtaining 2.1 productive brothers on average per plant.

Even if the discussion of the land emphasized twinning in all the fertilization options, not all brothers reached maturity, productive.

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