

THE BEHAVIOR OF SOME COTTON (*GOSSYPIMUM HIRSUTUM*) GENOTYPES UNDER SANDY SOIL CONDITIONS IN SOUTHERN OLTENIA

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Abstract

This study follows the behaviour of seven genotypes of cotton (*Gossypium hirsutum*), cultivated on the sandy soils of Dăbuleni, with the aim of diversifying the range of plants tolerant to climatic factors in southern Oltenia. Observation of vegetative characteristics such as plant height, number of sympodia, number of flowers in the first decade of flowering and quantitative characteristics such as boll weight, fibre weight, seed weight and number of seeds / plant were the object of the study. Research on cotton plant development was correlated with climatic data recorded by the weather station of Dăbuleni RDSPCS, during the growing season from plant sowing in the field to boll formation. Following the study and showing positive results, The Beli-Lom genotype stood out in terms of flowering yield and fibre percentage, and the Cirpan-539 and Beli-Iskar genotypes had positive vegetative growth yield.

Key words: *Gossypium hirsutum*, cotton plants, genetic resources, sandy soils.

INTRODUCTION

Cotton is a melliferous species, being one of the most important textile plants, its fibre being used in the manufacture of fabrics, cotton wool, clothing and footwear. Cotton is an important industrial crop grown under various soil and climatic conditions (Snider, et al., 2015; Shao et al., 2016; Farooq et al., 2019). This species provides a major source on a global scale in terms of natural fibre production.

Cottonseed has about 20-27% low silica oil in its composition, with uses in industry, and is considered one of the best oils for table. The seed tegument can be used as fodder and the cotton stalks can be used in fuel production.

Systematically, cotton belongs to the genus *Gossypium* L. of the *Malvaceae*

family, and the genetic centres of origin of cotton are in the tropical and subtropical regions of Asia and America. Of the large number of species of the genus *Gossypium*, *Gossypium hirsutum* L., *Gossypium barbadense* L., *Gossypium arboreum* L. and *Gossypium herbaceum* L. are of particular importance for production (Mauer, 1954). Of the four cotton species, *Gossypium hirsutum* is the dominant species in cultivation, and provides 90% of the world's annual harvest (González, 2015). In temperate regions, varieties with a growing season of 140-148 days are recommended. It is a thermophilic species, having a requirement during the vegetation period of at least 1,500 hours of insolation (85

days of clear skies) to go through the phenophases of vegetation. The optimal development of cotton takes place in hot summers and autumns with dry intervals, because atmospheric humidity and rains would prevent the formation of capsules or their ripening, the plant succeeding well in a sandy, deep, alluvial soil (Carpinisan, T., 1983). Weather, soil, cultivars and cultural practices affect crop growth interactively, with plants sometimes reacting differently to deficient conditions (Reddy, K. R. et al., 1998). Research by Xiao, J. et al. (2000) demonstrated a close relationship between plant development and water.

The optimal development of this crop occurs during periods with hot summers and long, dry autumns, and the quality of the cotton plant is influenced by climatic factors, as this species has high temperature requirements. Unfavourable factors cause a significant number of buds and young bolls to fall (Jukovski, 1950). The highest demands on temperature are made during the budding and flowering period. Light is another important factor, as cloudy periods delay vegetation, therefore it is recommended to grow cotton in areas with low rainfall. Soil also plays an important role in terms of production, the best yield is obtained on light and medium soils, these conditions being suitable in the southern part of our country.

MATERIALS AND METHODS

The research was carried out at SCDCPN Dăbuleni and aimed at the behavior in 2022 of 7 cotton genotypes (*Cirpan-539*, *Beli-Lom*, *Beli-Iskar*, *Trakia*, *Helius*, *Boyana*, *Viki*), under the conditions of irrigated sandy soils in the south of Oltenia.

The experiment was located according to the method of randomized blocks in 3 repetitions, in the conditions of a sandy

soil with low natural fertility, given by the low content of nitrogen (0.05%-0.07%) and organic carbon (0.56% - 0.71%), having a good supply in extractable phosphorus (65.3-78.5 ppm), medium in exchangeable potassium (71-102 ppm), with a moderately acidic to neutral soil reaction ($pH_{H_2O} = 6.8-7.15$), according to the specialized literature (Davidescu, D. et al., 1981). It was sown on April 15, at a distance of 70 cm between rows and 10 cm between plants per row, ensuring 14 plants/m². Fertilization was carried out with N150P80K80, and weed prevention was achieved with the product *Dual Gold*, in a dose of 1.5 l/ha, applied pre-emergence. At the beginning of vegetation, to prevent and combat infection with pathogens and aphid infestation, a phytosanitary treatment was carried out with *Decis*, at a dose of 0.075 l/ha + *Cabrio Top*, at a dose of 1.5 kg/ha. At the appearance of the sympodia and during the growth period of the capsules, there was an attack of the red spider (*Tetranychus urticae*), which was fought with the product *Milbeknock*, applied in a dose of 0.075%, and also infections with bacterial spotting (*Xanthomonas campestris*), which was treated with the product *Cabrio Top*, in a dose of 2 kg/ha or *Melody Compact 49 WDG*, applied in a dose of 2 kg/ha. During the vegetation period, observations were made on the development of the vegetation phenophases, the daily growth rate in the first 5 weeks, the plant height and the leaf surface with the help of the AM 300 device. At harvest, the elements that make up cotton production were analyzed, respectively the number, diameter and weight of the capsules, and the percentage and length of the cotton fibre. The obtained results were processed by the analysis of variance (ANOVA) method.

RESULTS AND DISCUSSIONS

The analysis of the climatic conditions recorded during the cotton vegetation period (May-September) highlighted an average temperature of 21.88 °C, which was favorable for the development of the metabolism of the cotton plant, considering that the plant is a heat-loving species that germinates at 12-14 °C and vegetates/fruits at 20-28 °C, (Table 1). The recording of rather oscillating temperatures in April, with minimums between -3.1 °C, determined an uneven emergence of the plants, making it necessary to fill in gaps, for some varieties. For germination, the plant needs a temperature of 18-30 °C, with a minimum of 14 °C and a maximum of 40 °C. The optimum temperature for growth is 27-32 °C. Growth problems occur when the temperature drops below 12 °C at night. Also, high temperatures in the air can affect the biology of the plant, so that if the temperature registers a value higher

than 38 °C, for a long period of time, it can lead to the loss of flowers and capsules. Analyzing the rainfall regime, it was sufficient for the consumption of the plant, it being necessary to apply sunrise irrigation and then 5 waterings were applied to the vegetation with norms of 250-300 m³ water/ha, depending on the humidity in the soil. In July, the cotton crop was irrigated every 4-5 days. On the graph (Figure 1) it can be seen that most of the precipitation that fell was insignificant (below 5 mm). Compared to the multi-year average, we observe an accentuation of the drought phenomenon, when, during the cotton vegetation period, there was a plus of 1.09 °C and a minus of 61.3 mm. This reason forces us to find solutions to reduce the negative effect of drought, and the cultivation of some plant species adapted to the arid climate, including cotton, is one of the measures taken.

Table 1. Climatic conditions recorded at the weather station of SCDCPN Dăbuleni during the cotton vegetation period (2022)

Climatic elements	Calendar month						Average
	April	May	June	July	August	September	Mai-September 2022
Average temperature (°C)	11.7	18.3	22.9	25.2	25.1	17.9	21.88
Minimum temperature (°C)	-3.1	3.5	11.8	12.5	14.1	3.9	3.5
Maximum temperature (°C)	26.3	31.8	35.7	41.6	40.8	34.1	41.6
Rainfall (mm)	73.6	38.4	48.6	15	49.4	56.4	207.8
Relative air humidity (%)	62.6	56.8	61.6	50.7	57.3	68	58.88
Multiannual average temperature (1956-2021)	12.42	17.65	21.73	23.61	22.99	17.99	20.79
Multiannual precipitation (mm)	46.33	63.26	70.47	55.06	38.62	41.69	269.1
Deviation of average temperature from the multiannual average	-0.72	0.65	1.17	1.59	2.11	-0.09	1.09
Precipitation deviation from the multi-year average	27.27	-24.86	-21.87	-40.06	10.78	14.71	-61.3

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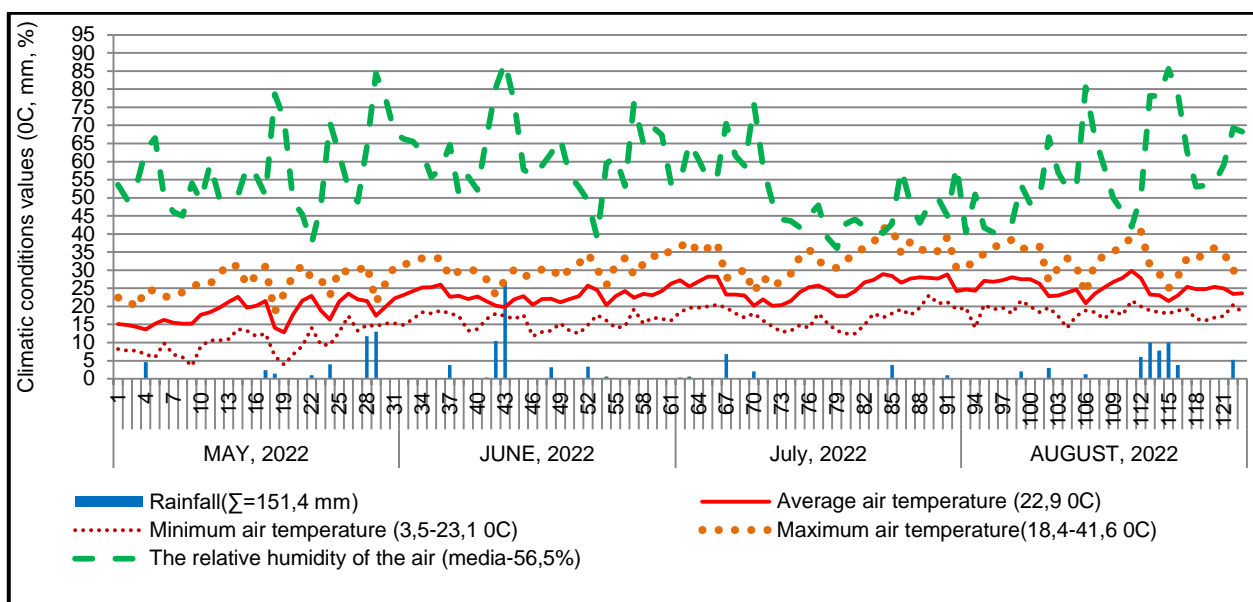


Figure 1. Evolution of the climatic conditions recorded at the weather station of SCDCPN Dăbuleni during the period of growth and development of cotton plants

The results obtained under the conditions of the present study showed that in the temperature conditions recorded immediately after sowing on April 15, with oscillating temperatures (-3 ... 18.2 °C), the initiation of the emergence process was recorded after 17-19 days after sowing, when they accumulated in the air of approx. 233.3-261.2 °C, (Table 2). Also, the amount of rainfall recorded during April 15-30, of 33 mm, was insufficient for the germination of the cotton seed, necessitating the irrigation work for emergence. Under these conditions, plant emergence was uneven in some

genotypes (Notes 1-3, 67). Analyzing the need for thermal resources for the development of the metabolism of the cotton plant, in the conditions of sandy soils (Table 2), it can be observed that, from emergence to the appearance of the first true leaf, the cotton genotypes needed approx. 141.4-197.1 °C, until flowering, of approx. 1370.6-1485.2 °C, and the phenophase of capsule formation on the plant was triggered when approx. 1848.8-2018.2 °C accumulated in the air since the plant emerged.

Table 2. The thermal requirement for the development of the phenophases of vegetation in some cotton genotypes studied in the conditions of the sandy soils of southern Oltenia

variety	Uniformity of plant emergence (grades 1-9)	Thermal resources (°C) Sown - emergence	Thermal resources (0C) from plant emergence to:		
			The first true leaf	The flowering of the plant (75% from plants)	Capsule formation/plant (75% from plants)
<i>Cirpan 539</i>	1.00	233.3	197.1	1423.1	1878
<i>Beli-Iskór</i>	1.33	233.3	141.4	1485.2	2018.2
<i>Beli-Lom</i>	2.00	247.6	161	1431.2	1936.9
<i>Trakia</i>	2.00	261.2	167.9	1370.6	1903.6
<i>Helius</i>	2.67	261.2	167.9	1393.9	1848.8
<i>Boyana</i>	2.33	247.3	182.2	1408.2	1863.1
<i>Viki</i>	2.00	233.3	141.4	1485.2	2018.2

Regarding the duration in days for the initiation of the vegetation phenophases (Figure 2), the observations highlighted the fact that in the conditions of sandy soils, the emergence of plants occurred after 17-19 days, from sowing, the first true leaf appeared at an interval of 25- 29 days after sowing, flowering started after 82-87 days after sowing, and capsule formation after 95-98 days. The development of the vegetation phenophases was differentiated according to the genotype. From this point of view, the genotypes *Cirpan 539*, *Trakia*, *Helius* and *Boyana* (82-83 days) had the best early flowering, while *Beli-Iskór* and *Viki* (87 days) were the latest.

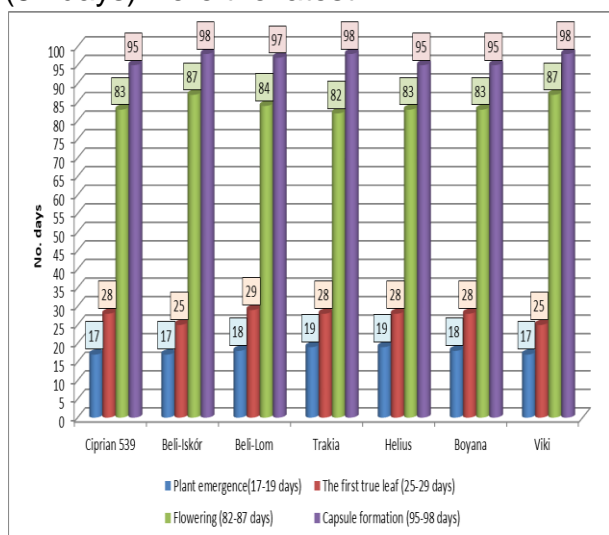


Figure 2. Duration (days) of the initiation of vegetation phenophases in some cotton genotypes tested on sandy soils

Determinations regarding plant biometry in the cotton genotypes studied revealed a plant height in the range of 88-99 cm, with maximum values in the *Cirpan 539* and *Beli-Lom* genotypes and a minimum in the *Trakia* genotype, the average of the varieties was 94 cm (Figure 3). Similar results were obtained by Fowler J. in 1966, where the height values of the cotton plants studied varied between the values of 81.43-58.55 cm. Shao D. (2016)

mentions an average height of 100.80 cm for cotton plants. The leaf surface index determined in the flowering phase (end of July) was differentiated according to the genotype, with the highest values of 3.42-3.52 for the genotypes *Beli-Lom*, *Boyana* and *Cirpan 539*, which exceeded the average by 7.5-10.7%.

At harvest, the elements that make up the production of cotton were analyzed (Table 3), respectively, the number, diameter and weight of the capsules, as well as the percentage and size of the cotton fiber, and the results obtained revealed the following:

- the average number of capsules, determined on September 30, was 10.7-13, with an average of 12.21 capsules/plant. The *Viki* variety was highlighted with the maximum value. Good results, with more than 12 capsules per plant, were also obtained with the genotypes *Cirpan 539*, *Beli Lom* and *Trakia*;
- the diameter of the capsules fluctuated between 4.51-5.46 cm, the *Cirpan 539* variety registering the maximum value.
- the number of seeds formed in a capsule is quite large and difficult to separate from the fiber manually. This averaged 32.75 seeds, with ranges between 30.53-37.13 seeds/capsule.
- the total weight of the capsule (fiber + seeds) was 4.4-6.09 g, of which the weight of the fiber recorded values of 1.83-2.56 g, representing a percentage between 39.88-45.53%.
- the length of the fiber, determined by the "butterfly" method, showed values between 2.2-2.53 cm, with an average of 2.38 cm. Values greater than 2.5 cm of cotton fiber length were recorded in *Beli Iskor* and *Cirpan 539* genotypes. Similar results were obtained by Jarwar A. et al

(2018), who highlighted the average weight of cotton capsules of 4.5 g with the minimum and maximum value between 5.4-11.4 g, and the number of seeds per the cotton capsule varied between 21.0 and 32.5 with an average of 30.3. Likewise, the research carried out by Dhivya, et al 2014 revealed an average weight of cotton capsules of 4.3 g, with the minimum and maximum value between 5.5-12.4, with an average number of seeds per capsule of 27.4 with a minimum limit of 23.0 and a maximum of 35.5. Fowler J. (1966), specifies the average number of seeds per capsule between 22.4 and 30.2.

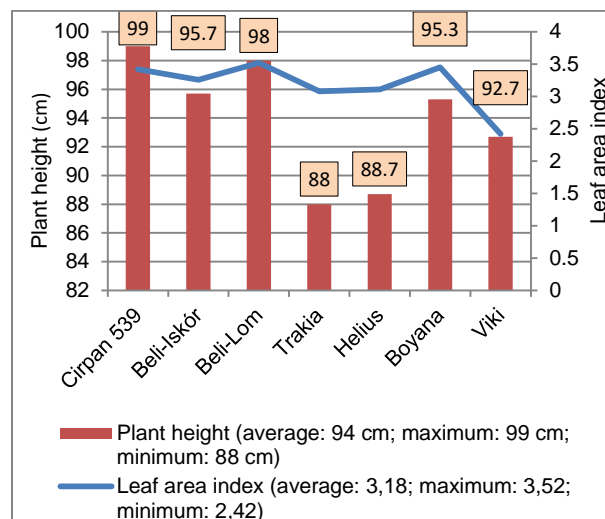


Figure 3. Variability of plant height and leaf area index in the assortment of cotton genotypes grown under sandy soil conditions

Table 3. Plant productivity determinations for some genotypes of cotton grown on sandy soils

Variety	No. capsules/plant	Capsule diameter	No. of seeds/capsule	Capsule weight (g)			% fiber	Fiber length (cm)
				Total	Fiber	Seeds		
<i>Cirpan 539</i>	12.90	5.46	37.13	6.09	2.56	3.53	42.02	2.52
<i>Beli Iskor</i>	11.90	4.60	30.67	5.54	2.52	3.02	45.53	2.53
<i>Beli Lom</i>	12.80	4.51	33.13	5.50	2.45	3.05	44.54	2.25
<i>Trakia</i>	12.40	5.04	32.80	5.84	2.33	3.51	39.88	2.48
<i>Helius</i>	10.70	4.86	30.53	4.40	1.83	2.57	41.52	2.20
<i>Boyana</i>	11.80	4.96	34.33	5.48	2.32	3.16	42.39	2.37
<i>Viki</i>	13.00	4.89	30.67	5.78	2.43	3.35	42.11	2.29
Average	12.21	4.90	32.75	5.52	2.35	3.17	42.57	2.38
Minimum	10.70	4.51	30.53	4.40	1.83	2.57	39.88	2.20
Maximum	13.00	5.46	37.13	6.09	2.56	3.53	45.53	2.53

In the conditions of sandy soils, the opening of capsules in cotton varieties was staggered, starting from the 3rd decade of August. In order to prevent the depreciation of the cotton fiber from the open capsules, in the event of unfavorable conditions (precipitation, wind), the cotton harvest was carried out in 5 stages, starting on August 29, depending on the existence of a significant number of open capsules in the experimental version (Figure 4). The average production per variety, at each harvest, was between 260.4-566.5 kg/ha of raw cotton (fiber+seeds), with the maximum

production at the first harvest on August 29. Among the 7 cotton varieties, *Beli Iskor*, *Trakia*, *Cirpn 539* and *Hellius* stood out early, which recorded the highest percentage of the total production (more than 27%) at the first harvest. The statistical calculation of the total production results (the sum of the harvests) revealed raw cotton productions between 1719-2525.4 kg/ha, the varieties not differing significantly from the experience average (Table 4). The most productive genotypes were *Viki*, *Cirpan 539*, *Trakia* and *Beli Iskor* with productions of over 2200 kg/ha raw cotton, which

exceeded the experience average by 95.4-352.5 kg/ha. The calculation of fiber production, according to the percentage of fiber contained in each genotype, highlighted the genotypes: *Beli Iskor*, *Viki*

and *Cirpan 539*, with productions of 997.6-1063.4 kg/ha fiber, which exceeded the control by 7, 9-15%.

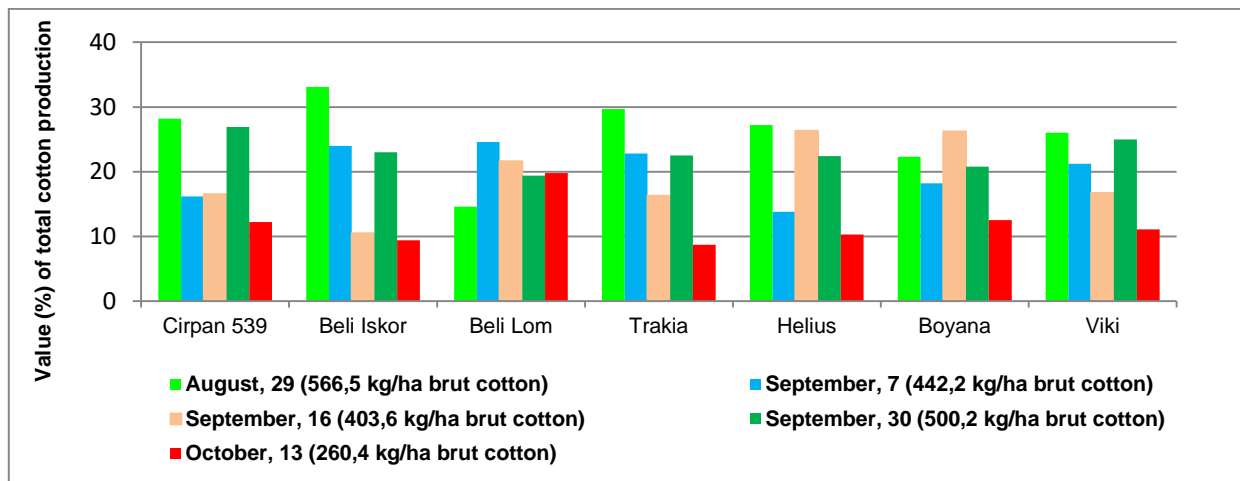


Figure 4. Percentage values of the total raw cotton production recorded by cotton harvesting according to the opening of the capsules

Table 4. Statistical analysis of raw cotton and fiber cotton productions, recorded for cotton genotypes in the conditions of sandy soils in the south of Oltenia, 2022

Genotipul	Raw cotton production				Fiber production			
	Kg/ha	%	Difference from control (kg/ha)	Significanc e	Kg/ha	%	Difference from control (kg/ha)	Significanc e
Cirpan 539	2373.8	109.2	200.9	-	997.6	107.9	72.7	-
Beli Iskor	2268.3	104.4	95.4	-	1032.8	111.7	107.9	-
Beli Lom	2160.3	99.4	-12.6	-	962.1	104.0	37.2	-
Trakia	2354	108.3	181.1	-	938.7	101.5	13.8	-
Helius	1809.5	83.3	-363.4	-	751.2	81.2	-173.7	-
Boyana	1719	79.1	-453.9	-	728.6	78.8	-196.3	-
Viki	2525.4	116.2	352.5	-	1063.4	115.0	138.5	-
Average	2172.9	100.0	0	Control	924.9	100.0	0	Control
LSD 5%			663.0				280.4	
LSD1%			979.1				414.1	
LSD 0.1%			1513.5				640.1	

CONCLUSIONS

The climatic conditions recorded in 2022 were favorable for the growth and development of cotton plants, whose average values were: height of 94 cm, a foliard index of 3.18; 12.21 capsules/plant with a diameter of 4.9 cm and a total weight of 5.52 g.

In the conditions of sandy soils, the opening of the capsules in the cotton

varieties was staggered, starting from the 3rd decade of August until October 13, generating a harvest in 5 stages.

Among the 7 cotton varieties, the genotypes *Beli Iskor*, *Trakia*, *Cirpn 539* and *Hellius* stood out early, which recorded the highest percentage of the total production (more than 27%) at the first harvest.

The results obtained at the harvest showed

a gross production level (fiber+seeds) of 1719-2525.4 kg/ha, depending on the genotype.

The length of the fiber, determined by the "butterfly" method, showed values between 2.2-2.53 cm, with an average of 2.38 cm. Values greater than 2.5 cm of cotton fiber length were recorded in *Beli Iskor* and *Cirpan 539* genotypes.

The calculation of fiber production, according to the percentage of fiber contained in each genotype (39.88-45.53%), highlighted the genotypes: *Beli Iskor*, *Viki* and *Cirpan 539*, with the highest productions of 997.6-1063, 4 kg/ha fiber, which exceeded the experience average by 7.9-15%.

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