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Agrobiological parameters of various cultivars and hybrids of sweet sorghum

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Purpose. To reveal the features of agrobiological parameters formation of sweet sorghum various varieties and hybrids in the conditions of the Right-Bank Forest-Steppe of Ukraine. **Methods.** During 2018–2020 twenty-one varieties and hybrids of sweet sorghum of various ecological and geographical origins (Ukraine, Russia, USA, France, Germany, Hungary, Brazil) were studied in the field. Parameters like plant height and indices of their individual productivity (grain weight per panicle, 1000 grain weight, etc.), yield of dry biomass and grain, content of sugar in juice and protein in grain, as well as estimated sugar and protein yield in a crop. The counts were carried out in the phase of physiological ripeness of the culture. **Results.** In the group of Ukrainian varieties and hybrids, the plants were from 272 to 306 cm high, in the foreign group – from 274 to 412 cm. Varieties 'Red Amber', 'Sioux', 'Affas CJ 899', 'Freed' and 'Early Orange' are of high value for breeding practice, their plants were the tallest – from 388 to 412 cm. The panicle length of sweet sorghum cultivars of Ukrainian breeding ranged from 16.0 to 17.3 cm, foreign – from 11.0 to 19.4 cm. Grain weight from one panicle varied from 32.8 to 41.6 g and from 29.2 to 43.5 g, respectively. In a wide range, depending on the varietal characteristics, the indicator of the number of grains per panicle also varied from 1338 to 1708 pcs. The mass of 1000 grains of sweet sorghum ranged from 28.0 to 31.0 g in varieties and hybrids of Ukrainian breeding, in foreign ones – from 19.3 to 31.0 g. The yield of dry vegetative mass of cultivars of Ukrainian breeding was at the level of 8.24–9.11 t/ha. The highest rates were shown in hybrid 'Mamont' and 'Huliver' variety – 9.05 and 9.11 t/ha, respectively. For cultivars and hybrids of foreign breeding, this indicator varied from 7.00 to 12.17 t/ha. Significantly higher biomass in comparison with the standard variety ('Sylosne 42') was produced by 'Vorai Sumac', 'Sorgo Cucre', 'Sioux', 'Freed', 'Red Amber', 'Mohavk', 'Affas CJ 899', 'Early Orange' – 9.03–12.17 t/ha. The sugar content in sweet sorghum juice varied from 15.2 to 17.2%. The estimated sugar yield in Ukrainian cultivars was at the level of 0.82–0.89 t/ha, in foreign ones – from 0.72 to 1.18 t/ha. In all studied varieties it was the highest in 'Sorgo Cucre', 'Sioux', 'Freed', 'Red Amber', 'Mohavk', 'Affas CJ 899', 'Early Orange' – 0.94–1.18 t/ha. **Conclusions.** The productivity of sweet sorghum varies greatly depending on the origin of the variety and hybrid. In the conditions of the Right-Bank Forest-Steppe, in order to obtain a high sugar yield, it is advisable to grow 'Sylosne 42', 'Favoryt', 'Troistyi', 'Dovista', 'Huliver' varieties and 'Ananas', 'Medovyi', 'Mamont' hybrids. Varieties 'Vaconia Orange', 'Vorai Sumac', 'Sorgo Cucre' and hybrids 'Ald Sorghum', 'Sioux', 'Freed', 'Red Amber', 'Mohavk', 'Affas CJ 899', 'Early Orange' provide high yields of vegetative masses. Hybrids 'Freed', 'Affas CJ 899' and 'Early Orange' produce a large vegetative mass (11.08–12.17 t/ha), grain yield (8.00–8.15 t/ha) and a high protein content (9.8–11.3%).

Keywords: *sweet sorghum; variety, hybrid; corn; yield; sugar content; protein content.*

Introduction

Sweet sorghum [*Sorghum bicolor* (L.) Moench] is the fifth most widespread cereal in the world. It is suitable for growing in various agro-climatic conditions, including those with resource-saving technologies, and is resistant to adverse environmental conditions. Sweet sorghum is capable of producing significant volumes of biomass with a high sugar content in stems, and is a valuable raw material for biofuel production [1]. In addition, it provides grain production, which compares favorably with sugar cane, sugar beet, corn and wheat. The culture has a good aftermath, which additionally increases its productivity and agronomic stability [2, 3]. Grains remain viable for up to 10 years [4].

Sweet sorghum is genetically very diverse and has significant differences in agrotechnical parameters in comparison with other crops [5]. To ensure its maximum productivity, appropriate management of agro-technological components is necessary, for example, fertilization and soil processing systems, timing and methods of sowing, etc. [6]; its effectiveness largely depends on the characteristics of cultivated varieties or hybrids [7, 8].

One of the decisive stages in the cultivation of sweet sorghum for commercial purposes, in

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particular to maintain the uninterrupted production of bioethanol, is the establishment of the timing of the harvest [9]. Therefore, the dynamics of sugar accumulation in stems of the crop and production of biomass in general, which also depend on the characteristics of the grown cultivars, should be considered.

Biomass production of sweet sorghum may vary depending on the variety, harvest time, plant height, soil moisture, soil cultivation method and types of fertilizers [10–12]. In particular, the yield of vegetative mass of sweet sorghum, depending on the variety and harvesting period, can vary from 14.8 to 35.2 t/ha [13]. It should be noted that in the structure of vegetative mass, the proportion of stems is approximately 60.0% (according to other data, from 63.4 to 76.7% [14]), and the rest is leaves.

Plant biomass and sugar content in it gradually increase during the maturation of sweet sorghum. According to O. Olugbemi et al. [12], high levels of total soluble dry matter (14.9%), sugar content in juice (22.9%), sugar concentration in juice (527.5 mg/g^{-1}), the content of dry biomass (60.0%) and its total output (19.0 t/ha) were noted in the phase of physiological ripeness of the culture [12].

Reliable influence of varietal characteristics on the formation of sweet sorghum biomass is also confirmed by the studies by E. Daniel et al. [15]. In particular, the weight of one stem in the variety 'Theis' was 1096 g, while in the variety 'Dale' it was 896 g. In particular, the weight of one stem in 'Theis' variety was 1096 g, while in 'Dale' variety it was 896 g. The calculated bioethanol yield when growing 'Theis' was at the level of 7619 l/ha^{-1}, and significantly less in 'Dale' – 5077 l/ha^{-1}. Based on the obtained data, the researchers emphasize the importance of choosing the right variety to ensure high productivity of this crop.

An accompanying part of the sweet sorghum crop – grain is a valuable source of carbohydrates, protein and bioactive compounds [16]. Its biochemical composition also largely depends on the characteristics of cultivated varieties [17]. In particular, according to Y. M. Kardeş et al. [13], sorghum grain contained more than 9.7% protein (according to the results of assessment of 80 breeding samples), digestible protein (94 samples) – more than 56.3%, oil (75 samples) – more than 3.9%, starch (two samples) – more than 77.1%, amylose (10 samples) – 25.3%; the coefficient of starch stability (32 samples) was more than 3.9%. The content of phytic acid, depending on the breeding sample of sorghum, was at the level of 0.02–0.09%, and condensed tannins – 5.4–6.5%.

So today, sweet sorghum is a valuable grain crop and a promising alternative raw material for biofuel production, since it can be grown using resource-saving technologies; it responds to stress more efficiently than traditional crops, and has a great potential for biomass production. But the productivity of this culture reliably and significantly changes depending on the varietal characteristics of the selected cultivars.

Obviously, different varieties and hybrids have unequal resistance to bio- and abiotic factors, and therefore realize their productive potential in different ways under specific growing conditions. Taking this into account, today it is relevant to study the characteristics of growth, development and formation of sweet sorghum productivity of cultivars of various ecological and geographical origin when grown in different soil and climatic conditions of Ukraine.

The purpose of the research is to reveal the peculiarities of the formation of agrobiological parameters of various sweet sorghum cultivars and hybrids in the conditions of the Right-Bank Forest-Steppe of Ukraine.

Materials and methods

The studies were carried out during 2018–2020 in the conditions of the educational, scientific and industrial complex of Uman National University of Horticulture and Experimental field of the Institute of Bioenergy Crops and Sugar Beet of the National Academy of Agrarian Sciences of Ukraine (IBCSB) (Ksaverivka 2, Bila Tserkva district, Kyiv region).

The soil of the experimental field is podzolized heavy loam chernozem on loess. The humus content in the arable layer is 3.8%, the nitrogen content of easily hydrolyzed compounds is low, mobile phosphorus and potassium compounds are high, pH_{KCl} is 5.7. The soils of the experimental field of the IBCSB are coarse-dusty-medium loamy in texture. The content of the organic part of the soil varies from 2.1 to 4.0%, the depth of humus horizons is 100–120 cm.

Twenty one cultivars of sweet sorghum of various ecological and geographical origin were investigated: Ukrainian varieties 'Sylosne 42', 'Favoryt', 'Troistyi', 'Dovista', 'Huliver' and hybrids 'Ananas', 'Medovyi', 'Mamont'; foreign varieties 'Chayka', 'Debyut', 'Haliya' (Russia), 'Vorai Sumac' (Hungary), 'Vaconia Orange' (Brazil), 'Sorgo Cucre' (France) and hybrids 'Ald Sorghum' (Germany), 'Mohavk', 'Red Amber', 'Sioux', 'Affas CJ 899', 'Freed and 'Early Orange' (USA).

The total area of the experimental site was 210 m², and the accounting area was 172 m². The experiment was conducted three times. The harvest was collected by hand. The protein content in the grain was determined by infrared spectroscopy according to GOST 4117:2007, the weight of 1000 grains was determined by weighing 500 seeds in accordance with GOST 520:2015, juice sugar content was studied with the use of a sugar polarimeter SU-4.

The package of standard programs (SIC "Agrostat", MS Office Excel) was used for statistical processing of research results and determination of the reliability of the obtained experimental data. The tightness of the relationship between the studied indicators was assessed using the correlation coefficient: 1 – full connection, 0.9–0.99 – very high, 0.7–0.9 – high, 0.5–0.7 – significant, 0.3–0.5 – moderate, 0.1–0.3 – weak connection [18].

Research results

Agrobiological parameters of plants of sweet sorghum studied varieties and hybrids differed significantly (Table 1). In particular, in the group of domestic cultivars, the plant height indicator varied from 272 to 306 cm, in the group of foreign cultivars – from 274 to 412 cm. Hybrids of foreign origin 'Red Amber', 'Sioux', 'Affas CJ 899', 'Freed' and 'Early Orange' can be noted as the most valuable for breeding practice, their plants were the highest – from 388 to 412 cm. None of the domestic varieties and hybrids reached these values.

The panicle length of sweet sorghum cultivars of Ukrainian breeding ranged from 16.0 to 17.3 cm, foreign – from 11.0 to 19.4 cm. The grain weight per panicle varied from 32.8 to 41.6 g and from 29.2 up to 43.5 g, respectively. In a wide range, depending on the varietal characteristics, the indicator of the number of grains per panicle varied – 1338–1708 pcs. The mass of 1000 grains of sweet sorghum ranged from 28.0 to 31.0 g in domestic varieties and hybrids, in foreign ones – from 19.3 to 31.0 g.

The productivity of sweet sorghum also varied significantly depending on the variety and hybrid (Table 2). In particular, the yield of dry matter (stems + leaves) of Ukrainian cultivars was at the level of 8.24–9.11 t/ha. The highest one was observed in hybrid 'Mamont' and 'Huliver' variety – 9.05 and 9.11 t/ha, respectively.

For cultivars of foreign breeding, this indicator varied from 7.00 to 12.17 t/ha. A significantly higher biomass yield compared to the standard cultivar ('Sylosne 42') was produced by the cultivars 'Vorai Sumac' and 'Sorgo Cucre', as well as hybrids 'Sioux', 'Freed', 'Red Amber', 'Mohavk', 'Affas CJ 899', 'Early Orange' – 9.03–12.17 t/ha.

Sugar content in sweet sorghum juice varied from 15.2 to 17.2%. The conditional sugar yield in varieties and hybrids of Ukrainian breeding was at the level of 0.82–0.89 t/ha. This indica-

Table 1

Agrobiological parameters of different varieties and hybrids of sweet sorghum (average for 2018–2020)

Variety, hybrid	Plant height, cm	Panicle length, cm	Grain weight per panicle, g	Number of grains per panicle, pcs.	Weight of 1000 grains, g
'Sylosne 42' (St)	272	16.0	34.3	1437	30.6
'Dovista'	189	17.3	32.8	1464	30.0
'Favoryt'	232	17.0	37.4	1414	29.0
'Ananas' F_1	268	16.8	39.8	1412	26.3
'Medovyi' F_1	273	16.2	37.6	1481	31.0
'Huliver'	274	16.5	41.8	1424	28.4
'Troistyi'	306	16.8	40.0	1489	29.4
'Mamont' F_1	306	17.0	41.6	1482	28.0
'Chayka'	274	11.3	29.2	1185	26.3
'Debyut'	288	11.8	30.4	1264	19.3
'Haliya'	308	11.0	30.2	1108	24.3
'Vorai Sumac'	313	12.6	34.6	1440	24.8
'Ald Sorghum' F_1	325	17.5	32.0	1338	21.0
'Vaconia Orange'	355	17.3	33.0	1492	26.5
'Mohavk' F_1	368	18.3	39.4	1604	30.0
'Sorgo Cucre'	368	18.1	39.2	1521	27.1
'Red Amber' F_1	388	19.4	36.8	1708	30.9
'Sioux' F_1	394	17.8	38.2	1502	29.8
'Affas CJ 899' F_1	398	18.0	43.5	1612	31.0
'Freed' F_1	406	18.5	39.6	1445	29.6
'Early Orange' F_1	412	18.7	42.4	1603	29.4
$LSD_{0.05}$	14–16	0.7–0.8	1.9–2.1	72–75	1.5–1.6

Table 2

Productivity of different varieties and hybrids of sweet sorghum (average for 2018–2020)

Variety, hybrid	Vegetative mass			Grain		
	Yield, t/ha	Juice sugar content, %	Sugar yield, t/ha	Yield, t/ha	Protein content, %	Protein yield, t/ha
'Sylosne 42' (St)	8.66	16.7	0.87	3.79	8.7	0.33
'Favoryt'	8.24	16.6	0.82	4.87	10.0	0.49
'Troistyi'	8.27	16.5	0.82	5.80	7.3	0.42
'Dovista'	8.64	16.8	0.87	4.91	10.0	0.49
'Ananas' F_1	8.73	16.5	0.86	5.00	10.2	0.51
'Medovyi' F_1	8.78	16.9	0.89	5.16	9.7	0.50
'Mamont' F_1	9.05	16.4	0.89	5.12	9.5	0.49
'Huliver'	9.11	16.2	0.89	5.06	8.8	0.45
'Haliya'	7.00	17.1	0.72	3.12	6.3	0.20
'Chayka'	7.00	17.2	0.72	3.00	5.5	0.17
'Debyut'	7.06	17.1	0.72	3.12	6.0	0.19
'Vaconia Orange'	8.50	16.8	0.86	4.88	9.4	0.46
'Ald Sorghum' F_1	8.57	16.4	0.84	7.17	8.4	0.60
'Vorai Sumac'	9.03	16.1	0.87	4.26	6.8	0.29
'Sorgo Cucre'	9.61	16.3	0.94	5.93	10.0	0.59
'Sioux' F_1	10.04	15.8	0.95	7.00	7.3	0.51
'Freed' F_1	10.30	15.7	0.97	8.12	11.3	0.92
'Red Amber' F_1	11.08	15.6	1.04	8.10	8.6	0.70
'Mohavk' F_1	11.78	15.4	1.09	6.08	9.6	0.58
'Affas CJ 899' F_1	12.15	15.2	1.11	8.00	10.4	0.83
'Early Orange' F_1	12.17	16.1	1.18	8.15	9.8	0.80
$LSD_{0.05}$	0.40–0.52	0.8–0.9	0.04–0.05	0.21–0.26	0.3–0.4	0.02–0.03

tor varied significantly among cultivars of foreign origin – from 0.72 to 1.18 t/ha. It was the highest in the variety 'Sorgo Cucre' and hybrids 'Sioux', 'Freed', 'Red Amber', 'Mohavk', 'Affas CJ 899', 'Early Orange' – 0.94–1.18 t/ha.

The grain yield of sweet sorghum in varieties and hybrids of Ukrainian breeding varied from 3.79 to 5.80 t/ha. The highest grain yield was obtained when growing the 'Troistyi' variety. For cultivars of foreign breeding, this indicator was from 3.00 to 8.15 t/ha. The highest grain yield was obtained when growing hybrids 'Freed', 'Red Amber', 'Affas CJ 899' and 'Early Orange' – 8.00–8.15 t/ha.

Grain protein content in varieties and hybrids of Ukrainian breeding was 7.3–10.2%, the conditional yield of protein with a crop was 0.33–0.51 t/ha, and in hybrids of foreign breeding – 5.5–11.3% and 0.17–0.92 t/ha, respectively.

In general, high productivity indicators among all studied cultivars – grain yield at the level of 8.00–8.15 t/ha with a protein content of 9.8–11.3% and its conditional yield of 0.80–0.92 t/ha were determined in hybrids 'Freed', 'Affas CJ 899' and 'Early Orange'. These indicators were also high for 'Ananas', 'Medovyi' and 'Mamont' hybrids.

A very high negative correlation was established between the yield of dry matter and sugar content (–0.91), it was high (0.80) with grain yield, moderate – with protein content in grain (0.49), and high with plant height (0.72). The correlation between grain yield and protein content was significant – 0.55. It is obvious that plant height can be used to predict the amount of vegetative mass production and grain yield at different stages of the breeding process.

Conclusions

The productivity of sweet sorghum varies significantly depending on the origin of the variety and hybrid. In the conditions of the Right-Bank Forest-Steppe, in order to obtain a high yield of sugar, it is advisable to grow varieties 'Sylosne 42', 'Favoryt', 'Troistyi', 'Dovista', 'Huliver' and hybrids 'Ananas', 'Medovyi', 'Mamont'.

Varieties 'Vaconia Orange', 'Vorai Sumac', 'Sorgo Cucre' and hybrids 'Ald Sorghum', 'Sioux', 'Freed', 'Red Amber', 'Mohavk', 'Affas CJ 899', 'Early Orange' provide high yield of vegetative mass.

Hybrids 'Freed', 'Affas CJ 899', 'Early Orange' produce large biomass volume (11.08–12.17 t/ha), high grain yield (8.00–8.15 t/ha) and high content of protein in it (9.8–11.3%).

References

1. Shukla, S., Felderhoff, T. J., Saballos, A., & Vermerris, W. (2017). The relationship between plant height and sugar accumulation in the stems of sweet sorghum (*Sorghum bicolor* (L.) Moench). *Field Crops Res*., *203*, 181–191. doi: 10.1016/j.fcr.2016.12.004
2. Rolz, C., de León, R., Mendizábal de Montenegro, A. L., Porras V., & Cifuentes, R. (2017). A multiple harvest cultivation strategy

for ethanol production from sweet sorghum throughout the year in tropical ecosystems. *Renew. Energy*, *106*, 103–110. doi: 10.1016/j.renene.2016.12.036
3. Liubych, V. V., Voitovska, V. I., Klymovych, N. M., & Tretiakova, S. O. (2020). Sowing properties of sugar sorghum grain depending on variety, storage duration and treatment by growth regulators. *Visnik Umans'kogo NUS* [Bulletin of Uman NUH], *1*, 30–37. doi: 10.31395/2310-0478-2020-1-30-35 [in Ukrainian]
4. Storozhyk, L. I., Voitovska, V. I., Liubych, V. V., & Rohalskyi, S. V. (2020). Sowing characteristics of sugar sorghum grain depending on storage duration and treatment with preparations. *Nauk. pracì Ìnst. bioenerg. kul't. cukrov. burâkiv* [Scientific Papers of the Institute of Bioenergy Crops and Sugar Beet], *28*, 129–139. doi: 10.47414/np.28.2020.211064 [in Ukrainian]
5. Pannacci, E., & Bartolini, S. (2016). Evaluation of sorghum hybrids for biomass production in central Italy. *Biomass Bioenergy*, *88*, 135–141. doi: 10.1016/j.biombioe.2016.03.024
6. Adimassu, Z., Alemu, G., & Tamene, L. (2019). Effects of tillage and crop residue management on runoff, soil loss and crop yield in the humid highlands of Ethiopia. *Agric. Syst.*, *168*, 11–18. doi: 10.1016/j.agsy.2018.10.007
7. Bunphan, D., Jaisil, P., Sanitchon, J., Knoll, J. E., & Anderson, W. F. (2015). Estimation methods and parameter assessment for ethanol yields from total soluble solids of sweet sorghum. *Ind. Crops Prod.*, *63*, 349–356. doi: 10.1016/j.indcrop.2014.10.007
8. Liu, Q., Ma, H., Lin, X., Zhou, X., & Zhao, Q. (2019). Effects of different types of fertilizers application on rice grain quality. *Chil. J. Agric. Res.*, *79*(2), 202–209. doi: 10.4067/S0718-58392019000200202
9. Biberdzic, M., Barac, S., Lalevic, D., Djikic, A., Prodanovic, D., & Rajicic, V. (2020). Influence of soil tillage system on soil compaction and winter wheat yield. *Chil. J. Agric. Res.*, *80*(1), 80–89. doi: 10.4067/S0718-58392020000100080
10. Tovignan, T. K., Fonceka, D., Ndoye, I., Cisse, N., & Luquet, D. (2016). The sowing date and post-flowering water status affect the sugar and grain production of photoperiodic, sweet sorghum through the regulation of sink size and leaf area dynamics. *Field Crops Res.*, *192*, 67–77. doi: 10.1016/j.fcr.2016.04.015
11. Pittelkow, C. M., Linquist, B. A., Lundy, M. E., Liang, X., van Groenigen, K. J., Lee, J., … van Kessel, C. (2015). When does no-till yield more? A global meta-analysis. *Field Crops Res.*, *183*, 156–168. doi: 10.1016/j.fcr.2015.07.020
12. Olugbemi, O., Aboyeji, C. M., Olofintoye, J. A. T., & Eifediyi, E. K. (2018). Growth and ethanol yield responses of sweet sorghum [*Sorghum bicolor* (L.) Moench] varieties to nitrogen fertilizer rates. *J. Agric. Sci. – Sri Lanka*, *13*(1), 1–14. doi: 10.4038/jas.v13i1.8296
13. Kardeş, Y. M., Kaplan, M., Kale, H., Yılmaz, M. F., Karaman, K., Temizgül, R., & Akar, T. (2021). Biochemical composition of selected lines from sorghum (*Sorghum bicolor* L.) landraces. *Planta*, *254*(2), 26. doi: 10.1007/s00425-021-03670-9
14. Zhang, F., Wang, Y., Yu, H., Zhu, K., Zhang, Z., & Zou, F. L. J. (2016). Effect of excessive soil moisture stress on sweet sorghum: physiological changes and productivity. *Pak. J. Bot.*, *48*(1), 1–9.
15. Ekefre, D. E., Mahapatra, A. K., Latimore Jr., M., Bellmer, D. D., Jena, U., Whitehead, G. J., & Williams, A. L. (2017). Evaluation of three cultivars of sweet sorghum as feedstocks for ethanol production in the Southeast United States. *Heliyon*, *3*(12), e00490. doi: 10.1016/j.heliyon.2017.e00490
16. Perrin, R., Fulginiti, L., Bairagi, S., & Dweikat, I. (2018). Sweet sorghum as feedstock in great plains. Corn ethanol plants: the role of biofuel policy. *J. Agric. Resour. Econ.*, *43*(1), 34–45.
17. Ganesh Kumar, C., Fatima, A., Srinivasa Rao, P., Reddy, B. V. S., Rathore, A., Nageswar Rao, R., … Kamal, A. (2011). Characterization of improved sweet sorghum genotypes for biochemical parameters, sugar yield and its attributes at different phenological stage. *Sugar Tech.*, *12*(3–4), 322–328. doi: 10.1007/s12355-010-0045-1
18. Hospodarenko, H. M., Martyniuk, A. T., Liubych, V. V., & Polianetska, I. O. (2017). Cereal properties of different variety and strain of spelt wheat. *Visnik Dnipropetrovs'kogo deržavnogo agrarno-ekonomičnogo universitetu* [News of Dnipropetrovsk State Agrarian and Economic University], *1*, 12–16. [in Ukrainian]

Використана література

1. Shukla S., Felderhoff T. J., Saballos A., Vermerris W. The relationship between plant height and sugar accumulation in the stems of sweet sorghum (*Sorghum bicolor* (L.) Moench). *Field Crops Res*. 2017. Vol. 203. P. 181–191. doi: 10.1016/j.fcr.2016.12.004
2. Rolz C., de León R., Mendizábal de Montenegro A. L. et al. A multiple harvest cultivation strategy for ethanol production from sweet sorghum throughout the year in tropical ecosystems. *Renew. Energy*. 2017. Vol. 106. P. 103–110. doi: 10.1016/j.renene.2016.12.036
3. Любич В. В., Войтовська В. І., Климович Н. М., Третьякова С. О. Формування посівних властивостей зерна сорго цукрового залежно від сорту, тривалості зберігання та оброблення регуляторами росту. *Вісник Уманського НУС*. 2020. № 1. С. 30–37. doi: 10.31395/2310-0478-2020-1-30-35
4. Сторожик Л. І., Войтовська В. І., Любич В. В., Рогальский С. В. Посівні властивості зерна сорго цукрового залежно від тривалості його зберігання та оброблення препаратами. *Наукові праці ІБКіЦБ*. 2020. Вип. 28. С. 129–139. doi: 10.47414/np.28.2020.211064
5. Pannacci E., Bartolini S. Evaluation of sorghum hybrids for biomass production in central Italy. *Biomass Bioenergy*. 2016. Vol. 88. P. 135–141.
6. Adimassu Z., Alemu G., Tamene L. Effects of tillage and crop residue management on runoff, soil loss and crop yield in the humid highlands of Ethiopia. *Agric. Syst*. 2019. Vol. 168. P. 11–18. doi: 10.1016/j.agsy.2018.10.007
7. Bunphan D., Jaisil P., Sanitchon J. et al. Estimation methods and parameter assessment for ethanol yields from total soluble solids of sweet sorghum. *Ind. Crops Prod*. 2015. Vol. 63. P. 349–356. doi: 10.1016/j.indcrop.2014.10.007
8. Liu Q., Ma H., Lin X. et al. Effects of different types of fertilizers application on rice grain quality. *Chil. J. Agric. Res*. 2019. Vol. 79, Iss. 2. P. 202–209. doi: 10.4067/S0718-58392019000200202
9. Biberdzic M., Barac S., Lalevic D. et al. Influence of soil tillage system on soil compaction and winter wheat yield. *Chil. J. Agric. Res*. 2020. Vol. 80, Iss. 1. P. 80–89. doi: 10.4067/S0718-58392020000100080
10. Tovignan T. K., Fonceka D., Ndoye I. et al. The sowing date and post-flowering water status affect the sugar and grain production of photoperiodic, sweet sorghum through the regulation of sink size and leaf area dynamics. *Field Crops Res*. 2016. Vol. 192. P. 67–77. doi: 10.1016/j.fcr.2016.04.015
11. Pittelkow C. M., Linquist B. A., Lundy M. E. et al. When does no-till yield more? A global meta-analysis. *Field Crops Res*. 2015. Vol. 183. P. 156–168. doi: 10.1016/j.fcr.2015.07.020
12. Olugbemi O., Aboyeji C. M., Olofintoye J. A. T., Eifediyi E. K. Growth and ethanol yield responses of sweet sorghum [*Sorghum bicolor* (L.) Moench] varieties to nitrogen fertilizer rates. *J. Agric. Sci. – Sri Lanka*. 2018. Vol. 13, Iss. 1. P. 1–14. doi: 10.4038/jas.v13i1.8296
13. Kardeş Y. M., Kaplan M., Kale H. et al. Biochemical composition of selected lines from sorghum (*Sorghum bicolor* L.) landraces. *Planta*. 2021. Vol. 254, Iss. 2. 26. doi: 10.1007/s00425-021-03670-9
14. Zhang F., Wang Y., Yu H. et al. Effect of excessive soil moisture stress on sweet sorghum: physiological changes and productivity. *Pak. J. Bot*. 2016. Vol. 48, Iss. 1. P. 1–9.
15. Ekefre D. E., Mahapatra A. K., Latimore M. Jr. et al. Evaluation of three cultivars of sweet sorghum as feedstocks for ethanol production in the Southeast United States. *Heliyon*. 2017. Vol. 3, Iss. 12. e00490. doi: 10.1016/j.heliyon.2017.e00490
16. Perrin R., Fulginiti L., Bairagi S., Dweikat I. Sweet sorghum as feedstock in great plains. Corn ethanol plants: the role of biofuel policy. *J. Agric. Resour. Econ*. 2018. Vol. 43, No 1. P. 34–45.

17. Ganesh Kumar C., Fatima A., Srinivasa Rao P. et al. Characterization of improved sweet sorghum genotypes for biochemical parameters, sugar yield and its attributes at different phenological stage. *Sugar Tech*. 2011. Vol. 12, Iss. 3–4. P. 322–328. doi: 10.1007/s12355-010-0045-1

18. Господаренко Г. М., Мартинюк А. Т., Любич В. В., Полянецька І. О. Круп'яні властивості зерна різних сортів і ліній пшениці спельти. *Вісник Дніпропетр. ДАЕУ*. 2017. Вип. 1. С. 12–16.

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Любич В. В.[1], Сторожик Л. І.[2], Войтовська В. І.[2*], Терещенко І. С.[2], Лосєва А. І.[2] Агробіологічні параметри різних сортів і гібридів сорго цукрового. *Plant Varieties Studying and Protection*. 2021. Т. 17, № 3. С. 193–198. https://doi.org/10.21498/2518-1017.17.3.2021.242966

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Мета. Установити особливості формування агробіологічних параметрів різних сортів і гібридів сорго цукрового в умовах Правобережного Лісостепу України. **Методи.** Упродовж 2018–2020 рр. у польових умовах досліджували 21 сорт і гібрид сорго цукрового різного еколого-географічного походження (Україна, Росія, США, Франція, Німеччина, Угорщина, Бразилія). Оцінювали такі параметри, як висота рослин і показники їх індивідуальної продуктивності (маса зерна з однієї волоті, маса 1000 зерен тощо), урожайність сухої біомаси й зерна, уміст цукрів у соку та білка в зерні, а також умовний вихід цукру й білка з урожаєм. Обліки проводили у фазі фізіологічної стиглості культури. **Результати.** У групі українських сортів і гібридів рослини були заввишки від 272 до 306 см, у групі закордонних – від 274 до 412 см. Високу цінність для селекційної практики мають сорти 'Red Amber', 'Sioux', 'Affas CJ 899', 'Freed' та 'Early Orange', рослини яких були найвищими – від 388 до 412 см. Довжина волоті сорго цукрового культиварів української селекції становила від 16,0 до 17,3 см, закордонної – від 11,0 до 19,4 см. Маса зерна з однієї волоті змінювалась від 32,8 до 41,6 г і від 29,2 до 43,5 г відповідно. У великому діапазоні залежно від сортових особливостей варіював і показник кількості зерен з однієї волоті – 1338–1708 шт. Маса 1000 зерен сорго цукрового становила від 28,0 до 31,0 г у сортів і гібридів української селекції, у закордонних – від 19,3 до 31,0 г. Урожайність сухої вегетативної маси культиварів української селекції була на рівні 8,24–9,11 т/га. Найвищі показники формували гібрид 'Мамонт' і сорт 'Гулівер' – 9,05 і 9,11 т/га відповідно. У сортів і гібридів закордонної селекції цей показник змінювався від 7,00 до 12,17 т/га. Істотно вищу біомасу порівняно із сортом-стандартом ('Силосне 42') формували 'Vorai Sumac', 'Sorgo cucre', 'Sioux', 'Freed', 'Red Amber', 'Mohavk', 'Affas CJ 899', 'Early Orange' – 9,03–12,17 т/га. Уміст цукрів у соку сорго цукрового змінювався від 15,2 до 17,2%. Умовний вихід цукру в культиварів української селекції був на рівні 0,82–0,89 т/га, у закордонних – від 0,72 до 1,18 т/га. Найвищим серед усіх досліджуваних сортів і гібридів культури він був у 'Sorgo Cucre', 'Sioux', 'Freed', 'Red Amber', 'Mohavk', 'Affas CJ 899', 'Early Orange' – 0,94–1,18 т/га. **Висновки.** Продуктивність сорго цукрового значною мірою змінюється залежно від походження сорту та гібрида. В умовах Правобережного Лісостепу з метою отримання високого виходу цукру доцільно вирощувати сорти 'Силосне 42', 'Фаворит', 'Троїстий', 'Довіста', 'Гулівер' і гібриди 'Ананас', 'Медовий', 'Мамонт'. Сорти 'Vaconia Orange', 'Vorai Sumac', 'Sorgo Cucre' і гібриди 'Ald Sorghum', 'Sioux', 'Freed', 'Red Amber', 'Mohavk', 'Affas CJ 899', 'Early Orange' забезпечують високу врожайність вегетативної маси. Гібриди 'Freed', 'Affas CJ 899' і 'Early Orange' формують велику вегетативну масу (11,08–12,17 т/га), урожайність зерна (8,00–8,15 т/га) та високий уміст білка (9,8–11,3%).

Ключові слова: *сорго цукрове; сорт; гібрид; зерно; урожайність; уміст цукрів; уміст білка.*

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