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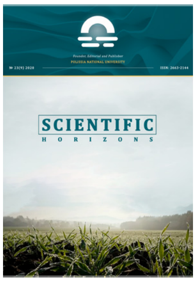

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Study of the efficiency of growing maize for silage for processing into biogas and digestate

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Abstract. Given the growing area of maize cultivation in Ukraine and globally, research into the possibilities of using silage as a component of biogas plants to produce biogas as an alternative fuel and digestate as a bio-organic fertiliser is of high relevance and production necessity. The purpose of this study was to investigate the chemical composition of green mass of maize and its changes depending on the growing season for its use in biogas production. Field, laboratory, laboratory-field, and statistical research methods were used in the study. The findings of this study showed that the quality of maize silage depends on soil and climatic conditions, elements of growing technology, genetic characteristics of a particular hybrid, its maturity group, harvesting time, etc. The genetic characteristics of the hybrid had the greatest influence on the dry matter content, specifically, the mid-early hybrid Amaros stood out in terms of dry matter content on 10-14 August 2020 (26.61%). The highest crude fibre content was observed in the hybrid P9170 – 6.32% and 26.86%, respectively, in natural and absolutely dry matter. This hybrid belongs to the mid-season ripeness group. The shift in the harvesting time of the green mass of the maize hybrids under study also affected the characteristics of the chemical composition and the carbohydrate-lignin complex of the green mass of the maize hybrids under study. The yield of green mass of maize

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hybrids substantially depended on the maturity group of maize hybrids and was highest in the mid-season maize hybrids Burito – 78.1 t/ha and P9170 – 73.1 t/ha, while in the group of mid-early hybrids it was 55.3 t/ha and 68.9 t/ha in Amaros and P9071. Hybrids with a long growing season have higher green mass yields and dry matter yields per unit area. The findings can be used by farms that grow silage maize and have the opportunity to use the vegetative mass as a component of biogas plants for biogas production and digestate production

Keywords: bioorganic fertilisers; silage maize; dry matter; starch; lignin; structural carbohydrates; crude protein

INTRODUCTION

Maize is one of the most productive cereals and uses many resources, including soil, moisture, light, nutrients, etc., to generate its productivity. In the context of energy shortages, global warming and military aggression, the issue of using biomass from crops, including maize, to produce alternative fuels (biogas and bioethanol) has become quite acute. Research on the cultivation and use of silage maize as a substrate for a biogas plant is very effective, as silage maize can increase the efficiency of biogas production, and the crop itself forms a powerful vegetative mass, which is quite favourable for anaerobic digestion in biogas plants by its chemical composition.

Maize cultivation has two main focuses: grain and silage. The area under grain maize cultivation has been steadily increasing, reaching 5.5 million hectares in 2021, and in 2022 it decreased by 17% to 4.267 million hectares, due to a range of factors, including Russia's military aggression against Ukraine, problems with fuel and lubricants (especially for drying grain), logistics, etc. In 2021, silage maize occupied only 214 thousand hectares, although it is effectively used as a substrate for a biogas plant (Statistical Yearbook, 2021). M. Doyeni *et al.* (2021) point out that in European countries, growing silage maize for biogas plants is a widespread practice and has proven to be effective. Ukraine, which has significant agricultural resources, also has the potential to successfully develop a biogas sector. The cultivation of silage maize for biogas production has been supported in developed European countries (Germany, the UK, Poland, Switzerland, Denmark, the Netherlands, France, etc.) due to favourable legislative policies (IEA, 2019).

V. Smutný *et al.* (2018), S. Theuerl *et al.* (2019) note that the use of green mass of maize for biogas fermentation in biogas production is based on an anaerobic fermentation process under the influence of microorganisms. The use of green mass of maize has the following advantages over other crops: high yields, high organic matter content, high starch content, and the well-established technology of growing silage maize. N. Boltianska and O. Boltianskyi (2019) point out that as a result of green mass fermentation, apart from biogas, digestate is obtained, which is a very valuable bioorganic fertiliser for increasing soil fertility, replenishing macro- and microelements and carbon accumulation in the soil (carbonisation), increasing crop yields and quality. According to S. Corden *et al.* (2019), up to 180 million tonnes of digestate are produced annually in the EU countries, a considerable share of which is digestate from maize silage. J. Urra *et al.* (2019) and B. Karimi *et al.* (2022) note that loading 100 thousand tonnes of silage into a biogas plant produces the same amount of bio-organic fertiliser (digestate), which contains calcium, phosphorus, and nitrogen in liquid and solid fractions.

V. Popović *et al.* (2020) note that the use of digestate will reduce the need for mineral fertilisers, which are industrially produced with significant use of fossil fuels and increased CO_2 emissions. S. Kudria *et al.* (2022) note that for Ukraine, as an agricultural country in the world, the prospects for using green mass of maize for biogas production and digestate production are determined by the availability of substantial acreage of this crop, a large assortment of hybrid composition of various maturity groups, favourable soil and climatic conditions and chemical composition of the green mass. V. Palamarchuk *et al.* (2023) notes that the efficiency of the biological process of anaerobic digestion and the yield of biogas and digestate from maize silage depends on the chemical composition of green mass and the amount of organic matter. Furthermore, the chemical composition of organic matter is influenced by climatic conditions, growing area, hybrid composition, growing and silage technology, and the duration of the growing season.

A review of the literature showed that the chosen subject is understudied. That is why the purpose of this study was to investigate the efficiency of using green mass of maize as a substrate for biogas plants, depending on the dynamics of changes in the chemical composition during certain periods of vegetation of hybrids of various maturity groups.

MATERIALS AND METHODS

Research on the quality of silage maize and elements of its cultivation technology has been conducted since 2020 (as of 18.10.2023, research is ongoing) at "Organic-D" LLC in Sutysky village, Vinnytsia region, Ukraine. The findings presented in this paper were collected in 2020. The researchers used maize hybrids of two maturity groups: mid-early Amaros (FAO 230) and P9071 (FAO 280) and mid-season P9170 (FAO 320) and Burito (FAO 390).

The soil of the experimental plot is grey forest medium loamy by mechanical composition, with a humus content determined according to the Tyurin method (DSTU 7828:2015, 2016) of 1.5%; hydrolytic acidity – 1.3 mg/eq. per 100 g of soil; the amount of absorbed bases – 28 mg/eq. per 100 g of soil; nitrogen content was determined according to the Cornfield method (DSTU 7863:2015, 2016) – 9.6 mg per 100 g of soil, mobile phosphorus – 8.5 mg and exchangeable potassium – 11.4 mg per 100 g of soil determined according to the Chirikov method (DSTU 4115:2002, 2003). The technology is generally accepted for this soil and climate zone. The predecessor was winter wheat, sown in the third decade of April using a wide-row method with a John Deere precision seeder (United States of America), with a row spacing of 70 cm and a plant density of 75 thous. pcs./ha. The maize hybrids were sown in the third decade of April at a soil temperature of 10-12°C at the depth of seed placement. The main tillage system included discing and ploughing at a depth of 22-25 cm. The fertilisation system involved the application of 60 t/ha of Effluent bio-organic fertiliser, produced through anaerobic digestion of pig manure in a biogas plant.

Replication of the experiment was fourfold; variants were placed in the experiment in randomised blocks. The size of the variant plot is 25 m^2, and the accounting plot is 10.5 m^2, i.e., four adjacent rows of 5 m in length. Harvesting and accounting of maize silage yield was carried out in the phase of milky wax and wax ripeness of grain manually from each experimental plot by cutting 10 typical plants from two adjacent rows of each variant (Ushkarenko *et al.*, 2014). The quality and chemical composition of the green (silage) mass of maize hybrids was determined in the laboratory of the Institute of Feed and Agriculture of Podillia, National Academy of Agrarian Sciences of Ukraine, accredited to perform measurements in the field of quality control and safety of feed, raw materials, and food products in the "UkrAgroStandart" system.

Experimental studies of plants (both cultivated and wild), including the collection of plant material, were following the institutional, national, or international guidelines. The authors adhered to the standards of the Convention on Biological Diversity (1992) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1979).

RESULTS AND DISCUSSION

The study found a link between the quality of maize silage and soil and climatic conditions, elements of cultivation technology, genetic characteristics of a particular hybrid, its maturity group, harvesting time, etc. Thus, for the harvesting of green mass on 10-14 August 2020 in the phase of milky wax ripeness, the chemical composition, carbohydrate-lignin complex in natural and absolutely dry matter are presented in Tables 1-3.

Table 1. *Chemical composition of green mass of maize hybrids, %*

Sample name (green mass of maize)	Dry matter	Crude protein		Crude fibre	
		in a natural substance	in an absolutely dry substance	in a natural substance	in an absolutely dry substance
Amaros (FAO 230)	26.61	1.75	6.58	6.52	24.51
P9071 (FAO 280)	22.21	1.65	7.43	5.50	24.77
P9170 (FAO 320)	23.52	2.01	8.55	6.32	26.86
Burrito (FAO 390)	22.87	1.88	8.22	6.56	28.68

Source*: compiled by the authors*

Table 1 shows that the dry matter content in the green mass of maize as of 10–14 August was as follows in the group of medium early hybrids: Amaros (FAO 230) – 26.61%, P9071 (FAO 280) – 22.21%, and in the group of mid-season hybrids: P9170 (FAO 320) – 23.52% and Burito (FAO 390) – 22.87%. Proceeding from the data on dry matter content (Table 1), the genetic characteristics of the hybrid had the greatest influence on this indicator, specifically, the mid-early hybrid Amaros (26.61%) stood out in terms of dry matter content on 10-14 August 2020 compared to other hybrids under study.

The content of crude protein in natural and absolutely dry matter was the highest in the hybrids of the mid-season group P9170 – 2.01% and 8.55% and Burito – 1.88% and 8.22%, respectively, while in the group of mid-early hybrids it was for Amaros – 1.75% and 6.58%, and for the P9071 hybrid – 1.65% and 7.43%, respectively. The biogas yield and the quality of the silage feed value are substantially influenced by the crude fibre content, which was also found in natural and dry matter. The highest crude fibre content was observed in the hybrid P9170 – 6.32% and 26.86%, respectively, in natural and absolutely dry matter. This hybrid belongs to the mid-season ripeness group. The crude fibre content of other hybrids was as follows: Amaros (FAO 230) – 6.52% and 24.51%, P9071 (FAO 280) – 5.50% and 24.77%, and Burito (FAO 390) – 6.56% and 28.68%, respectively. Therewith, the findings of the study revealed a difference in the carbohydrate-lignin complex of the green mass of the studied maize hybrids of different maturity groups depending on the genetic characteristics of the hybrid itself (Table 2).

Table 2. *Carbohydrate-lignin complex of green mass of maize hybrids, % in natural matter*

Sample name (green mass of maize)	Starch	Sugar	Sum of easily soluble carbohydrates	Hemicellulose	Cellulose	Lignin	Sum of structural carbohydrates
Amaros (FAO 230)	0.63	5.04	12.69	6.66	6.33	1.35	14.34
P9071 (FAO 280)	0.44	3.39	9.40	5.29	4.47	1.09	10.85
P9170 (FAO 320)	0.37	2.15	9.71	6.83	6.61	1.25	14.69
Burrito (FAO 390)	0.18	6.91	13.44	6.03	5.31	1.60	12.94

***Source**: compiled by the authors*

The content of readily soluble carbohydrates and sugars ensures high quality silage. Table 2 shows that the highest starch content as of 10-14 August 2020 was observed in the Amaros hybrid – 0.63%, while in other hybrids under study it was: for P9071 – 0.44%, for P9170 – 0.37%, and for Burito – 0.18%; sugar content was as follows: Burito – 6.91%, Amaros – 5.04%, P9071 – 3.39% and P9170 – 2.15%. The amount of easily soluble carbohydrates was the highest in the mid-season hybrid Burito – 13.44% and the mid-early hybrid Amaros – 12.69%, while in other hybrids it was 9.40% and 9.71% in P9071 and P9170, respectively.

Hemicellulose, cellulose, and lignin have rather poor solubility, and their high content in plant biomass can reduce biogas yields. The content of these substances in the hybrids under study ranged within 5.29-6.83% for hemicellulose, 4.47-6.61% for cellulose, and 1.09-1.60% for lignin. The highest content of hemicellulose and cellulose was found in hybrids P9170 (FAO 320) – 6.83% and 6.61% and Amaros (FAO 230) – 6.66% and 6.33%, respectively. The lignin content was highest in the mid-season maize hybrid Burrito at 1.60% and the mid-early hybrid Amaros at 1.35%. The amount of structural carbohydrates was the highest in hybrids P9170 (FAO 320) – 14.69% and Amaros (FAO 230) – 14.34%, while in the Burito hybrid (FAO 390) it was 12.94%, and in the P9071 hybrid (FAO 280) it was the lowest and amounted to 10.85%. An analogous analysis can be carried out for the carbohydrate-lignin complex of the green mass of maize hybrids in terms of absolutely dry matter (Table 3).

Table 3. *Carbohydrate-lignin complex of green mass of maize hybrids, % in absolutely dry matter*

Sample name (green mass of maize)	Starch	Sugar	Sum of easily soluble carbohydrates	Hemicellulose	Cellulose	Lignin	Sum of structural carbohydrates
Amaros (FAO 230)	2.38	18.95	47.68	25.04	23.78	5.08	53.90
P9071 (FAO 280)	1.98	15.26	42.31	23.81	20.12	4.89	48.82
P9170 (FAO 320)	1.58	9.16	41.31	29.04	28.09	5.32	62.45
Burrito (FAO 390)	0.79	30.21	58.77	26.38	23.22	7.00	56.60

***Source**: compiled by the authors*

Table 3 shows that the patterns of accumulation of chemicals in terms of absolutely dry matter are analogous to those in natural matter. Thus, the highest starch content was in Amaros (FAO 230) – 2.38% and P9071 (FAO 280) – 1.98%, while in other hybrids it was P9170 (FAO 320) – 1.58% and Burito (FAO 390) – 0.79%. The highest sugar content was found in the Burito hybrid (FAO 390) – 30.21%, while in other hybrids it was Amaros (FAO 230) – 18.95%, P9071 (FAO 280) – 15.26% and P9170 (FAO 320) – 9.16%. The amount of easily soluble carbohydrates in the hybrids under study ranged within 41.31-58.77%, with the highest value in the mid-season maize hybrid Burito – 58.77% and the lowest value in the mid-season hybrid P9170 – 41.31%, while among the mid-early hybrids this indicator in Amaros was 47.68% and in P9071 – 42.31%. The amount of structural carbohydrates (hemicellulose, cellulose, and lignin) was the highest in mid-season maize hybrids P9170 – 62.45% and Burito – 56.60%. In the group of mid-early hybrids, this figure was 53.90% for Amaros and 48.82% for P9071.

The shift in the harvesting time of the green mass of the maize hybrids under study also affected the chemical composition and carbohydrate-lignin complex. Thus, when harvesting green mass on 20-24 September at the beginning of the waxy ripeness phase, the chemical composition of green mass and the carbohydrate-lignin complex in absolutely dry matter are presented in Tables 4-5.

Table 4. *Chemical composition of green mass of maize hybrids, % in absolutely dry matter*

Sample name (green mass of maize)	Crude protein	Crude fibre
Amaros (FAO 230)	6.45	19.63
P9071 (FAO 280)	7.22	14.72
P9170 (FAO 320)	7.19	15.67

Table 4. Continued

Sample name (green mass of maize)	Crude protein	Crude fibre
Burrito (FAO 390)	9.49	14.04

***Source**: compiled by the authors*

Table 4 shows that when harvesting green mass on 20-24 September 2020, the mid-season maize hybrid Burito had the highest crude protein content of 9.49%. Whereas in the other hybrids under study, it was 7.22% for P9071 (FAO 280), 7.19% for P9170 (FAO 320), and 6.45% for Amaros (FAO 230). The crude fibre content was highest in maize hybrids Amaros (FAO 230) – 19.63% and P9170 (FAO 320) – 15.67%. The characteristics of the carbohydrate-lignin complex of the green mass of maize hybrids harvested on 20-24 September in absolutely dry matter are presented in Table 5.

***Table 5.** Carbohydrate-lignin complex of green mass of maize hybrids, % in absolutely dry matter*

Sample name (green mass of maize)	Starch	Sugar	Sum of easily soluble carbohydrates	Hemicellulose	Cellulose	Lignin	Sum of structural carbohydrates
Amaros (FAO 230)	27.76	5.05	48.94	15.47	14.14	3.53	33.14
P9071 (FAO 280)	39.70	4.49	57.19	13.02	13.02	3.63	29.67
P9170 (FAO 320)	38.10	4.09	54.97	12.78	10.44	3.56	26.78
Burrito (FAO 390)	33.25	4.81	59.29	16.23	15.48	3.88	35.59

***Source**: compiled by the authors*

During this period, the starch content increased by 25.38-27.72% compared to the content on 10-14 August 2020, and amounted to 39.70% for P9071 hybrid (FAO 280), 38.10% for P9170 hybrid (FAO 320), 33.25% for Burito hybrid (FAO 390) and 27.76% for Amaros hybrid (FAO 230). The sugar content in the green mass decreased by 5.07-25.40% compared to the period of 10-14 August and amounted to Amaros (FAO 230) – 5.05%, Burito (FAO 390) – 4.81%, P9071 (FAO 280) – 4.49%, and P9170 (FAO 320) – 4.09%. Therewith, the amount of easily soluble carbohydrates was the highest in the mid-season maize hybrid Burito – 59.29% and the mid-early hybrid P9071 – 57.19%. The sum of structural carbohydrates (hemicellulose, cellulose, and lignin) was the highest in the mid-season maize hybrid Burito – 35.59% and the mid-early hybrid Amaros – 33.14%. To determine the biogas yield, it is essential not only to know the chemical composition of the green mass of maize hybrids and the dry matter content, but also the yield of the dry mass of maize per unit area. The characteristics of the green mass yield of the maize hybrids under study as of 14 August 2020 are presented in Table 6.

***Table 6.** Green mass yield of maize hybrids of different ripeness groups (for 2020)*

Sample name (green mass of maize)	Dry matter, %	Yield, t/ha	Dry matter yield per 1 ha, t
Amaros (FAO 230)	26.61	55.3	14.72
P9071 (FAO 280)	22.21	68.9	15.30
P9170 (FAO 320)	23.52	73.1	17.19
Burrito (FAO 390)	22.87	78.1	17.86
LSD_{05}, t/ha		4.82	1.30

***Source**: compiled by the authors*

Table 6 shows that the yield of green mass of the maize hybrids under study significantly depended on the maturity group of maize hybrids and was highest in the mid-season maize hybrids Burito – 78.1 t/ha and P9170 – 73.1 t/ha, while in the group of mid-early hybrids it was Amaros – 55.3 t/ha and P9071 – 68.9 t/ha. A comparable trend can be observed for the dry matter yield per unit area. The highest yields were recorded for mid-season maize hybrids Burito – 17.86 t/ha and P9170 – 17.19 t/ha. Thus, lengthening the growing season in the maize hybrids under study not only increases the yield of green mass but also increases the dry matter yield per unit area. The findings are confirmed by the studies of other scientists who have worked in this area and investigated the chemical composition of maize silage and the specifics of using silage and green mass for anaerobic digestion in biogas plants to increase the efficiency of biogas and digestate production.

R. Skliar (2020) notes that the addition of lignin-containing organic plant material to the biogas reactor helps to reduce nitrogen losses during the fermentation process. S. Shvorov and Ye. Antypov (2019) argue that silage as a technological operation improves biogas production and methane yield from maize plant material compared to the use of green mass without silage. O. Skliar and R. Skliar (2020) indicate that the high content of organic matter, cellulose, starch and lignin in maize silage allows for, after fermentation and obtaining digestate to be applied to the soil, the increase of the humus content and accumulate carbon in the soil and ensure the cultivation of environmentally friendly products. According to H. Heletukha *et al*. (2022), the use of special energy maize hybrids with a dry weight yield of 18-25 t/ha as a substrate for biogas production will yield 5,300-9,000 m^3/ha of methane, depending on the hybrid, growing conditions, and the harvesting phase of maize.

A. Ehmann *et al*. (2018) point out that the quality and structure of organic matter in biogas digestates depends on the feedstock, its chemical composition and the technology used. M. Grabovsky (2019) notes that due to the higher dry matter content, the specific biogas yield per unit of silage mass applied to maize was 33.7-50.6% higher than that of sugar sorghum and 9.2-13.0% higher than that of a mixture of these crops. With a dry matter content of 30-42%, the average methane yield was 0.40 m^3/kg of substrate. M. Szymanska *et al*. (2018) point out the difficulty of using plant biomass from crops other than maize as a substrate for biogas plants due to unfavourable physical and mechanical (dry matter content, moisture content, organic dry matter content) and chemical composition (protein, carbohydrate, and fat content). For instance, the use of plant biomass, which contains a branched capillary structure covered with hydrophobic components (waxes, lignin), contributes to the formation of dense floating layers in the bioreactor.

M. Grabovsky (2020) found that an increase in the maturity group of maize hybrids contributes to a decrease in the specific methane yield. The optimum specific methane yield was observed at a dry matter content of 30-35%. If the dry matter content is less than 20%, the silage properties deteriorate, a significant amount of filtrate is produced and the potential for biogas production and yield is substantially reduced. It was found that the highest yield of green mass (73.1 t/ha and 78.1 t/ha) was formed by hybrids of the mid-season ripeness group P9170 (FAO 320) and Burito (FAO 390) with a dry matter yield of 17.19 t/ha and 17.86 t/ha, which is characterised by a favourable carbohydrate-lignin complex, crude protein and fibre content, and therefore the use of green mass of these hybrids as a substrate for biogas plants to increase biogas yield will be most appropriate.

CONCLUSIONS

The chemical composition and carbohydrate-lignin complex of the green mass of the maize hybrids under study can vary depending on the phenological phase of plant growth and development. The highest content of dry matter was recorded in the mid-early Amaros hybrid – 26.61%, crude protein in natural and absolute dry matter – in the hybrids of the mid-season group P9170 – 2.01% and 8.55%, and Burito – 1.88% and 8.22%, respectively. The starch content in Amaros was 0.63%, in P9071 – 0.44%, P9170 – 0.37% and in Burrito – 0.18%, while the sugar content in Burrito was 6.91%, in Amaros – 5.04%, in P9071 – 3.39% and in P9170 – 2.15%. Hemicellulose, cellulose, and lignin have rather poor solubility, and their high content in plant biomass can reduce biogas yield, the highest content of hemicellulose and cellulose was found in hybrids P9170 (FAO 320) – 6.83% and 6.61% and Amaros (FAO 230) – 6.66% and 6.33%, respectively. The lignin content was highest in the mid-season maize hybrid Burrito at 1.60% and the mid-early hybrid Amaros at 1.35%.

Shifting the harvesting dates of the green mass of the maize hybrids under study to 20-24.09.2020 also affected the characteristics of the chemical composition and carbohydrate-lignin complex. Therewith, the starch content increased by 25.38-27.72% during this period, while the sugar content in the green mass decreased by 5.07-25.40% compared to the content on 10-14 August. The amount of structural carbohydrates (hemicellulose, cellulose, and lignin) in the period 20-24.09.2020 was the highest in the mid-season maize hybrid Burito – 35.59% and the mid-early hybrid Amaros – 33.14%.

The yield of green mass and dry matter yield of the maize hybrids under study significantly depended on the maturity group of maize hybrids and was the highest in the mid-season maize hybrids Burito – 78.1 t/ha and 17.86 t/ha and P9170 – 73.1 t/ha and 17.19 t/ha, while in the group of medium-early hybrids it was Amaros – 55.3 t/ha and 14.72 t/ha and P9071 – 68.9 t/ha and 15.30 t/ha, respectively. Therefore, the most suitable for biogas production as a substrate for biogas plants are silage maize hybrids of the medium-ripening maturity group P9170 (FAO 320) and Burito (FAO 390), which provide the highest yield and organic matter yield per unit area and have a favourable chemical composition and carbohydrate-lignin complex of green mass. In the future, it is planned to confirm the obtained patterns by long-term research and investigate the efficiency of using maize silage with different chemical composition in the biogas reactor of "Organic-D" LLC.

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None.

CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

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Дослідження ефективності вирощування кукурудзи на силос для переробки на біогаз та дигестат

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Анотація. Дослідження, в умовах зростання площ в ирощування кукурудзи в Україні та світі, можливості використання силосної маси як компонента біогазових станцій для отримання альтернативного виду палива – біогазу та біоорганічного добрива – дигестату мають високу актуальність та виробничу необхідність. Метою роботи було вивчення хімічного складу зеленої маси кукурудзи та зміни його залежно від періоду вегетації для використання її на біогаз. В роботі використовували польові, лабораторні, лабораторно-польові та статистичні методи досліджень. Результатами проведених досліджень встановлено, що якість силосної маси кукурудзи залежить від ґрунтово-кліматичних умов, елементів технології вирощування, генетичних особливостей конкретного гібриду, його групи стиглості, строків проведення збиральних робіт та ін. Найбільший вплив на вміст сухої речовини здійснювали генетичні особливості гібриду, зокрема за вмістом сухої речовини на 10-14 серпня 2020 року виділився середньоранній гібрид Амарос (26,61 %). Найвищий вміст сирої клітковини відмічений у гібриду П9170 – 6,32 та 26,86 %, відповідно у натуральній та абсолютно сухій речовині. Даний гібрид відноситься до середньостиглої групи стиглості. Зміщення строків збирання зеленої маси досліджуваних гібридів кукурудзи вплинуло і на характеристику хімічного складу та на вуглеводно-лігніновий комплекс зеленої маси досліджуваних гібридів кукурудзи. Урожайність зеленої маси гібридів кукурудзи істотно залежала від групи стиглості гібридів кукурудзи і найвищою вона була у середньостиглих гібридів кукурудзи Буріто – 78,1 т/га та П9170 – 73,1 т/га, тоді як у групі середньоранніх гібридів вона склала Амарос – 55,3 т/га та П9071 – 68,9 т/га. Гібриди із тривалим вегетаційним періодом мають вищу урожайність зеленої маси та вихід сухої речовини із одиниці площі. Отримані результати можуть використовуватись господарствами, які займаються вирощуванням силосної кукурудзи та мають можливість використовувати вегетативну масу в якості компоненту біогазових станцій для виробництва біогазу та отримання дигестату

Ключові слова: біоорганічні добрива; силосна кукурудза; суха речовина; крохмаль; лігнін; структурні вуглеводи; сирий протеїн