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CHANGES IN PRODUCTIVITY INDICATORS OF AGROCENOSIS IN MISCANTHUS GIANTUS WITH DIFFERENT METHODS OF WEEDS CONTROL

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Abstract

Deforestation without their subsequent restoration leads to the disruption of natural ecosystems. This led to the need to create fast-growing artificial plantations. From this point of view, heightened interest is shown in the plant of the bluegrass family - the giant miscanthus. As a renewable source of raw materials, it can become an alternative to forest crops. Differing in slow growth in the initial period, miscanthus weakly competes with weeds. Therefore, the purpose of the research was to determine the optimal way to combat weeds, ensuring the creation of a highly productive agrocenosis of Miscanthus giant in the forest-steppe of the Middle Volga region. In this regard, in 2015-2017. on the light gray soil of the experimental plot of the Penza State Agrarian University, a field experiment was laid on agrotechnical and chemical measures to control weeds in the culture of miscanthus. On average, over three years, the use of herbicides Magnum and Ballerina against the background of Tornado improved the conditions for the formation of leaves and before leaving for winter their area was the largest 18.36 and 19.09 thousand m^2/ha, respectively, FP 496.1 ... 508.7 thousand .m^2 • day/ha, NPF decreased to 0.01 ... 0.08 g/m^2 • day. due to shading and death of the lower leaves. The maximum yield of dry matter of 2.96 t/ha was obtained with a double herbicide treatment. The main component that forms the frame of a plant is cellulose, the content of which in the aboveground mass was 56.96 ... 60.57%. The mass fraction of crude ash did not exceed 4.59%, potassium and calcium in it was 0.54% and 0.2%, respectively, the amount of nitrogen was 0.87%.

Key words*: Miscanthus giganteus, introduction, productivity.*

INTRODUCTION

The reason for the inevitable transition of society to resource-saving technological processes is the intensive and irrational use of the primary natural resource, which leads to the depletion of natural resources, especially the exhaustible sources of raw materials, which account for 81% of the final world energy consumption. Renewable energy sources account for 18%, which also includes biomass, which includes specially grown plants for energy, including trees. (Beringer et al., 2011; Khakhulaet et al., 2020)

However, deforestation without their subsequent restoration leads to disruption of natural ecological systems. Therefore, it became necessary to create artificial plantations, where plant growth is usually faster (Daviset et al., 2013)

From this point of view, heightened interest is shown in the plant of the bluegrass family - the giant miscanthus *(Miscanthus giganteus*). As a renewable source of raw materials, it can become an alternative to forest crops, which will take at least 80-100 years to recover. (Gushina et al., 2020) A fast-growing perennial herb is capable of forming colossal potential productivity - up to 40 t / ha of dry matter, since it belongs to the group of plants with the C4 photosynthesis type, which effectively uses solar radiation and water (Wang et al., 2011).

The average annual increase in the biomass of miscanthus is much higher than the average increase in wood in Russian forests, that is, aspen grows annually by 2.7 t/ha, birch - by 3.4, pine - by 3.6 t/ha. Miscanthus gives an annual increase of up to 9.3 t/ha and it is positioned as a promising cellulose-containing raw material (CCRM) for the isolation of cellulose and the production of products of its chemical modification, as well as biochemical transformation into glucose-pentose hydrolysates with subsequent conversion into ethanol, lactic acid, bacterial cellulose, etc.,

since its biomass is almost 60% cellulose (Makarova, 2013; Namsaraevet et al., 2018).
However, such productivity of miscanthus is not achieved in Russia. This is due to the slower growth of plants in the initial period, when rapidly developing weeds compete with it in the consumption of moisture, nutrients and light. Therefore, the purpose of the research was to determine the optimal way to combat weeds, ensuring the creation of a highly productive agrocenosis of Miscanthus giant in the conditions of the Middle Volga region.

MATERIALS AND METHODS

In this regard, in 2015-2017. On the basis of the experimental site of the Penza State Agrarian University, a one-factor field experiment was carried out on light gray soil, characterized by the following agrochemical indicators in the arable horizon: humus content - 2.7% (GOST 26213-91), alkaline hydrolyzable nitrogen - 102.8 mg/kg (according to Cornfield), mobile phosphorus and exchangeable potassium - 188 and 110 mg/kg, respectively (GOST 26204-91), pH(KCL) - 5.7 (GOST-26483-75).
The experimental scheme includes agrotechnical and chemical measures to control the weed component in the agrocenosis of miscanthus. 1. Absolute control (control 1); 2. Production control (control 2 - two inter-row treatments); 3. Treatment with herbicide Tornado 500 (4 l/ha); 4. Treatment with herbicide Ballerina (0.6 l/ha); 5. Treatment with herbicide Magnum (0.01 kg/ha); 6. Treatment with herbicide Tornado 500 (4 l/ha) + treatment with herbicide Ballerina (0.6 l/ha); 7. Treatment with herbicide Tornado 500 (4 l/ha) + treatment with herbicide Magnum (0.01 kg/ha). The repetition was fourfold; the placement of the plots was systematic.
Soil cultivation consisted of autumn plowing to a depth of 20-25 cm with preliminary application of the herbicide Tornado 500 in mid-August, early spring harrowing and cultivation before planting miscanthus, which was carried out with rhizomes to a depth of 10 cm with a density of 20 thousand pcs/ha and a row spacing of 75 In the first and third years of the experiment, miscanthus was planted on May 6 and 4, respectively, in 2016 - April 16, since there was an early and friendly spring with a temperature exceeding the norm by 4.5.
Observations, records and analyzes were carried out according to generally accepted methods.
According to the moisture conditions, the first year of research was arid with a hydrothermal coefficient of 0.64, the second and third years were characterized by moderate (GTK-1.17) and sufficient (GTK-1.29) moisture.

RESULTS AND DISCUSSIONS

The productivity of agrophytocenoses is determined by the amount of solar energy utilized in the process of photosynthesis, during which organic matter is formed, which determines the level of crop productivity. Controlling the photosynthetic activity of plants is one of the most effective ways to regulate their production processes that affect productivity (Weissmann et al., 2012).
As a perennial plant, miscanthus gigantic develops poorly in the first year of life. Therefore, a technique that accelerates the development of the assimilation surface of miscanthus can be a method of combating weeds in the year of its planting. On average, over three years by the harvesting period, which coincided with the end of September, the plants formed 5.19 ... 19.09 thousand m^2/ha of photosynthetic surface. The autumn application of Tornado 500 increased the assimilation surface by 2.17 times, inter-row cultivation by 1.34 times.
The leaf area after plantation treatment with only systemic herbicides exceeded the absolute control by 1.96… 2.59 times. The use of Magnum and Ballerina on the Tornado background improved the conditions for the formation of the leaf apparatus and the area of miscanthus was the largest, 18.36 and 19.09 thousand m^2/ha, respectively.
The total leaf area is characterized by the photosynthetic potential (PP), which is formed in accordance with the increase in the assimilation surface. By the end of the growing season, the highest rate was observed in plants grown under conditions of double herbicide treatment. On average, over three years, FP was 496.1 ... 508.7 thousand m^2 day/ha. In the absolute control, it was the lowest (136.8

thousand m^2 day/ha) due to the weak development of the photosynthetic surface, and with inter-row cultivation it increased by 1.37 times. The use of herbicides in their pure form increased the FP by 133.6 ... 215.4 thousand m^2 · day/ha. The indicator of the total dry biomass that is formed by plants during the day per square meter of "working" leaves is the net productivity of photosynthesis (NPF). On average, over the growing season, it was 0.32 ... 0.41 g/m^2 day. It is believed that the productivity of plants determines the accumulation of dry matter, which is a function of the assimilation process.

In dry 2015, miscanthus formed a rather low dry matter yield of 0.57 ... 2.18 t/ha (Table 1). However, its highest yield of 1.49 ... 2.18 t/ha was obtained with the use of herbicides Ballerina and Magnum based on the Tornado 500 background. Treatment of plantations with only systemic herbicides made it possible to improve the conditions for plant growth and increase the yield of dry matter, in comparison with the absolute control, by 0.33 ... 0.56 t/ha. With the introduction of a continuous herbicide in the fall, it increased by 0.83 t/ha, and with inter-row cultivation - by only 0.04 t/ha.

Table 1. Productivity of dry mass of *Miscanthus giant* first year of life, t/ha

Option	2015	2016 Nov.	2017	Average
Absolute control	0.57	1.33	1.19	1.03
Production control	0.61	2.21	1.60	1.47
Treatment with herbicide Tornado 500	1.40	3.24	1.76	2.13
Herbicide treatment Ballerina	1.13	3.68	1.80	2.20
Herbicide treatment Magnum	0.90	2.67	1.70	1.76
Herbicide treatment Tornado 500 + Ballerina	1.49	5.56	1.84	2.96
Herbicide treatment Tornado 500 + Magnum	2.18	4.57	2.15	2.97
Average by experience	1.18	3.32	1.72	2.07
NSR05	0.026	0.084	0.042	

The maximum dry mass yield of 1.33 ... 5.56 t/ha was obtained in 2016, which is 2.10 ... 3.73 times more than in the previous year and 1.12 ... 3.02 times more than in the next. In variants with double herbicide treatment, it was 4.57 ... 5.56 t/ha. The dry matter yield, in comparison with the absolute control, after the application of the herbicides Magnum and Balerina on the plantations was higher by 1.34 ... 2.35 t/ha, one herbicide Tornado 500 - by 1.91 t/ha. In the production control received 2.21 t/ha dry weight.

The biomass yield in 2017 varied within 1.19 ... 2.15 t/ha and the highest was obtained when using the systemic herbicide Magnum against the background of Tornado 500. Separate application of the continuous herbicide contributed to an increase in yield to 1.76 t/ha, and in combination with the herbicide Ballerina - up to 1.84 t/ha. In absolute control, 1.19 t/ha dry weight was obtained. The yield was slightly higher during inter-row cultivation of plantations (1.60 t/ha), and where the systemic herbicides Magnum and Ballerina were used, the weight increased by 1.43 ... 1.51 times.

On average, over three years, the use of the herbicide Tornado 500, both separately and in combination with systemic herbicides, contributed to an increase in the yield of dry aboveground mass by 1.10 ... 1.94 t/ha. The lowest dry matter yield of 1.03 t/ha was obtained in absolute control. The year 2016 was optimal for the growth and development of Miscanthus. According to the results of three-year studies, on average, according to the experience, miscanthus against a natural background of fertility is able to form the yield of dry matter - 2.07 t/ha. The most productive are plantations where there was a complex application of herbicides of systemic action Ballerina and Magnum with Tornado 500.

The above analysis made it possible to reveal the patterns of changes in the yield of dry matter from weather conditions and methods of weed control. The maximum productivity potential of *Miscanthus giganteus* is manifested with an optimal combination of these factors

affecting an increase in the number of stems and their height.

For the production of cellulose in order to save the forest fund, non-woody plants are considered as promising sources of raw materials. Energy crops are also used to obtain solid (wood chips, pellets, briquettes), liquid and gaseous fuels.

The ash content shows how much ballast is in the fuel, which does not burn, and therefore does not bring any benefit. Typically, the ash content of solid fuels ranges from 0.5% (quality wood) to 50% (rice husks and pelleted droppings).Compared to wood, miscanthus is characterized by a fairly high ash content, which is explained by the metabolism of rapid growth (accumulation of nutrients). The mass fraction of crude ash over the years of research in plants of the first year of life varied slightly from 4.55 to 4.59%. Its highest indicator was noted in 2015, and the lowest in 2016.

One of the main elements that form ash are potassium and calcium. Potassium occupies a special place among the macronutrients most important for plants. In plants, it is most concentrated in young, growing tissues characterized by a high level of metabolism: meristems, cambia, young leaves and shoots. Promotes the synthesis of proteins and sugars, the movement and accumulation of carbohydrates in the productive parts of plants, normalizes the process of photosynthesis, increases the osmotic pressure of cell sap, thereby increasing drought resistance and winter hardiness of crops. This element also contributes to an increase in the mechanical strength of fabrics. The share of potassium in the dry matter of the crop in 2015 and 2017 was the same - 0.54%, in 2016 its content was 0.53%.

Calcium accumulates in adult organs, especially in leaves, serves as a neutralizer of oxalic acid harmful to plants and protects them from the toxic effects of various salts. Participates in the construction of cell membranes. The highest calcium content of 0.20% was found in plants of plantations in 2015, in subsequent years it was less by 0.01 ... 0.02%.

Nitrogen is a part of many organic compounds, the most important of which are amino acids, proteins, nucleic acids, chlorophyll, in addition, nitrogen contains phosphatides, vitamins, ATP, alkaloids, etc. Young organs contain more nitrogen than old ones, and leaves more than stems. Energetic crops has a higher nitrogen content than wood. This can lead to high emissions of NO_x during combustion, which is the collective name for oxides NO and NO_2. But the combustion indicators of miscanthus chips are completely within the Austrian quality standard for fuel briquettes and pellets (in the Russian Federation there are no relevant standards yet). The dry mass over the years of research contained almost the same amount of nitrogen 0.86 ... 0.87%.

The main component that forms the carcass of a plant is cellulose. Cellulose with obsession in the aboveground mass by years of research was from 56.96 to 60.57%. The largest mass fraction of fiber was noted in 2016, the smallest in 2015, and in 2017 its content in dry matter did not exceed 58.76%.

CONCLUSIONS

Thus, over three years of research, it was established that in 2016 the content of cellulose in the dry mass of miscanthus was the highest, and the ash and its components - the lowest, which is associated with favorable development conditions, which made it possible to obtain a more powerful aboveground biomass with the best quality indicators.

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