Artículo de investigación

Photosynthetic activity of spring barley plants depending on moisture provision

Фотосинтетическая активность растений ярового ячменя в зависимости от влагообеспеченности

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Abstract

The technology of cultivation of malting barley is distinguished by a number of features associated primarily with the task of obtaining high-quality raw materials for the processing industry. As the objects of research, varieties of spring barley, Viscount and Mamluk, were used that were approved for use in the North Caucasus region. The aim of this work was to study the formation of photosynthetic activity of spring barley plants depending on the seeding rate and moisture level during the year, which is important to increase yield and grain quality. Studies have shown that the size of the leaf surface, dry weight, photosynthetic potential, and net productivity of photosynthesis significantly affected by the seeding rate and soil moisture during the growing season. The authors have the best indicators of these characteristics in the Viscount variety, with a seeding rate of 5.5–6.0 million viable seeds per hectare in 2017. On this showing this option is 7-8% more than other version.

Keywords: Spring barley, varieties, leaf area, photosynthetic potential, net productivity of photosynthesis, moisture year, seeding rate.

Аннотация

Технология возделывания пивоваренного ячменя отличается рядом особенностей, связанных, прежде всего, с получением качественного сырья для перерабатывающей промышленности. В качестве объектов исследования были использованы сорта ярового ячменя, Виконт и Мамлюк, допущенные для использования в Северокавказском регионе. Целью данной работы являлось изучение формирования фотосинтетической активности растений ярового ячменя в зависимости от нормы высева и уровня влажности в течение года, что немаловажно для повышения урожайности и качества зерна. Исследования показали, что размер поверхности листьев, вес, фотосинтетический потенциал и чистая продуктивность фотосинтеза существенно зависят от скорости высева и влажности почвы в течение вегетационного периода. Лучшие показатели этих характеристик встречаются у сорта Виконт, при этом что в 2017 году норма высева составляла 5,5–6,0 млн. жизнеспособных семян на гектар. При этом показателе этот вариант на 7–8% больше.

Ключевые слова: яровой ячмень, сорт, фотосинтетический потенциал, чистая продуктивность фотосинтеза, уровень влажности, норма высева.

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Introduction

The technology of cultivation of malting barley is distinguished by a number of features associated primarily with the task of obtaining high-quality raw materials for the processing industry (Goncharov, 2005). It is built in such a way that with the minimum expenditure of labor and means to get the maximum grain yield that meets the requirements of GOST 5060-86 "Malting barley. Technical conditions" (2011). Grain must have not only a certain chemical composition, but also have specific properties. Therefore, in the technological process of cultivating brewing barley, along with the creation of conditions for growing grain of the desired biochemical composition, operations that preserve the biological characteristics of the grain as a living organism become important (Kunze, 2009).

In contrast to the cultivation of fodder barley, the cultivation of brewing varieties requires a more thorough and accurate implementation of the entire complex of agricultural technology. Deviation from the conditions stipulated by the technology or violation of its individual links often leads to irreparable negative consequences (Fedotov, Goncharov, Rubtsov, 2006).

Get high quality malting barley only if you implement a scientifically based system of measures developed for each zone, taking into account its soil and climatic conditions. This principle underlies the technology of growing valuable raw materials (Khokonova et al., 2018). Based on the above, we were tasked to study the characteristics of the formation of the photosynthetic activity of spring barley plants, depending on the seeding rate and the moisture content of the year, which is of no small importance for increasing the yield and quality of grain.

The establishment of optimal seeding rates is an important issue in the cultivation of brewing barley. From this depends largely on the yield and grain quality (Khokonova, Adzieva, Karashaeva, 2017).

It should be emphasized that the seeding rate does not remain constant. It needs to be refined depending on a number of continuously changing factors: the level of farming culture, the dose of fertilizers, soil fertility and varietal characteristics (Khokonova, Karashaeva, Zavalin, 2015).

Objects and research methods

Our studies were conducted in 2016-2018 in the conditions of the KBR foothill zone at ZAO NP «Shadzhem» and at the department “Technology of production and processing of agricultural products” of the Kabardino-Balkarian State Agrarian University.

As the objects of research, varieties of spring barley, Viscount and Mamluk, were used that were approved for use in the North Caucasus region.

The soil of the experimental plot is leached chernozem, the reaction is neutral. The humus content is 3.1%, easily hydrolyzed nitrogen — 155-165 mg / kg of soil (according to Confield), mobile phosphorus — 85 (according to Chirikov), exchangeable potassium — 100 mg / kg of soil (according to Chirikov). Agrotechnics - typical for the zone (Dospekhov, 1985).

Experience two-factor, randomized by the method of split plots, in fourfold repetition, the accounting area plots 54-55 m2, total - 60-63 m2.

Sowing was carried out in an ordinary way in the first decade of April.

The scheme of experiments was as follows:
Experience 1. The influence of seeding rate on the photosynthetic activity of spring barley plants:

- 5.0 million viable seeds / ha;
- 5.5 million viable seeds / ha;
- 6.0 million viable seeds / ha.

Experience 2. The effect of moisture supply of the year on the photosynthetic activity of spring barley plants:

- 2016 - drought-resistant;
- 2017 - moisture-proof;
- 2018 - drought-resistant.

The growing season of 2016 was generally favorable for the formation of barley harvest. Spring was characterized by unstable weather. Most of the precipitation fell in the second half of the month.

The vegetation period of 2017 was characterized by abundant rainfall at the beginning of summer, which played a positive role in the formation of larger, made grains with a high mass of 1000 grains and high yields.

The vegetation period of 2018 differed more drought-resistant weather. Winter weather conditions prevailed at the beginning of spring.

The end of spring and the beginning of summer were characterized by unusually hot weather.

Phosphorus and potash fertilizers were applied on all variants - superphosphate and potassium salt of 45 kg d.v. each. per hectare in the fall before plowing.

Results

Studies show that the size and dynamics of leaf surface development are influenced by numerous agrotechnical, climatic and biological factors. These parameters significantly depend on the density of standing plants. The leaf surface index largely depends on both the hydrothermal conditions and the plant density (Grujic, Pejin, Przulj, 2005). Crops of the studied varieties of spring barley developed leafy surface, which varied from 33.2 to 37.3 thousand m2 per hectare. Various sowing norms had a direct impact on their value (Table 1).

Table 1. Photosynthetic activity of spring barley plants depending on the seeding rate

INDICATORS	Sort					
	Viscount			**Mamluk**		
	5.0	**5.5**	**6.0**	**5.0**	**5.5**	**6.0**
2016						
Leaf surface area, thousand m^2 / ha	32.9	33.8	34.3	32.2	33.4	33.7
The accumulation of dry weight, centners / ha	23.1	25.9	26.8	22.4	25.4	26.2
FP, ml. m^2·days/ha	1.48	1.52	1.59	1.42	1.47	1.51
CHPF, gr/m^2 in nautical day	4.8	4.6	4.5	4.6	4.5	4.3
NCR_{05} (centners / ha)			2.8			3.0
2017						
Leaf surface area, thousand m^2 / ha	34.2	36.6	37.2	33.6	35.0	36.2
The accumulation of dry weight, centners / ha	25.7	27.4	28.4	24.2	25.9	26.3
FP, ml. m^2·days/ha	1.59	1.72	1.74	1.50	1.63	1.69
CHPF, gr/m^2 in nautical day	5.4	5.3	5.0	5.0	4.7	4.5
NCR_{05} (centners / ha)			2.2			1.7
2018						
Leaf surface area, thousand m^2 / ha	32.2	33.4	34.0	31.9	33.0	33.5
The accumulation of dry weight, centners / ha	22.8	25.1	26.6	22.0	24.7	25.3
FP, ml. m^2·days/ha	1.41	1.49	1.52	1.49	1.43	1.48
CHPF, gr/m^2 in nautical day	4.7	4.5	4.4	4.5	4.4	4.4
NCR_{05} (centners / ha)			2.3			2.7

These tables show that spring barley plants form a fairly well-developed leaf surface. The size of the leaf surface index is in direct proportion to the seeding rate. If the leaf surface area is 33.9 thousand m2 per hectare (5.5 million seeds per hectare), then when sown 6.0 million seeds, it is 34.3 thousand m2.

A similar phenomenon is observed in other indicators. In particular, the accumulation of dry weight at a seeding rate of 5.0 million seeds was 23.1 centners/ha per hectare, while at a rate of 6.0 million it was 26.8 centners/ha. This is 3 centners/ha more than in thinned crops. Indicators of photosynthetic potential and net productivity of photosynthesis are also characterized in different ways, depending on the seeding rate. The photosynthetic potential is most pronounced with a seeding rate of 6.0 million seeds, which is 1.59 million m2 days per hectare (2016). This is 110.000 m2 days more than at a seeding rate of 5.0 million seeds per hectare.

As for the net productivity of photosynthesis, there is an inverse relationship. The fewer plants per unit area, the higher the performance of each plant for the net productivity of photosynthesis. For example, the net productivity of photosynthesis of spring barley plants with a seeding rate of 5.0 million seeds per hectare was 4.8 g / m2 per day, and with a seeding rate of 6.0 million – 4.5, that is, with an increase in the

seeding rate decreases individual plant development. However, the total dry mass of plants with more thickened sowing is higher due to the number of plants per unit area.

Of particular interest is the comparison of the photosynthetic activity of plants of different varieties of spring barley. It should be noted that, although not as significant, the Viscount variety is characterized by better indicators on the photosynthetic activity of plants than the Mamluk variety. Indicators of this variety are 5-7% less than those of Viscount. This is observed during three years of research in all variants of experience.

Equally important is the availability of plants in the formation of the leaf surface. If in 2016 and 2018 there was insufficient rainfall, especially during the period of going into the tube and loading grain, which is very important for cereal crops, then in 2017 moisture availability was sufficient. Indicators of photosynthetic activity of this year were higher by 7-8% than in other years of research. In particular, the leaf surface area in 2016 at the best option was 34.2 thousand m2 per hectare (Viscount variety), and in 2017 the same variety had 37.2 thousand m2 per hectare.

The accumulation of dry mass was, respectively, 26.8 centners/ha and 28.4 centners/ha, the photosynthetic potential was 1.59 million m2 days and 1.74 million m2 days. The net productivity of photosynthesis in the first case was 4.5 g / m2 per day, and in the second – 5.0 g / m2. Comparative data on the photosynthetic activity of spring barley plants depending on the moisture content of the year are given in Table 2.

Table 2. Photosynthetic activity of spring barley plants depending on the moisture content of the year (seeding rate 5.5 million viable seeds per hectare)

Indicators	Sort	
	Viscount	Mamluk
2016		
Leaf surface area, thousand m^2 / ha	33.8	33.4
The accumulation of dry weight, centners / ha	25.9	25.2
FP, ml. m^2·days/ha	1.52	1.47
CHPF, gr/m^2 in nautical day	4.6	4.5
2017		
Leaf surface area, thousand m^2 / ha	36.6	35.0
The accumulation of dry weight, centners / ha	27.4	25.9
FP, ml. m^2·days/ha	1.72	1.63
CHPF, gr/m^2 in nautical day	5.3	4.7
2018		
Leaf surface area, thousand m^2 / ha	33.4	33.0
The accumulation of dry weight, centners / ha	25.1	24.7
FP, ml. m^2·days/ha	1.49	1.43
CHPF, gr/m^2 in nautical day	4.5	4.4

One of the factors adversely affecting the photosynthetic productivity of plants is water deficiency. It is established that the stress associated with the lack of water strongly affects the activity of the photosynthetic apparatus.

The analysis results show that with the same seeding rate, the studied varieties have different indicators on the photosynthetic activity of spring barley plants, depending on the soil moisture during the growing season of the plants.

As already noted above, the year 2017 is characterized by more optimal hydrothermal conditions for the normal growth and development of spring barley plants.

Unlike winter varieties of barley, spring varieties are characterized by a significantly short growing season. Although varietal characteristics remain with respect to productivity elements, the size or value of each element depends on the growing conditions. Especially hydrothermal conditions affect the degree of tillering, the formation of productive stems, the laying of spikelets, and hence the grains, since each spikelet represents one grain, the grain size of grains, as well as the chemical composition of grain, which determines the suitability of grain for the brewing industry (Narcissus 2007).

In addition to hydrothermal conditions, seeding rates have a certain effect on the formation of

plant productivity and grain quality (Tretiak, 2012). It is known that with thinned crops each plant individually develops better. Due to more optimal conditions in relation to moisture and nutrition, plants form larger ears, more spikelets, grains are large, aligned, with a mass of 1000 grains 40 or more grams. However, this does not mean that the yield of such crops is higher than that of more dense crops (Troughton, 1982).

Our analyzes showed that the number of productive stems per square meter depended on the seeding rate and varietal characteristics. In the subsequent development of plants, the amount of yield was mainly determined, since it is composed of the number of productive stems and the mass of grain of each ear.

Conclusion

Thus, on the basis of the conducted research, it was established that the size of the leaf surface, dry weight, photosynthetic potential, and net productivity of photosynthesis is significantly affected by the seeding rate and moisture supply of the soil during the growing season of plants. We have the best indicators of these characteristics in the Viscount variety, with a seeding rate of 5.5–6.0 million viable seeds per hectare in 2017. Indicators of this option is 7-8% more than other options.

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