The grain yield of winter barley varieties in the Southern Ukraine depending on factors and conditions of vegetation years

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Annotation. The article presents the results of two experiments with winter barley conducted during 2015-2019 yrs on Southern Chernozem in the conditions of Steppe of Ukraine with a number of zoned varieties of this crop. The optimal sowing period, the best varieties, preparations for pre-sowing optimal sowing period, the best varieties, preparations for pre-sowing treatment of seeds and sowing of plants in the main periods of vegetation were determined. It was established that when choosing a variety, sowing period and optimization of nutrition, winter barley would be able to form a grain yield at the level of 5-7 t/ha.

Keywords: winter barley, varieties, growth-regulating preparations, sowing period, harvest.

Introduction. Ukraine is known in the world as one of the most powerful grain producers and an active participant in the export grain market. In our country it is formed the gross yield of grain by winter crops primarily, which provide higher productivity compared to spring cereals. The greatest production value in Ukraine belongs to soft wheat, rye, triticale, hard wheat and barley. Each of these winter wedge crops occupies a certain niche in the economy of farms, it has its positives and disadvantages. Again, every year there is a market demand for a certain amount of grain production, of course their demand dictates the price policy for grown grain, which in the context of crops can vary significantly over the years. This is partly due to the state of strategic planning of areas under crops, including winter crops, which is especially evident in recent decades.

A brief overview of publications on the topic. The stability of the grain complex is an extremely important aspect of management and it should provide for the selection of crops, technology elements and their adaptation to the conditions of a certain zone, including in adverse weather and climatic factors [1].

A number of scientists and breeders who had conducted studies with winter cereals, found that modern varieties with high genetic yield potential for a different way to implement it, as it depended on the year conditions, biological characteristics of the crops, varieties, elements of the technology [2,3]. The productivity of winter plants significantly depends on the conditions of overwintering. Thus, according to studies with winter wheat, which is more resistant to low temperatures compared to barley, in years with severe winters, the yield of middle – winter varieties compared to hardy ones decreases by 17.4–25%, and the yield of low-winter varieties decreases by 53.0 and up to 89.7% [4].

It is known that from all winter grain crops barley is the most sensitive to adverse conditions of overwintering, it withstands frosts at the depth of tillering node in the range of minus 11-13°C. This temperature is critical to the freezing of this culture, through which winter barley is allocated small areas. Given the high level of freezing of winter barley, researchers advise most areas of winter grains in the conditions of the left-bank Forest-Steppe of Ukraine to place to wheat, rye and triticale, and winter barley would occupy only 3-5% of the area [5]. However, winter barley has a high productivity potential and under favorable growing conditions it is able to form high levels of grain yield compared to the most common winter wheat. It is successfully cultivated in many European countries, the USA and in the Western regions of Ukraine [6].

In studies conducted in different regions of Ukraine, it was justified the importance of selecting the sowing period, as it was in close connection with the thermal regime, which determined the success of growth and development of winter barley plants during the autumn growing season – the first stage of organogenesis. The provision of plants with moisture also significantly depends on the sowing period, as the accumulation of thermal energy in combination with a sufficient amount of precipitation affects on the state of plant seedlings, their development and the risks of their damage and loss during the winter [7,8].

Purpose of research. Given all the outlined and changes in climatic conditions which occur in the direction of mitigation and warming, as well as the ability of winter barley to form a high level of grain yield in favorable years of cultivation, we decided to take this crop for research and improve its basic agricultural techniques of cultivation, which would significantly increase its productivity and reduce the risks of freezing.

Materials and methods. The study was conducted during 2015-2018 yrs in three-factor experience in conditions and terms of Velykooleksandrivskiy district, Kherson region with varieties of winter barley Dostoinyi, Snigova Koroleva and the Devyatyi Val of the study three dates of sowing with the purpose of establishing frost hardiness and winter hardness of culture depending on the factors, as well as in two-factor experience in 2016 – 2019 yrs, held in the educational-scientific-practical center of Mykolaiv NAU with four varieties of winter barley Dostoinyi, Valkyrie, Oscar and Jason, it was studied their reaction to optimization of nutrition on resource-saving principles to increase yield and improve grain quality. Full schemes of experiments are given in the corresponding tables.

Soil surface - southern middle loam Chernozem. In both experiments, for study it was taken the nutrition of winter barley plants. This factor significantly affects the yield and quality of grain, the accumulation of sugars in the tillering nodes, on which the conditions of overwintering of the crop depend.

The repetition in both experiments was fourfold. The seeding rate was about 200 kg/ha at the rate of 4.5-5.0 million pieces/ha.
Results and their discussion. When growing winter barley varieties, we first of all determined the temperature regime and soil moisture in the years of research, which differed, including depending on the sowing period (table 1).

**Table 1.** Soil moisture and temperature at different sowing times of winter barley (average over 2015-2017 yrs)*

| Sowing period | Soil moisture, % HB | Air temperature, °C |
|---------------|---------------------|---------------------|
| 1st decade of October | 80.0 | 17.5 | 4.1 |
| 2nd decade of October | 87.3 | 12.5 | 11.0 |
| 3rd decade of October | 78.3 | 8.0 | 9.7 |

*In another experiment sowing of barley was provided by zonal recommendations 1st decade of October.

The data of Table 1 show that the moisture reserves in the soil layers 0-20 cm and 20-50 cm on average, are the highest as determined by sowing in the 2nd decade of October. The temperature regime with the shift of sowing periods decreases, but in the years of research it was higher compared to long-term indicators for the same period. So, if according to long-term observations, the average daily temperature in the 2nd decade of October was 11°C, then it was the same in fact during the experiments on sowing of winter barley in the 3rd decade of October. This indicates some warming of the climate, which has taken place in recent years in the southern Steppe of Ukraine, and therefore for obtaining of full shoots and normal hardening of winter barley plants, it is necessary to allow for these changes in the crop calendar and the entry of plants into winter.

Climatic conditions and the studied factors in the years of research affected on the yield levels of spring barley grain (table 2).

As defined by the research, regardless of the biological characteristics of varieties and pre-treatment of seeds with micronutrients, the low productivity of barley was obtained in last sowing in the 3rd decade, and the highest productivity of barley was obtained in second period of sowing 2nd decade of October.

**Table 2.** Winter barley grain yield depending on varietal characteristics, micronutrients and sowing time (average over 2016-18 yrs), t/ha

![Fig. 1. Influence of sowing period and pre-sowing seed treatment on grain yield of the investigated winter barley varieties (average for 2016-2018), t/ha](image)

Notes: □ Control (seed treatment with water) □ Microfertilizer seed treatment (average for all variants)

Thus, on average for the studied varieties and variants of pre-sowing seed treatment, for sowing in the 1st decade of October, the yield of winter barley grain increased from 5.17 t/ha (in the control when processing seeds with water) to 5.88 t/ha (when processing seeds with trace elements), or by 13.7% to the control. Sowing in the 2nd decade of October, the following indicators were: 5.63; 6.30 t/ha and 11.9%, and in the 3rd decade of October: 5.56; 5.79 t/ha and 4.1%, respectively, or for the last period, the increase in grain yield from this factor was the smallest for the duration of the autumn vegetation of plants before their entry into winter.

Studies found that the higher yield was characterized in 2017yr, and the lowest one was in 2018yr. In all the years of research, the stable yield was formed by the Snigova Koroleva variety, which in comparison with the Devyatyi Val and Dostoiniy was more plastic, this variety also responded well every year by increasing the yield on the pre-sowing treatment of seeds with trace elements.

In the following experiment to determine the effectiveness of foliar fertilizing of winter barley plants with growth-regulating drugs in the main periods of vegetation, their importance in increasing the grain yield of four varieties of this crop was established (table 3).
### Table 3. The grain yield of barley under the influence of growth-regulating preparations, t/ha

| Variety (factor A) | Variant of nutrition (factor B) | 2017 | 2018 | 2019 | 2017-2019 yrs |
|-------------------|--------------------------------|------|------|------|---------------|
| Dostoiniy         | Control (water treatment)      | 4.86 | 3.16 | 3.88 | 3.97          |
|                   | Azotophyte I                   | 5.26 | 3.88 | 4.52 | 4.55          |
|                   | Azotophyte I+II                | 5.59 | 3.97 | 4.83 | 4.80          |
|                   | Micofrend I                    | 5.21 | 3.79 | 4.27 | 4.30          |
|                   | Micofrend I+II                 | 5.46 | 3.84 | 4.30 | 4.60          |
|                   | Melanor I                      | 4.89 | 3.59 | 4.16 | 4.21          |
|                   | Melanor I+II                   | 4.94 | 3.64 | 4.37 | 4.32          |
|                   | Organic-balance I              | -    | 3.91 | 4.74 | 4.33          |
|                   | Organic-balance I+II           | -    | 4.05 | 5.06 | 4.56          |
| Valkyrie          | Control (water treatment)      | 4.64 | 3.22 | 4.96 | 4.27          |
|                   | Azotophyte I                   | 4.93 | 4.49 | 5.87 | 5.10          |
|                   | Azotophyte I+II                | 5.24 | 4.54 | 6.14 | 5.31          |
|                   | Micofrend I                    | 4.89 | 4.03 | 5.64 | 4.85          |
|                   | Micofrend I+II                 | 5.12 | 4.16 | 5.88 | 5.05          |
|                   | Melanor I                      | 4.78 | 3.54 | 5.28 | 4.53          |
|                   | Melanor I+II                   | 4.91 | 3.86 | 5.59 | 4.79          |
|                   | Organic-balance I              | -    | 4.75 | 5.99 | 5.37          |
|                   | Organic-balance I+II           | -    | 5.04 | 6.23 | 5.63          |
| Oscar             | Control (water treatment)      | 4.31 | 3.96 | 5.20 | 4.49          |
|                   | Azotophyte I                   | 4.81 | 4.54 | 6.11 | 5.15          |
|                   | Azotophyte I+II                | 5.03 | 4.64 | 6.25 | 5.31          |
|                   | Micofrend I                    | 4.54 | 4.37 | 5.84 | 4.92          |
|                   | Micofrend I+II                 | 4.87 | 4.52 | 6.28 | 5.22          |
|                   | Melanor I                      | 4.41 | 4.08 | 5.73 | 4.74          |
|                   | Melanor I+II                   | 4.46 | 4.24 | 5.88 | 4.86          |
|                   | Organic-balance I              | -    | 4.71 | 6.17 | 5.48          |
|                   | Organic-balance I+II           | -    | 4.91 | 6.29 | 5.60          |
| Jason             | Control (water treatment)      | 4.09 | 3.36 | 4.31 | 3.92          |
|                   | Azotophyte I                   | 4.34 | 3.85 | 4.94 | 4.38          |
|                   | Azotophyte I+II                | 4.82 | 4.15 | 5.26 | 4.74          |
|                   | Micofrend I                    | 4.23 | 3.78 | 4.84 | 4.28          |
|                   | Micofrend I+II                 | 4.67 | 3.80 | 5.01 | 4.43          |
|                   | Melanor I                      | 4.13 | 3.59 | 4.53 | 4.08          |
|                   | Melanor I+II                   | 4.19 | 3.96 | 4.82 | 4.32          |
|                   | Organic-balance I              | -    | 4.26 | 5.34 | 4.80          |
|                   | Organic-balance I+II           | -    | 4.49 | 5.49 | 4.99          |
| HPI, t/ha by factor A | by factor B                     | 0.17 | 0.11 | 0.19 | 0.17          |
|                   | by factors AB                  | 0.14 | 0.16 | 0.19 | 0.21          |

It was determined that the ability to form yields from lower one to higher one as without fertilizing with growth-regulating drugs, and for their use, on average for three years, the studied varieties of winter barley were distributed as follows: Dostoiniy, Jason, Oscar and Valkyrie. However, according to the potential of productivity in the 2017 favorable year, it was the Dostoiniy barley variety which differed, the plants of which after the resumption of the spring vegetation per unit area were determined more, compared to other varieties taken for study. In the following years, and especially in the 2018 least favorable year it formed the unstable low yields that characterize the grade as a decent enough plastic one.

From the preparations taken for foliar fertilizing of winter barley plants, Azotophyte and Organic balance were determined more effectively, which allow to increase the grain yield by double treatment of sowing by 0.82-1.04 t/ha and 0.59-1.36 t/ha in the context of varieties, respectively, compared with treatment of plants with water.

The effect of modern drugs which were taken for study, more significantly manifested by double treatment of sowing plants, compared with one treatment in the phase of spring tillering. It was established that a considerably large increase of the crop enables the use of Azotophyte and Organic balance compared to Micofrend and Melanor. All of this can be observed according to figure 2, which allows us to argue about the advantages of more effective drugs for foliar fertilizing winter barley plants and the number of nutritions.

**Conclusions.** For increasing the production of winter barley grain in the southern Steppe of Ukraine it should grow barley varieties such as Snigova Koroleva, Devyatyi Val, Valkyrie and Oscar.

Sowing should be carried out in the 2nd decade of October with a seeding rate of 4.5-5.0 million pieces/ha.

Before sowing of winter barley, its seeds should be treated with micronutrients Myfosat 1 with Chelate Combi, which, depending on the sowing period and varietal characteristics, allows to increase productivity up to 14.5%.

During the growing season in early spring tillering and stooling it should conduct the foliar nutrition of barley plants with modern growth-regulating drugs Azotophyte or Organic-balance rate of 200 g/ha at the norm of working solution of 200 l/ha, as it increases grain yield by 1.04 up to 1.36 t/ha, and in the single treatment (only in the first phase) it increases grain yield by 0.83 up to 0.99 t/ha.

![Fig. 2. The value of the regenerative drugs in the yield increase of grain of winter barley varieties in the years of researches (average on preparations), t/ha](chart)
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