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WINTER BARLEY CULTIVATION INCLUDING CLIMATE CHANGES AND SOIL®

Uprawa jęczmienia ozimego w tym zmiany klimatu i gleby®

Key words: barley, crop cultivation, quality, food production, brewing barley.

The increasing demand for the production of cereals, both in Poland and in the world, puts farmers face a major challenge due to the constantly changing climatic and soil conditions. A sustainable policy of managing natural resources limits or excludes use of plant protection products and pesticides. Cultivation of cereal varieties with high resistance to pests as well as climate and soil changes constitute a new challenge for plant production. The article presents the results of field research on Winter Barley cultivation – Kanagoo and cultivars Conchita taking into account the changing soil and climatic conditions. From the obtained research, it can be concluded that the results achieved by the Kangoo variety could have been influenced by the application of two-treatment protection and the earlier sowing date.The lower protein content of the Conchita variety, despite the use of a higher dose of nitrogen, is a species characteristic of this variety.

Słowa kluczowe: jęczmień, uprawa roślin, jakość, produkcja żywności, jęczmień browarny.

Rosnący popyt na produkcję zbóż, zarówno w Polsce, jak i na świecie, stawia przed rolnikami duże wyzwanie ze względu na stale zmieniające się warunki klimatyczne i glebowe. Zrównoważona polityka zarządzania zasobami naturalnymi ogranicza lub wyklucza stosowanie środków ochrony roślin i pestycydów. Uprawa odmian zbóż o wysokiej odporności na szkodniki oraz zmiany klimatyczne i glebowe stanowią nowe wyzwanie dla produkcji roślinnej. W artykule przedstawiono wyniki badań polowych uprawy jęczmienia ozimego – Kanagoo i odmian Conchita z uwzględnieniem zmieniających się warunków glebowych i klimatycznych. Z przeprowadzonych badań można wnioskować, że na wyniki uzyskane w przypadku odmiany Kangoo mogło mieć wpływ zastosowanie ochrony dwuzabiegowej oraz wcześniejszy termin siewu. Niższa zawartość białka odmiany Conchita, pomimo zastosowania wyższej dawka azotu, wskazuje na to, że jest to cecha charakterystyczna dla tej odmiany.

INTRODUCTION

In 2019, the domestic production of cereals in Poland amounted to 28.9 million tons, while in 2021 this production exceeded the threshold of 30.7 tons. Increasing the production of grains such as wheat, corn, canola, barley and others [5]. Barley is one of the grasses that occur in different climatic zones. The structure of the plant consists of roots, stalks, which end with an inflorescence in the form of leaves and ear. A large part of the barley kernel forms is drenched, and the chaff is fused with the kernel, but recently the chaff-less, naked forms have started to gain importance [3]. As emphasized by Żur et al., temperature variation plays a key role in the cultivation of barley, as it is one of the plants that is not very resistant to frost [6, 12].

Leszczyńska et al. emphasizes that many species of barley winter has the highest tolerance to spring drought due to early ripening and better use of winter water reserves [6, 7, 12]. In contrast to Western European countries, there is a forecast for steady increase in the cultivation of winter barley in Poland. Previously, numerous scientific studies were carried out on the use of nitrogen fertilizers[1, 2, 4, 8, 9, 11]. Other studies have focused on the analysis of the optimal sowing date [7]. It is important to use a good grade of material for the production of good quality beer. Breweries that purchase crops require the producer to meet certain criteria. The most important criterion for assessing the value of purchased barley is the % protein content in the dry matter of grains. It should contain up to 11.5% of protein, and 8.5% is not eligible for purchase [10]. Inadequate amount of protein lowers the starch content and causes the beer to become cloudy. Other features, which the malting barley buyer requires is the grain moisture of 15%, impurities – no more than 3% and grain uniformity – over 90%. All these factors influence the further production of barley malt [10].

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PURPOSE AND SCOPE OF WORK

The aim of the study was to analyze and present agrotechnics along with the characteristics of overlaps of malting barley grown in changing soil and climatic conditions of the Prudnik commune in the Opole region. The scope of work included carrying out field tests with the participation of two Winter Barley cultivars in the cultivation field in the Prudnik commune.

RESEARCH METHODOLOGY

The field research was carried out in the Prudnik commune in the Opole region, and the period of cereal vegetation lasts about 180–200 days. The beginning of vegetation takes place between the third decade of March and the first decade of April. The average sum of precipitations is around 750 mm / year, and the average air humidity is 78%. The average annual temperature is around 8° C and from year to year shows an upward trend. During the growing season, the average temperature is approx. 14.2° C. Winter Barley of the Kangoo and Conchita cultivars were used in the yield study. The field research was carried out on an agricultural plot of 19.77 ha, the plot was divided into two parts, part I – 8.9 ha, and part II – 10.87 ha, and field experiments were carried out on the first part of the plot. In a given area, the prevailing soil valuation class is III b, moreover, in a small part there are III a and IV a. Before pre-sowing fertilization, the soil was analyzed for the content of macronutrients, and soil samples were taken in 4 places.

Preparation of the research substrate

Post-harvest tillage was performed with a disc harrow, thanks to which the stubble was removed and the harvest residues were mixed to a depth of 8 cm. This procedure was carried out in the third decade of August, then it was repeated in the second decade of September. Then the disc harrow was operated at a depth of 12 cm. I made a spinning plowing in the so-called sharp ridge plough at the beginning of the third decade of October.

Fig. 1. Post-harvest tillage with the use of a disc harrow.
Rys. 1. Uprawa pożniwna broną talerzową.
Source: Own study
Źródło: Opracowanie własne

I performed the spring agriculture work at the end of March 2021, after having previously spread NPK fertilizers. The cultivation depth with a narrow-leg cultivator with string rollers was approx. 7 cm. This treatment smoothed and compacted the top layer of soil and mixed the fertilizer previously spread.

Fig. 2. Cultivating the soil.
Rys. 2. Uprawa gleby.
Source: Own study
Źródło: Opracowanie własne

Knowing the abundance of the soil in available forms of P_2O_5 and K_2O, it was determined based on the fertilizer dose table for a field of 8.9 ha, which was previously divided into 4 plots. The applied doses of phosphorus and potassium have been presented in Table 1.

Potassium salt (60% K_2O) and Polidap (18% N; 46% P_2O_5) were used for fertilization. The doses of fertilization with Potassium Salt and Polidap have been presented in Table 1.

Table 1. Applied doses of P_2O_5, K_2O and Potassium Salt (60% K_2O) and Polidap (18% N; 46% P_2O_5)

Tabela 1. Zastosowane dawki P_2O_5, K_2O i Sól Potasowa (60% K_2O) oraz Polidap (18% N; 46% P_2O_5)

Quarter	P_2O_5 [kg/ha]	K_2O [kg/ha]	A dose of Potassium Salt [kg/ha]	A dose of Polidap [kg/ha]
1	70	60	100	152
2	50	50	84	109
3	70	60	100	152
4	50	50	84	109

Source: Own study
Źródło: Opracowanie własne

Table 2. Applied nitrogen doses per plot of land

Tabela 2. Zastosowane dawki azotu na działkę

Quarter	Nitrogen from Polydap [kg/ha]	Supplementing Kędzierzyn Ammonium Saltpetre [kg/ha]	A dose of Kędzierzyn Ammonium Saltpetre
1	27	23	72
2	20	30	94
3	27	23	72
4	20	30	94

Source: Own study
Źródło: Opracowanie własne

Polidap phosphorus fertilizer, apart from phosphorus, also contains 18% of nitrogen. When determining the nitrogen dose, I took into account the contained nitrogen in the Polidap fertilizer. Without knowing the soil's abundance in the form of assailable nitrogen, the dose for the entire field was 8.9 ha, for 50 kg N / ha based on presented Table 2. Used once, entirely before in pre-sowing. In order to supplement the nitrogen dose, I chose Kędzierzyn Ammonium Saltpetre 32% N. The doses required for the supplement have been presented in Table 2.

Prepared variety Kangoo seed of malting spring barley, was sown to a depth of 3 – 4 cm at the end of March 2021 by using a cultivating and sowing unit. The sowing density was 350 seeds/m2. The data for the calculation of the sowing amount was given on the label of the seed packaging which is MTN – 44 g and a germination capacity of 95%.

Sowing

The emerging malting Kangoo variety spring barley from the date of sowing (23-24 March 2021) to the first decade of April, was problematic. The lack of rainfall at that time and the sunny weather were not favorable for growth. In the tillering phase, the barley density per 1 m2 was 300-310 plants. In the 2nd and 3rd decade of April there was little rainfall in the Prudnik commune, after which the condition of the barley improved. During this period, it was possible to improve the propagation of plants by applying an additional dose of nitrogen, which was provided in the form of top dressing or by foliar fertilization. However, such practices were abandoned due to the risk of increasing the protein content in the grain.

Spraying and pest control

In the initial stage of tillering, the field was inspected for weeds. The following dicotyledonous weeds that exceeded the harmfulness thresholds have been observed on the plantation: clinging weeds, field violet, self-seeding rapeseed. In addition to these weeds, also other dicotyledonous weeds were observed, but their severity was less. In order to control the above-mentioned weeds, the herbicide Lintur 70 WG was applied in the maximum dose dedicated to spring barley, amounting to 150 g / ha. The procedure was performed with a sprayer within one month of sowing the seeds. The presence of weeds was effectively eliminated. Monocotyledonous weeds, i.e. grain broom or oats deaf in the plantation did not occur.

At the end of the tillering phase, and at the beginning of the stem shooting phase, a disease appeared on plants – powdery mildew of cereals and grasses. In order to control this disease, a full spray rate of 1 l / ha was applied to the plant protection agent Tilt Turbo 575EC. A retardant in the form of Cerone 480SL was also used when the second elbow appeared at the dose of 0.75 l / ha. When carrying out the first fungicide treatment, it was used additionally the Karate Zeon 050 CS insecticide at a dose of 0.1 l/ha. During the second verification of the growth and development of barley (May 28, 2021), the appearance of cereal horsetail was observed. Later, there were no indications to repeat the protection treatments for malting spring barley of the Kangoo variety.

Fig. 3. Conducting protective spraying.
Rys. 3. Przeprowadzanie natrysku ochronnego.
Source: Own study
Źródło: Opracowanie własne

Harvest

The harvest was carried out in one stage with the use of the Bizon harvester on August 1, 2021. The maturity of the grain is shown in Figure [4].

Fig. 4. Maturity of Winter Barley grain before harvest.
Rys. 4. Dojrzałość ziarna jęczmienia ozimego przed zbiorem.
Source: Own study
Źródło: Opracowanie własne

ANALYSIS AND DISCUSSION OF THE RESULTS

The results of the research and the field conditions of the experiments of individual experimental points were carried out and published by the Central Research Center for Cultivar Testing (COBORU).Below I present the characteristics of the Conchita variety (Table 3) and the field conditions in which the experiment at HR DANKO in Modzurów was conducted (Table 3).

Table 3. Conchita variety profile, elaboration: [13]
*** a_1 – average level of agricultural technology**
*** a_2 – high level of agrotechnics**
9° scale:
1 - the least favorable evaluation

Tabela 3. Profil odmiany Conchita, opracowanie: [13]
***a_1 – średni poziom techniki rolniczej**
***a_2 – wysoki poziom agrotechniki**
Skala 9°:
1 - ocena najmniej korzystna

Direction	brewing
Year of entry into the National Register	2020
Yield-forming properties	
Grain yield a_1 [% of reference]	99
Grain yield a_2 [% of reference]	100
The mass of 1000 grains	50
Disease resistance	
Powdery mildew	8,5
Net blotch	7,5
Barley rust	7,7
Rynchosporiasis	8
Black spot	7,6
Agricultural and utility features	
Reaction to Alt ++ [9° scale]	5
Plant height	68
Lodging [9° scale]	6,5
Waxy maturity	196
Quality	
Grain equalization (2.5 mm) [%]	92
loose grain density [9° scale]	5
protein content	5
Synthetic evaluation	6,7
Extractiveness	7

Source: Own study
Źródło: Opracowanie własne

Table 4. Field conditions of the experiment according to [14] suitability 9 – the most favorable assessment

Tabela 4. Warunki terenowe eksperymentu według [14] przydatności 9 – najkorzystniejsza ocena

Description	HR DANKO Modzurów, Raciborski
agricultural soil usefulness	2
valuation class	II
soil pH	6,48
forecrop	Winter oilseed rape
date of sowing	28.03.2021
grain cast	300
harvest date	31.08.2021
grain moisture during harvest	15,2%
Mineral fertilization	
N at the level of a_1 [kg / ha]	40
N at the level of a_2, [kg / ha]	80
P_2O_5 [kg / ha]	36
K_2O [kg / ha]	161
Protection products	
Seed dressing	Kinto Duo 80 FS
Herbicides	Lintur 70 WG 150 [g/ha]
Insecticides	Danadim 400 EC 0,5 l/ha[]
Only at the level a_2	
Fungicides	Prosaro 250 EC 1 [l/ha]
Fungicides	–
Growth Regu	Cerone 480 SL 0,75 [l/ha]

Source: Own study
Źródło: Opracowanie własne

The grain yield at the level of agrotechnics a2, which was obtained in the HR of DANKO Modzurów of. Conchita variety, was 92% of the standard, where 100% of the standard was 75.5 dt. After conversion, 92% gave the achieved yield of 69.5 dt. In the area of the Prudnik commune, the studied variety of spring malting barley Kangoo yielded at the level of 71.3 dt, which gave 94.5% of the COBORU standard from the

Racibórz District. The next points of comparison are presented in the table below. (Tab. 5).

Table 5. Comparison of the two barley varieties

Tabela 5. Porównanie dwóch odmian jęczmienia

Parameter	Kangoo – Prudnik	Commune Conchita – Raciborski District
Crop dt	71,3	69,5
Crop %	94,5	92
Grain moisture at harvest	13,25	15,2
Protein content	10,65	9,2

Source: Own study

Źródło: Opracowanie własne

The Kangoo barley variety, compared to the Conchita variety, looks better despite the poorer soil conditions and the soil's lower nutrient abundance. The results achieved by the Kangoo variety could have been influenced by the application of two-treatment protection and an earlier sowing date. The lower protein content of the Conchita variety, despite the use of a higher dose of nitrogen, is a species characteristic of this variety.

SUMMARY AND CONCLUSIONS

1. It has been proved that under given soil and climatic conditions a favorable and high yield of winter barley was obtained. The Kangoo variety achieved a higher yield compared to the Conchita variety.
2. The obtained parameters of the winter barley of the Kangoo variety were satisfactory and put it in the leading position in the production for the brewing industry.
3. The input of work and the processes performed did not constitute exceptions to the basic agrotechnical procedures.
4. The obtained crops may be the result of favorable weather and climatic and soil conditions in a given year.

PODSUMOWANIE I WNIOSKI

1. Wykazano, że w danych warunkach glebowo-klimatycznych uzyskano korzystny i wysoki plon jęczmienia ozimego. Odmiana Kangoo dała wyższy plon w porównaniu z odmianą Conchita.
2. Uzyskane parametry jęczmienia ozimego odmiany Kangoo były zadowalające i stawiały go na czołowej pozycji w produkcji dla przemysłu piwowarskiego.
3. Nakład pracy i wykonywane procesy nie różniły się od podstawowych zabiegów agrotechnicznych.
4. Uzyskiwane plony mogą być wynikiem sprzyjających warunków pogodowych i klimatyczno-glebowych w danym roku.

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