

# BREAD-MAKING POTENTIAL AND YIELDING OF HYBRID WHEAT UNDER VARIED AGRONOMIC AND ENVIRONMENTAL FACTORS

– Research paper –

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**Abstract:** The purpose of this study was to determine the effect of simplified tillage systems (RT, NT) in comparison with conventional tillage (CT) on technological grain quality and baking value, as well as of hybrid wheat grown under variable weather conditions. A three-year field trial experiment was conducted using a randomised block design, in triplicate. The factors studied were as follows: I - three tillage systems - no-tillage (NT), reduced (RT), and conventional (CT); II - two winter wheat cultivars ‘Hylux’ (cv. hybrid) and for comparison ‘Bogatka’ (cv. common). The use of CT and RT tillage systems compared to NT significantly increased yield by 8.9 and 7.7%, respectively, and selected grain quality parameters along with a more favorable gluten protein profile. The flour obtained, with water absorption above 58.0%, can be classified as strong flour with good farinographic and alveograph parameters. The genetic characteristics of the wheat cultivars determined the technological quality of the grain and the baking value, as well as the grain yield. For ‘Hylux’ cv. hybrid wheat, there was a higher yield and better grain quality, which contained significantly more gliadins and glutenins, and the flour was characterised by higher parameters that determine the preferred viscoelastic properties of the dough. The common ‘Bogatka’ wheat cv. accumulated higher contents of  $\omega$  gliadins and LMW and HMW glutenin subunits in the grain, while for  $\alpha/\beta$  and  $\gamma$  gliadin contents the difference was not significant. A fairly dry period (June–July) of wheat ripening reduced the grain yield but was favourable for higher values of quality characteristics, gluten protein fractions, as well as the farinographic (WAF, DDT, DS) and alveograph (W, P, L) parameters.

**Keywords:** dough rheology, protein fractions, grain yield, hybrid winter wheat, soil tillage, weather conditions

## INTRODUCTION

Common wheat (*Triticum aestivum* ssp. *vulgare*) is one of important cereal crops grown both in Poland and worldwide, of determining human nutrition. The nutritional needs for essential nutrients, including energy compounds and protein, are met by cereal crops, mainly wheat production (Godfrey et al., 2010; Hofmeijer et al., 2019). The primary use of wheat grain is for in the production of flour, which is the basis of bakery production due to its exceptional baking properties. The quality of wheat grain, and thus the corresponding flour quality obtained from grain grinding, depends primarily on varietal factors, but is also shaped by the weather

conditions prevailing during wheat growth and grain harvest, the applied agrotechnical treatments, and the postharvest storage conditions of the grain (Miś, 2001; Horvat et al., 2015).

Soil tillage is one of important operations in wheat agrotechnics, and at the same time the most energy-intensive, often accounting for part of the total energy needed for wheat production. Soil tillage is also an significant factor that influences grain quality and yield, and soil structure properties (Jaskulska et al., 2018, Małecka et al., 2012). Previous research (Sip et al., 2013, Hausherr Lüder et al., 2019, Wozniak and Rachoń, 2020), suggests that reducing or eliminating conventional tillage (CT) improves soil quality by improving bioactivity and water retention capacity, reducing the risk and

Received: 07.12.2022

Accepted in revised form: 14.12.2022

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increasing carbon content. Furthermore, reducing the intensity of tillage intensity and using reduced tillage (RT) and no-tillage (NT) reduces labour and fuel consumption compared to conventional tillage (CT). In conventional tillage and in reduced tillage systems, the wheat yield and grain quality parameters are functions of the interaction of many agronomic and environmental factors. In particular, the variety profile, availability of nitrogen (N) and also hydrothermal factors (temperature, precipitation) are main factors for protein accumulation during grain filling (Hadnadev et al. 2013, Silva et al. 2019).

One of the most important wheat traits that determines the selection of wheat cultivars for improved quality traits is the protein content, which determines the viscoelastic properties of the wheat dough. Rheological properties are determined by the amount and composition of glutenin and gliadin that make up gluten, and glutenin proteins show a significantly greater influence on favorable rheological properties. Thanks to rheological studies, it is possible to obtain influence on the dough properties during mixing and fermentation under conditions similar to those of industrial dough production, which significantly facilitates the prediction of the quality of the baking product (Horvat et al. 2015, Stępniewska and Słowik 2016). According to some authors (Jaskulska et al. 2018, Peigné et al. 2013.), there is a decrease in wheat yields when applying a conventional tillage (CT) system to reduced tillage (RT or NT systems), with no variation in quality traits, fractional composition, and baking value parameters. A study by Pagnani et

al. (2019) shows that the use of no-tillage (NT) with the simultaneous introduction of a legume-based rotation results in an increase in wheat yields and protein, gluten-gluten, and gluten protein fractions in the grain. Lopez-Bellodo et al. (1998) found that wheat grain from the CT system was characterized by higher protein content than wheat grain from the NT system. Yousefian et al. (2021) further showed that CT, compared to NT, resulted in a higher ash content and more favourable grain physicochemical properties but lower levels of fat and water in the grain.

Most studies in the literature deal with the impact of conventional tillage (CT) and reduced tillage (RT, NT) in the context of evaluating the productivity and commodity science value of grain and flour of common wheat cultivars (Haliniarz et al. 2013, Sip et al. 2013), durum wheat (De Vita et al. 2007, Pagnani et al. (2019) and spelt wheat (Podolska et al. 2020). There is a lack of or few studies (Buczek et al. 2021) studies on hybrid wheat performance and, in particular, on the evaluation of the baking value of hybrid varieties in the context of obtaining high grain quality both under conventional tillage (CT) and also in relation to tillage systems (RT, NT) that reduce tillage and use simplified methods.

Therefore, the objective of this study was to influence how reduced tillage systems (RT, NT) in comparison to conventional tillage (CT) affect the technological value of the grain, including the fractional protein composition (profile) and baking value, as well as the productivity of hybrid wheat grown under variable weather conditions.

## MATERIAL AND METHODS

### Field experiment and plant material

The field trial was conducted in the growing 2016/2017, 2017/2018 and 2018/2019 in Boguchwała (49°59'N, 21°56'E), Subcarpathian Voivodeship, in the south-east of Poland. The experiment was established with the method of completely randomized blocks (6×100 m) in three replications.

The tillage systems (I Factor) included conventional tillage (CT), reduced tillage (RT) and no-tillage (NT). In conventional tillage (CT), shallow ploughing, harrowing and pre-sowing ploughing were performed. The shallow ploughing was performed with a 5-share reversible plough and the pre-sowing ploughing was performed with a 3-share reversible plough.

The reduced tillage (RT) was performed with a disc harrow, and before sowing, seedbed preparation combine (cultivator + mounted rolling basket +

harrow). In no-tillage (NT), herbicide treatment with glyphosate was performed 4.0 dm<sup>3</sup>/ha. The wheat was sown with a seeding machine with double disc coulters, directly into the stubble field. Two bread cultivars (II Factor) of winter wheat were tested: 'Hylux' hybrid cv. (Saaten-Union GmbH, France) and common 'Bogatka' cv. (Danko GmbH, Poland) for comparison. The tested wheat cultivars were classified in the CCA (2020). The wheat cultivars were sown from the 25th of September to the 15th of October during the study period. The sowing depth was 3–4 cm and the spacing between rows was 13.5 cm. The forecrop was winter rapeseed. The sowing rate of the hybrid cultivar ('Hylux' cv.) was 2.0 million grains·ha<sup>-1</sup>, and that of the common cultivar ('Bogatka' cv) was 3.6 million grains·ha<sup>-1</sup>, respectively. Before sowing, tebuconazole in the amount of 0.5 dm<sup>3</sup>/ha was applied as seed dressing. For weed control,

fenoxaprop-P-ethyl and 2,4-dichlorophenoxyacetic acid + mecoprop-P at a dose of 1.0 and 2.0 dm<sup>3</sup>/ha were used in the stage 22 BBCH. In the stages 33 BBCH and 56 BBCH, the fungicides propiconazole + fenpropidin (1.0 dm<sup>3</sup>/ha) and propiconazole + cyproconazole (0.5 dm<sup>3</sup>/ha) were used to control diseases. The insecticide dimethoate (0.5 dm<sup>3</sup>/ha) was used in the ear emergence stage 56 BBCH. The growth retardant in dose 0.4 dm<sup>3</sup>·ha<sup>-1</sup> (trinexapac-ethyl) was used in the stage 33 BBCH. Nitrogen fertilization (NH<sub>4</sub>NO<sub>3</sub>, 150 kg/ha) of wheat cultivars was carried out in three doses. After vegetation began, 60 kg/ha was applied in spring, and in the growing period doses of 50 and 40 kg/ha in the stem elongation stage 33 BBCH and in the ear emergence stage 56 BBCH, respectively, were used. Phosphorus (Ca(H<sub>2</sub>PO<sub>4</sub>)<sub>2</sub>) and potassium fertilisers (KCl) were applied once in autumn in doses of 90 kg P/ha and 140 kg K/ha. In addition, a preparation of foliar fertilisation with FoliQ Mikromix (33 BBCH, 1.5 dm<sup>3</sup>/ha) was applied. The fertiliser contained (in g/L): 120 N, 4.3 B, 7.2 Cu, 14.5 Fe, 21.7 Mn, 0.15 Mo and 14.5 Zn. Mineral fertilising, plant protection products, foliar fertilisation and wheat harvest were performed in accordance with the BBCH scales (2001). Wheat harvest was performed during the research years between 20–30 July in the ripening stage 92 BBCH.

### Soil and Weather Conditions

The trial was conducted on brown alluvial soils of granulometric composition of loamy clay, Fluvic Cambisols WRB (2015). In terms of agricultural suitability, the soil is included was to the rye complex very good (valuation class IVa, pH–slightly acidic/neutral, organic carbon–average,

N<sub>min</sub>–low). The content of available phosphorus (P) and potassium (K) were high. The magnesium (Mg) and microelements (Zn–zinc, Mn–manganese, Cu–copper) were average (Table 1).

During the autumn vegetation period (09–11 months), the years 2016/2017 and 2017/2018 were characterized by a higher and in 2018/2019 was lower amount of precipitation compared to the long-term period (Table 2). With the exception of 2018/2019, during the autumn vegetation (09–11 months) the temperature was higher. During the winter dormancy period (12–03 months) the temperature was lower than the long-term temperature.

In the period of spring–summer vegetation, the weather conditions were beneficial, with the 2016/2017 season being the closest to the multi-year averages. The seed formation and ripening period (June–July) in the 2016/2017 season can be classified as rather humid (K = 1.81), and in the periods of 2017/2018 and 2018/2019 as rather dry (K = 1.18) and dry (K = 0.93), respectively (Figure 1).

### Analytical methods

Grains of hybrid wheat cv. 'Hylux' and common wheat cv. 'Bogatka' with a moisture content of 13.0±0.1% were taken at random in an amount of 6 kg each and separated into 3 batches of 2 kg each, which were subjected to the milling process (Quadrumat Junior, Brabender, Germany).

Collected samples of wheat flour were analysed in the laboratory, and the following were determined, in accordance with the standards: protein content (AACC, 2009), wet gluten, gluten index, Zeleny sedimentation and the falling number (ICC, 1994).

Table 1. Properties of the soil (0–35 cm)

| Years     | pH<br>[mol L <sup>-1</sup><br>KCl] | organic<br>carbon<br>[g·kg <sup>-1</sup> ] | N <sub>min</sub><br>[kg·ha <sup>-1</sup> ] | Nutrients [mg·kg <sup>-1</sup> ] |       |       |      |       |     |
|-----------|------------------------------------|--------------------------------------------|--------------------------------------------|----------------------------------|-------|-------|------|-------|-----|
|           |                                    |                                            |                                            | P                                | K     | Mg    | Zn   | Mn    | Cu  |
| 2016/2017 | 7.31                               | 20.4                                       | 55.1                                       | 203.0                            | 269.2 | 126.1 | 13.1 | 388.0 | 6.1 |
| 2017/2018 | 6.05                               | 20.0                                       | 66.2                                       | 128.1                            | 180.1 | 141.2 | 12.1 | 252.1 | 6.5 |
| 2018/2019 | 6.11                               | 19.5                                       | 60.1                                       | 75.0                             | 251.0 | 228.4 | 11.4 | 264.5 | 6.0 |

Table 2. Temperature and precipitation in the experimental period and long-term trend

| Period/Months         | *Grownig seasons and long-term (L-t) |               |               |      |                    |               |               |       |
|-----------------------|--------------------------------------|---------------|---------------|------|--------------------|---------------|---------------|-------|
|                       | 2016/<br>2017                        | 2017/<br>2018 | 2018/<br>2019 | L-t  | 2016/<br>2017      | 2017/<br>2018 | 2018/<br>2019 | L-t   |
|                       | Temperature [°C]                     |               |               |      | Precipitation [mm] |               |               |       |
| Autum/09–11           | 7.1                                  | 8.3           | 8.7           | 8.3  | 234.5              | 230.1         | 135.0         | 135.2 |
| Winter rest/12–03     | –2.8                                 | –0.9          | –0.4          | –1.8 | 67.0               | 74.3          | 87.1          | 108.0 |
| Spring-summer/04–07   | 12.2                                 | 14.9          | 13.5          | 12.0 | 312.7              | 271.5         | 231.0         | 314.9 |
| Grain formation/06–07 | 18.5                                 | 18.0          | 17.8          | 17.4 | 125.0              | 95.6          | 72.8          | 69.4  |
| Sowing-harvest/09–07  | 6.6                                  | 7.5           | 7.9           | 6.9  | 614.2              | 575.9         | 453.1         | 558.1 |

The quantitative and qualitative protein were determined with the RP-HPLC technique according to Konopka et al. (2007) and Wieser and Zimmerman (2000). The content of albumins and globulins, gliadins and glutenins was analysed. General flours with an extract of approximately 70% were prepared from passage flour and used for farinographic and alveograph properties (AACC 2009). Flour water absorption, as well as development time (DT) and dough consistency, dough softening, and quality number were determined using a farinograph (Brabender, Germany; ISO, 2015). A flour sample equivalent to 50 g of flour flour was tested with a moisture

content of 14%. Gluten extensibility (L), tensile strength (P), baking value (W) and strength/extensibility ratio (P/L) were determined according to the instructions of the alveograph (Chopin, France) instructions (ISO, 2015).

### Statistical Analysis

Results achieved were elaborated statistically with the analysis of variance (ANOVA), whereas the significance of differences between mean values was evaluated with the Tukey's LSD test,  $P \leq 0.05$ . The computations were done using the Statistica 13.3 software (TIBCO Software Inc, Palo Alto, CA, USA).

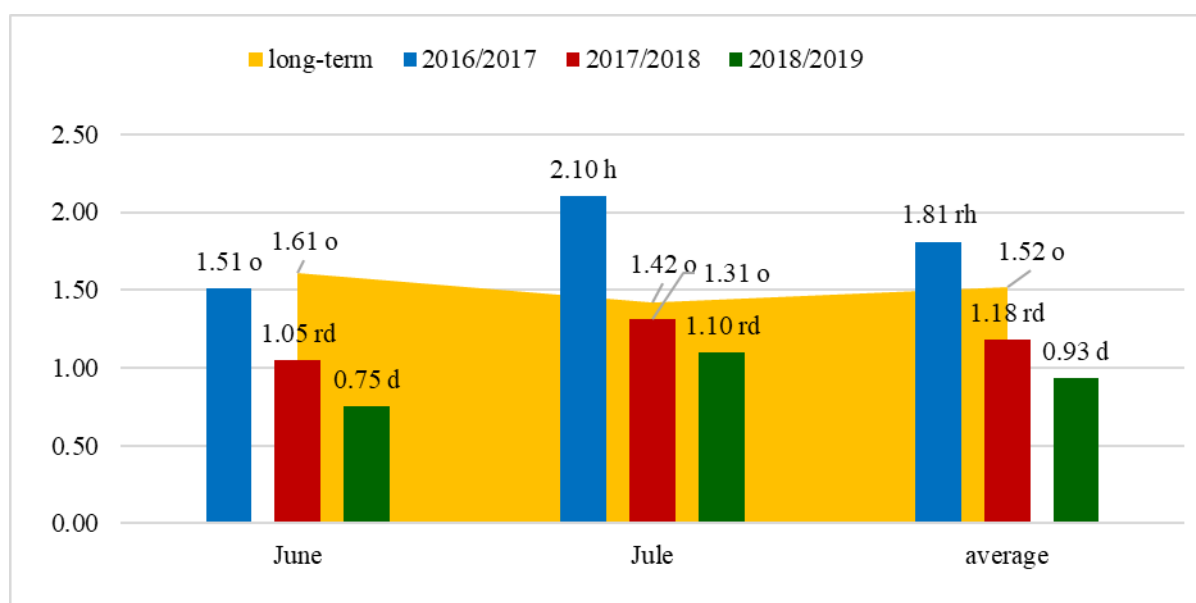


Figure 1. Coefficients [k] in grain formation period (d–dry, rd–rather dry, o–optimal, rh–rather humid, h–humid; Skowera, 2014)

## RESULTS AND DISCUSSION

### Quality parameters and grain yield

The results of the basic technological and chemical characteristics of the wheat grain analysed and grain yield are shown in Table 3.

The mean grain yield was  $8.36 \text{ t ha}^{-1}$ , with a significant dependence on experimental factors and years of study (Table 3). The application of the CT and RT cropping system, compared to NT, resulted in a important growth in yield by 8.9 and 7.7%, respectively. In contrast, yield differences between CT and RT amounted to  $0.11 \text{ t ha}^{-1}$  and were not significant. A study by Haliniarz et al. (2013) confirms an increase in wheat grain yield of 1.80 and  $0.95 \text{ t ha}^{-1}$  in CT and RT cropping systems compared to the NT. Małacka et al. (2012) found a important decrease in wheat yield (up to 24.0%) for NT compared to CT. According to De Vita et al.

(2007), the average wheat yield was similar in the CT and NT cropping systems, with a difference of  $0.52 \text{ t ha}^{-1}$ , which was statistically insignificant. Cvs. 'Bogatka' and 'Hylux' responded similarly, producing significantly higher grain yield yields in the CT and RT cropping systems relative to NT. The average grain yield of hybrid 'Hylux' cv. wheat was significantly higher by 5.0% than that of the common 'Bogatka' cv. The highest difference in grain yield was shown between the cultivars in the RT cropping system and the lowest in the CT system.

Hausherr Lüder et al. (2019) reported that the conventional cropping system (CT), compared to RT and NT, results in better nitrogen utilization, use, which improves wheat grain quality parameters.

Table 3. Chosen physico-chemical properties and grain yield

| Treatment |          | Total protein           | Gluten content          | Gluten index        | Zeleny test             | Falling number      | Grain yield              |
|-----------|----------|-------------------------|-------------------------|---------------------|-------------------------|---------------------|--------------------------|
| Tillage   | Cultivar | [g·kg <sup>-1</sup> ]   | [%]                     | [%]                 | [ml]                    | [s]                 | [t·ha <sup>-1</sup> ]    |
| CT        | Bogatka  | 127.2 <sup>b</sup> ±1.1 | 26.5 <sup>b</sup> ±1.9  | 92 <sup>b</sup> ±2  | 44.6 <sup>a</sup> ±3.4  | 330 <sup>a</sup> ±4 | 8.52 <sup>b</sup> ±0.45  |
|           | Hylux    | 135.1 <sup>a</sup> ±2.3 | 29.6 <sup>a</sup> ±1.7  | 96 <sup>a</sup> ±3  | 46.3 <sup>a</sup> ±2.1  | 317 <sup>d</sup> ±2 | 8.79 <sup>a</sup> ±0.65  |
| RT        | Bogatka  | 124.7 <sup>b</sup> ±1.1 | 25.1 <sup>ab</sup> ±1.7 | 90 <sup>b</sup> ±4  | 40.3 <sup>b</sup> ±3.5  | 311 <sup>b</sup> ±1 | 8.25 <sup>b</sup> ±0.55  |
|           | Hylux    | 131.4 <sup>a</sup> ±1.8 | 27.8 <sup>a</sup> ±1.4  | 95 <sup>a</sup> ±5  | 43.1 <sup>cd</sup> ±4.4 | 309 <sup>b</sup> ±2 | 8.85 <sup>a</sup> ±0.79  |
| NT        | Bogatka  | 117.3 <sup>c</sup> ±0.9 | 22.6 <sup>bc</sup> ±0.7 | 88 <sup>bc</sup> ±3 | 39.6 <sup>b</sup> ±2.1  | 318 <sup>c</sup> ±4 | 7.68 <sup>ac</sup> ±0.59 |
|           | Hylux    | 125.5 <sup>b</sup> ±1.2 | 23.5 <sup>b</sup> ±0.9  | 90 <sup>b</sup> ±0  | 42.6 <sup>cd</sup> ±6.2 | 315 <sup>c</sup> ±2 | 8.10 <sup>b</sup> ±0.69  |
| CT        |          | 131.2 <sup>a</sup> ±2.4 | 28.1 <sup>a</sup> ±2.5  | 94 <sup>a</sup> ±1  | 45.5 <sup>a</sup> ±1.6  | 324 <sup>a</sup> ±5 | 8.66 <sup>a</sup> ±0.82  |
| RT        |          | 128.1 <sup>a</sup> ±1.0 | 26.5 <sup>a</sup> ±1.2  | 93 <sup>a</sup> ±3  | 41.7 <sup>b</sup> ±1.9  | 310 <sup>b</sup> ±1 | 8.55 <sup>a</sup> ±0.78  |
| NT        |          | 121.4 <sup>b</sup> ±0.5 | 23.1 <sup>b</sup> ±0.9  | 89 <sup>b</sup> ±0  | 41.1 <sup>b</sup> ±3.2  | 317 <sup>b</sup> ±2 | 7.89 <sup>b</sup> ±0.56  |
|           | Bogatka  | 123.1 <sup>b</sup> ±0.8 | 24.7 <sup>b</sup> ±1.6  | 90 <sup>b</sup> ±1  | 41.5 <sup>b</sup> ±4.4  | 320 <sup>a</sup> ±4 | 8.15 <sup>b</sup> ±0.35  |
|           | Hylux    | 130.7 <sup>a</sup> ±3.1 | 27.0 <sup>a</sup> ±2.6  | 94 <sup>a</sup> ±3  | 44.0 <sup>a</sup> ±5.2  | 314 <sup>a</sup> ±2 | 8.58 <sup>a</sup> ±0.41  |
| Year      |          |                         |                         |                     |                         |                     |                          |
| 2016/2017 |          | 122.8 <sup>c</sup> ±0.9 | 23.8 <sup>b</sup> ±0.9  | 94 <sup>a</sup> ±1  | 38.3 <sup>b</sup> ±3.2  | 301 <sup>b</sup> ±3 | 8.41 <sup>a</sup> ±0.52  |
| 2017/2018 |          | 126.9 <sup>b</sup> ±1.1 | 25.5 <sup>ab</sup> ±1.3 | 92 <sup>a</sup> ±2  | 43.2 <sup>a</sup> ±1.8  | 311 <sup>b</sup> ±2 | 8.60 <sup>a</sup> ±0.35  |
| 2018/2019 |          | 130.9 <sup>a</sup> ±2.2 | 28.3 <sup>a</sup> ±2.4  | 91 <sup>a</sup> ±2  | 46.8 <sup>a</sup> ±4.5  | 338 <sup>a</sup> ±5 | 8.08 <sup>b</sup> ±0.38  |

± standard deviation; different letters in the same column indicate significant differences [ $p \leq 0.05$ ]

In our study, important growth content of total protein was found (7.5 and 5.2%), wet gluten (17.8 and 11.2%), and gluten index (by 5.3 and 4.3%) in the flour obtained from wheat grain derived from the CT and RT cropping systems compared to NT. The CT system also favoured more favourable values for sedimentation index and falling the decreasing number, with the parameters not statistically different in the RT and NT systems. A study by Sip et al. (2013) found that the total protein, gluten, and sedimentation index were significantly higher in CT than in RT, by 6.3, 6.2 and 4.3%, respectively. Hybrid 'Hylux' cv. compared to ordinary 'Bogatka' cv. had significantly higher total protein and sedimentation index contents (except CT) in each cropping system; gluten and falling number in the CT system and gluten index in the CT and RT systems (Table 3). The quality traits of the tested wheat cultivars did not differ from those reported by Jaskulska et al. (2018). On the other hand, it was higher than the values for total protein and gluten reported by Wozniak and Rachoń (2020), who further demonstrated the lack of influence of tillage systems on these parameters.

In the 2017/2018 growing season, where the hydrothermal conditions during the grain formation period were quite dry, the highest grain obtained yield (8.60 t·ha<sup>-1</sup>). Drought during the 2018/2019 growing season with a total rainfall of 453.1 mm and a temperature of 7.9°C favoured higher values of quality parameters (total protein, gluten content, sedimentation index, falling number), although the grain obtained had a lower gluten index. According to a study by Jaskulska et al. (2018), the optimal quality parameters of wheat grain (total protein,

gluten, sedimentation index) were obtained in a growing season with 369.2 mm of rainfall and a temperature of 8.1°C. According to García-Molina and Barro (2017), excess rainfall during the final growing season of wheat can weaken the mechanical strength of gluten. Regardless of the tillage systems performed, the occurrence of drought can be a major factor limiting yield and sometimes grain quality in wheat (Sip et al., 2013).

#### Protein fraction composition

The content of gluten and its individual fractions is very important for the baking value of a given flour, as gluten acts as a binding agent connecting the individual flour components and additives, ultimately forming the dough skeleton and structure (Bojňanská and Francáková 2002). The sum of gliadins in grain from the CT and RT cropping systems was significantly higher by 36.4 and 20.4% than from the NT system. The increase in glutenin in the CT cropping system compared to the RT and NT systems was 37.4 and 27.1%, respectively. The gliadin and glutenin content showed significant differences between the CT and RT cropping systems, which were 20.7 and 14.1%. No significant differences were shown in the albumin and globulin content of the grain according to the cropping systems (Table 4). Furthermore, Peigne et al. (2014) did not show significant changes in the content of albumin and globulins and glutenin content in wheat grain according to the CT and RT cropping systems, with a trend of higher amounts of gliadins from the RT system than from CT. Furthermore, the increase in gliadins and glutenins in the CT cropping system compared to NT may be due to a more favourable assimilation of nutrients, including mainly nitrogen, by wheat as a result of lower soil compaction in the

CT cropping system (Hofmeijer et al. 2019). According to Godfrey et al. (2010), the higher proportion of gliadin and glutenin proteins is determined by the increased application of nitrogen fertiliser especially during the wheat flowering period. This is acknowledged by the study of Krejčířová et al. (2007) where the share of stock proteins in conventional cultivation was 92.4% and albumin and globulins 7.5%, while in organic cultivation it was 82.4 and 17.6%, respectively. In our study, the proportion of gliadins and glutenins compared to albumins and globulins was clearly predominant and was 82.4% in the CT system and

81.1% in NT. The CT growing system resulted in a important increase in gliadin and glutenin subunit content compared to NT.

There were no statistical differences in the contents of  $\gamma$  and  $\omega$  gliadins and HMW and LMW glutenins in CT and RT and RT and NT cropping systems. The grain of hybrid 'Hylux' cv. compared to regular 'Bogatka' cv. contained on average much more glutenins and gliadins, from 15.5 to 23.0%, respectively. In the grain of cv. 'Hylux' had lower  $\omega$  gliadin and HMW and LMW glutenin subunit than cv. 'Bogatka', while for  $\alpha/\beta$  and  $\gamma$  gliadin the difference was not significant (Table 5).

Table 4. Composition and ratio of proteins

| Treatment              |           | Alb+Glo                | Gliadins                | Glutenins               | Sum<br>of protein       | Ratio                    |                          |
|------------------------|-----------|------------------------|-------------------------|-------------------------|-------------------------|--------------------------|--------------------------|
| Tillage                | Cultivar  |                        |                         |                         |                         | Gli/Glu                  | H/L                      |
| [mAU s <sup>-1</sup> ] |           |                        |                         |                         |                         |                          |                          |
| CT                     | Bogatka   | 11.2 <sup>a</sup> ±0.3 | 30.5 <sup>b</sup> ±0.9  | 22.4 <sup>b</sup> ±0.8  | 64.2 <sup>a</sup> ±0.5  | 1.36 <sup>b</sup> ±0.11  | 0.25 <sup>b</sup> ±0.02  |
|                        | Hylux     | 12.4 <sup>a</sup> ±0.3 | 35.1 <sup>a</sup> ±1.2  | 27.5 <sup>a</sup> ±0.6  | 75.1 <sup>d</sup> ±0.4  | 1.28 <sup>b</sup> ±0.14  | 0.37 <sup>a</sup> ±0.04  |
| RT                     | Bogatka   | 11.1 <sup>a</sup> ±0.7 | 25.0 <sup>bc</sup> ±0.6 | 18.6 <sup>bc</sup> ±1.1 | 54.8 <sup>b</sup> ±0.5  | 1.35 <sup>a</sup> ±0.02  | 0.31 <sup>a</sup> ±0.06  |
|                        | Hylux     | 11.5 <sup>b</sup> ±0.2 | 27.0 <sup>a</sup> ±0.7  | 24.2 <sup>a</sup> ±0.4  | 62.8 <sup>e</sup> ±0.4  | 1.12 <sup>b</sup> ±0.01  | 0.27 <sup>b</sup> ±0.04  |
| NT                     | Bogatka   | 10.4 <sup>b</sup> ±0.2 | 18.4 <sup>bc</sup> ±0.8 | 13.3 <sup>c</sup> ±0.2  | 42.1 <sup>c</sup> ±0.6  | 1.38 <sup>a</sup> ±0.07  | 0.29 <sup>b</sup> ±0.01  |
|                        | Hylux     | 8.9 <sup>c</sup> ±0.5  | 23.0 <sup>b</sup> ±0.6  | 17.9 <sup>b</sup> ±0.6  | 49.9 <sup>cf</sup> ±0.2 | 1.29 <sup>b</sup> ±0.08  | 0.28 <sup>b</sup> ±0.03  |
| CT                     |           | 11.8 <sup>a</sup> ±0.4 | 32.8 <sup>a</sup> ±1.5  | 24.9 <sup>a</sup> ±0.9  | 69.6 <sup>a</sup> ±0.8  | 1.32 <sup>b</sup> ±0.04  | 0.31 <sup>a</sup> ±0.04  |
| RT                     |           | 11.3 <sup>a</sup> ±0.6 | 26.0 <sup>b</sup> ±0.8  | 21.4 <sup>b</sup> ±0.5  | 58.8 <sup>b</sup> ±0.7  | 1.23 <sup>a</sup> ±0.06  | 0.29 <sup>a</sup> ±0.03  |
| NT                     |           | 9.7 <sup>b</sup> ±0.5  | 20.7 <sup>c</sup> ±0.7  | 15.6 <sup>c</sup> ±0.9  | 46.0 <sup>c</sup> ±0.4  | 1.34 <sup>b</sup> ±0.12  | 0.28 <sup>ab</sup> ±0.06 |
|                        | Bogatka   | 10.9 <sup>a</sup> ±0.4 | 24.7 <sup>b</sup> ±0.4  | 18.1 <sup>b</sup> ±0.8  | 53.7 <sup>b</sup> ±0.4  | 1.36 <sup>a</sup> ±0.04  | 0.28 <sup>a</sup> ±0.07  |
|                        | Hylux     | 11.0 <sup>a</sup> ±0.3 | 28.4 <sup>a</sup> ±0.6  | 23.2 <sup>a</sup> ±1.3  | 62.6 <sup>a</sup> ±0.5  | 1.23 <sup>b</sup> ±0.09  | 0.31 <sup>a</sup> ±0.03  |
| Year                   |           |                        |                         |                         |                         |                          |                          |
|                        | 2016/2017 | 10.0 <sup>b</sup> ±0.6 | 21.1 <sup>b</sup> ±0.4  | 17.0 <sup>b</sup> ±0.6  | 48.1 <sup>c</sup> ±0.2  | 1.24 <sup>b</sup> ±0.02  | 0.30 <sup>a</sup> ±0.01  |
|                        | 2017/2018 | 11.1 <sup>a</sup> ±0.2 | 27.9 <sup>a</sup> ±0.9  | 20.6 <sup>a</sup> ±0.8  | 59.6 <sup>b</sup> ±0.4  | 1.35 <sup>a</sup> ±0.03  | 0.29 <sup>a</sup> ±0.02  |
|                        | 2018/2019 | 11.5 <sup>a</sup> ±0.4 | 20.7 <sup>b</sup> ±0.8  | 24.3 <sup>a</sup> ±1.2  | 66.5 <sup>a</sup> ±0.6  | 1.26 <sup>ab</sup> ±0.04 | 0.30 <sup>a</sup> ±0.01  |

± standard deviation; letters in the same column indicate significant differences [ $p \leq 0.05$ ]; Alb+Glo–albumins+globulins; Gli/Glu–ratio of gliadins to glutenins. H/L–ratio of high molecular weight [HMW] to low molecular weight [LMW]

Table 5. Content of subunits of proteins

| Treatment              |           | Gliadins                |                        |                        | Glutenins              |                        |
|------------------------|-----------|-------------------------|------------------------|------------------------|------------------------|------------------------|
| Tillage                | Cultivar  | $\alpha/\beta$          | $\gamma$               | $\omega$               | HMW                    | LMW                    |
| [mAU·s <sup>-1</sup> ] |           |                         |                        |                        |                        |                        |
| CT                     | Bogatka   | 17.0 <sup>a</sup> ±0.1  | 9.6 <sup>a</sup> ±0.1  | 4.0 <sup>c</sup> ±0.2  | 4.5 <sup>c</sup> ±0.1  | 17.9 <sup>c</sup> ±0.4 |
|                        | Hylux     | 18.1 <sup>a</sup> ±0.3  | 10.8 <sup>a</sup> ±0.5 | 6.3 <sup>a</sup> ±0.2  | 7.4 <sup>a</sup> ±0.2  | 20.1 <sup>a</sup> ±0.4 |
| RT                     | Bogatka   | 13.9 <sup>a</sup> ±0.3  | 7.7 <sup>ab</sup> ±0.2 | 3.5 <sup>c</sup> ±0.4  | 4.4 <sup>c</sup> ±0.2  | 14.2 <sup>d</sup> ±0.2 |
|                        | Hylux     | 14.3 <sup>a</sup> ±0.2  | 8.0 <sup>a</sup> ±0.3  | 4.8 <sup>b</sup> ±0.2  | 5.2 <sup>b</sup> ±0.3  | 19.0 <sup>a</sup> ±0.3 |
| NT                     | Bogatka   | 10.4 <sup>a</sup> ±0.1  | 6.1 <sup>b</sup> ±0.1  | 2.0 <sup>d</sup> ±0.1  | 3.0 <sup>bd</sup> ±0.1 | 10.3 <sup>e</sup> ±0.2 |
|                        | Hylux     | 12.3 <sup>a</sup> ±0.4  | 7.3 <sup>b</sup> ±0.1  | 3.5 <sup>b</sup> ±0.1  | 3.9 <sup>b</sup> ±0.2  | 14.0 <sup>b</sup> ±0.1 |
| CT                     |           | 17.5 <sup>a</sup> ±0.2  | 10.2 <sup>a</sup> ±0.2 | 5.2 <sup>a</sup> ±0.0  | 6.0 <sup>a</sup> ±0.4  | 19.0 <sup>a</sup> ±0.4 |
| RT                     |           | 14.1 <sup>a</sup> ±0.2  | 7.8 <sup>b</sup> ±0.2  | 4.1 <sup>ab</sup> ±0.1 | 4.8 <sup>ab</sup> ±0.1 | 16.6 <sup>b</sup> ±0.5 |
| NT                     |           | 11.3 <sup>b</sup> ±0.0  | 6.7 <sup>3</sup> ±0.0  | 2.7 <sup>b</sup> ±0.0  | 3.5 <sup>b</sup> ±0.4  | 12.2 <sup>c</sup> ±0.1 |
|                        | Bogatka   | 13.7 <sup>a</sup> ±0.1  | 7.8 <sup>a</sup> ±0.0  | 3.1 <sup>b</sup> ±0.5  | 4.0 <sup>b</sup> ±0.0  | 14.1 <sup>b</sup> ±0.2 |
|                        | Hylux     | 14.9 <sup>a</sup> ±0.1  | 8.7 <sup>a</sup> ±0.1  | 4.9 <sup>a</sup> ±0.4  | 5.5 <sup>a</sup> ±0.2  | 17.7 <sup>a</sup> ±0.5 |
| Year                   |           |                         |                        |                        |                        |                        |
|                        | 2016/2017 | 12.0 <sup>b</sup> ±0.2  | 6.2 <sup>c</sup> ±0.0  | 2.9 <sup>b</sup> ±0.1  | 3.9 <sup>b</sup> ±0.1  | 13.1 <sup>b</sup> ±0.4 |
|                        | 2017/2018 | 14.8 <sup>ab</sup> ±0.4 | 8.8 <sup>a</sup> ±0.1  | 4.3 <sup>a</sup> ±0.2  | 4.6 <sup>ab</sup> ±0.2 | 16.0 <sup>a</sup> ±0.1 |
|                        | 2018/2019 | 16.1 <sup>a</sup> ±0.2  | 9.7 <sup>a</sup> ±0.4  | 4.9 <sup>a</sup> ±0.1  | 5.6 <sup>a</sup> ±0.1  | 18.7 <sup>a</sup> ±0.1 |

± standard deviation; different letters in the same column indicate significant differences [ $p \leq 0.05$ ]; HMW–high molecular weight; LMW–low molecular weight

Žilić et al. (2011) found that the contents of HMW and LMW glutenin fractions were variable depending on the variety and species, averaging 11.6 and 24.6% for bread wheat and 9.5 and 26.8% for hard wheat. Podolska et al. (2020) reported that the proportion of  $\omega$  gliadins was taking shape 2.5% for spelt wheat to 3.0% for common wheat, and  $\alpha/\beta$  gliadins characterized by 20.0% for the total protein of spelt wheat to 22.1% for common wheat. The  $\gamma$  gliadin content feature from 14.2% for spelt wheat to 15.4% for common wheat.

In our study, the smallest subfraction of gliadin was  $\omega$  gliadin, which feature from 5.9% of the total protein content for the common 'Bogatka' cv. to 7.8% for the hybrid 'Hylux' cv. The largest subfraction was  $\alpha/\beta$  gliadin, representing 23.8% of total wheat protein for cv. 'Hylux' to 25.6% for cv. 'Bogatka'. The  $\gamma$  gliadin content characterized by 13.9% of total protein (cv. 'Hylux') to 14.5% (cv. 'Bogatka'). Furthermore, the grain of hybrid 'Hylux' cv. compared to regular 'Bogatka' cv. was characterised by a higher proportion of HMW and LMW glutenins ranging from 7.4 to 8.8% and from 26.3 to 28.3% (Figure 2).

Quality of flour and its baking properties is favourably influenced by an growth in HMW glutenin content and its relationship to the glutenin subunit LMW. The Gli/Glu and HMW/LMW ratios of the wheat varieties ranged from 1.23 to 1.36 and from 0.28 to 0.31, respectively. The RT system significantly influenced a lower gliadin/glutenin

ratio, while the CT cropping system caused an increase in the HMW/LMW ratio. A higher gliadin/glutenin ratio can influence a reduced technological protein quality values of wheat cultivars (Konopka et al. 2007). More favourable Gli/Glu values were shown for hybrid 'Hylux' cv. and gliadin/glutenin ratios were higher in the 2018/2019 season where there was a periodic shortage of rainfall while the grain filling period (De Vita et al. 2007). Podolska et al. (2020) obtained a more favorable ratio HMW to LMW ratio in spelt wheat (0.40) than in common wheat (0.38). In our study, the CT cropping system influenced better HMW to LMW ratios in cv. 'Hylux', and the RT system in cv. 'Bogatka'. Furthermore, the grain of cvs. 'Hylux' and 'Bogatka' showed the lowest Gli/Glu ratio in the RT system compared to the CT and NT cropping systems.

A more favourable subunits composition and total chemical composition of proteins was found in the grain of the varieties in the 2017/2018 and 2018/2019 seasons, where lower rainfall was recorded during the growing season and the mean air temperature was advanced than during the multi-year period. A study by Horvat et al. (2015) found that extremely wet weather increased the subunits GLI and HMW subunits and decreased LMW content. The influence of environmental conditions and the composition of differentiating proteins by weather in wheat grain is also indicated by the study of Triboi et al. (2003).

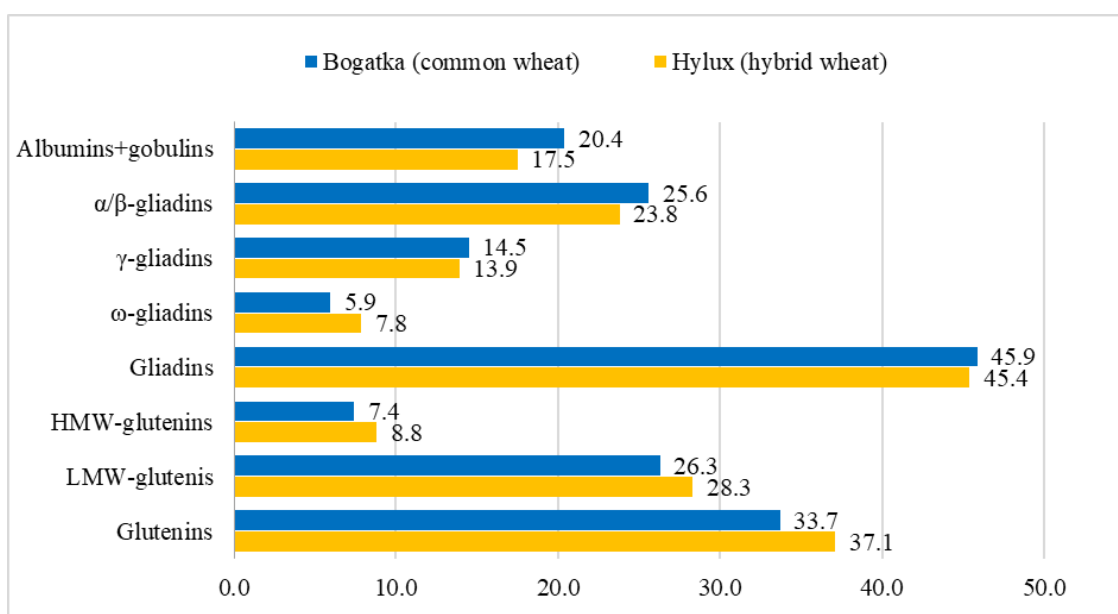


Figure 2. Participation [%] of protein fractions in common and hybrid wheat grains [sum of protein fractions = 100%]

### Bread-making properties of dough

Changes in dough structure during mixing and fermentation can be determined by examining their rheological properties. The quality of wheat dough is mainly determined by the degree of gluten lattice development with a significant contribution of water (Dąbkowska 2009). The farinographic analysis of flour plays a fundamental role in assessing the baking value of wheat flour (Vazquez et al. 2019). The quality characteristics of bread depend on the handling of the dough, including the baking value of the flour from which it was prepared. Optimising the fermentation process will ensure that bread is obtained with the right quality characteristics, including a pleasant aroma (Belcar et al. 2021; Różyło and Laskowski 2009). The water absorption of the flour obtained from ‘Hylux’ cv. hybrid wheat grain was significantly higher compared to the flour obtained from ‘Bogatka’ cv. common wheat grain by 4.7%, respectively (Table 6). Jaskulska et al. (2018) showed, not statistically confirmed, an increase in water absorption of flour from wheat grain grown in the strip till system likened to the CT and RT systems at similar levels of 0.4 to 0.5%. In our study, the increase in water absorption of flour obtained from wheat grain grown in the CT system likened to NT was shown to range from 2.6 (cv. ‘Bogatka’) to 4.4% (cv. ‘Hylux’). The examined parameter showed no statistical differentiation between the CT system and RT or NT in cv. ‘Hylux’ and RT and NT in cv. ‘Bogatka’. According to Keres et al. (2021), wheat flours with water absorption greater than 58.0% can be classified as strong. A parameter of this value was obtained by ‘Hylux’ cv. hybrid wheat from each cropping system and ‘Bogatka’ cv. common wheat from the CT system. The use of CT and RT systems compared to NT resulted in a significant increase in development time (1.3 and 0.6 min) and dough firmness (by 1.5 and 0.9 min). There were no statistical differences in the variability of the values of these characteristics in the CT and RT systems.

A study by Rachoń et al. (2016) found that wheat grown in intensive technology (high technology) production had an average of 1.7% higher water absorption than in medium technology (medium technology), with production technologies not affecting the increase in dough development time and constancy. According to Silva et al. (2019), varietal differences in wheat may determine the increase in time of these dough parameters, which affects the increase in the total protein content. The dough with these characteristics is obtained from flours containing high amounts of gluten, including high-molecular-weight glutenin.

In our study, the dough development and constancy times of the studied cultivars were within the range (2.0 to 4.9 and 3.0 to 8.3 min, respectively) reported by Stępniewska and Słowik (2016) for varieties of spring and winter wheat varieties. According to Keres et al. (2021), a dough stability time of 4.0 to 12.0 min indicates good quality. Significantly longer dough stability and development times of 3.1 and 1.4 min were distinguished by flour obtained from hybrid wheat ‘Hylux’ cv. compared to common ‘Bogatka’ cv. This indicates a strong flour of the hybrid variety, especially from the CT and RT system. In addition, quality number and degree of dough softening, the flour obtained from the ‘Hylux’ cv hybrid wheat was evaluated more favourably than the ordinary ‘Bogatka’ cv. According to Liniņa and Ruža (2015) when the degree of softening is below 70 FU, dough mixing qualities are considered satisfactory. There was no significant variation in dough softening according to tillage systems and years of study.

The most important alveographical parameter is assumed to be the work of dough deformation, called the baking quality index. This parameter varied from 125 to 345·10<sup>-4</sup> J depending on the experimental factors in our study, indicating its wide technological usefulness (Szafrńska & Stępniewska 2021).

Table 6. The farinographic and alveographic properties in flours

| Features  | Tillage                |                         |                        | Cultivar               |                        | Year                   |                         |                        |
|-----------|------------------------|-------------------------|------------------------|------------------------|------------------------|------------------------|-------------------------|------------------------|
|           | CT                     | RT                      | NT                     | Bogatka                | Hylux                  | I                      | II                      | III                    |
| WAF       | 59.7 <sup>a</sup> ±0.3 | 58.7 <sup>ab</sup> ±0.4 | 57.6 <sup>a</sup> ±0.4 | 57.2 <sup>b</sup> ±0.5 | 60.1 <sup>a</sup> ±0.7 | 57.4 <sup>c</sup> ±0.2 | 58.2 <sup>ab</sup> ±0.1 | 60.2 <sup>a</sup> ±0.3 |
| DDT       | 3.9 <sup>a</sup> ±0.1  | 3.2 <sup>a</sup> ±0.4   | 2.6 <sup>b</sup> ±0.2  | 2.5 <sup>b</sup> ±0.0  | 3.9 <sup>a</sup> ±0.3  | 2.7 <sup>b</sup> ±0.0  | 3.0 <sup>ab</sup> ±0.2  | 4.0 <sup>a</sup> ±0.3  |
| DS        | 7.3 <sup>a</sup> ±0.4  | 6.7 <sup>a</sup> ±0.2   | 5.8 <sup>b</sup> ±0.1  | 5.0 <sup>b</sup> ±0.3  | 8.1 <sup>a</sup> ±0.1  | 4.9 <sup>b</sup> ±0.5  | 7.0 <sup>a</sup> ±0.4   | 7.8 <sup>a</sup> ±0.4  |
| DoS       | 69 <sup>a</sup> ±3     | 65 <sup>a</sup> ±1      | 69 <sup>a</sup> ±2     | 69 <sup>a</sup> ±2     | 67 <sup>a</sup> ±4     | 72 <sup>a</sup> ±5     | 65 <sup>a</sup> ±3      | 67 <sup>a</sup> ±4     |
| QN        | 93 <sup>a</sup> ±5     | 80 <sup>b</sup> ±4      | 74 <sup>c</sup> ±4     | 74 <sup>b</sup> ±2     | 90 <sup>a</sup> ±3     | 80 <sup>a</sup> ±6     | 85 <sup>a</sup> ±7      | 82 <sup>a</sup> ±3     |
| W         | 59.7 <sup>a</sup> ±1.1 | 58.7 <sup>ab</sup> ±1.2 | 57.6 <sup>a</sup> ±2.1 | 57.2 <sup>b</sup> ±1.3 | 60.1 <sup>a</sup> ±6.1 | 57.4 <sup>c</sup> ±4.2 | 58.2 <sup>ab</sup> ±3.7 | 60.2 <sup>a</sup> ±5.8 |
| P         | 3.9 <sup>a</sup> ±0.2  | 3.2 <sup>a</sup> ±0.3   | 2.6 <sup>b</sup> ±0.1  | 2.5 <sup>b</sup> ±0.0  | 3.9 <sup>a</sup> ±0.4  | 2.7 <sup>b</sup> ±0.1  | 3.0 <sup>ab</sup> ±0.3  | 4.0 <sup>a</sup> ±0.2  |
| L         | 7.3 <sup>a</sup> ±0.6  | 6.7 <sup>a</sup> ±0.4   | 5.8 <sup>b</sup> ±0.6  | 5.0 <sup>b</sup> ±0.4  | 8.1 <sup>a</sup> ±0.5  | 4.9 <sup>b</sup> ±0.2  | 7.0 <sup>a</sup> ±0.6   | 7.8 <sup>a</sup> ±0.3  |
| P/L ratio | 69 <sup>a</sup> ±2     | 65 <sup>a</sup> ±4      | 69 <sup>a</sup> ±3     | 69 <sup>a</sup> ±1     | 67 <sup>a</sup> ±2     | 72 <sup>a</sup> ±5     | 65 <sup>a</sup> ±3      | 67 <sup>a</sup> ±4     |

± standard deviation; letters in the same column indicate significant differences [p≤0.05]; WAF–water absorption of flour [%]; DDT–development time [min]; DS–stability [min]; DoS–degree of softening [FU]; QN–quality number; W–deformation work [10<sup>-4</sup> J]; P–dough elasticity [mm]; L–dough extensibility [mm]; P/L ratio; I–2016/2017; II–2017/2018; III–2018/2019

The best raw material for bread production is flour, for which the value of the dough deformation ranges from  $180$  to  $250 \cdot 10^{-4}$  J (Miś 2001). The value of this parameter, obtained for flour derived from 'Hylux' cv hybrid wheat ( $W > 300 \cdot 10^{-4}$  J) indicates the potential use of the flour for the production of plain and toasted bread, while the wheat 'Bogatka' cv flour received from the grain of the population wheat ( $W < 200 \cdot 10^{-4}$  J) can be used for the production of biscuits, sponge cakes or baguettes, among others (Stępniewska and Słowik 2016).

The hybrid wheat flour of 'Hylux' cv. was also characterised by significantly higher parameters of elasticity and extensibility parameters (by 28.0 and 64.0 min) than the ordinary 'Bogatka' cv., indicating the different viscoelastic properties of the dough of these cultivars. The significant variation in the absorption of flour water and wheat dough elasticity and extensibility of the wheat dough as a variety-dependent factor was also received by Rachoń et al. (2015) and Silva et al. (2019). According to Podolska et al. (2020), moderately extensible and very strong dough is when a P/L value of 1.50, and to while dough for bakery production it should have with a P/L value in the range of 0.40 to 0.80, as shown in our study especially for Hylux cv hybrid wheat.

The use of the CT and RT system, compared to NT, resulted in important growth in dough strain work (by 1.3 and 0.6 min), dough elasticity (by 1.3 and 0.6 min) and dough extensibility (by 1.3 and 0.6 min). In contrast, no differences were found in the variability of the values of these dough characteristics in the CT and RT systems. López-Bellido et al. (2001) showed an increase in alveographic parameters in CT, compared to NT, after earlier cultivation of wheat after legumes and with increasing nitrogen fertiliser rates. According

to Troccoli et al. (2022), for durum wheat grown in CT and NT systems in long-term monoculture, the dough strain work ranged from 142.9 (CT) to  $139.5 \cdot 10^{-4}$  J (NT) and the P/L ratio from 1.94 (CT) to 2.04 (NT). In our study, comparing the CT system with RT and NT did not significantly affect the variability of the P/L ratio, which ranged from 0.8 (CT, NT) to 0.9 (RT). According to Podolska et al. (2020), raw material for bakery production should be characterized by with a P/L value in the range of 0.40 to 0.80. The P/L values for flour received from grain of 'Bogatka' common wheat cv. were 0.9 and for flour received from grain of 'Hylux' hybrid wheat cv. 0.7, indicating that the dough of both cultivars is of good strength and extensibility.

The variability of weather conditions during the study years (2016-2019) resulted in different values of the quality traits of the flour and dough of the wheat cultivars studied, as also shown in the studies of López-Bellido et al. (1998), Keres et al. (2020) and Keres et al. (2021). In the 2018/2019 season, higher rheological and alveographic parameters were obtained during wheat grain formation, where hydrothermal conditions, especially in the month of June, were described as dry and in July as rather dry. Lacko-Bartošová et al. (2021) showed an increase in alveographic parameters in wheat during the study years where, during the growing season, total precipitation and mean air temperature were 547.6 mm and 9.9°C, respectively. Furthermore, Hadnadev et al. (2013) found that optimal values of the rheological (WAF, DDT, DS) and alveographic (W, P, L) characteristics of wheat flour and dough are possible when during the grain formation period (June-July) the average air temperature is between 18.0 and the 20.0°C and precipitation sum is between 70 and 90 mm.

## CONCLUSIONS

The results of the study showed that the technological parameters of the grain, including the baking value of the flour, as well as the productivity of the wheat depended mainly on the genotype of the sowing system, the cultivar and the hydrothermal conditions prevailing especially during the grain formation period. The no-tillage (NT) system for both cultivars reduced yield, grain quality traits, as well as gluten protein fractional composition and flour baking value with respect to RT and CT. During the period (June-July) of wheat grain formation, no precipitation (dry hydrothermal conditions) caused higher farinographic and alveographic parameters were obtained, with the highest values for protein fractional composition

grain and flour quality parameters shown for the CT cropping system. Hybrid wheat 'Hylux' cv. compared to common wheat 'Bogatka' cv. produced better results and higher technological values of grain and flour quality parameters were obtained. A better protein fractional composition was also recorded in the CT cropping system. Wheat grain and flour from reduced tillage (RT) were found to have similar or slightly worse quality and baking value than those from the CT cropping system. Therefore, in hybrid wheat cultivation, the reduced tillage (RT) system can be an alternative to conventional tillage (CT), especially in variable agrotechnical and hydrothermal conditions during the growth wheat.

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