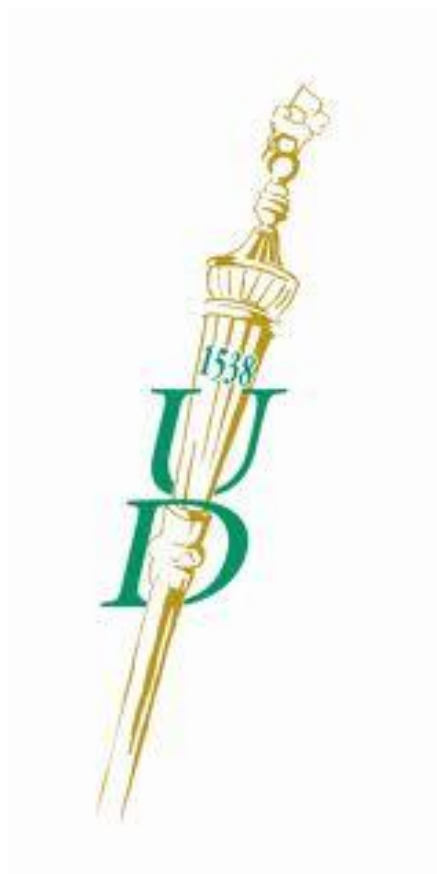


**Theses of PhD dissertation**

**THE EFFECT OF CROP YEAR ON SOME QUALITATIVE AND  
QUANTITATIVE PARAMETERS OF WINTER WHEAT  
GROWN IN GREAT CUMANIA**

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**Debrecen, 2016**

## 1. PRELIMINARIES AND GOALS OF THE THESES

The efficiency of wheat production in a given year is determined by the quantitative and qualitative parameters together. The analysis and assessment of these parameters need a complex approach. The knowledge of these parameters, their correlation and their changeability by the year effect is essential for breeding as the main goal of plant breeding is to create such new varieties that exceed the old ones in one or more features.

At the same time the quantitative and qualitative parameters are of great importance for the farmers as well, since the quality of the wheat sold to the mills must meet some qualitative criteria, even extra price is not really paid for higher quality nowadays. Nevertheless farmers must know which varieties worth to grow from economical point of view. The chosen variety and the applied agricultural techniques give 30% each of the profitability of winter wheat production is the rest 40% is determined by the given production site and the year effect together.

Even in 1947, in the year of the foundation of Karcag Research Institute, a mission was declared aiming the institute to contribute to the safety of living of the people working in agriculture in the countryside and to ensure the export base of Hungary. This mission was poured into words by dr. Ernő Vezekényi, the first director of the Institute in 1949 too: „We aim to create such new varieties for sodic lands that can tolerate the unfavourable soil conditions and the changeable weather of the region, give higher yields with higher safety, show stronger resistance to diseases, and provide high quality of flour”.

The main goal of the actual winter wheat breeding programme of the Institute is to ensure that our varieties meet the following criteria:

- accommodating to the extreme soil and climatic conditions of the Nagykunság region
- having high quality
- tolerant to rust diseases
- can be sown with lower seed number due to good bushing out

- suitable for mechanical harvest having narrow seed:straw ratio
- pay for sufficient plant nutrition
- serve as gene reserve

The increasing frequency of weather extremes in the Carpathian Basin is often mentioned during regional climate conferences. Beyond the agrotechnical tools, proper variety selection based on suitable plant breeding is a good response to the increasing frequency of weather extremes. On the base of plant production experiences, plant varieties bred under unfavourable agro-ecological conditions can tolerate the unfavourable conditions of a certain region better providing higher stability and other advantages to the farmers. These varieties provide excellent yield with high qualitative and quantitative parameters under favourable conditions too.

According to the definition of the Cyclopaedia of Horticulture, region-specific varieties are such characteristic varieties that were naturally and artificially selected and accommodated to the climatic conditions of a certain region during continuous production.

Local varieties are such varieties produced for own consumption or to be sold a nearby market that are the most suitable for production, the most economical among the varieties got to the area due to its agri-ecological conditions hence the most widely extended varieties in a certain region or district (MURAKÖZI et al., 1963).

'Creol' or mixed varieties must also be mentioned that originate from bred varieties, but accommodated to the local agro-ecological conditions due to the continuous selection becoming practically region-specific varieties (BRUSH et al., 1992; WOOD, 1997). According to the Hungarian nomenclature they are mentioned as the variants of old bred varieties maintained like region-specific varieties having significant economic value especially when high quality food is required by the market.

Hungarian wheat breeding and production were always famous for the region-specific varieties formed in different wheat production regions for a long time. Region-specific varieties were of great importance for the Hungarian wheat breeding. These varieties traditionally had high baking quality but were genetically heterogeneous as they were changing permanently due to the changing climatic conditions and diseases (HANKÓCZY, 1938).

In my Ph.D. dissertation I summarised the results of my research work carried out at Karcag Research Institute Centre for Agricultural Sciences University of Debrecen and I try to give suggestions to farmers in order to help to choose a winter wheat variety and/or genotype that can be grown safely with acceptable stability under the unfavourable agro-ecological conditions of Great Cumania.

Furthermore my goal is to prove the justice of region-specific wheat breeding on the base of scientific facts by showing that winter wheat varieties bred at Karcag exceed the performance and/or stability of other varieties in droughty or extremely wet years or in years with uneven distribution of precipitation.

## **2. MATERIAL AND METHODS**

### **Location of the experiments, investigated varieties, meteorological data**

The experiments were set in four replications on 10 m<sup>2</sup> large microplots with random block arrangement in the territory of Karcag Research Institute Centre for Agricultural Sciences University in the vegetation periods of 2008-2014.

23 different extensive and intensive winter wheat varieties were investigated. The latter ones were grouped furtherly from different points of view: maturity time (early-, medium-, and medium-late maturity groups), bearded or bald wheat varieties, and the place of breeding (Szeged, Martonvásár, Karcag).

The meteorological data are gained from the meteorological station of Karcag Research Institute Centre for Agricultural Sciences University which has been operating since 2004 and belongs to the network of the National Meteorological Service.

The precipitation and air temperature data of the vegetation periods between 2008 and 2014 are shown in *Tables 1-2*.

**Table 1: Precipitation data of the investigated vegetation periods (mm)**

*(Karcag Research Institute CAS UD, 2008-2014)*

Months	Vegetation periods						50 year average
	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	
<b>X.</b>	15.2	49.7	23.1	18.6	40.6	42.1	31.8
<b>XI.</b>	25.4	116.2	56.2	0.0	18.7	48.5	43.6
<b>XII.</b>	64.4	41.3	93.1	57.8	41.6	0.2	39.7
<b>I.</b>	30.4	51.4	12.7	16.8	42.5	30.0	28.4
<b>II.</b>	40.1	62.3	15.0	18.0	51.0	23.5	26.5
<b>III.</b>	46.9	12.1	22.0	2.5	110.2	20.0	24.9
<b>IV.</b>	17.0	63.3	18.9	13.1	47.3	46.5	37.2
<b>V.</b>	16.9	124.8	46.9	61.9	81.9	49.3	54.2
<b>VI.</b>	121.9	105.2	49.3	57.6	62.9	37.8	71.3
<b>Total</b>	<b>378.2</b>	<b>626.3</b>	<b>337.2</b>	<b>246.3</b>	<b>496.7</b>	<b>297.9</b>	<b>357.6</b>
<b>Deviation from the mean</b>	<b>+20.6</b>	<b>+268.7</b>	<b>+76.6</b>	<b>-111.3</b>	<b>+139.1</b>	<b>-59.7</b>	

**Table 2: Mean temperature values of the investigated vegetation periods (°C)**

*(Karcag Research Institute CAS UD, 2008-2014)*

Months	Vegetation periods						50 year mean
	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	
<b>X.</b>	12.0	11.6	7.9	10.4	11.8	12.6	10.1
<b>XI.</b>	6.3	7.6	8.0	2.0	6.9	7.8	4.5
<b>XII.</b>	2.1	1.7	-1.1	2.4	-0.7	1.2	0.1
<b>I.</b>	-2.1	-2.0	-0.6	0.4	-0.3	2.5	-2.5
<b>II.</b>	0.7	0.5	-1.1	-5.1	2.6	4.1	-0.6
<b>III.</b>	5.4	6.0	6.0	7.0	3.8	9.3	4.9
<b>IV.</b>	14.4	11.4	13.1	12.3	12.8	12.6	10.6
<b>V.</b>	17.0	16.1	16.9	17.1	17.3	16.1	16.3
<b>VI.</b>	19.4	19.7	20.9	21.4	20.4	20.2	19.4
<b>Total</b>	<b>8.4</b>	<b>8.1</b>	<b>7.8</b>	<b>7.5</b>	<b>8.3</b>	<b>9.6</b>	<b>7.0</b>
<b>Deviation from the mean</b>	<b>+1.4</b>	<b>+1.1</b>	<b>+0.8</b>	<b>+0.5</b>	<b>+1.3</b>	<b>+2.6</b>	

## 2.2. Examinations and their method of assessment

The yield averages and the hectolitre weights were measured from whole seeds as follows:

**yield:** the whole area of each microplot was harvested, then the moisture content of the seeds were determined with a FOSS Infratec 1241 Grain Analyser (annually calibrated) and standardised to 14%. All the yield data in the dissertation mean standardised data.

**hectolitre weight:** it was determined by means of a standard hectolitre meter and a Gibertini Europe 6000  $d_4 = 0.1$  g laboratory scale.

For the determination of the quality parameters seed samples of 2 kg from each microplot were grained with a Labor MIM laboratory mill, then the measurements were done according to the relevant standards.

- ***Wet gluten content + gluten dispersion:*** a Perten Glutomatic gluten washing device with a matching centrifuge according to Hungarian standards MSZ ISO5531:1995 (gluten content) and MSZ 3430:2008 (gluten dispersion).
- ***Zeleny sedimentation index:*** Brabender shaking machine according to standard MSZ ISO 5526:1993.
- ***Hagberg falling number:*** with a Perten Falling Number 1400 device according to standard MSZ ISO 3093:1995.
- ***Valorigraph number, water binding capacity:*** with a Labor MIM Valorigraph device according to standard MSZ ISO 5530-3/1995.

For data processing I used Microsoft Word text editor, Excel spreadsheet application and SPSS statistical analyser programme pack. The statistical assessments were done by means of Analysis ToolPack under Excel and SPSS statistical analyser programme. The tables were constructed with Microsoft Office Word, while the figures were graphically edited with Excel. The maps published in the appendix of the dissertation were drawn in the GIS laboratory of the Institute after vocational consultations.

### 3. RESULTS

#### 3.1. Joint evaluation of the investigated parameters by each vegetation period

The parameters of all six years<sup>1</sup> were analysed together.

Bearded and bald varieties are not evaluated separately as the bearded varieties showed the better results in each parameter every year, except for 3 yield data (indicated in the text). Table 3. shows the averages of the investigated parameters.

*Table 3: The investigated parameters by vegetation periods  
(Karcag Research Institute CAS UD, 2008-2014)*

Parameter	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	Average (2009-2014)
Yield (t ha <sup>-1</sup> )	7.83	5.55	7.45	7.32	5.88	7.15	<b>6.87</b>
Hectolitre weight (kg)		74.9	79.1	80.7	81.6	81.3	<b>79.5</b>
Wet gluten content (%)	31.7	23.7	25.3	31.3	32.1	31.0	<b>29.2</b>
Gluten dispersion (mm)			2.0	1.8	3.2	2.9	<b>2.5</b>
Zeleny sedimentation index (ml)	35.2	29.8	42.3	59.6	43.6	57.0	<b>44.6</b>
Hagberg falling number (s)	329	209	332	358	365	317	<b>318</b>
Water binding capacity (ml)	60.9	54.4	58.2	58.8	64.2	60.9	<b>59.6</b>
Baking quality	64.4	36.0	59.5	73.9	60.3	78.0	<b>62.0</b>

#### *Vegetation period of 2008/2009*

- As that year can be considered an optimal wheat growing year, the highest yields could be detected (**7.83 t ha<sup>-1</sup>**) and the lowest deviation between the lowest and the highest yields among the varieties (43.2 %). The medium late maturity group reached the highest yields (8.56 t ha<sup>-1</sup>), the average yield of the bald varieties exceeded the yield of bearded ones. Only small differences could be detected among the varieties bred in different places, even though the varieties from Karcag had the highest yields.

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<sup>1</sup> except for hectolitre weight and gluten sedimentation values where only data for 5 and 4 years are available, respectively.

- The *wet gluten contents* classified the varieties into category I in average (31.7%), except for the extensive varieties, which reached the category of improving quality (35.6%). The medium late maturity group was the best in this parameter (33.2%), while the varieties bred in Karcag were the best according to the breeding place (31.6%).
- Assessing the *Zeleny sedimentation index* values it can be concluded that improving category wheats grew in that vegetation period (35.2 ml). Even the differences were not considerable, the varieties of the medium late maturity group reached the best result (38.7 ml). According to the place of breeding the varieties bred in Karcag considerably exceeded the other varieties (41.7 ml).
- The average value of *Hagberg falling number* was optimal (329 s), even the averages of all groups were the optimal range (except for the extensive varieties which can be considered enzyme-poor with the average of a 413 s). The best results were achieved by the medium-late maturity group (345 s) and the varieties bred in Karcag (330 s).
- The average *baking quality* of the varieties was B1 (64.4; vf: 63.6 ml), the highest quality was achieved by the varieties belonging to the medium late maturity group (73.8; vf: 62.6 ml) and the varieties bred in Szeged (67.8; vf: 58.1 ml).
- In this vegetation period statistically significant, negative correlation could be figured out between the amount of yield and the wet gluten content (-0.470\*), positive, medium strong correlation between the wet gluten content and the falling number (0.481\*) and the water binding capacity (0.653\*\*), strong correlation between the wet gluten content and the baking quality (0.804\*\*).

#### ***Vegetation period of 2009/2010***

- In this very wet vegetation period (water inundations were characteristic to the investigation plots) we measured the lowest *yield* average (**5.55 t ha<sup>-1</sup>**) and got the biggest difference between the minimum and maximum values of the yields taking the means of the vegetation period or of the different groups into comparison. Again the medium-late maturity group had the highest yield (6.45 t ha<sup>-1</sup>), while the performance of the extensive varieties was very poor (3.62 t ha<sup>-1</sup>). The difference among the varieties bred in different places was little again, though the varieties bred in Karcag were the best.



- The average *hectolitre weight* value classified the varieties into category III (74.9 kg), only the medium-late maturity group was in category I (76.9 kg), while the extensive varieties reached the improving category even under such unfavourable conditions (79.5 kg). The average of the varieties bred in Karcag was the highest among the groups of the three breeding places (75.4 kg).
- According to the average values of *wet gluten content* the varieties had fodder quality (23.7 %); though the extensive varieties were exceptions in that year too giving category II quality (28.7 %). Among the maturity groups the medium-late group, while among the breeding places Karcag reached the highest values (25.0-25.0%).
- According to the *Zeleny sedimentation indexes* it can be established that the gluten quality was poor due to the high amount of precipitation (298 ml). Only the extensive (33.3 ml) and the varieties from Martonvásár (31.3 ml) could reach the quality of category II.
- The annual mean of the *Hagberg falling number* (209 s) meant fodder quality, only the medium-late maturity group (255 s), the bearded wheats (230 s), the extensive varieties (262 s) and the varieties bred in Karcag (226 s) reached the milling quality category.
- The poor gluten quality due to the rainy year could be figured out in the *baking quality* as well. The annual average fall into the fodder quality category (36.0-C1; vf: 54.4 ml). None of the varieties could reach the milling quality category, only four varieties could be ranged into the category B2. Among the group averages of category C1 the varieties of the medium-late maturity group (43.0-C1; vf: 57.3 ml), the extensive group (43.7-C1; vf: 54.7 ml) and the ones bred in Karcag (37.6-C1; vf: 54.7 ml) could reach the highest values.
- In this vegetation period statistically significant, positive, medium strong correlation could be figured out between the water binding capacity and the wet gluten content (0.546\*\*) and also the falling number (0.536\*\*). The falling number showed medium strong correlation with the baking quality (0.651\*\*) too. The wet gluten content was in strong correlation with the falling number (0.813\*\*) and the baking quality (0.710\*\*).

### ***Vegetation period of 2010/2011***

- That was a nearly optimal vegetation period providing the second highest *average yield* (**7.45 t ha<sup>-1</sup>**), and the difference between the extremes was just slightly higher than in the optimal vegetation period of 2008/2009. The medium-late maturity group produced the highest yield (8.09 t ha<sup>-1</sup>), as well as the varieties from Karcag among the different breeding places (7.69 t ha<sup>-1</sup>). The yield of the extensive varieties was lower than of the yield measured in the optimal year.
- The annual mean of the *hectolitre weights* classified the varieties into the improving category (79.1 kg), but the group averages also reached this category. The extensive varieties had the highest value (80.7 kg), the medium-late maturity group was the second (80.5 kg) then the varieties bred in Martonvásár were in the third place (79.3 kg).
- According to the average value of *wet gluten contents* fodder quality was reached by the varieties of all (25.3 %) probably due to the unfavourable effect of the almost 30 mm of rain fallen directly before harvest. Contrary to this rainfall, the medium-late maturity group (30.3%) and the varieties bred in Karcag (27.7%) reached the milling quality level. No significant negative effect of the rain before harvest time could be figured out on the *gluten dispersion* (2.0 mm).
- Assessing the *Zeleny -index* values it can be established that not only the quantity but the quality of gluten was depressed by the precipitation fallen just before harvest (42.3 ml), but not such an extent as it when the whole vegetation period was extremely wet. The best results were achieved by the medium-late maturity group (46.0 ml) and the varieties bred in Karcag (43.1 ml).
- According to the mean of the *Hagberg falling numbers* (332 s) improving quality characterised the investigated varieties. Not only the total mean value but the averages of the groups were good on the base of this parameter. Except for bald varieties (295 s), all the other groups realised an average value above 300 s.
- The lower gluten quality caused by the rain event before harvest was also manifested in the *baking quality*. Milling quality was reached in the average of the vegetation period (59.5-B1; vf: 58.2 ml), none of the group averages classified them into the improving quality category. Generally stable B1 quality was characteristic, except for the bald and the extensive varieties, where only B2 quality

was produced. The early maturity group (64.6-B1; vf: 58.9 ml) and the varieties bred in Szeged (59.9-B1; vf: 54.2 ml) had the highest values.

- I found statistically significant, positive, medium strong correlation between the wet gluten content and the baking quality (0.593\*\*), the water binding capacity (0.621\*\*), the falling number (0.611\*\*), the Zeleny sedimentation index (0.729\*\*). The falling number showed medium strong correlation with the water binding capacity (0.684\*\*) and the Zeleny sedimentation index with the baking quality (0.631\*\*).

### ***Vegetation period of 2011/2012***

- Contrary to the relatively dry vegetation period good *yield averages* were characteristic (**7.32 t ha<sup>-1</sup>**) and low difference between the extremes. Among the groups the medium-late maturity group had the highest yield (8.33 t ha<sup>-1</sup>), and the varieties bred in Karcag tolerated the dryness the best (7.70 t ha<sup>-1</sup>).
- That vegetation period resulted in satisfactory *hectolitre weights* (80.7 kg), the averages of all groups reached the value of 80 kg, except for the bald- and the varieties bred in Szeged. I detected the highest values in the medium-late maturity group (82.0 kg), in the group of the varieties bred in Martonvásár (81.3 kg) and of the extensive varieties (81.7 kg).
- According to the average value of *wet gluten contents* milling quality category I was reached by the varieties of all (31.3%), but several varieties reached the improving quality. The medium-late maturity group (33.0%), the extensive varieties (33.0%) and the varieties bred in Martonvásár (32.2%) reached the highest values. Significant negative effect of the dryness could be figured out on the *gluten dispersion* (1.8 mm).
- Assessing the *Zeleny -index* values it can be established that that vegetation period was the best from the point of view of this parameter (59.6 ml), but the highest difference between the extremes was also characteristic. The averages of several groups reached or exceeded the value of 60 ml (medium maturity group: 60.0 ml, bearded varieties: 66.0 ml, extensive varieties: 69.5 ml, varieties bred in Martonvásár: 63.8 ml).
- I measured high average of *Hagberg falling numbers* (358 s) in that vegetation period. All the groups reached the improving quality category on the base of the

group averages. The medium maturity group (367 s), the extensive varieties (382 s) and the varieties bred in Karcag (357 s) reached the highest values.

- As a consequence of the dry vegetation period relatively high *baking quality values* were characteristic (73.9-A2; vf: 58.8 ml). All groups reached the improving quality category except for the bald and the extensive varieties. The early maturity group (75.4-A2; vf: 58.9 ml), the varieties bred in Martonvásár (73.5-A2; vf: 59.6 ml) and the extensive varieties (85.0-A1; vf: 57.5 ml) had the highest values.
- I figured out statistically significant, positive, medium strong correlation between the wet gluten content and the water binding capacity (0.788\*\*), the falling number (0.676\*\*), the gluten dispersion (0.554\*\*), the Zeleny index (0.521\*). Beyond these, the hectolitre weight showed medium strong correlation with the Zeleny index (0.632\*\*) and the baking quality (0.710\*\*).

#### ***Vegetation period of 2012/2013***

- That was a rainy vegetation period having considerable negative effect on *the yield average* of the varieties (**5.88 t ha<sup>-1</sup>**). Among the groups the medium-late maturity group had the highest yield (6.32 t ha<sup>-1</sup>), and the varieties bred in Karcag tolerated the water surplus the best (6.78 t ha<sup>-1</sup>). The average yield of the extensive varieties just slightly exceeded the value of 4 t ha<sup>-1</sup> due to considerably extent of falling. In that vegetation period the average yield of the bald varieties exceeded the yield of the bearded varieties.
- Contrary to the high amount of precipitation (the most of that fall in the autumn-winter period) I measured the highest average of *hectolitre weights* (81.6 kg), and only two varieties could not reach the value of 80.0 kg. Among the groups the medium-late maturity group had the highest yield (8.33 t ha<sup>-1</sup>), and the varieties bred in Karcag tolerated the dryness the best (7.70 t ha<sup>-1</sup>). The lowest difference between the extremes was detected that year among and within the groups as well.
- The highest variety average of *wet gluten content* was measured that vegetation period (32.1%), one third of the varieties reached the improving quality category. The medium-late maturity group (33.2%), the extensive varieties (39.0%) and the varieties bred in Martonvásár (32.1%) reached the highest values. The *gluten dispersion* of almost all the varieties was the highest in that vegetation period giving a mean of 3.2 mm.

- Assessing the *Zeleny -index* values it can be established that due to the high amount of precipitation of that vegetation period the high gluten content did not link to high quality of gluten, even the mean value was 43.6 ml. The averages of all the groups reached or exceeded the threshold value of the improving quality category, but in most of the cases just hardly. The highest values were characteristic to the medium maturity group (45.3 ml), the bearded varieties (48.2 ml), the extensive varieties (58.2 ml) and the varieties bred in Martonvásár (44.3 ml).
- I measured highest average of *Hagberg falling numbers* (365 s) in that vegetation period. All the groups reached the improving quality category on the base of the group averages. The medium maturity group (367 s), the extensive varieties (382 s) and the varieties bred in Karcag (357 s) reached the highest values. The difference between the extremes was low among and within the groups as well. The groups reaching the highest values: early maturity group (376 s), bearded wheats (380 s), extensive varieties (391 s) and the varieties bred in Karcag (362 s).
- As I mentioned regarding the Zeleny-index, the high gluten content did not mean high quality, as the *baking quality values* also show (60.3-B1; vf: 64.2 ml), even the best varieties could not reach the category A1. Stable B1 category characterises the averages of the groups. The groups reaching the highest baking quality: early maturity group (65.7-B1; vf: 65.2 ml), bearded wheats (62.2-B1; vf: 67.3 ml), extensive varieties (63.5-B1; vf: 64.8 ml) and the varieties bred in Martonvásár (61.0-B1; vf: 66.5 ml).
- I figured out statistically significant, negative, medium strong correlation between the amount of yield and the wet gluten content (-0.697\*\*) and the Zeleny sedimentation index (-0.649\*\*). The wet gluten content was in positive, medium strong correlation with the gluten dispersion (0.544\*\*), the Zeleny-index (0.608\*\*), the falling number (0.446\*), the water binding capacity (0.695\*\*) and the baking quality (0.479\*). Beyond these, the Zeleny index weight showed medium strong correlation with the falling number (0.646\*\*), the water binding capacity (0.518\*) and the baking quality (0.7632\*\*).

#### ***Vegetation period 2013/2014***

- That was a slightly dry vegetation period with the mean winter temperature higher than the average. The *average yield* of the varieties (**7.15 t ha<sup>-1</sup>**) was usual, that was

the only vegetation period when the early maturity group produced the highest yield ( $7.67 \text{ t ha}^{-1}$ ), the bald wheats were slightly better than the bearded ones. The varieties bred in Karcag realised the highest average yield ( $7.70 \text{ t ha}^{-1}$ ) compared to the varieties bred in other two breeding places.

- Taking the *hectolitre weights* into account, that vegetation period was good (81.3 kg), all the group averages reached the value of 80.0 kg. I detected the highest values in the medium-late maturity group (81.9 kg), in the group of the varieties bred in Karcag (81.5 kg) and of the extensive varieties (82.5 kg).
- According to the average value of *wet gluten contents* milling quality category 1 was reached by the varieties (31.0%), only four varieties reached the improving quality category. The medium maturity group (32.3%), the bearded wheats (33.8 %), the extensive varieties (39.3%) and the varieties bred in Karcag (30.5%) reached the highest values. The highest differences and fluctuations in the *gluten dispersion* (2.9 mm) were experienced in that vegetation period.
- I measured the second highest average value of *Zeleny sedimentation index* in that vegetation period (57.0 ml), so it can be concluded that the lower gluten content was coupled with higher quality, though the difference between the extremes was very high. The group averages exceeded the value of 50.0 ml, except for the bald- and the varieties bred in Szeged. The highest values were characteristic to the medium maturity group (57.6 ml), the bearded varieties (62.7 ml), the extensive varieties (69.8 ml) and the varieties bred in Karcag (56.6 ml).
- In this vegetation period favourable *Hagberg falling number* (317 s) was characteristic. All the groups reached the milling quality category 1 or even the improving category on the base of the group averages, except for two varieties. This was the vegetation period when I detected the lowest differences among the different groups. The groups reaching the highest values: early maturity group (321 s), bearded wheats (326 s) and the varieties bred in Szeged (323 s).
- The highest *baking quality values* characterised this vegetation period (78.0-A2; vf: 60.9 ml), though the highest differences between the extremes was detected too (from C1 to A1). Each group average reached the improving quality category, the varieties from Szeged were the best getting into the category A1 (85.7-A1; vf: 59.9 ml).

- I figured out statistically significant, negative, medium strong correlation between the amount of yield and the wet gluten content (-0.480\*) and the gluten dispersion (-0.505\*). The water binding capacity was in positive, medium strong correlation with the wet gluten content (0.571\*\*), the gluten sedimentation (0.478\*), the Zeleny-index (0.593\*\*) and the falling number (0.586\*\*). Beyond these, the hectolitre weight showed medium strong correlation with the baking quality (0.646\*\*).

### 3.2. Joint assessment of the stability of the varieties

The assessment of the stability of the varieties was carried out as follows:

- The first step was the calculation of the averages of the yields then I calculated the difference between the extremes; the lower is this difference, the lower is the influence of the weather on the generation of the yield of the given variety. Last I ranked the varieties according to these values (1=lowest, 23=highest).
- The next step was the ranking of the varieties according to their performance in each year (1=best, 23=worst).
- I calculated the sum of these two numbers (the sum can be between 2 and 46 in the case of 23 varieties, the lower, the more favourable).
- On the base of the numbers I got, I could choose those varieties which are the best according to their stability and the measured parameters.

I examined the stability of the varieties for each investigated parameter according to the method described above. I summed the values I got for each parameter and ranked the varieties according to their points (the lower the better). Finally I got the rank of the varieties representing their stability and value according to the investigated parameters in the investigated six years.

*Table 4* contains the summarised data of the most stable varieties<sup>2</sup>, while *Figure 1* shows the results graphically. It is visible that not always those varieties are the most

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<sup>2</sup> It must be mentioned that two extensive varieties had more points than variety Róna, but those two varieties are not listed among the suggested ones as their stem stability is poor hence their production is not suggested under intensive conditions.

stable in a certain parameter which have the highest quality, and consequently the most stable varieties are not always the best in the investigated parameters.

**Table 4: The best and most stable varieties in the average  
of the investigated six years**  
(Karcag Research Institute CAS UD, 2009-2014)

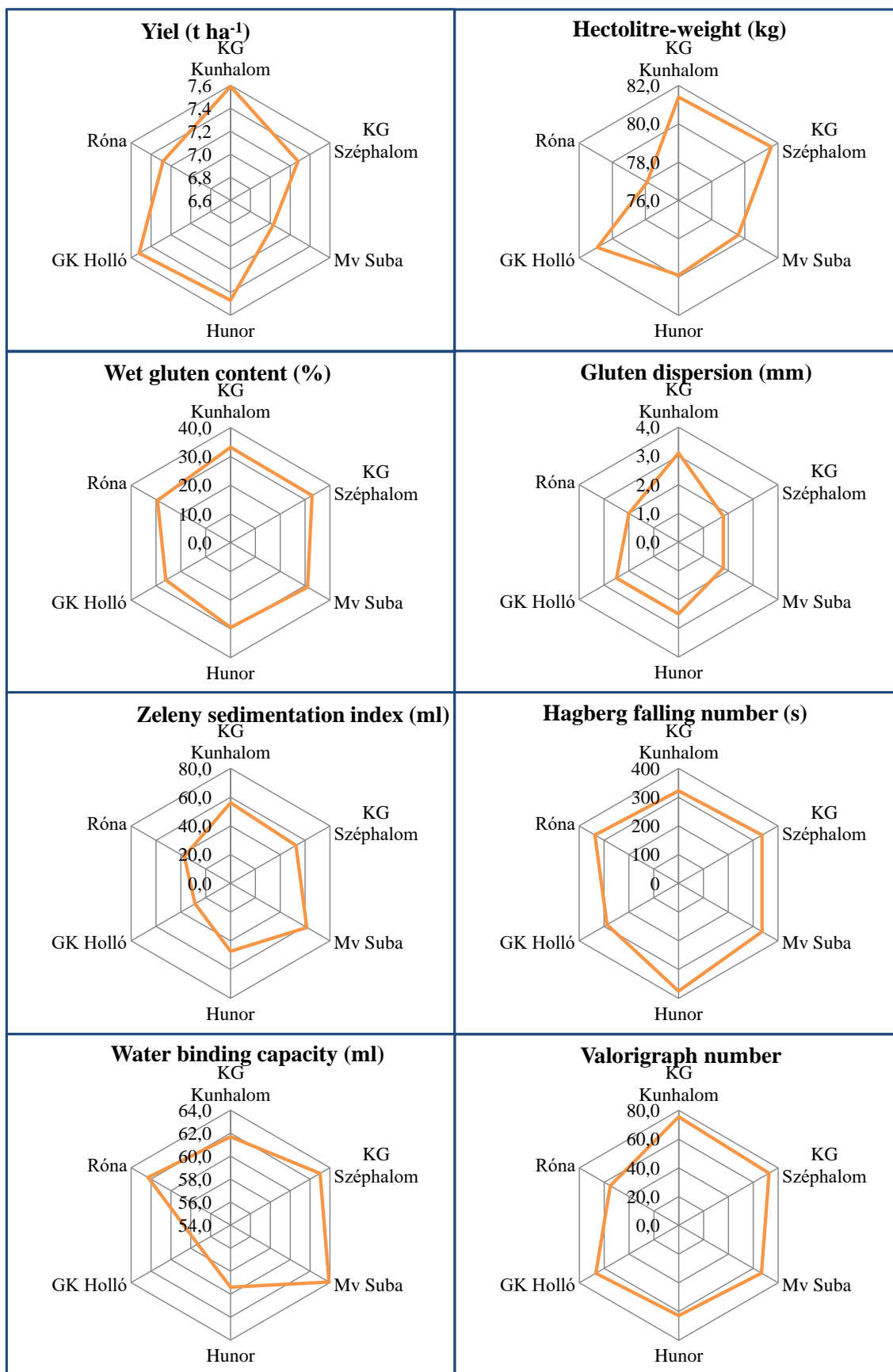
	$\Sigma$ points	Maturity group	Bearding	Place of breeding
<b>KG Kunhalom</b>	138	medium-late	bearded	Karcag
<b>KG Széphalom</b>	141	early	bearded	Karcag
<b>Mv Suba</b>	143	early	bearded	Martonvásár
<b>Hunor</b>	155	medium	bald	Karcag
<b>GK Holló</b>	157	medium-late	bald	Szeged
<b>Róna</b>	174	medium	bearded	Karcag

Analysing the data of the table it can be established that among the list leader six varieties four were bred in Karcag proving the justice of region-specific wheat breeding that I described among my goals. According to the literature the proper choice of the variety has approximately 30% of contribution to the high quality of winter wheat, but the proper choice is not only important because of the growing goal. Due to region-specific breeding, the region-specific varieties have higher and more stable accommodation capacity to the characteristic agroecological conditions of a specific region, therefore their production is safer.

The higher stress tolerance of bearded genotypes of winter wheat has been mentioned in the literature for decades. The results of my data analyses also proved this fact.

It cannot be obviously concluded that the varieties belonging to a specific maturity group are more suitable – the parallel production of varieties with various maturity time is suggested hence the harvest can be split and done in optimal time ensuring the highest potential quality





**Fig. 1: The best and most stable varieties**  
(Karcag Research Institute CAS UD, 2009-2014)

#### **4. NEW SCIENTIFIC RESULTS OF THE DISSERTATION**

1. I investigated the changes of some parameters and the stability of winter wheat varieties due to the weather of different vegetation periods in a field experiment in Karcag located in Great Cumania. I elaborated a new method for I elaborated a new, own method for the stability assessment that can be used for the choice of the variety accommodating the best to a certain wheat growing region. My own assessment method is applied in the region-specific breeding programme in Karcag supporting the fruitful selection work very well. During my activity as a plant breeder I contributed to create several new varieties and variety candidates, I am co-breeder of several varieties and patents (varieties: 2 winter wheat, 1 winter barley, 1 chickling vetch; patents: 3 winter wheat, 2 winter barley).
2. I proved the higher abiotic stress tolerance ability of the bearded wheat varieties compared to the bald ones.
3. I established that the optimum of the amount of precipitation in the vegetation period of winter wheat in Great Cumania is 230-380 mm, the lower or higher amounts result in a yield depression. By means of statistical analyses I proved that the increasing amount of precipitation above the optimum range results in the decrease of the quantitative and qualitative parameters of winter wheat grown in Great Cumania.
4. On the base of my own assessment method I also proved that the extensive winter wheat varieties can reach excellent results in quality (35-39% wet gluten content, 58-69 ml Zeleny sedimentation index and baking quality value above 80.0). I suggest these extensive varieties to be integrated into the breeding programmes in a higher degree and their utilisation as crossing partners.
5. I proved that the qualification of the factors affecting the different genotypes (weather and soil conditions, tillage) valid for a given production area can be done only in a complex system based on the assessment of long-term data.

## **5. PRACTICAL UTILISATION POSSIBILITIES OF THE RESULTS**

1. In wet years – due to the unfavourable water regime of heavy textured soils or the plough/disc pan layer characteristic to conventional tillage – surplus water is accumulated in the root zone of winter wheat causing airless situation.
2. The justice of region-specific plant breeding and production is a proven fact, the region-specific varieties can be grown economically and with high stability. The breeding of region-specific varieties can contribute the sustainability of our environment as the production of varieties that can accommodate of the local conditions has the lower environmental load under the given soil-, weather and agrotechnical circumstances.
3. The new method elaborated for the assessment of the stability of varieties is a useful tool for plant breeding experts in order to select the winter wheat variety that can accommodate the most to a specific growing area.
4. As the extensive winter wheat varieties can reach excellent results in quality under the unfavourable agro-ecological conditions, their integration into the breeding programmes in a higher degree and their utilisation as crossing partners are suggested.
5. Bearded wheat varieties can be grown with higher safety in areas with extreme agro-ecological conditions as their abiotic stress tolerance ability is higher compared to the bald varieties.

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Registry number:  
Subject:

DEENK/20/2016.PL  
Ph.D. List of Publications

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MTMT ID: 10035937

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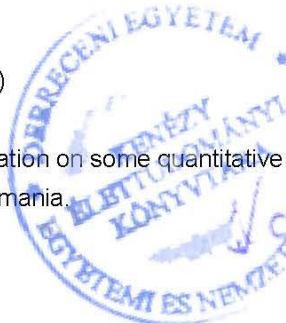
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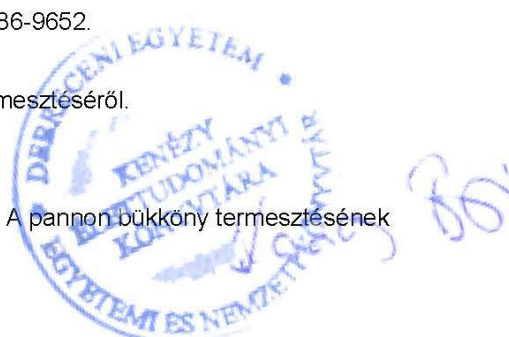


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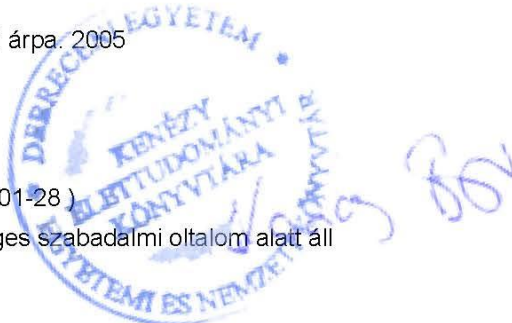
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The Candidate's publication data submitted to the iDEa Tudóstér have been validated by DEENK on the basis of Web of Science, Scopus and Journal Citation Report (Impact Factor) databases.

1 February, 2016





