

A STUDY OF SOME FOREIGN WHEAT CULTIVARS IN BULGARIA (*Triticum aestivum* L.)

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Abstract

The purpose of the study is to investigate four winter wheat cultivars (*Triticum aestivum* L.). The areas were found to be heavily weeded with Lamb's (*Chenopodium album*), Amaranth (*Amaranthus retroflexus* L.), Field mustard (*Sinapis arvensis* L.) and Wild oats (*Avena fatua* L.). The studied cultivars are characterized by good productivity as the average yield for the group is 773.7 kg/da. Avenue cultivar showed the highest grain yield - 861 kg/da. It was found that the tested cultivars are characterized by good baking qualities. The average wet gluten content is 27.6%. It has been found that foreign cultivars are significantly attacked by Powdery mildew (*Erysiphe graminis* De candolle), Brown (*Puccinia recondita* Rob. Et Desm. f. sp. tritici) and wheat stripe (yellow) rust (*Puccinia striiformis* West.) and *Septoria tritici* leaf blight (*Septoria tritici* Rob. ex Desm.).

Key words: wheat, cultivars, weeds, disease, yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the main crop in Bulgaria, and it occupies about 60 % of the area of cereals in the country and in the last decade provides nearly three quarters of the grain for the local economy. Wheat is a major cereal crop. It is grown exclusively for grain, which serves as food for most people in the world. Its wide distribution is due to the high nutritional value of the grain. The protein content of wheat grain is 13-15% and carbohydrates – 70-78 %. Bread made from soft wheat flour is porous and large in volume. In addition to food, wheat grain is used as a raw material for alcohol and other derivatives, and in the food industry the grain of the cultivars with low baking qualities is used for fodder. The area of wheat in the world is over 2 billion hectares with an average yield of 230-240 kg/da. In our country it occupies 11-12 million hectares, and the average yields are 450 – 550 kg/da.

Wheat forms its leaf mass in different phases. The leaf consists of a petiole and a leaf base and has a structure typical for cereals. The leaf surface of a plant varies from 70 to 140 square centimeters. The larger the leaf surface and the longer it stays fresh, the higher the expected yield will be. The upper leaves have a great importance for the formation of the yield (Tsenov et al., 2002., Yankov et al. 2009).

Wheat grain contains an average of 12 – 14 % protein, 60 % nitrogen-free extracts, 2% fat, 3 % cellulose and 1.6 % ash. Carbohydrates (starch) occupy the largest share, with the most significant amount in the middle of the grain. However, protein substances are the most important ones. The quality of bakery products depends on the quality and quantity of proteins and especially on the water insoluble ones - gluten (Panayotov & Todorov, 2008., Penchev et al. 2007). Soft wheat, has the ability to swell strongly, absorb gases, form crusts, as a result this kind of bread is highly valued. In durum wheat, gluten is highly stretchable, does not break and the flour is used to obtain quality pasta, noodles, semolina and other pasta products (Nikolova & Panayotov, 2006). In Bulgaria, as one of the countries of the temperate climate zone, the cultivation of wheat is carried out mainly through winter type of development cultivars. Modern winter wheat cultivars need to have a balanced complex set of features and properties to ensure consistently high and stable grain yields with appropriate technological properties, suitable for the production of a quality product (Stefcheva, 2005; Chavdarov & Kolev, 2008). Many pests attack the wheat crops in the country (Raykov et al., 2010). Rust, Wheat powder head, *Septoria* and others are economically significant diseases for the crops

(Gospodinova, 1973; Townley-Smith, 2001; Todorova, 2008; Patrick & Mills, 2008; Wolf, 2008; Chungu et al. 2001; Pavlova & Grigorova, 2011).

MATERIALS AND METHODS

The study was conducted in a Limagrain Company experimental region in the area of Madara village. The climate of Shumen municipality is characterized by a temperate – continental features. The main factors determining this type of climate are the location of the municipality in the southeastern part of the Danube plain and the possibility of free flow of northwestern, northern and northeastern air masses.

The temperature regime of the municipality is typical for the temperate – continental climate - with hot summers and cold winters.

The average monthly temperature of the coldest month (January) is -1.1°C (Table 1).

Table 1. Meteorological data for the study period

Month	Norm/ Year					
	t° C	2019	2020	mm/m ²	2019	2020
I	-0.6	0.2	1.7	45	36.8	36.2
II	1.3	2.0	2.3	49	44.3	42.4
III	5.6	7.1	7.8	47	48.1	67.5
IV	10.1	12.1	11.7	55	24.1	19.8
V	16.3	17.3	15.9	70	63.5	72.5
VI	19.0	20.8	19.4	82	79.9	123.4
VII	21.6	22.5	21.6	65	32.4	68.4
VIII	21.0	21.1	22.5	51	19.9	57.6
IX	17.4	17.5	15.7	40	44.4	110.9
X	10.6	11.3	11.6	40	96.3	63.6
XI	6.9	9.8	5.7	55	66.3	99.2
XII	3.2	2.3	3.8	53	25.4	86.6

The average monthly temperature of the warmest month (July) is $+22^{\circ}\text{C}$, thus forming a significant annual temperature amplitude of $23 - 24^{\circ}\text{C}$. The average annual temperature is 16.9°C . The average annual rainfall is 606 mm. The soil type in the area is calcic chernozems (FAO-UNESCO), with a strong humus horizon. The mechanical composition of the soil is heavy sandy-clay containing 30 – 60 %

physical clay. It is considered to be well stocked with mobile forms of molybdenum (Mo), magnesium (Mg) and others.

The study included four cultivars with a sown area of 60 decars for each one. According to the manufacturer, the most common characteristics of the cultivars are the following Alcantara cultivar was presented, as a highly productive cultivar of the second strongest wheat group. It has good tillering and very good resistance to lodging. This is an awned head type cultivar with a height of 80 – 90 cm. under normal cultivation. Airbus cultivar has an excellent complex assessment of the quality of grain for the production of bakery products. Quality group: Strong wheat.

Annapurna – a representative of the new wave of wheat, perfectly adapted to local growing conditions. Superior qualities and excellent yield potential. Registered in Bulgaria in 2018. Avenue cultivar is a low stemmed, awnless cultivar with reduced leaf mass and a well – defined waxy coating, with a high tillering ratio. It has good resistance to lodging. It shows good resistance to some fungal diseases. A route method (by placing meters) was carried out to determine the species composition of weeds. It was done diagonally across the field. Five meters of each cultivar were reported in detail. Weeding was established by meters before the introduction of herbicides and the assessment was grouped as follows:

- Degree of weed distribution
- + - weak - up to 25%
- ++ - average – 25% to 50%
- +++ - strong – 50% to 75%
- ++++ - massive – 75% to 100%.

Visual diagnosis of the presence of diseases was performed according to generally accepted methods (Bobev, 2009). A precise general assessment of 50 – 100 plants was performed. A symptomatic picture of randomly taken plants was analyzed, and the data from the general assessment was recorded in a journal of route reviews. The same evaluation criteria were used, on a five-point scale from zero to 100%. During the inspections, the development of diseases that appeared in the crops was reported and samples were taken from diseased plants with well-defined symptoms of the diseases.

RESULTS AND DISCUSSIONS

Table 2 presents the data on weeding of the experimental area planted with wheat. The data shows that there is a wide variety of weeds. It is necessary to point out that the weeding with annual deciduous weeds is relatively stronger. Relatively weak is the weeding with annual and perennial wheat weeds. Our survey found that the areas are heavily weeded with Lamb's quarters (*Chenopodium album* L.), Amaranth (*Amaranthus retroflexus* L.) and Field mustard (*Sinapis arvensis* L.). We can point out a significant weeding with Creeping thistle (*Cirsium arvense* (L.) Scop.) and Field bindweed (*Convolvulus arvensis* L.). We definitely consider a significant problem the severe weeding with Wild oats (*Avena fatua* L.).

Table 2. Weed species and their distribution in wheat average for the period (2019 – 2020)

Weed species	Degree
1. Annual weeds	
1.1 Annual cereal weeds	
<i>Echinochloa crus – galli</i> L.	+
<i>Avena fatua</i> L.	+++
1.2 Annual deciduous weeds	
<i>Chenopodium album</i> L.	+++
<i>Solanum nigrum</i> L.	++
<i>Galium tricorne</i> L.	++
<i>Papaver rhoeas</i> L.	+
<i>Amaranthus retroflexus</i> L.	++++
<i>Anthemis arvensis</i> L.	++
<i>Consolida regalis – Gray.</i>	+
<i>Xanthium strumarium</i> L.	+
<i>Sinapis arvensis</i> L.	++++
<i>Polygonum convolvulus</i> L.	++
2. Perennial weeds	
2.1 Perennial root and shoot weeds	
<i>Sonchus arvensis</i> L.	+
<i>Cirsium arvense</i> (L.) Scop.	+++
<i>Convolvulus arvensis</i> L.	++++
<i>Aristolochia clematitidis</i> L.	+

For the agricultural manufactures, the average yields obtained from wheat are essential (Figure 1). Avenue cultivar was reported with the highest yield of grain of the tested cultivars – 861 kg/da, where the excess over the average of the four cultivars is 10.1%. The second and the third places are occupied by the Airbus cultivar – 795 kg/da and Alcantara cultivar 752 kg/da. Overall an average yield of 773.7 kg/da was obtained from the tested cultivars.

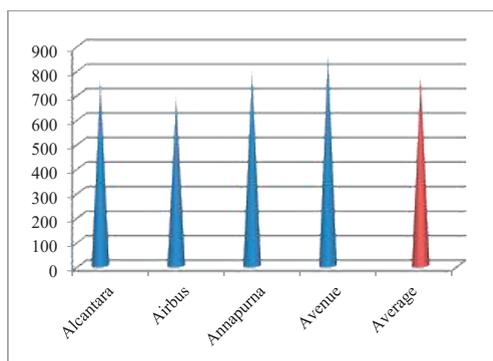


Figure 1. Wheat cultivars average yields in kg/da

The hectoliter mass is an indicator of the milling qualities of wheat. This shows how much flour can be provided by different batches of wheat. The effective minimum of total flour yield in wheat processing for the three groups is 76 kg. This is a limit value below which the efficiency of the technological process falls.

Figure 2 presents the data for the reported hectoliter weight of the tested cultivars. The average hectoliter mass for the group was 77.3%. The highest value was reported for Avenue cultivar – 80.1%. These results give us reason to conclude that the tested cultivars have good milling qualities.

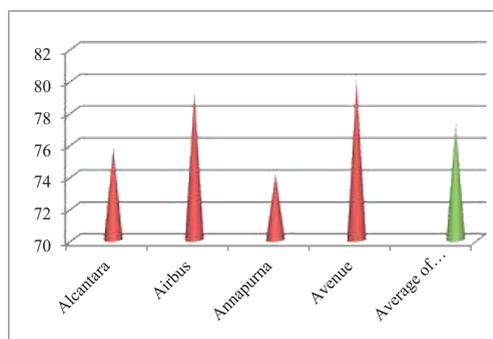


Figure 2. Hectoliter weight of wheat cultivars in kg

In practice, special attention is paid to the indicator of wet gluten, which is shown a percentage. On the one hand, the yield of wet gluten in the grain provides, the protein content and nutritional value. On the other hand, it guarantees a corresponding amount of gluten in the flour (Figure 3). According to this indicator, the values of Alcantara (23.4%) and Airbus

cultivars (24.8%) are approximately the same. The content of wet gluten is higher in the cultivars Annapurna (30.1%) and Avenue (31.2%).

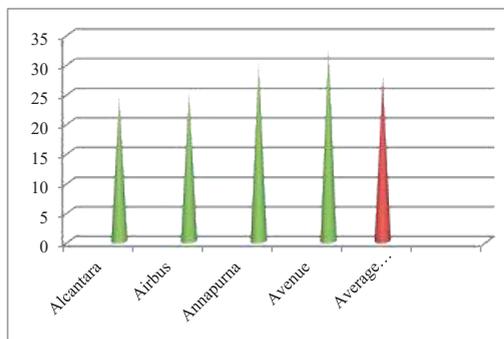


Figure 3. Wet gluten content in wheat cultivars in %

The average wet gluten content is 27.6%. The mass of 1000 seeds (in the older nomenclature it is known as absolute weight), shows the weight of 1000 absolutely dry seeds. This feature guides us about the nutrition of wheat seeds (Figure 4). It is necessary to point out that in all cultivars the nutrition of the seeds is good (37.6 g). The highest value – 43.1 g. was reported for Avenue cultivar, where the excess compared to the average for the group was 14.5 %.

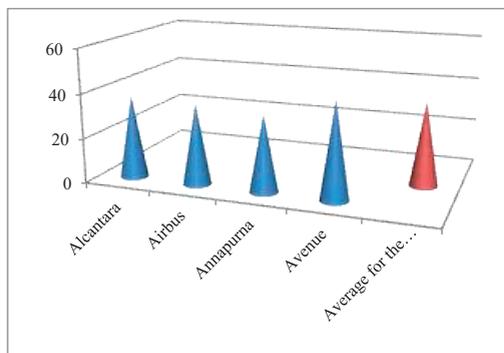


Figure 4. Mass per 1000 seeds of wheat cultivars in g.

The grain hyaliness as an indicator of the milling properties provides a certain minimum yield of light flours. The range for the three groups of wheat regarding their strength is from 40% to 50%. These values are limit values, below which the yield of light (white) flours significantly decreases (Figure 5).

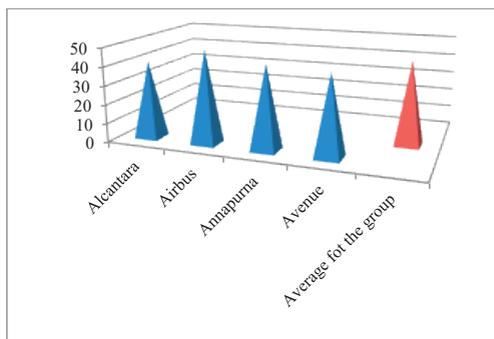


Figure 5. Grain hyaliness of wheat cultivars in %

From the data review on the grain hyaliness it was found that the studied cultivars show an average value of 44.7%, from which we can conclude that the studied cultivars guarantee a high percentage of white flours.

Wheat as a crop provides about 20% of human energy (carbohydrates). At the same time, wheat grain is a basic protein food for humans and in this respect it is in the first place. According to literature data (Panayotov & Todorov, 2008, Yankov et al. 2002), the protein content in wheat cultivars in our country - varies from 15.1 to 18.8%. The studied cultivars (Figure 6) show an average grain protein content of 17.2%. The highest protein content in the grain was reported in Avenue cultivar 18.3%. Alcantara (15.8%) is characterized by a lower protein content. The other cultivars occupy position between these two.

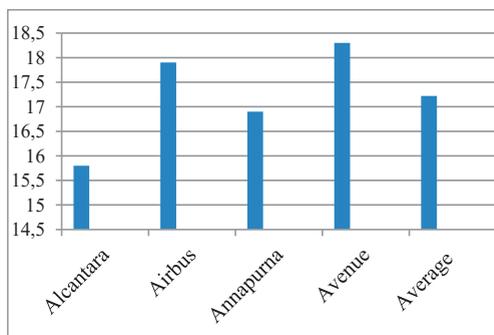


Figure 6. Protein content in the grain of wheat cultivars in %

A higher degree of damage from these diseases was found in Airbus cultivar. Avenue cultivar is presented with good resistance to these diseases.

Wheat diseases are one of the most important factors for grain production and if the control over them is not adequate, the danger of losing millions of tons of production and deteriorating its quality is very high. The most important are the diseases that cause damage to the leaves and stems of cereals during the growing season – Powdery mildew, Brown rust, Yellow rust, Septoria under certain conditions Fusarium on wheat ear and others. The crop loss can reach 25 – 30% of the yield for each disease separately and is mainly due to a reduction in the number of wheat ears and seeds.

Table 3 presents the reported data of economically important diseases attacks in the studied foreign wheat cultivars.

Table 3. Wheat diseases

Pathogen	Cultivars			
	Alcantara	Airbus	Annapurna	Avenue
Powdery mildew Erysiphe graminis De candolle	++	+++	++	++
Brown rust Puccinia recondita Rob. Et Desm. f. sp. tritici	++	+++	+++	+
Septoria tritici leaf blotch Septoria tritici Rob. ax Desm.	+	++	++	+
Tilletia foetida Tilletia foetida (Wall.) Liro (syn. T. levis)	0	0	+	0
Tilletia contraversa Tilletia contraversa Kuhn	+	+	0	0
Ustilago tritici Ustilago tritici (Pers) Jens	+	0	+	0
Fusarium head/ear blight/scab Fusarium graminearum Schwabe.	0	0	+	+
Early leaf blight Septoria tritici Rob. at Desmazieres	0	0	+	0
Wheat stripe(yellow) rust Puccinia striiformis West f. sp. tritici	++	+++	++	+

In general, the cultivars are significantly attacked by Powdery mildew, Brown rust, Yellow rust and Septoria.

A higher degree of damage from these diseases was found in Airbus cultivar. Avenue cultivar is presented with good resistance to these diseases.

CONCLUSIONS

The areas were found to be heavily weeded with Lamb's quarters (*Chenopodium album* L.), Amaranth (*Amaranthus retroflexus* L.) and Field mustard (*Sinapis arvensis* L.). As significant we can point out the weeding with Creeping thistle (*Cirsium arvense* (L.) Scop.) and Field bindweed (*Convolvulus arvensis* L.). The studied cultivars show a good productivity, as the average yield for the group is 773.7 kg/da. Avenue presented the highest grain yield of the tested cultivars 861 kg/da where the excess compared to the average of the four cultivars is 10.1%.

It was found that the tested cultivars have good milling qualities. The average hectoliter mass for the group was 77.3% The highest value was reported for Avenue cultivar – 80.1%.

In terms of wet gluten, the values are approximately the same for the cultivars Alcantara (24.3%) and Airbus (24.8%). The content in Annapurna (30.1%) and Avenue (31.2%) cultivars is higher. The average content of wet gluten is 27.6 %.

The studied cultivars guarantee the production of a high percentage of white flours. The data for the grain hyaliness index shows an average value of 44.7% for the studied cultivars.

It has been found that foreign wheat cultivars are significantly attacked by Powdery mildew, Brown, Wheat stripe (yellow) rust and Septoria tritici leaf blotch. A higher degree of damage from these diseases was found in Airbus cultivar. Avenue cultivar is characterized by good resistance to the presented diseases.

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