

EFFECTS OF DIFFERENT SOWING DENSITY IN WINTER WHEAT IN ECOLOGICAL PRODUCTIONS IN TWO DIFFERENT LOCATIONS IN ROMANIA

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Abstract

Straw cereals, especially wheat (Triticum aestivum), are the most widely cultivated plant in the world, grown in over 100 countries, and are a prime commercial source. The uses of straw cereals are many and varied. The grains are used for a range of milling products from which a rich assortment of bakery products, pastries and biscuits are made, which constitute basic foods for 35-55% of the world's population, providing 50-55% of calories consumed worldwide, along with other grains grown. The processing of wheat in high-capacity mills results in large quantities of bran, which is a valuable concentrated feed (rich in protein, lipids and mineral salts) and germs high in vitamins, which is a natural provitamin but also lipids with uses in cosmetics. Straw left over from harvesting can be used to make pulp, bulk feed or bedding for various categories of animals, organic fertilizer after a period of composting or incorporated as such into the soil after harvest, and by briquetting can be used as fuel. The agronomic importance is given by: integral mechanization of the crop; early release of the land and the possibility of summer plowing, being a good precrop for most crops; according to the early varieties, it allows the location of successive crops in certain areas. In this respect, a field experiments were established in the year 2020 at the Agricultural and Development Research Station Secuieni (ADRS Secuieni) located in North Romania (Neamț County) and at Experimental Trials of Saaten Union Romania at Drajna Nouă located in South-East (Călărași County). The experimental variants were represented by the nine winter wheat varieties (Trublion, Centurion, Katarina, Glosa, Aspekt, Izvor, Avenue, Solehio, Alcantara) and one hybrid wheat (Hyxperia) in three repetitions in both locations, with the following graduations: a) 250 germinable kernels/sm; b) 360 germinable kernels/sm; c) 500 germinable kernels/sm. The obtained results indicate that at medium density the production results are superior to the variants of low and high density, which implies giving us more profitability.

Key words: wheat, ecological system, sowing rate, wheat varieties, hybrid wheat.

INTRODUCTION

Winter wheat (*Triticum aestivum*) is a rustic and drought-tolerance plant, with very good adaptability to different climatic and soil conditions, from south to north areas.

In Romania, the areas cultivated with wheat have undergone minor changes in recent decades. Thus, in 1938, 2.5 million ha of wheat were cultivated with wheat, and the areas were gradually reduced to 2.1 million ha during 1979-1981. In recent years, surface oscillations can be reported, around this value (2.1-2.2 million ha) (Bilteanu, 1998).

The three main groups of grain classification according to protein content are: feed wheat

(below 12.5%), baking wheat (12.5-14.5%) and durum wheat or premium wheat (>14.5%) (Tabără et al., 2008).

Wheat cultivation offers the following advantages:

- kernels has a high content of carbohydrates and proteins, corresponding to the requirements of the human body;
- kernels has a good shelf life over long periods of time;
- the grains are easily transported over long distances;
- wheat grains have different alternatives for capitalization;
- wheat grains are an important source of trade on the world market;

- wheat can be grown in different soil and climatic conditions, ensuring satisfactory yields wherever it is grown;

- cultivation technology is completely mechanized and well developed, without special problems;

- wheat is a very good precrop for most crops;

- according to the early wheat varieties, successive crops can be sown, especially if the varieties are irrigated (Ion, 2010).

The vegetation period of autumn wheat lasts, in the conditions of our country, about 9 months (270-290 days). During this period, from germination to maturity, wheat plants go through certain phenological phases (stages), which are recognized by changes in the external appearance of plants and which are accompanied by internal changes in plant biology. Usually, it is difficult to strictly delimit these phases, because they partially overlap, or run in parallel.

It is generally accepted to divide the vegetation period of wheat plants into the following phenological phases: germination (emergence); rooting; twinning; straw formation (elongation); sprouting-flowering-fertilization; grain formation and ripening. In turn, the presented phases are grouped in the vegetative stage (period), characterized by the development of the vegetative organs of plants (from germination to twinning) and the generative (reproductive) stage, characterized by the development of inflorescence, flowers and berry formation (from beginning of straw elongation and until full ripening) (Axinte et al., 2006).

Practically, choosing the good agricultural practices, especially related to the soil management, is a key factor in granting food, clean water, feed, energy, safe climate, diverse ecosystem services and biodiversity for future generations (Muşat et al., 2021).

The yields obtained, by applying ecological system, show that differentiated results can be obtained, the choice of the working variant in relation to the crop plant being decisive (Guş et al., 2004).

In last years, ecological system of winter wheat has gained more and more ground. Organic wheat is one of the best listed and most sought-after organic products on the world market.

For organic farming, wheat varieties grown in conventional agriculture are also used.

Beneficial effects of organic farming at farm level:

- Restoring the natural balance of water and nutrients and infesting weeds, diseases, insects and other pests.

The restoration of natural balances is achieved, both by using classical technological measures (fertilization, soil work, etc.) and by using ecological measures (rotation, associated and intercropping crops, agroforestry curtains, hedges, grassy strips, etc.), soil improvement measures (green manure, mulching, conservation work, etc.) and plant protection (preventive, biological, biotechnical methods, etc.).

- Sustainable growth of soil fertility Organic farming has the healthiest methods and means of restoring and preserving soil fertility by stimulating the activity of soil microorganisms and the use of compost, green manure and long rotations with perennials and annuals with rich and/or deep root system.

- Decreasing soil erosion. The reduction of soil erosion is achieved as a result of soil improvement (increasing the organic matter content and improving the structure) and its better coverage (mulching, protection crops, etc.).

- Better water conservation in the soil. High soil organic matter content leads to better water retention and conservation in the soil, which has the effect of reducing irrigation needs.

- Respecting the intrinsic needs of animals regarding food, shelter, movement

(<http://madr.ro/docs/dezvoltare-rurala/rndr/buletine-tematice/PT4.pdf>-page 11). In the case of ecological system, soil fertility must be maintained as follows:

- cultivation or tillage practices maintain or increase soil organic matter, improve soil stability and biodiversity, and prevent soil compaction and erosion;

- practicing multiannual crop rotation, including legume crops and green manures;

- the application of fertilizers of animal origin or organic matter, both preferably composted, from organic production;

- use of biodynamic preparations.

If these measures do not cover the nutritional needs of the plants, the fertilizers and soil

amendments listed in Annex I to EC Regulation 889/2008 may be used.

The following are prohibited in organic farming:

- hydroponic production (cultivation method which consists of placing the roots of the plants in a solution of mineral nutrients or in an inert medium, such as perlite, gravel or mineral wool, to which is added a solution of nutrients);
- administration of nitrogen (from animal fertilizers) in quantities greater than 170 kg/year/ha agricultural area;
- use of nitrogen-based inorganic fertilizers (N);
- composts of household waste that have not been sorted or have not been composted;
- raw materials containing GMOs or other derivatives thereof;
- slaked lime (calcium oxide) or slaked lime (calcium hydroxide); only calcium carbonate (in the form of chalk, marl, powdered calcium rock, sand deposit with calcareous impregnated algae (marl), phosphate chalk) or industrial lime obtained from the manufacture of sugar or salt (<https://www.srac.ro/files/documente/Ghid-03%20ECO%20e1%20r0%20Ghid%20practic%20Productia%20vegetala.pdf>).

The sources of organic agriculture are represented by the three currents that have emerged in Europe. The first is the one that appeared in Germany in 1924 under the impetus of Rudolf Steiner, with the name of biodynamic agriculture. The second current, published in Britain in 1940, was based on the theory developed by Sir Albert Howard and Lady Eve Balfour under the name of organic agriculture. Last but not least, the third current, called organo-biological agriculture, was developed in Switzerland by Hans Peter Rush and H. Müller

In the 1940s, in Switzerland, Hans Peter Rush and Müller H. emphasized the autarky of producers and the interest of short market circuits. These ideas have resulted in a method that the authors have called organic farming that focuses on renewable resources to ensure food security for the population. Organic farming is defined as a productive system that avoids the use of synthetic fertilizers, pesticides, plant growth regulators, feed additives in animal husbandry. Technological elements are allowed and practiced various sowing processes, use of plant resources after

harvest, manure, legumes, green manure, mechanical cultivation, use of rock dust - a mineral source for maintaining high fertility, biological and physical control pests, diseases and weeds. The fundamental aims of this model of organic farming are: - long-term maintenance of soil fertility, - avoidance of all forms of pollution that can be caused by agricultural techniques, - production of sufficient quantities of food of high nutritional quality, - minimization of use fossil energy - non-recoverable energy in agricultural practice, - raising animals in living conditions in accordance with their physiological needs. At present, the principles of organic farming are increasingly conquering the food market, becoming an inseparable component of the agricultural policy of economically developed countries, which have an organization of organic farming through laws, ordinances and regulations. Organic farming (sustainable). The system of industrial agriculture, with its accompanying shortcomings, tends to be replaced by "organic farming" ("sustainable farming") (Toncea et al., 2012).

It has begun to take on a clearer outlook since the last decade in our country as well. Agriculture has been "ecological" since its inception, but in recent years the application of systematic vision and modern technologies to agriculture has been sought. Organic farming promotes the cultivation of the land through those means that ensure a balance between agroecosystems and the environment (generating "specific agroclimaxes") (Puia and Soran, 1981).

It is based on the use of those means and six methods offered by society, by the scientific and technical achievements that ensure the obtaining of large, constant and high-quality productions, in the conditions of environmental protection. Organic farming is in fact becoming synonymous with the agriculture of the coming years, which ensures the integrity of the biosphere, maximizing the production capacity of agroecosystems and obtaining good quality products (Ionescu et al., 1978).

It will require more conscientious and imaginative work and will ensure an abundance of food while reducing fossil energy consumption, maintaining or increasing the natural fertility of soils, improving man's living environment and protecting the environment as

a whole. Organic farming, agriculture that is being born now for the future, is and must be thought of on an ever-widening, efficient and generous scale, ensuring the prosperity of society and nature on all the meridians of the globe. The structure of the new curricula and analytical programs in higher agronomic education must respond to the guidelines on the development of agriculture on ecological principles and in our country. For this reason, agricultural scientific research in our country must act on a systemic basis, both in the field of creating varieties (hybrids) of plants and animal breeds, and in improving the technologies of plant cultivation and animal husbandry, non-polluting, the protection of flora and fauna, the preservation of ecological balances and the protection of the environment (Toncea et al., 2012).

The characteristics to be followed in the choice of a wheat variety are its adaptability to the pedoclimatic conditions of the area, the increased tolerance to the specific pathogenic pressure and the efficient use of nitrogen, in order to maximize yields (Roman et al., 2009). Taking in consideration these aspects, the objective of the present paper is to put into evidence the effects of different winter wheat sowing density in two different locations from Romania.

MATERIALS AND METHODS

Researches were carried out in field experiments at the Agricultural and Development Research Station Secuieni (ADRS Secuieni) located in North Romania (Neamț County) and at Experimental Trials of Saaten Union Romania at Drajna Nouă located in South-East (Călărași County) in the years 2020.

The researches were performed under rainfed conditions on a soil of cambic chernozem type for both locations (Secuieni and Drajna).

Secuieni: the soil has a medium nitrogen supply (20.7 ppm N-NO₃); well supplied with phosphorus (74.8 ppm, P_{AL}); poor potassium supply (142.6 ppm, K₂O); well supplied with calcium and magnesium (1.6 meq/100 g/soil); humus - 2.44% and pH (in water) = 5.55.

Drajna: the soil has a high nitrogen supply (45.0 ppm N-NO₃); well supplied with phosphorus (80.1 ppm, P_{AL}); medium potassium

supply (160.2 ppm, K₂O); well supplied with calcium and magnesium (2.2 meq/100 g/soil); humus - 3.15% and pH (in water) = 6.1.

Experimental design

The experiment was based on the method of subdivided plots into 3 replications, with the following factors:

o Factor A - variety, with 10 graduations:

- a₁ = Trublion;
- a₂ = Centurion;
- a₃ = Katarina;
- a₄ = Glosa;
- a₅ = Aspekt;
- a₆ = Izvor;
- a₇ = Avenue;
- a₈ = Solehio;
- a₉ = Alcantara;
- a₁₀ = Hyxperia.

o Factor B - plant density, with 3 graduations:

- b₁ = 250 germinable kernels/sm;
- b₂ = 360 germinable kernels/sm;
- b₃ = 500 germinable kernels/sm.

o Factor C - locations, with 2 graduations:

- c₁ = Secuieni;
- c₂ = Drajna.

Crop management

The preceding crop was peas in both locations. The technology was the same in Secuieni and Drajna.

Seed treatment was with Bordeaux mixture in a concentration of 5%, substance, spring fertilizer with manure. All studied variants were sown on 28 of October in both locations. The sowing was performed mechanized.

During the vegetation period no phytosanitary treatments were performed.

For disease and insect control were apply two times the product Ortimag - 100 ml/100 l water, insecto-fungicide homologated for ecological agriculture.

The productivity elements were evaluated at 10 plants chosen at random from each experimental variant.

The calculation and interpretation of the results was done based on the analysis of variance (Săulescu and Săulescu, 1967).

The percentage of protein contain in the wheat seeds was determined with the device Nir

Noise Instruments Quick Analyzer, Agri Check Plus model.

Climatic data

In terms of temperature in the experimental year 2020, winter wheat plants benefited throughout the vegetation period from temperatures higher than the multiannual average value in both location (Figure 1 is for Secuieni location and Figure 2 is for Drajna location).

In terms of water, in 2020, in Drajna location there were excess rainfall in May (+6.8 mm) and June (+12.3 mm), while in April, July and August a cumulative deficit of -98.1 mm was registered, compared to the multiannual averages of the area. In July, it can be said that the total drought was installed, when only 2.5 mm of rainfall was recorded, the rainfall being practically absent. In August, 12.1 mm of rainfall was recorded, of which 12.0 mm in the second decade (Figure 3).

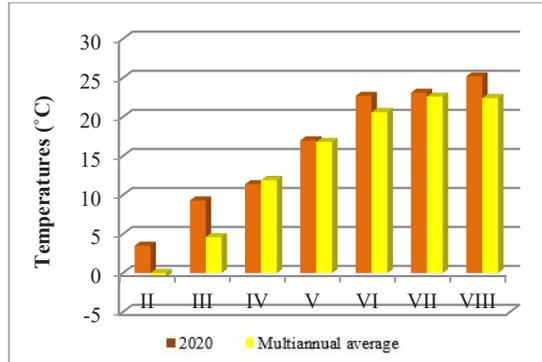


Figure 1. Evolution of average monthly temperatures at ARDS Secuieni in the year 2020

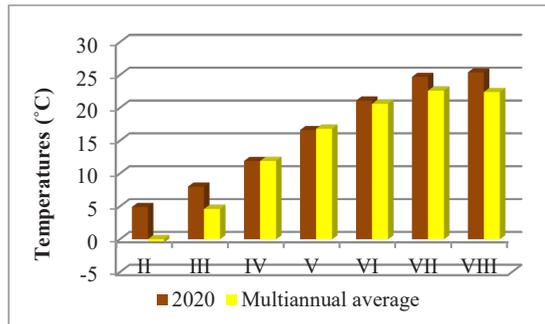


Figure 2. Evolution of average monthly temperatures at Drajna in the year 2020

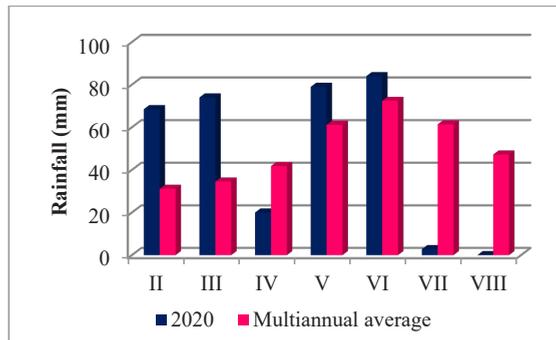


Figure 3. Evolution of rainfall at Drajna in the years 2020

RESULTS AND DISCUSSIONS

Due to the architecture of the winter wheat plant, a high density of the plants is a phenomenon that can cause significant production losses for same varieties. The use of high density can result in overcrowded plants prone to falling, low tillering capacity, high diseases pressure, late flowering, prolongs the

vegetation period and consequently reduces productivity.

The percentage of emerged plants by variants had significant differences as follows: the variant with lower sowing rate registered the highest emergence percentage reported to the same sown period (18.8%) and in the medium density, the emergence was later (9.9%) (Table 1).

Table 1. Emergence of the winter wheat varieties plants in different sowing rate (ARDS Secuieni, Drajna in 2020)

No.	Variety	Sowing rate (g.k./sm)	Sowing date	Emergence date in Secuieni	No. of days for emergence in Secuieni	Emergence date in Drajna	No. of days for emergence in Drajna	Average days for emergence
1	Trublion	250	28.10.2020	20.11.2020	22	15.11.2020	17	19.5
	Trublion	360	28.10.2020	20.11.2020	22	16.11.2020	18	20
	Trublion	500	28.10.2020	19.11.2020	21	15.11.2020	17	19
2	Centurion	250	28.10.2020	19.11.2020	21	14.11.2020	16	18.5
	Centurion	360	28.10.2020	20.11.2020	22	14.11.2020	16	19
	Centurion	500	28.10.2020	19.11.2020	21	15.11.2020	17	19
3	Katarina	250	28.10.2020	17.11.2020	19	12.11.2020	14	16.5
	Katarina	360	28.10.2020	17.11.2020	19	14.11.2020	16	17.5
	Katarina	500	28.10.2020	19.11.2020	21	12.11.2020	14	17.5
4	Glosa	250	28.10.2020	21.11.2020	23	13.11.2020	15	19
	Glosa	360	28.10.2020	20.11.2020	22	14.11.2020	16	19
	Glosa	500	28.10.2020	23.11.2020	25	14.11.2020	16	20.5
5	Aspekt	250	28.10.2020	19.11.2020	21	16.11.2020	17	19
	Aspekt	360	28.10.2020	18.11.2020	20	19.11.2020	21	20.5
	Aspekt	500	28.10.2020	18.11.2020	20	17.11.2020	19	19.5
6	Izvor	250	28.10.2020	18.11.2020	24	14.11.2020	16	20
	Izvor	360	28.10.2020	23.11.2020	25	16.11.2020	18	21.5
	Izvor	500	28.10.2020	21.11.2020	23	14.11.2020	16	19.5
7	Avenue	250	28.10.2020	19.11.2020	21	14.11.2020	16	18.5
	Avenue	360	28.10.2020	18.11.2020	20	15.11.2020	17	18.5
	Avenue	500	28.10.2020	19.11.2020	21	15.11.2020	17	19
8	Solehio	250	28.10.2020	18.11.2020	20	15.11.2020	17	18.5
	Solehio	360	28.10.2020	18.11.2020	20	16.11.2020	18	19
	Solehio	500	28.10.2020	16.11.2020	18	14.11.2020	16	17
9	Alcantara	250	28.10.2020	20.11.2020	22	16.11.2020	18	20
	Alcantara	360	28.10.2020	21.11.2020	23	20.11.2020	22	22.5
	Alcantara	500	28.10.2020	19.11.2020	21	18.11.2020	20	20.5
10	Hyxperia	250	28.10.2020	19.11.2020	21	14.11.2020	16	18.5
	Hyxperia	360	28.10.2020	17.11.2020	19	16.11.2020	18	18.5
	Hyxperia	500	28.10.2020	19.11.2020	21	14.11.2020	16	18.5

The average of tillers capacity of winter wheat varieties counted in winter period, before winter, had significant differences as follows: the variants with medium sowing rate 360 g.k./sm registered the highest number of tillers reported to the same period (3.7 tillers/sm) and in the higher density sowing rate, 500 g.k./sm, number of tillers were lower (3.3 tillers/sm) (Table 2).

On average, the lowest percentage of plants affected by disease (1.66%) was recorded at

250 g.k./sm sowing rate and the highest percentage plants affected by diseases (3.26%) (Table 3).

On average per plant density with the increase of plant density increased the percentage of plants affected by diseases and decrease in plant density from 500 g.k./sm to 250 g.k./sm decrease the plants affected by disease (Table 3).

Table 2. Density in autumn and number of tillers of winter wheat varieties plants in different sowing rate (ARDS Secuieni, Drajna in 2020)

No.	Variety	Sowing rate (g.k./sm)	Sowing date	Density in autumn (plants/sm), Secuieni			No. of tillers in Secuieni	Density in autumn (plants/sm), Drajna			No. of tillers in Drajna	Average of tillers
				R ₁	R ₂	R ₃		R ₁	R ₂	R ₃		
1	Trublion	250	28.10.2020	210	232	220	3	208	215	207	4.5	3.75
	Trublion	360	28.10.2020	296	280	299	4.2	348	350	317	4.7	4.45
	Trublion	500	28.10.2020	480	457	466	3.3	490	468	470	3.1	3.2
2	Centurion	250	28.10.2020	249	241	232	2.9	250	230	235	4.8	3.85
	Centurion	360	28.10.2020	340	320	324	3.6	350	355	349	4.5	4.05
	Centurion	500	28.10.2020	480	457	466	3.3	490	468	470	3.1	3.2
3	Katarina	250	28.10.2020	247	249	250	2.2	249	232	218	3.1	2.65
	Katarina	360	28.10.2020	349	355	358	2.6	350	325	312	3.8	3.2
	Katarina	500	28.10.2020	490	478	485	3.5	499	470	480	3.5	3.5
4	Glosa	250	28.10.2020	192	178	169	2.2	248	250	219	2.5	2.35
	Glosa	360	28.10.2020	310	292	286	2.4	308	301	315	2.5	2.45
	Glosa	500	28.10.2020	487	490	495	2.6	480	500	495	3.8	3.2
5	Aspekt	250	28.10.2020	237	243	247	2.4	240	241	249	3.8	3.1
	Aspekt	360	28.10.2020	345	333	356	2.3	340	312	350	4.1	3.2
	Aspekt	500	28.10.2020	491	476	498	2	495	478	456	3.2	2.6
6	Izvor	250	28.10.2020	246	249	235	2.8	246	249	235	2.8	2.8
	Izvor	360	28.10.2020	332	348	320	1.9	330	335	350	2.7	2.3
	Izvor	500	28.10.2020	444	419	428	2.4	415	490	430	2.6	2.5
7	Avenue	250	28.10.2020	238	210	244	3.6	238	210	244	3.6	3.6
	Avenue	360	28.10.2020	316	288	288	2.7	320	290	300	3.8	3.25
	Avenue	500	28.10.2020	464	432	473	2.2	490	471	456	3.5	2.85
8	Solehio	250	28.10.2020	242	236	228	4.2	242	236	228	4.8	4.5
	Solehio	360	28.10.2020	342	312	351	3.2	350	320	341	4.7	3.95
	Solehio	500	28.10.2020	488	496	491	3.4	490	499	475	3.6	3.5
9	Alcantara	250	28.10.2020	199	220	189	2.6	199	220	189	4.9	3.75
	Alcantara	360	28.10.2020	284	340	312	2.4	312	350	359	4.5	3.45
	Alcantara	500	28.10.2020	356	352	378	2.3	360	450	380	3.9	3.1
10	Hyxperia	250	28.10.2020	228	200	198	4.2	228	200	198	6.1	5.15
	Hyxperia	360	28.10.2020	236	329	347	2.8	302	330	350	6.1	4.45
	Hyxperia	500	28.10.2020	438	460	467	3.4	450	480	456	3.2	3.3

Table 3. Disease resistance of the winter wheat plants at different sowing rate (ARDS Secuieni, Drajna in 2020)

No.	Variety	Density (g.k./sm)	<i>Puccinia striiformis</i> resistance		<i>Septoria tritici</i> resistance		<i>Erysiphe graminis</i> resistance	
			Drajna	Secuieni	Drajna	Secuieni	Drajna	Secuieni
1	Trublion	250	1	2	2	3	1	2
	Trublion	360	1	1	1	2	2	2
	Trublion	500	2	2	3	5	4	3
2	Centurion	250	2	2	2	2	1	1
	Centurion	360	1	1	1	2	2	2
	Centurion	500	2	3	4	3	4	4
3	Katarina	250	2	1	2	3	1	2
	Katarina	360	1	1	1	2	2	2
	Katarina	500	2	2	3	5	4	3
4	Glosa	250	1	1	2	2	1	2
	Glosa	360	1	1	1	2	2	2
	Glosa	500	3	4	3	4	3	2
5	Aspekt	250	1	1	1	1	1	1
	Aspekt	360	1	2	2	2	1	2
	Aspekt	500	3	4	3	2	4	4
6	Izvor	250	1	1	2	2	1	2
	Izvor	360	1	1	1	2	2	2
	Izvor	500	2	3	3	3	3	2
7	Avenue	250	1	2	2	3	1	2
	Avenue	360	1	1	1	2	2	2
	Avenue	500	3	6	3	5	4	3
8	Solehio	250	1	2	2	3	1	2
	Solehio	360	2	1	1	2	2	2
	Solehio	500	4	5	3	3	2	4
9	Alcantara	250	2	2	2	2	1	2
	Alcantara	360	2	1	1	1	2	2
	Alcantara	500	3	4	3	3	2	2
10	Hyxperia	250	2	2	2	2	1	2
	Hyxperia	360	2	2	1	1	2	2
	Hyxperia	500	4	5	3	3	4	6

Notes: 1 - resistant 9 - sensible

Regarding the percentage of lodging plants, the tendency can be observed that we cannot had lodging in all sowing density and varieties, but

in high density we can observe that the plants are taller (average 86.81 cm) then in lower density (82.87 cm) (Table 4).

Table 4. Lodging resistance of the winter wheat plants at different sowing rate (ARDS Secuieni, Drajna in 2020)

No.	Variety	Sowing rate (g.k./sm)	Plant height (cm)	Lodging resistance
1	Trublion	250	77.00	1
	Trublion	360	76.60	1
	Trublion	500	80.30	1
2	Centurion	250	89.00	1
	Centurion	360	91.80	1
	Centurion	500	95.20	1
3	Katarina	250	71.60	1
	Katarina	360	75.20	1
	Katarina	500	77.10	1
4	Glosa	250	81.60	1
	Glosa	360	83.10	1
	Glosa	500	89.60	1
5	Aspekt	250	90.00	1
	Aspekt	360	95.20	1
	Aspekt	500	95.20	1
6	Izvor	250	92.80	1
	Izvor	360	92.20	1
	Izvor	500	95.20	1
7	Avenue	250	77.20	1
	Avenue	360	71.40	1
	Avenue	500	75.30	1
8	Solehio	250	86.40	1
	Solehio	360	92.80	1
	Solehio	500	90.80	1
9	Alcantara	250	84.00	1
	Alcantara	360	88.80	1
	Alcantara	500	83.80	1
10	Hyxperia	250	79.10	1
	Hyxperia	360	83.20	1
	Hyxperia	500	85.60	1

Notes: 1 - resistant 9 - sensible

As in the case of morphological elements of the winter wheat plants, the productivity characters (number of ears per s.m., length of ear, number of grains per ear, weight of the seeds per ear) varied depending on the previous crop, sowing rate and soil type, tillage variants (Table 5).

Also, the smallest values of the productivity characters were registered in the case of the variant in high density. The protein, gluten and amidon content of the seeds is not influenced by sowing rate (Table 6).

Table 5. Number of ears/sm, ear length, number of kernels/ear, kernels weigh (ARDS Secuieni and Drajna, 2020)

No.	Variety	Sowing rate (g.k./sm)	No. of ears/sm, Secuieni	No. of ears/sm, Drajna	Ear length (cm), Secuieni	Ear length (cm), Drajna	No. of kernels/ear, Secuieni	No. of kernels/ear, Drajna	Kernels weigh/ear (g), Secuieni	Kernels weigh/ear (g), Drajna
1	Trublion	250	780	800	7.90	8.20	46	45.00	1.33	1.20
	Trublion	360	896	840	8.10	7.10	43	46	1.40	1.50
	Trublion	500	856	750	7.70	7.50	40	41	1.32	1.15
2	Centurion	250	576	620	7.20	7.50	45	48.00	1.52	1.40
	Centurion	360	832	750	7.40	7.00	39	45	1.44	1.52
	Centurion	500	784	795	6.50	7.10	30	40.00	1.28	1.12
3	Katarina	250	524	642	7.10	6.80	41	45.00	1.31	1.32
	Katarina	360	664	701	8.40	7.60	49	46	1.50	1.50
	Katarina	500	628	529	8.30	8.30	46	48	1.40	1.10
4	Glosa	250	676	512	7.00	6.20	56	45.00	1.38	1.20
	Glosa	360	844	789	7.40	8.00	49	51	1.50	1.20
	Glosa	500	752	810	8.20	8.30	44	49	1.26	1.25
5	Aspekt	250	748	815	7.90	8.90	44	50.00	1.26	1.25
	Aspekt	360	808	820	8.50	5.60	42	53	1.73	1.30
	Aspekt	500	844	650	8.00	7.10	39	48	1.45	1.02
6	Izvor	250	704	690	7.40	8.00	37	41.00	1.41	0.98
	Izvor	360	820	800	7.90	8.10	37	39	1.43	1.15
	Izvor	500	836	820	8.00	3.00	40	43	1.11	1.30
7	Avenue	250	752	680	7.00	7.80	32	38.00	0.97	1.10
	Avenue	360	824	789	7.60	8.30	33	35	1.10	1.30
	Avenue	500	820	750	7.80	7.90	39	40	1.35	1.50
8	Solehio	250	708	680	6.80	7.20	28	32.00	0.99	0.89
	Solehio	360	876	720	7.20	7.50	29	38	1.11	0.90
	Solehio	500	864	750	6.80	6.80	32	35	1.07	1.30
9	Alcantara	250	732	789	8.90	8.90	47	42.00	1.39	1.50
	Alcantara	360	792	825	8.80	7.90	41	35	1.47	1.11
	Alcantara	500	804	650	7.40	8.10	33	38	1.14	1.30
10	Hyxperia	250	756	862	7.90	9.10	37	48.00	1.18	1.50
	Hyxperia	360	872	856	8.40	8.60	45	41	1.55	1.32
	Hyxperia	500	764	750	7.70	8.30	39	35	1.47	0.80

Table 6. Protein, gluten and amidon content of the seeds at different sowing density (ARDS Secuieni and Drajna, 2020)

No.	Variety	Sowing rate (g.k./sm)	Protein content (%)	Gluten content (%)	Amidon content (%)
1	Trublion	250	12.6	25.1	68.9
	Trublion	360	12.8	25.7	68.6
	Trublion	500	12.6	25.2	69.1
2	Centurion	250	13.8	28.1	68.7
	Centurion	360	13.6	27.6	68.6
	Centurion	500	13.7	27.8	69.1
3	Katarina	250	13.3	26.8	68.8
	Katarina	360	13.1	26.4	68.8
	Katarina	500	12.7	26.6	69.5
4	Glosa	250	13	26.1	68.4
	Glosa	360	13.1	26.3	68.1
	Glosa	500	12.9	25.8	68.3
5	Aspekt	250	12.2	24.3	69
	Aspekt	360	12.2	24.3	69
	Aspekt	500	11.8	23.5	69.8
6	Izvor	250	12.8	25.7	68.6
	Izvor	360	13.4	27.1	68.9
	Izvor	500	12.2	24.4	69.4
7	Avenue	250	12.5	25.1	76.7
	Avenue	360	12.3	24.4	62.9
	Avenue	500	11.9	23.7	69.1
8	Solehio	250	11.6	23	70.2
	Solehio	360	11.4	22.4	70.1
	Solehio	500	11	21.5	70.8
9	Alcantara	250	13	26	68.7
	Alcantara	360	12.6	25.2	69.1
	Alcantara	500	12.4	24.9	69.5
10	Hyxperia	250	12.8	25.7	68.5
	Hyxperia	360	12.6	25.2	68.6
	Hyxperia	500	12.1	24.1	69

The highest seed yields were registered in the case of variant with lower sowing rate, while the smallest seed yields were registered in the case of the variant with higher sowing rate. The lower TGW was for one variety in higher

sowing rate (29.6 g and 30.8 g, for both locations) and the higher TGW (43.8 g) was in lower sowing rate at Secuieni and 43.1 g at Drajna, variant with medium sowing rate - 360 g.k./sm (Table 7).

Table 7. Seed yields obtained at different sowing rate and locations (ARDS Secuieni and Drajna, 2020)

No.	Variety	Sowing rate (g.k./sm)	Average of yield STAS (kg/ha), Secuieni	Average of yield STAS (kg/ha), Drajna	TGW (g) average, Secuieni	TGW (g) average, Drajna	HLM (kg/ha) average, Secuieni	HLM (kg/ha) average, Drajna
1	Trublion	250	8,536	8,280	37.3	36.2	70.5	71.8
	Trublion	360	9,187	8,911	34	35.1	71.0	72.3
	Trublion	500	8,300	8,051	32.9	30.8	69.9	70.7
2	Centurion	250	11,120	10,786	43.8	42.3	78.0	75.9
	Centurion	360	10,769	9,560	41	43.1	76.8	75.4
	Centurion	500	8,921	8,653	43.3	40.2	75.3	76.3
3	Katarina	250	7,669	7,439	33.20	35.4	77.0	76.2
	Katarina	360	7,545	7,319	35.90	36.9	72.2	76.4
	Katarina	500	7,499	7,274	29.60	34.5	76.0	77
4	Glosa	250	8,397	8,145	37.5	39.4	75.4	77.1
	Glosa	360	7,786	7,552	32.7	37.0	75.9	75.4
	Glosa	500	8,281	8,033	35	37.8	74.0	76.1
5	Aspekt	250	8,350	8,500	35.1	41.1	79.0	71.7
	Aspekt	360	8,900	7,890	38.3	39.8	80.1	74.1
	Aspekt	500	7,950	7,712	38.6	35.0	78.9	74.2
6	Izvor	250	8,239	7,992	34.2	38.3	79.2	78.2
	Izvor	360	9,356	8,075	42.8	41.2	78.0	75.8
	Izvor	500	8,481	8,227	35.1	38.9	78.6	78.4
7	Avenue	250	7,923	7,685	30.09	33.2	75.1	70.5
	Avenue	360	8,312	8,063	31.4	35.8	72.3	73.6
	Avenue	500	8,827	8,750	30.8	32.3	74.9	72.3
8	Solehio	250	9,448	7,560	35.9	35.9	73.8	75.5
	Solehio	360	9,950	5,630	34.9	38.5	74.2	76.3
	Solehio	500	8,860	8,950	35.4	36.5	75.2	75.9
9	Alcantara	250	8,003	7,763	32.6	35.2	74.5	72.2
	Alcantara	360	8,588	8,960	34.9	36.8	74.9	74.3
	Alcantara	500	8,573	7,560	33.3	34.2	73.5	73.9
10	Hyxperia	250	9,840	9,545	35.4	40.1	78.3	70.6
	Hyxperia	360	9,510	9,225	32.6	38.5	75.8	69.7
	Hyxperia	500	7,970	7,731	35.9	36.9	73.9	71.6

CONCLUSIONS

Taking in consideration the architecture of the plant and the way the plant growth and develop, it is very important to find for winter wheat the optimal sowing density adapted for each variety. An optimal sowing rate can be obtained by reducing the sowing density and obtaining high yields on the main plants and fertile tillers. Some variety has very good tillering capacity and in this case, it is recommended to adapt the sowing rate.

The use of high density can result in overcrowded plants prone to falling, low tillering capacity, high diseases pressure, late flowering, prolongs the vegetation period and consequently reduces productivity.

Increasing sowing rate is associated with decreasing of yield, while decreasing the plant density is associated with increasing of yield.

The yields obtained, on average over the varieties and locations of experimentation, were of 7,386 kg/ha for Katarina variety in high density (500 g.k./sm) and 10,953 kg/ha for Centurion variety in lower density of 250 g.k./sm. So, the highest seed yields were registered in the case of variant with lower sowing rate, while the smallest seed yields were registered in the case of the variant with higher sowing rate.

The large differences in yields are explained by the differences in plant density at harvest, but also by the way of growth and development of plants throughout the vegetation period function of the space of nutrition.

The lower TGW was for one variety in higher sowing rate (29.6 g) and the higher TGW (43.8 g) was in lower sowing rate.

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