Scientific Papers. Series A. Agronomy, Vol. LXVI, No. 2, 2023
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

# PRODUCTIVITY OF DURUM WHEAT VARIETIES IN THE SOIL AND CLIMATE CONDITIONS OF PLOVDIV REGION

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***Abstract***

*Field experience was carried out in 2017-2020 at the Educational Experimental and Implementation Base of the Agricultural University of Plovdiv. The following new varieties of Durum wheat selected at the Institute of Field Crops in the city of Chirpan were tested: Kehlibar, Reyadur, Tserera and Trakiets. They are compared to the standard of productivity variety Predel. The aim of the study is to establish the productivity of Durum wheat variety Kehlibar, Reyadur, Tserera and Trakiets under the soil and climatic conditions of the Plovdiv region. The field experiment was conducted using the block method in four replications with a harvest plot size of 15 m$^2$. As a result of the three-year study, it was found that the productivity of Durum wheat variety Reyadur was the highest 4.520 t/ha with 0.455 t/ha (11.2%) higher grain yield compared to the standard variety Predel. Followed by Kehlibar variety 4.328 t/ha with 0.263 t/ha (6.5%); variety Trakiets 4.209 t/ha with 0.144 t/ha (3.5 %) and variety Tserera 4.146 t/ha with 0.081 t/ha (2.0 %) more grain compared to variety Predel. The higher productivity of the new varieties of Durum wheat is the result of the increased values of the structural components of the grain yield: productive tillering, number of grains and weight of grains per ear.*

***Key words:*** *durum wheat, varieties, productivity, grains yield.*

## INTRODUCTION

In recent years, the interest in durum wheat has been growing, and the areas and average yields from it are constantly expanding. During the past ten years, durum wheat occupies 13 to 16 million hectares of land globally, with a trend to increase the area.

Durum wheat is grown in the world on 13.5 million ha in 2020/2021, which represents 6.2% of the wheat area (Martínez-Moreno et al., 2022.)

Durum wheat in Europe in 2021 occupies an area of 2348000 ha, with yield 3230 kg/ha, and production 7581000 t.

Global demand for durum wheat is expected to grow by 1.0 MMT (Million Metric Tons) to 32.9 MMT in 2022/23. As a result of lower domestic production in many countries, world trade in durum wheat is estimated to grow by 1.5 MMT to 7.4 MMT in 2022/23.

The strategy Grains forecasts that EU import of durum wheat from non-EU members to be 2.4 MMT, i.e. with 1.0 MMT more than last year. Morocco's imported quantity is expected to increase by 400,000 MT to 1.1 MMT.

The necessity to increase crop production poses major tasks that must also be taken into account when solving the grain problem, including and in the production of grain from durum wheat (*Triticum durum* Desf.). In this respect, the importance of variety and variety structure are crucial (Alvaro, 2008; Arduini et al., 2006; Vafa et al., 2014; Bilgin et al., 2008; Sabella, 2020; Dekov et al., 1989; Kodanev, 1970; Sozinov, 1983).

Bulgaria is small in terms of territory, but very diverse in terms of soil and climatic conditions. To obtain high and stable yields and good revenue from durum wheat, the selection of a suitable variety composition for the respective ecological region is essential for the eventual economic results. This is required by the global changes that have occurred in the climate in recent years and the adaptive abilities of varieties to these conditions.

The purpose of the research carried out is to establish the productive abilities of new varieties of durum wheat in the soil and climatic conditions of Plovdiv region.

## MATERIALS AND METHODS

The field experiment was carried out during the period 2017-2020 in the Educational Experimental and Implementation Unit of the

Agricultural University of Plovdiv using the block method, in four repetitions and the size of the harvest plot of 15 $m^2$. The following new varieties of durum wheat (*Triticum durum* Desf.) selected at the Institute of Field Crops in Chirpan were tested: Kehlibar, Reyadur, Cerera and Trakiets. They are compared to the standard of productivity, i.e. Predel variety.

The soil on which the field experiment was conducted is carbonate alluvial-meadow soil Molic Fluvisols (FAO - UNESCO, 1990), which is characterized by an average sandy-clay mechanical composition, humus content 1-2%. The soil is characterized by a slightly alkaline pH reaction (7.2-7.7), the presence of carbonates (4.3-7.4%) and the absence of salts. In the soil layer of 0-20 cm, the content of the main nutritional elements was as follows: N - 15.1 mg/1000 g; $P_2O_5$ - 30 mg/100 g; $K_2O$ - 45 mg/100 g (Popova & Sevov, 2010). The soil has good physico-mechanical properties, loose structure, low plasticity and stickiness with good moisture capacity and filtration ability. (Tahsin & Popova, 2005).

The generally accepted technology was complied with in the cultivation of durum wheat (Bozhanova et al., 2018). The seeds of Durum wheat was sown in the optimal period from 20.10. to 5.11. in each year of experiment, with a seeding rate of 500 germinating seeds/$m^2$ and mineral fertilization 80 kg/ha $P_2O_5$ and 140 kg/ha N as active substance, as the entire amount of phosphorus fertilizer and 1/3 of the nitrogen fertilizer were applied before sowing, and the remaining quantity of the nitrogen fertilizer was applied in early spring as an additional nutrition. The structural elements of the yield were recorded: productive tillering, length of the wheat-ear (cm), number of grains in the wheat-ear, mass of the grains in the wheat-ear (g), and from the physical indicators of the grain - mass of 1000 grains (g), hectolitre mass (kg/hl) and vitreousness of the grain (%). Grain yield (t/ha) was reported by variants and repetitions. The harvest was carried out at full maturity, by direct harvesting with a small trial harvester Wintersteiger seedmaster universal.

The grain samples taken from the tested varieties of durum wheat were qualified according to the following indicators: mass per 1000 grains according to BDS ISO 520:2003; hectolitre mass according to BDS ISO 7971-2:2000; glassy quality of the grain according to BDS EN 15585:2008 in the Accredited Laboratory Complex for testing at the Agricultural University of Plovdiv.

The statistical processing of the data obtained on the studied indicators was carried out with the BIOSTAT software (Penchev, 1998).

## RESULTS AND DISCUSSIONS

During the period of the field experiment (2017-2020) during the vegetation of durum wheat, higher average monthly temperatures were observed compared to the climatic standard.

More significant deviations from the standard were observed in the precipitation during the durum wheat vegetation. The amount of raifall is as follows: 2017-2018 - 457.2 mm, in 2018-2019 - 466.1 mm and in 2019-2020 - 478.9 mm against 419.6 mm for the climatic standard.

The amount of rainfall in the three experimental years exceeds the climatic norm and due to its better distribution during the critical stages of plant development, the 2018-2019 harvest is more favorable for the growth and development of durum wheat. Due to the higher amount of precipitation during the flowering period in the months of April and May, respectively by 44 mm/$m^2$ and by 15.4 mm/$m^2$ more compared to a multi-year period, the pollination and fertilization of the flowers did not proceed normally, which also led to the formation of lower number of grains and lower grain yield in 2020 (Figures 1 and 2).

Average daily temperatures during the three years of the experiment were as high as the multi-year period. The exception is the month of April 2020, when they are lower compared to the climatic norm.

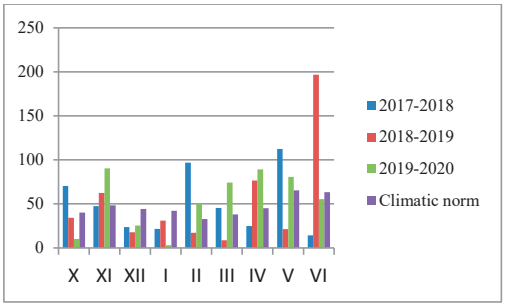


Figure 1. Raifall by months, sum mm/$m^2$, in Plovdiv region

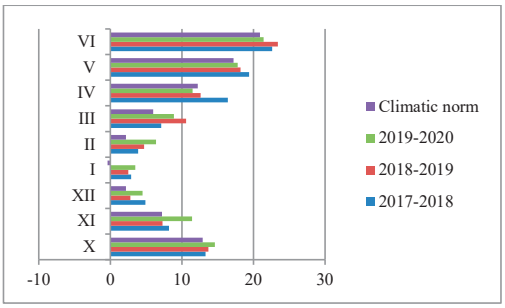


Figure 2. Monthly temperatures (average), in Plovdiv region

**Biometric data of the studied varieties of durum wheat**

***Plant height***. Plant height is primarily a characteristic of the variety (Zhelev, 1980; Dekov, 1982) and is a relatively constant value, but soil and climatic conditions and growing technology have a significant impact on the values of this indicator. The amount of rainfall in the spring, and more precisely from the tillering phase to the end of wheat-ear formation, significantly affects the height of the plants (Table 1[a]).

Table 1[a]. Biometric data (average 2017-2020)

| Variety | Height of the plants, cm | Productive tillering, number | Wheat-ear length, cm |
|---|---|---|---|
| Predel | 86.7 | 1.38 | 7.93 |
| Kehlibar | 88.2 | 1.55 | 8.22 |
| Reyadur | 89.5 | 1.72 | 8.45 |
| Tserera | 87.1 | 1.41 | 7.99 |
| Trakiets | 86.9 | 1.47 | 8.03 |
| GD 5 % | 2.76 | 0.16 | 0.25 |

In the carrying out of the present experiment, it was found that the plants with the highest stem were of the Reyadur variety - 89.5 cm (3.2%) on average during the research period which is higher than the Predel variety (Table 1[a]). Higher than the standard variety Predel are the varieties Trakiets (by 0.2 cm), Tserera (by 0.4 cm) and Kehlibar (by 1.5 %).

***Productive tillering***. The tillering of durum wheat depends on the variety, soil and climatic conditions, seeding density, seeding depth, availability of nutrients, light, time of sowing, seed size (Spaldan et al., 1984). Tillering is highly correlated with yield formation (Yani et al., 2012; Elhani et al., 2007; Delchev et al., 2000).

The ratio between the number of formed ears per unit area to the number of maximally formed tillers determines the productive tillering.

The highest productive tillering is demonstrated for the following varieties: Reyadur - 1.72 tillers and the Kehlibar variety - 1.55 tillers, respectively with 0.34 tillers and 0.17 tillers more than the standard Perdel variety. Then follow the varieties - Trakiets - 1.47 and Tserera - 1.41, which is by 0.09 tillers and by 0.03 tillers more than the standard (Table 1[a]).

***Wheat-ear length*** is a genetically determined trait for each durum wheat variety and as such it is a relatively constant value (Yanev et al., 2000).

On average for the research period, the longest ears were formed by the plants of the Reyadur variety 8.45 cm (6.6%), followed by the Kehlibar variety 8.22 cm (3.7%), Trakiets 8.03 cm (1.3%), Tserera 7.99 cm (0.8%) (Table 1[a]).

***Number of spikelets in a wheat-ear.*** Ear density depends on ear length and the number of spikelets per unit length. Climatic conditions, as well as the application of appropriate technology in the cultivation of durum wheat, play an essential role in the formation of spikelets in the ear.

During the experiment, we found that the Reyadur variety has the largest number of spikelets in the year, 29.3 pcs. it was followed by the Kehlibar variety with 27.9 pcs., Trakiets with 26.4 pcs. and Tserera with 25.1 pcs. which is respectively by 18.1 %, 12.5 %, 6.5 % and 1.2 % spikelets more than the standard (Table 1[b]).

***Number of grains per wheat-ear***. One of the important elements of productivity in cereal crops is the number of grains in the ear. By applying the optimal technological measures, their increase is achieved, which leads to an increase in grain yield per hectare.

Rainfall in the spring has a significant influence on the number of grains, and more precisely from the tillering phase to the end of the flowering phase. In the months of April and May of the third year of the study, the amount of precipitation was by 44 mm/m$^2$ and 15.4 mm/m$^2$, respectively, more compared to a multi-year period. Due to the higher amount of precipitation during flowering, the normal pollination and fertilization of the flowers did not take place, which also led to the formation

of a smaller number of grains and a lower grain yield in 2020.

It was established that, on average, during the three-year period of the experiment, the Reyadur variety formed the largest number of grains in the ear, 52.7 pcs. (8.7%). In second place is the Kehlibar variety 51.3 pcs. (5.8%), Trakiets variety with 49.4 pcs. (1.9%) and variety Tserera 48.7 pcs. (0.4%) compared to the standard variety Predel (Table 1[b]).

Table 1[b]. Biometric data (average 2017-2020)

| Variety | Number of spikelets in a wheat-ear | Number of grains per wheat-ear | Mass of grains in the wheat-ear |
|---|---|---|---|
| Predel | 24.8 | 48.5 | 2.14 |
| Kehlibar | 27.9 | 51.3 | 2.27 |
| Reyadur | 29.3 | 52.7 | 2.38 |
| Tserera | 25.1 | 48.7 | 2.19 |
| Trakiets | 26.4 | 49.4 | 2.21 |
| GD 5 % | 2.84 | 2.52 | 0.12 |

***Mass of grains in the wheat-ear*** is a very important component for the productivity of durum wheat. Several factors play an important role for the value of this indicator, such as: weather conditions during the period of grain formation, as well as the later development of plants until the end of the vegetation, cultivation technology, as well as the genetic abilities of a given variety.

In the implementation of the three-year field experiment, it was found that of all tested durum wheat varieties, the highest grain mass in the ear was demonstrated by the plants of the Reyadur variety - 2.38 g (11.2 %) (Table 1[b]). It was followed by the varieties Kehlibar 2.27 g (6.1 %), Trakiets with 2.21 g (3.3 %), Tserera with 2.19 g (2.3 %) (Table 1[b]).

***Grain yield***. The interaction between the soil and climatic conditions in the durum wheat production area and the studied variety have a significant impact on the yield and quality of the obtained grain.

The tested new varieties of durum wheat selected at the Institute of Plovdiv exceed in terms of grain yield the productivity standard Predel variety (Table 2).

The interaction between the soil and climatic conditions in the durum wheat production area and the studied variety have a significant impact on the yield and quality of the obtained grain.

Table 2. Grain yield the productivity

| Variety | 2018 t/ha | 2019 t/ha | 2020 t/ha | Average kg/ha | Average % |
|---|---|---|---|---|---|
| Predel | 4.150 | 4.571 | 3.473 | 4.065 | 100.0 |
| Kehlibar | 4.384 | 4.975 | 3.624 | 4.328 | 106.5 |
| Reyadur | 4.753 | 5.054 | 3.778 | 4.520 | 111.2 |
| Tserera | 4.215 | 4.632 | 3.591 | 4.146 | 102.0 |
| Trakiets | 4.295 | 4.843 | 3.569 | 4.236 | 104.2 |
| GD 5 % | 0.230 | 0.267 | 0.149 | | |

The tested new varieties of durum wheat selected at the Institute of Field Crops in Plovdiv exceed in terms of grain yield the productivity standard Predel variety (Table 2). For all tested varieties, the highest amount of grain was obtained in the climatically favorable year for the growth and development of durum wheat which is 2019, followed by that of 2018. The grain obtained of the tested varieties was the least in 2020, due to the higher quantity of precipitation during flowering, which led to difficulties in pollination and fertilization of the flowers, and therefore to the formation of a smaller number of grains and a lower grain yield.

From the data presented in Table 2, it is clear that both by year and on average for the research period, the highest grain yield is obtained from the Reyadur variety - 4.520 t/ha (11.4%) compared to 4,065 t/ha for the standard Predel variety. By years, in 2018 -4.753 t/ha (14.5%), in 2019 - 5.054 t/ha (10.6 %) and in 2020 - 3.778 t/ha (8.8%) were obtained from the Reyadur variety. The increase in grain yield by year is respectively 0.603 t/ha - in the first year, 0.483 t/ha in the second and 0.305 t/ha in the third, or on average by 0.455 t/ha more than the productivity standard Predel variety.

The results are one-way and mathematically very well proven.

From the varieties Kehlibar and Trakiets, on average, during the experimental period, 4.328 t/ha (6.5%) and 4.236 t/ha (4.2%) were obtained, respectively, which is 0.263 t/ha and 0.171 t/ha more than the Predel variety. The higher productivity of the Kehlibar variety was mathematically proven during the three years of the experiment, and the Trakiets variety proved a higher yield only in 2019.

The increase in grain yield in the Tserera variety is mathematically unproven.

**Physical properties of durum wheat varieties**

***Mass of 1000 grains***. The mass of 1000 grains is an indicator that characterizes the grain's fullness and serves as an indicator of determination of output. Large-sized grains are used as sowing material and yield from them is up to 15-20% higher (Dekov et al., 1989). The mass of 1,000 grains is a varietal characteristic, which is strongly influenced by soil and climatic conditions and cultivation technology.

Of the studied varieties of durum wheat Kehlibar variety stands out with the highest mass of 1000 grains (Table 3). Average for the study period, the weight of 1000 grains in this variety was 52.4 g, followed by the Reyadur variety with 51.8 g. For Trakiets variety it is slightly higher than the standard, and for the Tserera variety the mass of 1000 grains is lower than the standard (Table 3).

Table 3. Physical properties of durum wheat varieties

| Variety | Mass of 1000 grains, g | Hectolitre mass, kg/hl | Vitreousness of the grain, % |
|---|---|---|---|
| Predel | 50.1 | 80.15 | 96.2 |
| Kehlibar | 52.4 | 82.60 | 98.5 |
| Reyadur | 51.8 | 81.21 | 97.8 |
| Tserera | 49.5 | 80.53 | 97.1 |
| Trakiets | 50.7 | 80.72 | 96.7 |
| GD 5 % | 1.35 | 1.02 | 1.46 |

***Hectoliter mass***. An important physical indicator that serves to determine grain quality is the hectoliter mass. It gives an idea of uniformity, surface and density. The hectoliter mass depends on the type of impurities, the weed seeds, the unthreshed ears and the consistency of the grain.

Of the studied varieties of durum wheat, with a higher hectoriter mass of the grain are the Kehlibar variety - 82.60 kg/hl and Reyadur variety - 81.21 kg/hl compared to the Predel variety (Table 3).

***Vitreousness of the grain*** is an important physical property and its high values determine the production of high-yield flours. This indicator is strongly influenced by many factors, but the decisive ones are the variety with its characteristics, the soil and climatic conditions during the formation and ripening of the grain.

Durum wheat is characterized by a high glassy grain. It can be seen from Table 3 that, on average, for the three-year experimental period, the glassy quality was very high for all studied varieties of durum wheat. For the Kehlibar variety it is 98.5%, followed by Reyadur with 97.8%, Tserera with 97.1%, Trakiets with 96.7%, and for the standard Predel variety - it is 96.2%.

## CONCLUSIONS

The highest productivity in the soil and climatic conditions of Plovdiv region was reported for the Reyadur durum wheat. The harvested grainof this variety is in the range of 4.753 t/ha (14.5%) in 2018, of 5.054 t/ha (10.6%) in 2019 and 3.778 t/ha (8.8%) in 2020. The increase of grain yield by year is respectively 0.603 t/ha – in the first year, 0.483 t/ha in the second and 0.305 t/ha in the third, or an average of 0.455 t/ha more that the productivity standard Predel variety.

Kehlibar and Trakiets on average, during the experimental period, 4.328 t/ha (6.5%) and 4.236 t/ha (4.2%) were obtained, respectively, which is 0.263 t/ha and 0.171 t/ha more than Predel variety.

The productive abilities of the studied new varieties of durum wheat are greater compared to the standard Predel variety, which is a result of the higher productive tillering, the longer and more grain-filled ear and the higher grain mass in the plant ears.

The durum wheat variety Kehlibar has the highest mass per 1000 grains on average for the study period, which is is 52.4 g, followed by the Reyadur variety with 51.8 g. Trakiets variety has slightly higher values than the standard, and Tserera variety's mass per 1000 grains is lower than the standard Predel variety.

The hectoliter mass of the grain of the studied durum wheat varieties is greater in the varieties Kehlibar 82.60 kg/hl and Reyadur 81.21 kg/hl compared to Predel variety.

The glassy quality in the new tested durum wheat cultivars was very high on average over the three-year study period. For Kehlibar variety it is 98.5%, followed by Reyadur with 97.8%, Tserera with 97.1%, Trakiets with 96.7%, while for the Predel standard it is 96.2%.

## ACKNOWLEDGEMENTS

This research work was carried out with the support of Centre of Research, Technology Transfer and Protection of Intellectual Property Rights - Project 14-17, Agricultural University, Plovdiv, Bulgaria.

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