Study of various ripeness groups winter bread wheat varieties according to productivity and grain quality

E I Nekrasov, D M Marchenko, M M Ivanisov and N S Kravchenko

Agricultural Research Center “Donskoy”, 3 Nauchny Gorodok Street, Zernograd, Rostov region, 347740, Russia

E-mail: 89585748977@yandex.ru

Abstract. The purpose of the current study was a comparative estimation of productivity and grain quality of the early ripening, middle early and middle ripening winter bread wheat varieties in the conditions of the southern part of the Rostov region. The study was conducted in the Agricultural Research Center “Donskoy” in 2017-2019. The objects of the study were 15 winter bread wheat varieties. The study established that the middle early ripening varieties Krasa Dona, Lidiya, Lilit and Premiera showed a significant increase to the standard variety Don 107 from 0.46 to 0.85 t/ha according to productivity. The comparative estimation of the ripeness different groups varieties showed that such middle early ripening varieties with its maximum percentage as Don 107 (12.29%), Lidiya (12.46%), Volnitsa (12.72%) and the early ripening sample Podarok Krymu (with 12.68% of mass fraction of protein), that correspond to the 3rd quality class, were identified according to the mass fraction of protein in grain. The early ripening varieties Zhavoronok (24.98%) and Podarok Krymu (26.77%) with the highest values and the middle early ripening varieties Don 107 (24.81%), Volnitsa (25.22%) and Asket (26.30%), corresponding to the 3rd quality class, were identified according to the trait gluten content in grain.

1. Introduction
Among the various grain crops that provide food for people, wheat has always been extremely important. The improvement of wheat grain productivity and quality is an important national economic task of the Agricultural Industrial Complex of the Russian Federation [1, 2, 3].

However, the improvement of grain crop productivity often results in grain quality decrease. The task of agricultural production is to obtain not only large and stable yields, but also to obtain high quality grain, both technologically and nutritionally [4].

Wheat grain quality is a global and constantly relevant problem around the world. The protein percentage and gluten content in grain depends on many factors. First of all, these are climatic and soil growing conditions, both natural and those regulated by certain agrotechnical measures. The variety of wheat is not of less importance, although varietal differences can be smoothed out by soil and climatic conditions [5].

The purpose of the current study was a comparative estimation of productivity and grain quality of the winter bread wheat early ripening, middle early and middle ripening varieties in the conditions of the southern part of the Rostov region.
2. Materials and methods
The study was conducted at the experimental plots of the Agricultural Research Center “Donskoy” in 2017-2019. The soil of the experimental plots was the blackearth (ordinary chernozem). The humus content in soil was 3.0-3.5%, with pH 7.0-7.1. The phosphorus content was 15-20 mg per a kg of soil, the content of exchangeable potassium was 300-500 mg per a kg of soil [6].

The objects of the study were 15 winter bread wheat varieties developed in the Agricultural Research Center “Donskoy”. The study was conducted in the block of the Competitive Variety Testing. The standard variety was the variety Don 107. The forecrop was sunflower for grain.

The sowing was done in the optimal time by the seeder Wintersteiger Plotseed with the seeding depth of 4-6 cm, six-fold sequence on the plot of 10 m². The harvesting was carried out by the combine Wintersteiger Classik. The trials were conducted according to the Methodology of the State Variety Testing [7] and Methodology of a field trial [8].

The mass fraction of protein in grain was determined in accordance with the Interstate Standard “Grain and its Processed Products” (State Standard 108460-91); gluten content was determined in accordance with the National Standard of the Russian Federation “Methods for determining the amount and quality of gluten in wheat” (State Standard 54478-2011). Physical characteristics of the dough was determined according to the Interstate Standard “Wheat flour” (State Standard 5530-1-2013).

The weather conditions in 2017 were favorable in moisture supply and temperature, that allowed obtaining large yields. The year of 2018 was characterized by the almost complete lack of precipitation in April and June, as well as the increased temperature regime and dry winds. The weather conditions of 2019 in terms of the amount of precipitation, their distribution by seasons, and the temperature regime turned out to be more typical for this location than in the previous year.

3. Result and discussion
The study established that in 2017 the middle early ripening varieties Krasa Dona (10.73 t/ha), Lidiya (10.84 t/ha), Lilit (10.87 t/ha), and Premiera (10.73 t/ha) exceeded the standard variety Don 107 in productivity on 0.31-0.45 t/ha. The middle ripening variety Ambar produced the maximum yield (10.94 t/ha) that exceeded the yield indicators of the standard variety on 0.54 t/ha (Table 1).

Table 1. Productivity, mass fraction of protein and gluten content in grain of the winter bread wheat varieties.

| Variety       | Grain productivity, t/ha | Mass fraction of protein, % | Gluten content, % |
|---------------|--------------------------|----------------------------|-------------------|
|               | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| Early ripening varieties |     |      |      |      |      |      |      |      |      |
| Zhavoronok    | 10.20 | 7.54 | 6.51 | 11.30 | 11.16 | 13.69 | 25.70 | 22.24 | 27.00 |
| Podarok Krymu | 10.49 | 7.67 | 5.89 | 11.60 | 11.62 | 14.83 | 24.40 | 23.92 | 32.00 |
| Average       | 10.35 | 7.61 | 6.20 | 11.45 | 11.39 | 14.26 | 25.05 | 23.08 | 29.50 |
| Middle-early ripening varieties |     |      |      |      |      |      |      |      |      |
| Don 107, standard | 10.42 | 7.17 | 5.95 | 11.66 | 10.69 | 14.81 | 23.50 | 23.02 | 30.60 |
| Asket         | 9.59  | 6.72 | 5.90 | 11.82 | 11.17 | 13.75 | 22.30 | 25.50 | 31.10 |
| Izyuminka     | 9.83  | 7.53 | 5.93 | 11.24 | 10.97 | 14.23 | 22.60 | 21.40 | 32.40 |
| Lidiya        | 10.84 | 7.81 | 6.29 | 11.87 | 11.10 | 14.41 | 24.90 | 18.10 | 27.60 |
| Kaprizulya    | 10.63 | 7.68 | 6.33 | 11.50 | 10.90 | 13.05 | 24.50 | 19.20 | 25.90 |
| Lilit         | 10.87 | 8.07 | 6.19 | 11.33 | 10.72 | 13.87 | 22.80 | 21.60 | 25.30 |
| Krasa Dona    | 10.73 | 8.10 | 6.00 | 11.25 | 11.20 | 13.86 | 23.60 | 20.56 | 25.60 |
Under the conditions of 2018, almost all varieties formed the same or larger productivity than that of the standard variety Don 107 (7.17 t/ha). The largest productivity was identified in the middle early ripening varieties Kaprizulya, Volny Don, Lidiya, Lilit, Krasa Dona and Premiera, the excess over the standard variety was from 0.51 to 1.56 t/ha. There was also identified the early ripening variety Podarok Krymu, which significantly exceeded the productivity of the standard variety on 0.50 t/ha.

The large productivity in 2019 was produced by the early ripening variety Zhavoronok (6.51 t/ha), which significantly exceeded the standard variety Don 107 on 0.56 t/ha. The varieties Lilit (6.19 t/ha), Lidiya (6.29 t/ha), Kaprizulya (6.33 t/ha), Polina (6.46 t/ha), Volny Don (6.56 t/ha) and Premiera (7.15 t/ha) were identified among the middle early ripening varieties, they exceeded the productivity of the standard variety from 0.24 to 1.2 t/ha.

The three-year study established that according to average productivity, the middle early ripening varieties Krasa Dona, Lidiya, Lilit and Premiera showed a significant increase to the standard variety Don 107 from 0.46 to 0.85 t/ha (LSD$_{05}$ = 0.25) (Figure 1).

![Figure 1](image-url)
Grain quality is a combination of biological, physical-chemical, technological and consumer properties and traits that determine whether the grain is suitable for its intended use, namely for food purposes.

The mass fraction of protein in grain in all the studied varieties in 2017 and 2018 corresponded to the 3-rd (12.0-13.4%) and 4-th (10.0-11.9%) quality classes (Table 1). In 2019, this index was significantly higher. The two middle early ripening varieties Kaprizulya and Premiera corresponded to the 3-rd quality class (12.0-13.4%), the other varieties corresponded to the 2-nd quality class (with 13.5-14.4% of mass fraction of protein in grain). On average, over three years of study, there were identified the middle early ripening varieties Don 107, Lidiya, Volnitsa with the maximum protein percentage in grain (12.39-12.72%) and the early ripening variety Podarok Krymu (with 12.68% of mass fraction of protein), corresponding to the 3-rd quality class.

Unfavorable growing conditions often result in the production of grain with a low gluten content, as occurred in 2017 and 2018. Almost all varieties in the trials, regardless of the ripeness group, corresponded to the 3-rd (23.0-27.9%) and 4-th (18.0-22.9%) quality classes in terms of the gluten content in grain. Under the conditions of 2019, this indicator was higher for the winter bread wheat varieties. The early ripening variety Podarok Krymu and the middle early ripening variety Izuminka belonged to the first quality class, forming more than 32.0% of gluten in grain. The second quality class included the middle early ripening varieties Volnitsa, Don 107 and Asket (30.6-31.1% of gluten), the rest of the varieties corresponded to the 3-rd quality class (23.0-27.9%).

The early ripening varieties Zhavoronok, Podarok Krymu and the middle early ripening varieties Don 107, Volnitsa, Asket with maximum values of 24.8-26.8%, were identified according to the average gluten content in grain, that corresponded to the 3rd quality class.

The varieties Zhavoronok, Podarok Krymu, Don 107, Asket, Izyuminka, Volnitsa, Volny Don showed the largest indices of grain hardness (70-80%) (Table 2).

| Variety        | Protein mass fraction, % | Gluten content, % | Hardness, % | Valorigraphic estimation, u.v. | Volume of bread, cm³ | General baking assessment, point |
|----------------|--------------------------|-------------------|-------------|-------------------------------|----------------------|---------------------------------|
| Zhavoronok     | 12.05                    | 24.98             | 70          | 70.1                          | 545                  | 3.2                             |
| Podarok Krymu  | 12.68                    | 26.77             | 70          | 70.0                          | 530                  | 3.1                             |
| Don 107, standard | 13.29                   | 24.81             | 70          | 60.0                          | 470                  | 2.6                             |
| Asket          | 12.25                    | 26.30             | 70          | 68.3                          | 603                  | 3.7                             |
| Izyuminka      | 12.15                    | 25.45             | 80          | 65.0                          | 547                  | 3.3                             |
| Lidiya         | 12.46                    | 23.53             | 65          | 59.0                          | 510                  | 2.9                             |
| Kaprizulya     | 11.82                    | 23.20             | 62          | 65.7                          | 550                  | 3.5                             |
| Lilit          | 11.97                    | 23.23             | 69          | 64.3                          | 560                  | 3.3                             |
| Krasa Dona     | 12.11                    | 23.15             | 65          | 72.7                          | 520                  | 3.1                             |
| Volnitsa       | 12.72                    | 25.22             | 70          | 81.0                          | 590                  | 3.6                             |
| Volny Don      | 12.10                    | 23.12             | 70          | 65.0                          | 520                  | 3.2                             |
| Niva Dona      | 12.11                    | 22.60             | 66          | 70.0                          | 490                  | 2.9                             |
| Premiera       | 11.63                    | 21.14             | 62          | 66.7                          | 523                  | 3.2                             |
| Ambar          | 12.19                    | 21.53             | 68          | 71.2                          | 560                  | 3.3                             |
| Polina         | 12.06                    | 23.60             | 69          | 70.1                          | 463                  | 2.5                             |
Average early ripening varieties
12.4  25.9  70.0  70.1  537.5  3.2
middle-early ripening varieties
12.2  23.8  68.0  67.1  534.8  3.2
middle ripening varieties
12.1  22.6  68.7  70.7  511.7  2.9

The varieties Ambar, Krasa Dona and Volnitsa were identified according to the valorigraphic estimation, they showed the best indices of the trait (71.2-81.0 u.v.). The largest volume of bread was produced by the varieties Kaprizulya, Ambar, Lilit, Volnitsa, Asket (550-603 cm³). These varieties also showed the best baking assessment (3.3-3.7 points).

4. Conclusions
The three-year study established that the middle early ripening varieties Krasa Dona, Lidiya, Lilit and Premiera had the largest productivity (8.31-8.70 t/ha) and a significant increase to the standard variety Don 107 was from 0.46 to 0.85 t/ha.

The comparative estimation of the ripeness different groups varieties showed that such middle early ripening varieties as Don 107 (12.29%), Lidiya (12.46%), Volnitsa (12.72%) with the maximum protein percentage, and the early ripening sample Podarok Krymu (with 12.68% of mass fraction of protein), that correspond to the 3rd quality class, were identified according to the protein mass fraction in grain.

The early ripening varieties Zhavoronok (24.98%) and Podarok Krymu (26.77%) with the highest values and the middle early ripening varieties Don 107 (24.81%), Volnitsa (25.22%) and Asket (26.30%), corresponding to the 3rd quality class, were identified according to the trait ‘gluten content in grain’. The varieties are recommended for use in the breeding programs for improvement of winter bread wheat productivity and grain quality in the conditions of the Rostov region.

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