Comparative evaluation of potato varieties bred in Russia and Belarus

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Abstract. The paper contains findings on comparative evaluation of potato varieties of varied times to maturity bred in Russia and Belarus. The study identified potato varieties that are best adapted to the soil and the climate of the Volga-Vyatka region. Samba and Gulliver varieties deliver the highest yields amongst Russia-bred variety – 53.7 and 50.0 t/ha. These cultivars had the most smooth-skinned tubers without cracks and other damage. Amongst Belarus-bred cultivars, Breeze cultivar stood out – 50.1 t/ha. Samba, Gulliver, Yanka and Zorachka cultivars had the best gustatory qualities. Tuber analysis showed that 82% of Charoite tubers fall into seed grade. Gulliver and Pennant varieties produced large amount of seed tubers – 69.7 and 69% of the total number of tubers, respectively. Samba, Gulliver, Yanka and Zorachka were the tastiest.

1. Introduction

Like grain crops, potato is of utmost importance when it comes to Russia’s food security. Wide use of top-quality sowing seed of high-yielding potato varieties will seriously increase gross yields, which means more income for the farms [1]. Commercialization of new cultivars is not only highly effective to boost yields but provides the basis for sustainable and environmentally friendly farming. In 2019, over 400 potato varieties bred domestically and abroad were included in the state register of successful breeds. However, breeders actively work to develop new economically valuable varieties.

The importance of enhancing the quality and further development of seed potato market in the Russian Federation was mentioned more than 10 years ago and it is still relevant today [2, 3]. Potato is staple food following wheat and rice, and is gaining popularity in developing countries. Fitting in the demand means adapting potato to different soil and climate conditions. It must also be resistant to new threats from pests, diseases, heat and drought [4].

To commercialize cultivars, the influence of varietal features on their yield and yield quality shall be studied [5]. Today, potatoes often face great problems, including abiotic stress due to changing weather. In such stressful conditions, it is important that appropriate technologies are accompanied by tolerant varieties. Therefore, adaptation of cultivars to climate changes is crucial for boosting yields or, at least, maintaining current yields [6].

Breeding and commercializing of improved varieties are an important strategy to adapt to negative impacts of climate change. However, imperfect data about the varieties is often an unfortunate reality in many countries that impedes informed decision-making on breeding and cultivar propagation strategies to effectively adapt to climate changes. This raises the question of the need to select potato varieties that are best adapted to the soil and the climate of the Volga-Vyatka region. To adapt to the negative impact of weather, improved varieties with features specific to the growing region must be used [7, 8].
To properly choose one variety over another, qualitative assessment of the varieties in terms of economic value shall be carried out. For imports phase-out purposes, both cultivars recommended for cultivation in a specific region and promising Russia- and Belarus-bred cultivars shall be given special attention. A Feleke, G Regasa and M Muche pointed the importance of having new potato varieties in place to grow revenues and ensure food security in Ethiopia using the example of Belete potato cultivar [9]. Their studies showed that introducing a new variety is impossible without the State’s commitment which includes spread of knowledge and economic aid [9].

Some researchers who studied potato heat stress response pointed to differentiated response of the varieties and showed yield loss, fewer tubers and physiologic defects [10]. A variety’s performance was noted to be influenced by solar radiation, temperature, and photoperiod. All this affects the yield, thereby pointing to the need to cultivate highly plastic varieties [11].

Researchers in Chili studied how high temperatures effect the yield and physiological properties of tubers. Two-year studies of two aboriginal Chilean varieties and three commercial varieties showed that the variety genotype statistically significantly effects the sensitivity to temperature rises [12].

Thus, when choosing varieties, their plasticity to the soil and the climate of their cultivation location must be taken into account. The purpose of the study is to conduct a comparative assessment of potato varieties of Russian and Belarusian selection by yield, fractional composition and taste; to select the most suitable for the conditions of the Volga - Vyatka region of the Russian Federation.

2. Methods and materials
The studies were made in the trial field of the laboratory for potatoes propagation research of the Federal State Budgetary Educational Institution of Higher Education Chuvash State Agricultural Academy. The experiments to study cultivars bred in Russia and Belarus were carried out in spring 2019.

In 2019, growing season with transition to stable positive temperature above +5 °C started in last 10 days of April. The first half of the growing season had favorable weather conditions for the plants to grow and develop. Starting from the last 10 days of June, daily average temperature was decreasing versus long-term averages while precipitation was increasing which lasted up to the second third of August. In 2019 growing season, moisture regime is assessed as wet with the hydrothermal index (GTI) – 1.32 (figure 1). 2019 weather conditions generated rather high yields of commercial and seed potato tubers for Russia- and Belarus-bred varieties which suggests commercialization of these varieties is promising.

![Figure 1. Weather conditions for the growing season.](image-url)
Planting date was 17 May 2019. Potatoes were planted according to Dutch method. Elite sowing seeds were used for planting. Planted area – 600 m². The scheme of planting 70×30 cm. The registered area of the plot was 150 m². The experience was repeated three times. The collected potato tubers were divided into the following fractions: Ø <28 mm, Ø 28-55 mm, Ø55+ mm. The size of tubers was determined by the largest transverse diameter.

Potato cultivates bred in Russia and Belarus of varied maturity groups were taken as study objects. Early varieties – Meteor, Charoite, Gulliver, Fortress, Zorachka, Reggae. Middle-early – Samba, Breeze. Mid-season – Volat, Fritella, Pennant, Yanka. 

METEOR variety.

Very early, table variety. Growing season: 60-80 days, the first unearthing is possible on the 45th day after the crop has been established. Tuber is creamy white, flesh is yellow. Resistant to potato wart disease and golden potato cyst nematode. Originator – Federal State Budgetary Scientific Institution Russian Research Institute of Potato Farming named after A. G. Lorch (Russia).

CHAROIT variety.

Very early, table variety. Tuber is elongated oval, yellow, flesh is light yellow, very shallow-eyed. Resistant to potato wart disease, susceptible to golden potato cyst nematode. Originator – SF Liga LLC, Federal State Budgetary Scientific Institution Leningrad Scientific Research Institute of Agriculture “Belogorka” (Russia).

GULLIVER variety.

Early, table variety. Growing season: 60-70 days. Tuber is elongated oval, white, flesh is creamy white. Originator – Federal State Budgetary Scientific Institution Russian Research Institute of Potato Farming named after A. G. Lorch (Russia).

FORTRESS variety.

Early, table variety. Growing season: 60-70 days (the first unearthing is possible on the 45th day, the second one – on the 55th day). Tuber is yellow, flesh is creamy white. Resistant to potato wart disease and golden potato cyst nematode. Originator – State Scientific Institution Russian Research Institute of Potato Farming named after A. G. Lorch (Russia).

ZORACHKA variety.

Early, table variety. Growing season: 70-75 days (the first unearthing is possible on the 45th day after the crop has been established). Tuber is dark yellow, flesh is pale yellow. Resistant to potato wart disease, susceptible to golden potato cyst nematode. Originator – Republican Unitary Enterprise ‘Scientific and Practical Center of the National Academy of Sciences of Belarus for Potato and Horticlture’ (Belarus).

REGGAE variety.

Early, table variety. Growing season: 65-75 days. Tuber is elongated oval, yellow, flesh is light yellow. Resistant to potato wart disease, vein banding mosaic and leaf roll disease. Moderately susceptible to late blight disease of tops and tubers. Infectible by golden potato cyst nematode. Originator – Federal State Budgetary Scientific Institution Federal Research Center Kazan Scientific Center of the Russian Academy of Sciences (Russia).

SAMBA variety.

Middle-early, table variety. Growing season: 65-80 days. Tuber is oval, yellow, flesh is light yellow. Resistant to potato wart disease, wart disease and leaf roll disease. Infectible by late blight disease of tops and tubers, is susceptible to golden potato cyst nematode. Originator – Russian Research Institute of Potato Farming named after A. G. Lorch and Federal State Budgetary Scientific Institution Federal Research Center Kazan Scientific Center of the Russian Academy of Sciences (Russia).

BREEZE variety.

Medium-early, table variety. Growing season: 65-80 days. Tuber is yellow, flesh is yellow. Resistant to potato wart disease, susceptible to golden potato cyst nematode. Originator – Republican Unitary Enterprise ‘Scientific and Practical Center of the National Academy of Sciences of Belarus for Potato and Horticlture’ (Belarus).
VOLAT variety.
Mid-season, table variety. Resistant to drought and mechanical damage. Growing season: 80-95 days. Tuber is yellow, flesh is yellow. Resistant to nematode, potato wart disease, viruses, scab, black rot, rot, rhizoctonia, early blight, foliar blight. Infectible by late blight of tubers. Originator – Republican Unitary Enterprise ‘Scientific and Practical Center of the National Academy of Sciences of Belarus for Potato and Horticulture’ (Belarus).

FRITELLA variety.
Mid-season, table variety. Growing season: 80-100 days. Tuber is yellow, flesh is white. Resistant to potato wart disease, susceptible to golden potato cyst nematode. Originator – Federal State Budgetary Scientific Institution Russian Research Institute of Potato Farming named after A. G. Lorch (Russia).

PENNANT variety.
Mid-season, table variety. Growing season: 80-100 days. Tuber is yellow, flesh is light yellow. Resistant to potato wart disease and golden potato cyst nematode. Originator – State Scientific Institution Russian Research Institute of Potato Farming named after A. G. Lorch of the Russian Agricultural Academy (Russia).

YANKA variety.
Mid-season, table variety. Growing season: 90-100 days. Tuber is yellow, flesh is creamy white. Moderately resistant to causative agent of foliar blight, resistant to golden potato cyst nematode, potato wart disease, vein banding mosaic, leaf roll virus. Originator – Republican Unitary Enterprise ‘Scientific and Practical Center of the National Academy of Sciences of Belarus for Potato and Horticulture’ (Belarus).

Potato plant care included chemical weeding. Before planting, seed potato tubers were treated against the pests using Prestige suspension concentrate by Bayer. Fungicides were not applied. During monitoring of the phenology and potato unearthing, plants and tubers were visually inspected for the severity of diseases.

Assessment of eating qualities included analysis of the skin integrity, flesh texture, flouriness, and water content. After-cooking darkening of flesh and eating qualities were taken into account as well.

Skin integrity was assessed by the following scale:
9 – skin integrity is not damaged;
7 – skin integrity is damaged;
5 – skin integrity and outer layer of tuber are damaged;
3 – outer layers of tuber come off;
1 – tuber falls apart.

Flesh texture:
7 – soft (tender); 5 – rather fine; 3 – fine; 1 – fibrous.

Flesh flouriness:
9 – very floury, granular, sometimes glossy;
7 – very floury, fine-grained;
5 – moderately floury;
3 – slightly floury;
1 – not floury.

Water content:
7 – not watery; 5 – moderately watery; 3 – watery;

After-cooking darkening:
7 – does not get dark; 5 – gets slightly darker; 3 – gets moderately darker; 1 – gets very dark.

Taste:
9 – excellent;
7 – good;
5 – satisfactory (also, sweetish);
3 – flat;
1 – bad (unpleasant or bitter).
Based on the assessment, each variety was assigned to a particular cooking type in accordance with the international potato eating qualities classification.

Type A – potatoes with fine-textured flesh, little flouriness, not disintegrating during cooking.
Type B – commonly used potatoes with fine-textured flesh, a little floury, disintegrating slightly on cooking.
Type C – potatoes with soft flesh, rather floury, a rather marked disintegration during cooking.
Type D – potatoes with very floury flesh, disaggregating almost entirely during cooking.

3. Results and discussion

Potatoes were unearthed on 14 September 2019. Summer and autumn observations showed that Volat and Zorachka varieties were most resistant to viral diseases (potato virus Y, potato rugose mosaic, common mosaic) among Belarus varieties. However, these varieties yielded less compared to Breeze variety which outyielded the rest of the Belarussian cultivars – 50.1 t/ha (table 1).

Table 1. Yield and grade composition of potato tubers.

| No. | Variety   | Yield Σ t/ha | Grade          | Ø55+ mm commercial kg | Ø28-55 mm seed kg | Ø <28 mm fines kg | Ø55+ mm seed pcs | Ø28-55 mm seed pcs | Ø <28 mm fines pcs | Yield, t/ha Ø55+ mm kg | Ø28-55 mm seed kg | Ø <28 mm fines kg |
|-----|-----------|--------------|----------------|-----------------------|-------------------|-------------------|------------------|-------------------|-------------------|-----------------------|-------------------|-------------------|
| 1   | Volat     | 46.1         |                | 2.78                  | 1.78              | 28                | 0.05             | 4                 | 27.8              | 17.8                  | 0.5                |
| 2   | Samba     | 53.7         |                | 3.34                  | 1.95              | 29                | 0.09             | 9                 | 33.4              | 19.5                  | 0.9                |
| 3   | Yanka     | 46.9         |                | 2.70                  | 1.90              | 29                | 0.09             | 11                | 27.0              | 19.0                  | 0.9                |
| 4   | Charoite  | 38.1         |                | 0.43                  | 3.28              | 73                | 0.10             | 12                | 4.3               | 32.8                  | 1.0                |
| 5   | Fortress  | 26.6         |                | 2.10                  | 0.56              | 14                | n/a              | 2                 | 21.0              | 5.6                   | -                  |
| 6   | Reggae    | 46.0         |                | 3.49                  | 1.11              | 19                | n/a              | 3                 | 34.9              | 11.1                  | -                  |
| 7   | Zorachka  | 47.7         |                | 2.49                  | 2.18              | 41                | 0.10             | 12                | 24.9              | 21.8                  | 1.0                |
| 8   | Gulliver  | 50.0         |                | 1.97                  | 2.98              | 46                | 0.05             | 6                 | 19.7              | 29.8                  | 0.5                |
| 9   | Breeze    | 50.1         |                | 2.48                  | 2.48              | 50                | 0.06             | 8                 | 24.8              | 24.8                  | 0.6                |
| 10  | Meteor    | 45.4         |                | 2.53                  | 2.02              | 31                | n/a              | 1                 | 25.3              | 20.2                  | -                  |
| 11  | Fritella  | 41.0         |                | 2.51                  | 1.53              | 25                | 0.07             | 6                 | 25.1              | 15.3                  | 0.7                |
| 12  | Pennant   | 33.7         |                | 1.36                  | 1.95              | 40                | 0.07             | 8                 | 13.6              | 19.5                  | 0.7                |

Samba, Gulliver, Reggae were out yielding amongst Russia-bred varieties. These varieties had the most smooth-skinned tubers as well.

The highest yielding 55+ grade tubers were varieties of Reggae – 34.9 t/ha, Samba – 33.4 t/ha, Volat – 27.8 t/ha (figure 2). However, in percentage terms, the yield of 55+ grade tubers was the highest for varieties of Reggae – 47.6% and Fortress – 44.8%.

For speedy propagation of a variety, an important factor is the multiplication factor, i.e. the yield of the seed grade of Ø28-55 mm. Varieties of Charoite – 32.8 t/ha, Gulliver – 29.8 t/ha and Breeze – 24.8 t/ha excelled in seed grade yielding. Herewith, Breeze and Zorachka varieties yielded almost equal amounts of seed and commercial grades each, which means high uniformity of yield. Varieties of Charoite – 82.0%, Gulliver – 69.7%, Pennant – 69.0% and 69% produced the maximum seed grade yield of the total number of tubers.

Amount of small tubers in the yield ranged between 1.9% for Meteor variety to 19.0% for Yanka variety. The Meteor, Fortress, and Reggae potato varieties bred in Russia had virtually no tuber fractions of Ø <28 mm. Visual inspection of tubers during unearthing revealed that Charoite tubers were affected by silver scab, and Pennant tubers had second growth and skin cracking.
Figure 2. Productivity of seed and commercial grades of potatoes.

Of all the potato varieties, only Samba, Volat, Fortress and Reggae preserved the integrity of the peel during cooking (table 2). Zorachka, Charoite, Yanka varieties have delicate texture after cooking. Charoite tubers fell apart during cooking. Charoite variety had the most granular flesh, the Belarus-bred Volat variety had the wateriest flesh. Among Belarussian cultivars, Yanka and Zorachka varieties, and among Russian cultivars – Samba and Gulliver varieties excelled in tastiness. The assessment of the palatability of potato tubers showed that the Janka variety belongs to culinary type D, the Samba, Charoite, Zorachka, Gulliver, Breeze, Pennant varieties – to the C type, Fortress and Meteor varieties to the B type. The rest of the varieties are Fritella, Reggae and Volat – to culinary type A. Research results show that all varieties are characterized by high productivity from 26.6 to 53.7 t/ha, have high taste qualities and equalization of tubers.

Table 2. Assessment of eating qualities and cooking type of the varieties.

| No. | Variety  | Skin integrity | Flesh texture | Flouriness | Water content | After-cooking darkening | Taste | Cooking type |
|-----|----------|----------------|---------------|------------|---------------|------------------------|-------|--------------|
| 1   | Volat    | 9              | 3             | 1          | 3             | 5                      | 1     | A            |
| 2   | Samba    | 9              | 5             | 5          | 5             | 7                      | 9     | C            |
| 3   | Yanka    | 3              | 7             | 5          | 7             | 7                      | 9     | D            |
| 4   | Charoite | 1              | 7             | 9          | 7             | 7                      | 7     | C            |
| 5   | Fortress | 9              | 5             | 5          | 5             | 5                      | 5     | B            |
| 6   | Reggae   | 9              | 1             | 5          | 5             | 7                      | 7     | A            |
| 7   | Zorachka | 1              | 7             | 7          | 7             | 7                      | 5     | C            |
| 8   | Gulliver | 5              | 5             | 1          | 5             | 7                      | 9     | C            |
| 9   | Breeze   | 5              | 5             | 5          | 7             | 3                      | 7     | C            |
| 10  | Meteor   | 5              | 5             | 5          | 7             | 5                      | 7     | B            |
| 11  | Fritella | 5              | 1             | 7          | 5             | 5                      | 1     | A            |
| 12  | Pennant  | 5              | 1             | 7          | 5             | 3                      |       | C            |
4. Conclusion

Among all varieties tested in the trial field, the greatest yield and the most smooth-skinned tubers were observed in Russia-bred Samba and Gulliver varieties – 53.7 and 50.0 t/ha and Belarus-bred Breeze variety – 50.1 t/ha. Fortress and Reggae varieties – 44.8% and 47.6%, respectively, produced the highest yield of 55+ tuber grade. Tuber analysis showed that 82% of Charoite tubers fall into seed grade. Gulliver and Pennant varieties produced large amount of seed tubers – 69.7% and 69% of the total number of tubers, respectively. Samba, Gulliver, Yanka and Zorachka were the tastiest.

Thus, the results show that in the conditions of the Volga-Vyatka zone, it is advisable to grow Russian varieties Samba and Gulliver and the Belarusian variety Briz as the most productive and characterized by high quality of commercial tubers.

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