

Productivity of a collection *Solanum tuberosum* varieties in the conditions of the Northern Trans-Urals

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Abstract. Research to evaluate the collection of *Solanum tuberosum* varieties was carried out in the conditions of 2023, the Northern forest-steppe zone of the Tyumen region. In the collection, 49 varieties of different ripeness groups were studied, the varieties are represented by different geographies of origin of Russian and foreign breeding centers. Potato varieties differ significantly from each other in phenological indicators; among the early varieties, upon the onset of full budding, the varieties Colombo, Lyubava, Isetsky, and Antonina stood out. In the mid-early group, the budding phase began 9-11 days earlier in the varieties Stepana, Svitank Kyiv, Nevsky, Adretta, Ausonia, Belmando, Sineglazka, Arnika, and Lily. Among the mid-season varieties Otrada and Sokur, the budding phase began 8 days earlier than the standard (Tuleevsky variety). The onset of phenological phases with a delay in relation to the control in early-ripening varieties was 6-58%, in mid-early varieties 4.5-18%, and in mid-ripening varieties up to 10%. In terms of yield in the early ripening group, the varieties Labella (27.41 – 37.49 t/ha) and Colombo (28.64 – 38.60 t/ha) were higher than the standard variety Zhukovsky (26.74 – 35.65 t/ha). In the mid-early period, the following varieties distinguished themselves in yield: Arnika (33.84 t/ha), Banba (30.07 t/ha), Adretta (29.19 t/ha), Sarma (29.02 t/ha). As a result, varieties were identified that showed an increase in yield in conditions of a year with a lack of moisture, exceeding the standard in the early-ripening group of 11% of varieties, and in the mid-early and mid-ripening groups of 44% of varieties.

1 Introduction

Potatoes are one of the main plant sources used in food products and, accordingly, receive some attention among breeders, manufacturers, and testers. A sufficient amount of material has been published on testing varieties in different weather conditions and with changes in technology elements and the use of agrochemicals.

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A significant number of institutions are involved in research on the selection of a particular variety for cultivation for various purposes, the formation of genetic diversity, and the selection of a set of productive and biologically adaptive varieties for sustainable use.

Testers identify positive and negative aspects from a large set of varieties, there are certain indicators for obtaining a comparative assessment of the tested material, and of the entire set of varieties, only 10% percent exceed or are at the level of the standard in terms of productivity, certain nutrient content and taste properties [1, 2, 3, 4].

The authors identify varieties in different ripeness groups with a potential yield of at least 45 t/ha, exceeding the standard variety by more than 10%, and characterized by high marketability (up to 96%), starch content (over 18%), and high taste [5].

Widespread use of varieties requires not only their high productive properties under certain conditions, but also the formation of high resistance to a number of problematic diseases that deprive the variety of popularization and use [6, 7].

In the circumpolar conditions of Salekhard, potato growing has little use, but there there is a more significant selection of varieties for the development and formation of the crop and the natural conditions are such that they are convenient for obtaining biologically pure material [8].

The advantage in resistance to biotic and abiotic factors is in varieties of domestic selection, which show stability in different climates and response to growing season conditions and technological features of cultivation [9].

In a comparative assessment of potato varieties, home region researchers confirm the maximum yield obtained on the Collete potato variety - 709.6 c/ha, as well as the Vzryvnoy, Bellarosa and other varieties, which surpassed the standard Karatop variety by 126.6-260 kg/ha and emphasize that the studied potato varieties have high productivity potential [10].

It has been statistically established that potato yield depends on the variety by 30%, growth regulators - 33%, year conditions - 23%, the use of doses of complete mineral fertilizer - 66.9%, an increase from early planting - 4.0%, the total use of agricultural practices 18.5%, the yield of early potatoes depended on the genotype by 37%, year conditions - by 27% [11, 12, 13, 14].

Varietal evaluation of potatoes over a specific time interval for tuber yield and other important traits should be part of the country's potato research program to identify potential varieties that perform better in a wide range of agro-ecological zones of the country, as well as the desired use of the genotype [15, 16, 17].

The purpose of this work is to conduct a comparative assessment of a collection of potato varieties in the forest-steppe conditions of the Tyumen region, taking into account insufficient moisture during the growing season.

2 Materials and Methods

A comparative assessment of the collection of *Solanum tuberosum* varieties was carried out under dry conditions in 2023. The research was carried out in the field conditions of the Northern forest-steppe of the Tyumen region, at the Scientific Research Institute of Agriculture of the Northern Trans-Urals - a branch of the Tyumen Scientific Center SB RAS. Accounts and observations were carried out according to standard guidelines adopted in the State Variety Network, crop production and plant protection.

The soil on the experimental plot is soddy-podzolic, sandy loam, medium deep, the predecessor is *Avena sativa*. Tubers were planted in the competition nursery according to the standard 75x30 pattern. Observations and records were carried out according to the methods of the State Variety Testing of Agricultural Crops [18]. Productivity was taken into

account by test diggings in 4 repetitions, after 60, 70, 80 days. Yield data processed according to B.A. Dospheov [19].

Processing statistical data using Excel. Collection material in the amount of 49 varieties was studied, of which 17 varieties were early-ripening, 22 were mid-early, and 10 were mid-ripening.

Technological features of cultivation consisted of tillage: fall plowing at 22-24 cm, spring tillage, harrowing, fertilization in the amount of NO₂ - 34 kg, P₂O₅ - 50 kg, K₂O - 50 kg of active substance, deep loosening at 14-16 cm, slicing ridges and planting 75x30 to a depth of 10 cm, pre-planting treatment of tubers against diseases and pests, inter-row loosening and hilling during the growing season.

Planting date: 05/25/2023, treatment with herbicide against weeds in the phase of the beginning of seedling formation up to 5 cm of crop development and with a fungicide in the phase of beginning of bud formation.

In terms of precipitation, the agricultural year 2022-2023 was insufficiently moistened. During the period from the 2nd ten-day period of September 2022 to the 1st ten-day period of September 2023, 344.0 mm of precipitation fell, which is 76% of the long-term average. At the same time, during the growing season (May - 3rd ten-day period, September - 1st ten-day period, 167.0 mm fell - 70% of the norm. During the period May-August, 161.0 mm of precipitation fell - 66% of the norm.

3 Results and Discussion

One of the most important technological characteristics that determine the economic value of varieties and their suitability for cultivation in a particular climatic zone is the characteristics of the growing season of plants.

Potato varieties *Solanum tuberosum* differ significantly from each other in phenological indicators, duration of the growing season, timing of the onset of tuberization, the formation of the number of stems and tubers and their further growth. These parameters are important components of a certain morphobotype of potato plants and have a significant impact on productivity under certain climate conditions.

In the period from June 5 to June 13, sprouting was observed in all varieties and hybrids of the collection nursery of potato varieties. The early varieties Koroleva Anna, Empress, Novichok, and Rosara were characterized by the latest emergence of seedlings. Full budding in the early ripening varieties Colombo, Lyubava, Isetsky, Antonina occurred 2 days earlier than the control variety Zhukovsky ranniy, the remaining varieties of the early ripening group were at the control level.

In the mid-early group of varieties, the phase of full germination occurred earlier than the control variety Rosalind; it occurred in the varieties Nevsky, Adretta, Ausonia, and Belmando. The varieties August and Shelford distinguished themselves by the latest germination. The budding phase began 9-11 days earlier in the varieties Stepana, Svitanok Kyiv, Nevsky, Adretta, Ausonia, Belmando, Sineglazka, Arnika, Lily, the remaining varieties and hybrids met the standard.

Plants of the standard variety (Rosalind) and varieties Sarma, Tyumensky 1, Camellia, August, Galaxy, Sante, Shelford and Lily did not further differentiate the buds that had set, and they fell off.

Among the mid-season varieties Otrada and Sokur, the budding phase began 8 days earlier than the standard (Tuleevsky variety), while for the rest it was at the standard level. Later flowering occurred in the Romance and Fambo varieties (Table 1).

Table 1. Phenological development indicators of *Solanum tuberosum* varieties

Variety/hybrid	Plant growth and development phase					
	beginning of germination	full germination	beginning of budding	full budding полная	beginning of flowering	full flowering
Rannespelie						
1. Jukovskii control	5.06	13.06	26.06	5.07	5.07	14.07
2. Meteor	5.06	13.06	1.07	5.07	10.07	14.07
3. Bellarosa	5.06	13.06	28.06	5.07	10.07	17.07
4. Koroleva Anna	13.06	30.06	5.07	-	17.07	-
5. Red scarlet	5.06	13.06	28.06	5.07	10.07	-
6. Kolomba	5.06	13.06	28.06	3.07	5.07	-
7. Mishka	5.06	13.06	5.07	-	-	-
8. Imperatrice	13.06	16.06	7.07	14.07	17.07	19.07
9. Novichok	13.06	16.06	5.07	7.07	14.07	19.07
10. Kolette	5.06	16.06	5.07	7.07	14.07	-
11. Lubava	5.06	13.06	28.06	3.07	5.07	14.07
12. Laperla	5.06	13.06	5.07	7.07	14.07	-
13. Isetskii	5.06	13.06	26.06	3.07	5.07	17.07
14. Antonina	5.06	13.06	28.06	3.07	7.07	17.07
15. Rosara	13.06	13.06	5.07	7.07	17.07	-
16. Dnepryanka	5.06	13.06	26.06	5.07	14.07	19.07
17. Labella	5.06	13.06	28.06	5.07	-	-
Srednerannie						
18. Rosalind, control	13.06	16.06	5.07	7.07	17.07	-
19. Nikita	7.06	13.06	30.06	5.07	10.07	17.07
20. Stepana	5.06	13.06	28.06	3.07	5.07	14.07
21. Bankir	5.06	13.06	3.07	7.07	10.07	19.07
22. Svitnok Kievskii	7.06	13.06	28.06	5.07	17.07	-
23. Nevskii	5.06	10.06	28.06	5.07	7.07	14.07
24. Sarma	5.06	13.06	3.07	7.07	14.07	-
25. Tyumenskii	5.06	13.06	3.07	-	17.07	-
26. Banba	5.06	13.06	3.07	5.07	10.07	14.07
27. Adretta	5.06	10.06	26.06	3.07	5.07	14.07
28. Vasilek	13.06	21.06	5.07	7.07	10.07	17.07
29. Gala	5.06	13.06	3.07	5.07	10.07	19.07
30. Ausoniya	5.06	10.06	26.06	3.07	5.07	14.07
31. Belmondo	5.06	10.06	28.06	3.07	10.07	17.07
32. Sineglaska	5.06	13.06	26.06	3.07	5.07	10.07
33. Kameliya	13.06	16.06	3.07	7.07	10.07	-
34. Arnika	5.06	13.06	28.06	3.07	5.07	10.07
35. Avgust	13.06	28.06	5.07	10.07	14.07	-
36. Galaktika	13.06	21.06	5.07	10.07	14.07	-
37. Sante	5.06	13.06	5.07	7.07	-	-
38. Shelford	16.06	28.06	10.07	-	-	-
39. Lily	5.06	13.06	28.06	5.07	10.07	17.07
Srednespelie						
40. Tuleevskii, control	13.06	21.06	5.07	10.07	14.07	19.07
41. Kuzmich	13.06	-	5.07	-	14.07	-
42. Fambo	5.06	13.06	28.06	10.07	17.07	19.07

43. Otrada	13.06	-	3.07	-	5.07	-
44. Bruk	5.06	13.06	28.06	5.07	17.07	-
45. Irbitskii	8.06	13.06	28.06	5.07	5.07	10.07
46. Praim	13.06	16.06	5.07	7.07	10.07	14.07
47. Romance	13.06	21.06	5.07	14.07	14.07	-
48. Krinica	8.06	21.06	28.06	5.07	14.07	-
49. Sokur	5.06	13.06	5.07	7.07	5.07	14.07

The onset of the first phases of development depends on the reactivity of the variety, the earlier emergence of vegetative buds, the formation of the tuber, the quality of the seed material; the appearance of seedlings can vary greatly among varieties. In the group of early ripening varieties, the onset of the phase with a delay in relation to the control was observed in 6 to 58% of varieties when taken into account in different phases and, for the most part, due to the extended onset of the flowering phase.

In the group of mid-early varieties from 4.5 – 18%, and mid-ripening varieties the smallest difference among varieties in the onset of development phases is up to 10%. Significant changes and variations in varieties, response to climatic factors by changes in development and growth are observed to a greater extent among the common groups of mid-early and mid-ripening ripeness.

The response of the variety to dry hot weather conditions, with a slight influence and damage to the varieties by fungal and bacterial diseases, a difference in night-day temperatures, occurred with slow growth, limited development of the above-ground mass, but at the same time quite good tubers and productivity in general were formed. A feature of the cultivation technology of a variety should be its subsequent technological application, taking into account its development in different climate factors.

Potato varieties, regardless of their purpose, must be high-yielding. This is one of the criteria by which their economic value is assessed.

The economic ripeness of potatoes is determined by its ability to accumulate a harvest of marketable tubers in the earliest period, i.e. more intense tuber formation. In order to determine its rate, summer crop samples were taken 60, 70 and 80 days after planting. The dynamics of yield and productivity of varieties and hybrids are shown in Table 2.

Table 2. Productivity and marketability of *Solanum tuberosum* varieties

Variety/hybrid	Yield, t/ha			Marketability, %		
	60 days	70 days	80 days	60 days	70 days	80 days
Rannespelie						
1. Jukovskii control	26.74	30.60	35.65	73.99	82.52	68.93
2. Meteor	19.08	20.40	25.51	60.80	78.51	66.32
3. Bellarosa	12.57	20.34	25.31	57.79	88.65	76.33
4. Koroleva Anna	3.09	13.09	17.53	59.55	60.94	72.33
5. Red scarlet	16.19	25.80	29.22	63.54	86.86	71.10
6. Kolomba	28.64	35.39	38.60	69.90	74.48	71.61
7. Mishka	10.52	19.99	26.01	68.89	75.88	87.53
8. Imperatrice	2.16	8.62	14.70	0.00	67.80	79.13
9. Novichok	15.28	21.27	24.43	58.80	75.27	78.23
10. Kolette	21.60	25.28	31.12	58.73	73.53	81.31
11. Lubava	24.23	29.87	27.67	70.63	76.81	77.93
12. Laperla	12.92	20.54	30.95	64.68	71.98	86.78
13. Isetskii	16.39	29.37	29.08	38.72	62.79	68.44
14. Antonina	9.58	18.61	21.04	61.89	84.62	51.11
15. Rosara	16.72	23.67	29.57	71.07	79.88	85.18
16. Dnepryanka	14.26	20.86	30.65	58.20	72.13	72.55
17. Labella	27.41	34.25	37.49	50.53	76.02	72.49

NSR05	0.8	0.9	0.9	-	-	-
Srednerannie						
18. Rosalind, control	9.17	18.26	22.27	58.65	70.40	78.61
19. Nikita	15.25	23.99	23.41	39.46	74.67	64.79
20. Stepana	10.14	18.91	25.22	42.07	85.16	88.99
21. Bankir	10.26	19.20	20.84	26.35	49.16	55.12
22. Svitanok Kievskii	15.69	18.67	21.39	11.92	39.28	34.29
23. Nevskii	17.11	25.77	27.47	53.71	64.40	64.04
24. Sarma	19.70	24.43	29.02	37.31	56.82	57.40
25. Tyumenskii	15.96	22.47	26.30	53.66	67.88	57.56
26. Banba	17.43	30.33	30.07	60.12	79.87	81.63
27. Adretta	15.23	25.54	29.19	31.46	66.82	68.57
28. Vasilek	4.34	7.42	12.16	20.88	43.31	73.08
29. Gala	18.79	21.60	26.50	19.44	56.83	43.66
30. Ausoniya	10.98	22.85	24.69	57.86	83.12	73.73
31. Belmondo	16.33	21.07	26.15	61.73	85.02	76.42
32. Sineglaska	13.15	22.06	22.47	32.11	72.45	56.44
33. Kameliya	8.23	15.11	20.40	71.40	77.95	59.74
34. Arnika	17.38	26.91	33.84	48.09	59.72	68.22
35. Avgust	7.73	10.05	16.19	88.06	68.02	73.10
36. Galaktika	3.67	16.16	19.45	26.29	82.64	48.38
37. Sante	19.78	25.31	29.46	37.75	72.40	72.02
38. Shelford	1.26	9.56	18.44	48.84	63.91	80.19
39. Lili	13.20	16.36	20.10	33.76	65.36	72.67
NSR05	0.9	0.7	1.0	-	-	-
Srednespelie						
40. Tuleevskii, control	6.38	13.97	20.57	57.01	63.39	88.21
41. Kuzmich	2.97	8.21	8.42	25.59	65.84	58.68
42. Fambo	14.51	19.11	21.65	39.48	67.28	70.85
43. Otrada	3.72	5.93	22.65	5.90	41.38	77.55
44. Bruk	18.35	26.53	27.67	47.14	58.59	61.25
45. Irbitskii	13.66	20.75	23.76	40.22	64.79	73.80
46. Praitm	8.95	13.94	23.90	61.05	59.54	63.20
47. Romance	5.36	11.25	17.80	26.19	40.78	71.26
48. Krinica	10.97	15.84	16.80	60.48	79.70	87.65
49. Sokur	10.32	20.37	26.30	32.86	63.41	65.78
NSR05	0.5	0.9	1.0	-	-	-

In the early ripening group, 17 varieties and hybrids were studied; the Zhukovsky early variety was taken as the standard. Observations of the accumulation of yield in dynamics showed among this group throughout the entire period of trial digging (60, 70, 80 days) that the Labella varieties were higher than the standard variety Zhukovsky (26.74; 30.60; 35.65 t/ha) 27.41; 34.25; 37.49 t/ha) and Colombo (28.64; 35.39; 38.60 t/ha).

The lowest yields were for the varieties Empress (2.16; 8.62; 14.70 t/ha) and Koroleva Anna (3.09; 13.09; 17.53 t/ha). In terms of marketability after the third digging, the varieties Mishka (87.53%), Rosara (85.18%), and Colette (81.31%) stood out.

In the mid-early group, 22 varieties and hybrids were studied, the control variety Rosalind. Among the potatoes of the mid-early ripeness group, according to the final digging, the following varieties distinguished by yield can be distinguished: Arnika (33.84 t/ha), Banba (30.07 t/ha), Adretta (29.19 t/ha), Sarma (29.02 t/ha). In terms of the

percentage of marketability, the highest indicators are for the varieties Rosalind control (78.61%), Stepana (88.99%), Banba (81.63%), Shelford (80.19%).

The mid-season group included 10 varieties and hybrids, the Tuleevsky variety was taken as control. During the first digging, the following varieties had high performance: Brook (18.35 t/ha), Fambo (14.51 t/ha), Irbitsky (13.66 t/ha). In terms of marketability, the varieties Tuleevsky (57.01%), Prime (61.05%) and Krinitisa (60.48%) showed up.

Accounting for yield after 80 days showed the standout varieties Sokur (26.30 t/ha), Brook (27.67 t/ha), Prime (23.90 t/ha), Irbitsky (23.76 t/ha). The productivity of the Tuleevsky variety was 20.57 t/ha. The remaining varieties are at or below the standard. In terms of marketability, the highest indicators are for the Tuleevsky standard variety (88.21%) and the Krinitisa variety (87.65%).

Among the mid-season varieties and hybrids, the standard variety Tuleevsky and the varieties Brook, Irbitsky, Prime, and Krinitisa stand out in terms of yield and productivity.

4 Conclusion

The phenological development of collection nursery potato varieties in the group of early-ripening varieties with a delay in relation to the control was observed from 6 to 58% of varieties, in mid-early varieties from 4.5 to 18%, and in mid-ripening varieties the smallest difference in varieties was up to 10%.

In terms of yield under conditions of insufficient moisture during the growing season, the varieties Labella (37.49 t/ha), Colombo (38.60 t/ha) were superior to the control from the early ripening group, and the varieties Arnica (33.84 t/ha) and Banba were in the mid-early group. (30.07 t/ha), Adretta (29.19 t/ha), Sarma (29.02 t/ha), in the mid-season group varieties Sokur (26.30 t/ha), Brook (27.67 t/ha ha), Prime (23.90 t/ha), Irbitsky (23.76 t/ha).

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References

1. A. E. Shabanov, A. I. Kiselev, P. V. Solomentsev, *Agricultural Scientific Journal*, **7**, 51-55 (2022) DOI 10.28983/asj.y2022i7pp51-55.
2. E. A. Simakov, A. V. Mityushkin, A. A. Zhuravlev [et al.], *Bulletin of KrasGAU*, **11(176)**, 24-31 (2021) DOI 10.36718/1819-4036-2021-11-24-31.
3. V. E. Kizhaeva, V. O. Peshkova, D. Sh. Ramazanov, *Melioration and water management*, **4**, 14-18 (2023) DOI 10.32962/0235-2524-2023-4-14-18.
4. I. F. Ustimenko, S. V. Bavrovsky, M. V. Solovyova, *News of the Orenburg State Agrarian University*, **3(89)**, 70-74 (2021) DOI 10.37670/2073-0853-2021-89-3-70-74.
5. N. A. Chalaya, S. D. Kiru, *News of the St. Petersburg State Agrarian University*, **58**, 45-50 (2020). DOI 10.24411/2078-1318-2020-11045.
6. Electronic resource 10/08/2024 https://www.researchgate.net/publication/330925527_Genetika_i_selekcija_kartofela_Molecular_screening_of_potato_varieties_bred_in_the_northwestern_zone_of_the_Russian_Federation_Molekularnyj_skrining_sortov_i_gibridov_kartofela_severo-zapadnoj_zony_Ros

7. Electronic resource 10/08/2024 https://link.springer.com/chapter/10.1007/978-3-030-28683-5_10
8. N. O. Renev, M. V. Reneva, E. S. Rodina, O. A. Shakhova, *Bulletin of the Michurinsky State Agrarian University*, **2(73)**, 94-98 (2023)
9. A. E. Shabanov, A. I. Kiselev, P. V. Solomentsev, *Agricultural Scientific Journal*, **7**, 51-55 (2022) DOI 10.28983/asj.y2022i7pp51-55.
10. Yu. P. Loginov, A. S. Gaizatulin, *Agricultural Policy of Russia*, **6**, 13-19 (2019).
11. K. V. Moiseeva, E. A. Moiseev, *Bulletin of the Michurinsky State Agrarian University*, **4(63)**, 47-50 (2020).
12. M. A. Albert, A. F. Petrov, M. S. Shulga [et al.], *Innovations and food security*, **2(36)**, 45-51 (2022). DOI 10.31677/2311-0651-2022-36-2-45-51.
13. S. V. Balakina, *Scientific works on agronomy*, **1(1)**, 35-40 (2019).
14. A. E. Shabanov, A. I. Kiselev, *Scientific works on agronomy*, **1**, 42-49 (2022) DOI 10.35244/2658-7963-2022-7-1-42-49.
15. A. I. Murzin, P. N. Potapov, R. R. Galeev [etc.], *Vestnik NGAU (Novosibirsk State Agrarian University Agrarian University)*, **3(68)**, 74-81 (2023) DOI 10.31677/2072-6724-2023-68-3-74-81.
16. Tessema, Lemma, Mohammed, Wassu and Abebe, Tesfaye, *Open Agriculture*, **5 (1)**, 63-74 (2020) <https://doi.org/10.1515/opag-2020-0006>
17. Electronic resource https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/spe_s/spes-521/SPES-521.pdf accessed 11/09/2024).
18. *Metodika Gosudarstvennogo sortoispytaniya sel'skokhozyaystvennykh kul'tur* (M., 1997) 216.
19. B.A. Dospekhov, *Metodika polevogo opyta* (M.: Agropromizdat, 1985) 351.