Agroecological assessment of potato variety specimens in the conditions of the Astrakhan region

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Abstract. The article presents the results of the ecological test of 13 promising varieties of potato in a hot climate of the Astrakhan region. The analysis of the potato various samples productivity showed that under the spring planting period ten samples had the yielding capacity on 4.2-19.6 t/ha higher than the standard variety Impala (44.7 t/ha). High air temperatures during the summer planting period were the cause of the reduction in yield in almost all samples due to the decrease in the number and weight of tubers from one plant. The varietal specimen 10C-120-003 was able to produce a high yield under specific conditions of the region, which was on 2.4 t/ha higher compared to the same indicator in the spring planting period. The following specimens were distinguished by the starch content in potato tubers: Doka-2 and 10C-120-003 (19.2%), La Strada (18.4%), Flamingo (18.1%), Karmen (16.9%), 172/24 (16.3%), Real and 10C-135-015 (15.2%). The specimens Primabel, 802/17 and Baltic Rose have accumulated in tubers the largest amount of vitamin C, the surplus in relation to the standard was 0.1-0.3-0.6 mg% respectively. The cost-effectiveness analysis showed that cultivation of potato in the conditions of the Astrakhan region on drip irrigation conditions is profitable.

1. Introduction
The nutritional value of potato which consumption has significantly increased in recent years is determined by balanced ratio of the important nutrients content in tubers (such as starch, fats, vitamins, minerals, antioxidants and other important components) [1, 2, 3]. Potato yield enhancement and development of the efficiency of potato growing industry is essential in improving the sustenance of the population in the Astrakhan region. The area under potato planting in the region is increasing annually, and in 2020 it amounted to 13 thousand hectares, it was produced more than 300 thousand tons of potato. Irrigation and the usage of highly productive varieties allows farmers in the region to achieve yields of 29-30 t/ha, which is much higher than the average countrywide, and the yields of advanced farms reaches 40-45 t/ha. Within recent years, over 100 thousand tons of potatoes were sold outside the region [4, 5]. The environment and economic conditions of the region predetermined an important direction in the industry – cultivation and receipt of early potato production [6, 7, 8]. The early potato plantings occupy about 50% of the total potato fields. Breeders create new varieties with improved qualities which are gradually replacing non-competitive ones. The varieties should be renewed as they make it possible to improve agricultural production and increase its profitability [5, 6, 7]. The cultivation of environmentally yielding potato varieties allows farmers to achieve high and sustainable yields every
The purpose of the research was to conduct an agroecological assessment of potato varieties and to identify the highly productive ones, adapted to local climatic conditions, the utmost meet the requirements of the consumer market at different planting dates.

2. Materials and methods
The research on the agroecological assessment of 13 varieties of potato by domestic and foreign selection were carried out between 2019-2020 years in the diversified multi-sector peasant farm enterprise “Prelov A.A.” located in the Kamzyzyak district of the Astrakhan region. The fish pond was a predecessor in the field trial, which was arranged by the split-plot method, in 3-fold replication, the total area of the plot was 42 m², while the registration plot was 21 m². Planting scheme of potato tubers was 1.4 × 0.15 m with a plant density of 47.6 thousand plants per hectare. The early ripening recognized potato variety Impala was taken as the standard (control) one. Within three weeks at the temperature of +15-18 °C, the tubers of all potato varieties were vernalized. The landing was carried out in two periods: in the first decade of April – spring one; in the second decade of July – summer one. The harvesting and yield recording were carried out in the second decade of June and the second decade of October respectively. For growing the studied varieties on the experimental field there were used the agricultural methods according to the recommendations of the Astrakhan potato production technology. During the vegetation period of potato plants, it was performed the necessary records, observations, analyzes, in accordance with the methods.

3. Results and discussion
The conducted analysis allowed to establish that the soil of the experimental field was determined by its grain-size distribution as middle loam. The humus level of tilth-top soil amounted to 1.94% (according to Tyurin). The soils were characterized by a low probability of nitrogen, the content of easy hydrolysable nitrogen was 60.8 mg/kg (according to Cornfield). The content of mobile forms of phosphorus – 69.5 mg/kg and exchangeable potassium – 215.2 mg/kg (according to Machigin in the modification of the Central Research Institute of Agrochemical Services of Agriculture) corresponded to the average probability. At the beginning of the vegetation of cultivated plants, the soil density was 1.16 t/m³; by the end of the growing season the soil compaction by 0.07 t/m³ was noted.

In recent years, the increase in the number of days with high air temperatures and a deficiency of precipitation in the region in the spring-summer period was noted. Considering that the timely water supply of potato plants is the main method of increasing the productivity of the crop, despite a certain moisture reserve after the fish pond in the experimental plot, the potato plantings were irrigated by the drip method. The field moisture capacity was maintained at the level of 80-85% of the minimum moisture-holding capacity, per season the irrigation rate was 2240 m³/ha.

In the spring planting period, early ripe seedlings were received for all studied varieties – Karmen, La Strada, Doka-2, 172/24, Real, Primabel, Baltic Rose, Gioconda and Prime – on April 23rd; for 10C-120-003, 10C-134-015, 802/17 and Flamingo – on April 25th. While for the standard Impala they appeared on April 28th. The budding stage of aforementioned specimens took place on 2-5 days faster, and they entered the flowering phase on 5-10 days earlier than the standard variety Impala.

Biometrical observations made it possible to reveal that the specimens differed by growth rates (Table 1).

Under the first spring planting period, 8 varieties were distinguished by the intensive growth of potato plants – La Strada (69.5 cm), Doka-2 (67.6 cm), Real (65.3 cm), Karmen (65.1 cm), 172/24 (64.1 cm), Prime (63.0 cm), 802/17 (60.0 cm) and Baltic Rose (59.2 cm), in the flowering phase they were on 0.9-12.8 cm ahead of the standard variety Impala. The number of tubers per bush more depended on the characteristics of the variety than on the conditions of the year. During its vegetative season each potato specimen formed a different number of main stems per bush, so the maximum number of stems – from 5 to 6 pcs – was formed by potato plants of 2 varieties – Primabel and 172/24 respectively. The number of stems of the rest of the specimens and of the standard variety ranged from 3.0 to 4.8 pcs The following specimens had the highest values of the raw top mass of potato plants –
from 600.5 to 699.8 g: Karmen, 172/24, 10C-120-003, 802/17, La Strada, Primabel, Prime, Doka-2, Baltic Rose and Real.

**Table 1.** Biometrical indicators of potato plants in the flowering phase.

| Specimen name  | Plant height, cm | Number of main stems, pcs | Tops mass, g |
|----------------|------------------|---------------------------|-------------|
| Impala (st.)   | 56.7             | 4.2                       | 592.4       |
| Primabel       | 55.2             | 5.0                       | 630.6       |
| La Strada      | 69.5             | 4.0                       | 621.2       |
| Gioconda       | 55.0             | 4.0                       | 598.5       |
| Prime          | 63.0             | 3.0                       | 654.0       |
| Baltic Rose    | 59.2             | 5.7                       | 689.3       |
| 172/24         | 64.1             | 6.0                       | 600.9       |
| Real           | 65.3             | 3.3                       | 699.8       |
| Flamingo       | 52.3             | 4.2                       | 498.4       |
| Doka-2         | 67.6             | 4.5                       | 675.0       |
| 802/17         | 60.0             | 4.5                       | 607.6       |
| 10C-120-003    | 57.6             | 4.8                       | 601.4       |
| 10C-134-015    | 48.2             | 4.0                       | 588.3       |
| Karmen         | 65.1             | 4.3                       | 600.5       |
| LSD$_{0.05}$   | 4.4              | 1.2                       | 12.9        |

Yielding capacity is an important indicator for agroecological assessment of specimen. The analysis of the yield under the spring planting period showed that 10 specimens exceeded the standard variety Impala (44.7 t/ha) by 4.2-19.6 t/ha (Table 2).

**Table 2.** Productivity of potato specimens under the spring planting.

| Specimen name  | Number of tubers, pcs | Mass of tubers per plant, kg | Yielding capacity, t/ha | Marketability, % |
|----------------|-----------------------|-------------------------------|-------------------------|------------------|
| Impala (st.)   | 7.0                   | 0.98                          | 44.7                    | 97.3             |
| Primabel       | 18.0                  | 1.43                          | 64.3                    | 86.0             |
| La Strada      | 10.1                  | 1.39                          | 60.5                    | 98.7             |
| Gioconda       | 16.0                  | 1.27                          | 57.0                    | 89.5             |
| Prime          | 17.0                  | 1.23                          | 55.5                    | 89.2             |
| Baltic Rose    | 18.0                  | 1.20                          | 54.2                    | 83.0             |
| 172/24         | 10.0                  | 1.20                          | 54.0                    | 91.7             |
| Real           | 7.0                   | 1.13                          | 51.3                    | 99.0             |
| Flamingo       | 16.8                  | 1.13                          | 51.0                    | 85.3             |
| Doka-2         | 10.6                  | 1.13                          | 50.7                    | 94.7             |
| 802/17         | 8.6                   | 1.09                          | 48.9                    | 95.1             |
| 10C-120-003    | 8.5                   | 0.97                          | 43.9                    | 98.0             |
| 10C-134-015    | 9.0                   | 0.98                          | 43.4                    | 95.5             |
| Karmen         | 13.8                  | 0.83                          | 37.2                    | 98.8             |
| LSD$_{0.05}$   | -                     | -                             | 2.9                     | -                |

Only three specimens: 10C-120-003, 10C-134-015 and Karmen yielded to the standard variety by 0.8-7.5 t/ha. Four studied specimens: Real, Karmen, La Strada and 10C-120-003 were distinguished by high marketability – 98-99%. Other specimens had a marketability on 1.7-14.2% lower in comparison with the standard one.
The growth and development of potato plants of all the studied specimens and the standard variety, planted under the second summer planting period, took place at high daytime temperatures, low relative air humidity; therefore, as opposed to similar indicators of the spring planting period, the biometrical parameters of plants were lower. The decrease in yield of the standard variety – by 5.0 t/ha as well as for 62% of the studied potato specimens was noted (Table 3).

Table 3. Productivity of potato specimens under the summer planting.

| Specimen name | Number of tubers, pcs | Mass of tubers per plant, kg | Yielding capacity, t/ha | Marketability, % |
|---------------|------------------------|-------------------------------|-------------------------|-----------------|
| Impala (st.)  | 6.9                    | 0.88                          | 39.7                    | 99.0            |
| Primabel      | 13.2                   | 1.37                          | 55.1                    | 77.5            |
| La Strada     | 7.8                    | 1.22                          | 54.9                    | 97.6            |
| Gioconda      | 13.1                   | 1.15                          | 50.4                    | 86.3            |
| Prime         | 18.0                   | 1.20                          | 54.2                    | 83.2            |
| Baltic Rose   | 12.3                   | 0.94                          | 49.7                    | 81.7            |
| 172/24        | 9.0                    | 0.67                          | 30.2                    | 73.0            |
| Real          | 6.3                    | 0.86                          | 39.0                    | 90.0            |
| Flamingo      | 17.1                   | 0.89                          | 40.1                    | 73.8            |
| Doka-2        | 10.1                   | 0.99                          | 44.9                    | 93.4            |
| 802/17        | 10.2                   | 0.99                          | 44.5                    | 92.9            |
| 10C-120-003   | 7.0                    | 1.03                          | 46.3                    | 97.9            |
| 10C-134-015   | 6.0                    | 0.56                          | 25.3                    | 88.4            |
| Karmen        | 7.6                    | 0.78                          | 35.1                    | 87.0            |
| LSD0.05       | -                      | -                             | 3.0                     | -               |

A significant reduction in yield due to the decrease in the number and mass of tubers per plant, occurred for the following specimens: 172/24 – by 23.8 t/ha, 10C-134-015 – by 18.1 t/ha, Real – by 12.3 t/ha, Flamingo – by 10.9 t/ha and Primabel – by 9.2 t/ha. The other ones ranged from 1.3 t/ha (Prime) to 6.6 t/ha (Gioconda). Herewith it is worth highlighting the specimen 10C-120-003, which was able to form a high yield in the specific hot conditions of the region, which turned out to be on 2.4 t/ha more than the same indicator received during the spring planting period.

With the exception of the standard variety, which showed an increase in marketability by 1.7%, and the specimen 10C-120-003 that was already distinguished in terms of yield and nearly did not decrease marketability during the summer growing period, all other specimens showed the decrease in marketability. It was more significant for the following specimens: 172/24 – by 18.7%, Karmen – by 11.8%, Flamingo – by 15.5%, Real – by 9.0%, Primabel – by 8.5%, Prime – by 6.0% and less notable for La Strada – by 1.1%, Doka-2 and Baltic Rose – by 1.3% and 802/17 – by 2.2%.

An essential indicator of product quality is the biochemical composition of potato tubers. In matter of the starch content in potato tubers, there were distinguished the following specimens: Doka-2 and 10C-120-003 (19.2%), La Strada (18.4%), Flamingo (18.1%), Karmen (16.9%), 172/24 (16.3%), Real and 10C-135-015 (15.2%). The starch content of the following specimens Prime (12.2%), Primabel (11.9%), and Gioconda (14.0%) was lower compared to the standard variety by 0.5-2.6% respectively. Due to their dense consistency and low dry matter content potato tubers do not break dawn during cooking. Only two specimens: Primabel (18.32%) and Prime (18.88%) unveiled a low dry matter content compared to the standard one. The rest of the potato varieties had a dry matter content on 0.35-5.79% higher than the standard variety Impala (20.21%). The significant dry matter content was recorded for the specimens La Strada (26.00%), 10C-120-003 (25.80%), Doka-2 (25.72%) and Flamingo (24.64%).
In matter of the sugar content in tubers, the following specimens were distinguished: La Strada (0.90%), Prime (0.84%), 10C-120-003 (0.81%) and Flamingo (0.80%), which were by 1.4-1.6 times higher than the standard variety Impala (0.58%).

Three specimens should be distinguished: Primabel, 802/17 and Baltic Rose that accumulated the greatest amount of vitamin C in tubers, the surplus comparing to the standard was 0.1-0.3-0.6 mg% respectively.

Figure 1 show the results of carried out assessment of the potato specimens feeding (tasting) qualities of spring planting.

![Figure 1](image_url)

**Figure 1.** Tasting assessment of potato specimens under the spring planting.

The following specimens received the highest taste score: 10C-134-015 (5.0), Flamingo (4.8), La Strada (4.6); overall high score was achieved by La Strada, (29.0), Flamingo, (28.8), Baltic Rose (28.6), Doka-2 (28.5), Primabel and 10C-135-015 (28.4), Prime (28.3), Karmen (28.2), Gioconda (28.0).

The calculation of the various potato specimens cultivation economic efficiency under drip irrigation conditions showed a sufficiently high profitability. The profitability of nine studied specimens (Primabel, La Strada, Gioconda, Prime, 174/24, Baltic Rose, Real, Doka-2, 802/17) was on 24.0-111.4% higher compare to the standard variety Impala (149.7%).

4. Conclusion

The highest yielding capacity while a good quality and marketability of tubers under the spring planting period was received by the following specimens: La Strada (60.5 t/ha), 174/24 (54.0 t/ha), Doka-2 (50.7 t/ha); under summer planting period: La Strada (54.9 t/ha), 10C-120-003 (46.3 t/ha), Doka-2 (44.9 t/ha).

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