Morphotechnological parameters and analysis of microplants of potato varieties with accelerated reproduction (in vitro) in a selection nursery

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Abstract. The studies were carried out with in vitro test-tube micro plants at the Smolensk State Agricultural Academy in a research laboratory and in protected ground (frame greenhouses) under standard conditions and protection measures during the period of their cultivation. The article analyzes and presents data on the growth and development of potato varieties during their growing season. The object of research was micro plants of potato varieties Fritella, Grand, Mayak, Violet, Vympel, Vasilek, Meteor and Gulliver. The data obtained showed that test-tube micro plants of potato varieties by the end of the phase of intensive growth - the beginning of the phase of slow growth had a well-developed root system, 4-5 internodes, a plant height of 9.5-13.1 cm, a green color, a sufficiently developed leaf apparatus and planting them in flowerpots, survival rate was 100%. The duration of the growing season depended on the variety of micro plants and ranged from 82 to 107 days, height from 46.8 to 66.8 cm, the number of tubers from 3.5 pcs. up to 8.26 pieces, the yield of the seed fraction is from 44 to 92%. In terms of yield, the following potato varieties were distinguished: Gulliver (10.5 t / ha); Lighthouse (10.0 t / ha); Grand (9.24 t / ha); Meteor (9.20 t / ha); Purple (8.16 t / ha). The rest of the studied varieties had a lower yield level (5.5-7.35 t / ha), which is associated with both the high presence of fine-fraction tubers and the number of tubers in the nest. These circumstances necessitate additional seed reproduction of micro tubers (<15-20g) in the autumn-winter period in greenhouse conditions. In terms of morphobiological characteristics, the nature of setting, the formation of tubers, the structure of the clone, each variety, even one ripeness group, had its own varietal specificity, which should be taken into account when cultivating them in nurseries of original and elite seed production.

1. Introduction

Во всем документе используется шрифт Times New Roman [1]. All over the world, potatoes play a special role in providing the population with food, remaining the most valuable and irreplaceable everyday food product [1-2].

Potato growing is one of the main branches of crop production, where the level of self-sufficiency in products usually exceeds 100%. At the same time, this figure for the Central Federal District is 70% [2]. This is due to the fact that in the sector of agricultural enterprises, potatoes are grown on an area of about 20% of the total area of potato planting, and the remaining 80% are in the sector of the
population (PSP) and farms, where the predominantly small-scale type of production prevails with violation of cultivation technology and low the level of seed production [3-4].

The main task to increase the yield of potato varieties is to improve planting before harvesting and processing of potatoes, the introduction of new and promising varieties with the development of expanded and accelerated seed production on a virus-free basis (in vitro) [5-10].

The Smolensk region is not the originator of the production of potato varieties and there is virtually no seed production in original seed production. Elite seed production, namely the production of super-elite and elite potatoes, has been partially established, with a violation of the high varietal frequency, productive and sowing qualities. Reproduction seed production (1 and 2 reproduction) actually provides only up to 30% of plantings from the total volume of potato production.

In this regard, the study of the formation of yield, quality of tubers and seed productivity of new potato varieties obtained on a virus-free basis in the original nursery is relevant.

2. Materials and methods

The studies were carried out with in vitro test-tube micro plants at the Smolensk State Agricultural Academy in a research laboratory and in protected ground (frame greenhouses) under standard conditions and measures of protection against pests and diseases.

Certified batches of the original micro plants were purchased in the selection nursery at the name A.G. Lorkha.

The tests were carried out with new promising potato varieties: Fritella, Grand, Mayak, Violet, Vympel, Vasilek, Meteor and Gulliver. The varieties differed among themselves in terms of the growing season, morphobiological characteristics, responsiveness to biotic and abiotic conditions, economic purpose (table, technical, fodder, universal) and suitability for the preparation of semi-finished products, food and technological purposes.

In laboratory conditions, the original, virus-free, test tube material of growth cuttings of eight varieties in tenfold replication was laid.

During the period of morphogenesis, micro plants were monitored for the formation of morphological structures (internodes, leaves, development of the root system) and for the presence of viral, fungal and bacterial diseases.

At the end of the intensive growth phase - the beginning of the slow growth phase, micro plants had a well-developed root system, 4-5 internodes, a green color, a sufficiently developed leaf apparatus and were ready for transplantation into flowerpots with soil.

The removal of micro plants from the test tube was carried out according to the recommendations of the Federal State Budgetary Institution Rosselkhozsentr and the Federal State Budgetary Scientific Institution KNIikh and included the following stages: washing the roots from agar using warm water (+ 50 °C) and potassium permanganate; planting in flowerpots with peat-humus soil, watering and covering with a glass, under which the necessary humidity is created in the first days after transplanting and transferring the flowerpots under fluorescent lighting.

The plants were visually examined daily, watered and fed once every 10 days. When new strong shoots were formed on the plants, the flowerpots were placed in a greenhouse to form micro tubers.

All studies and analyzes were carried out in accordance with the existing GOSTs and guidelines.

3. Results and Discussion

In the experiment, when analyzing and planting micro plants, atypical, sick and underdeveloped were not observed. The overall score for micro plant varieties ranged from 4.6 to 5.0 points (table 1).

In our studies, the survival rate of micro plants in flowerpots on the 6th day was 100%. The morphological elements were formed according to varietal characteristics (stem, leaf, inflorescence) and corresponded to the author's descriptions of the variety. By the end of the growing season, the clones had a height of 46.8 cm (for the Grand variety) to 66.8 cm (for the Mayak variety).
Table 1. Phenological parameters and the yield of the seed fraction of potato micro plants in the nursery of meristem selection (2018-2020).

| Variety    | Removal from the tube and assessment of the root system, score | Survival on the 6th day, % | Micro plant length, cm | Clone height for harvesting, cm | Vegetation period from survival of plants to the beginning of wilting, days | Seed fraction output, % |
|------------|---------------------------------------------------------------|-----------------------------|------------------------|--------------------------------|--------------------------------------------------------------------------|------------------------|
| Meteor     | 5.0                                                          | 100                         | 13.1                   | 62.2                           | 82                                                                       | 68                     |
| Gulliver   | 4.8                                                          | 100                         | 10.3                   | 58.2                           | 93                                                                       | 75                     |
| Lighthouse | 4.7                                                          | 100                         | 10.6                   | 66.8                           | 97                                                                       | 83                     |
| Knapweed   | 4.8                                                          | 100                         | 12.8                   | 53.7                           | 99                                                                       | 61                     |
| Fritella   | 4.6                                                          | 100                         | 12.7                   | 54.75                          | 103                                                                      | 44                     |
| Pennant    | 4.7                                                          | 100                         | 9.5                    | 47.5                           | 106                                                                      | 84                     |
| Grandee    | 4.6                                                          | 100                         | 12.3                   | 46.8                           | 106                                                                      | 67                     |
| Purple     | 4.7                                                          | 100                         | 12.5                   | 60.2                           | 107                                                                      | 90                     |

Studies have shown that during the growing season, the presence of viral, fungal and bacterial diseases in micro plants was not observed.

The duration of the growing season in the studied varieties of potato micro plants, according to the classification of potato varieties, ranged from 82 to 107 days and corresponded to the author's descriptions of the variety. Varieties Meteor (82 days) and Gulliver (93 days) were assigned to the early maturing group. To the mid-ripening group - varieties Mayak and Vasilyok (97-99 days), varieties Fritella, Vympel, Grand, Violet entered the mid-ripening group of ripeness (103-107 days).

The analysis of tubers of micro plants showed that the varieties formed not only different numbers of tubers in the clone and in fractions, but there were differences in weight, tuber size and varietal color (figure 1 and table 2).

Figure 1. Analysis and rejection of micro tubers of potato varieties obtained on the basis of in vitro.

Morphobiometric analysis of micro plants showed that, depending on the variety, the number of tubers ranged from 3.5 pcs. up to 8.26 pcs / plant. By the number of formed tubers, the following varieties stand out: Vasilek, Gulliver, Grand, Meteor, Mayak (6.8-8.3 pcs / plant). The highest yield of the medium and large fractions was observed in the varieties Grand, Violet, Mayak, Meteor. Small
fraction – in varieties Meteor, Gulliver, Mayak, Vasilek, Grand. The relatively poor keeping quality during storage of tubers weighing less than 15 g necessitates their additional planting in the autumn-winter period, which will also increase the seed yield for the nursery for evaluating clones of the first year.

Table 2. Biological yield and fractional analysis of micro tubers depending on the variety, average over 3 years.

| Variety    | Quantity (pcs / clone) / Weight of clone (g) | Fraction participation in the harvest (%) | Productivity (t / ha) |
|------------|------------------------------------------|----------------------------------------|----------------------|
|            | fine fraction | middle fraction | large fraction | total          | fine fraction | middle fraction | large fraction |                      |
| Meteor     | 4.3/23.2     | 3.0/43.5       | 0.2/6.9       | 7.5/73.6       | 32            | 59             | 9             | 9.20                  |
| Gulliver   | 5.1/20.9     | 2.0/36.8       | 0.67/26.6     | 7.8/84.3       | 25            | 44             | 31            | 10.50                 |
| Lighthouse | 3.0/13.8     | 3.6/59.4       | 0.2/7.2       | 6.8/80.4       | 17            | 74             | 9             | 10.00                 |
| Knapweed   | 6.4/17.1     | 1.86/26.7      | -             | 8.26/43.8      | 38            | 61             | -             | 5.50                  |
| Fritella   | 1.2/3.5      | 1.7/30.6       | 0.6/24.8      | 3.5/58.9       | 6             | 52             | 42            | 7.35                  |
| Pennant    | 1.88/9.6     | 1.88/30.9      | 0.62/22.9     | 4.38/63.4      | 16            | 49             | 36            | 7.94                  |
| Grandee    | 4.14/24.8    | 3.3/42.9       | 0.14/5.9      | 7.58/73.6      | 33            | 58             | 9             | 9.24                  |
| Purple     | 1.4/6.5      | 3.0/58.8       | -             | 4.4/65.3       | 10            | 90             | -             | 8.16                  |

After a thorough analysis and rejection, the tubers of micro plants weighing more than 18-20 g were placed in mesh bags for storage under optimal temperature and relative humidity conditions. In the spring, micro tubers were carefully analyzed for the suitability of their planting in the nursery for evaluating clones of the 1st year (greenhouse nursery).

Fractional analysis of one clone of a micro plant showed that the average fraction (26.7-59.4 g) was distinguished by the mass and yield of tubers for all varieties.

The data in Table 2 showed that the mass of tubers in potted micro plants ranged from 43.8 g for the Vasilyok variety to 84.3 g for the Gulliver variety. Varieties Mayak also had a high mass of micro tubers (80.4 g); Grand (73.6 g); Meteor (73.6 g); Purple (65.3 g).

Yield is the main assessment of the variety and the calculation of seed requirements and area for seed nurseries.

On average, over 3 years of research, the estimated biological yield, based on fractional analysis of micro plants, ranged from 5.5 to 10.5 t / ha (table 2).

The highest yield was in the Gulliver varieties (10.5 t / ha); Lighthouse (10.0 t / ha); Grand (9.24 t / ha); Meteor (9.20 t / ha); Purple (8.16 t / ha).

Other varieties had a lower yield level (5.5-7.35 t / ha), which is associated with both a small number of tubers in the nest (Fritella - 3.5 pcs.) and a high presence of small fraction tubers (Vasilek - 6.4 pieces).

The data obtained (table 2) indicate that the largest share of participation in the harvest was the average fraction from 44 to 90%. The sum of the medium and coarse fractions forms the yield of the seed fraction. By the output of the seed fraction more than 70%, the following varieties were distinguished: Gulliver -75%; Lighthouse -83%; Fritella -94%; Pennant -84%; Purple -90%.

The setting of stolons characterizes the formation of the future harvest and its yield. According to the growth rate of tubers, potato varieties are divided into the following groups: with an intensive accumulation of the mass of tubers from the very beginning of their formation; with a slow at first, and then rapid accumulation of their mass; with a gradual accumulation of yield throughout the growing season. Early and mid-ripening varieties usually belong to the first group, mid- and late-ripening - to the second and third [12-15].

In our studies, the varieties differed in character, amicability and duration of stolon setting and formed a different number of tubers and their weight. Thus, the Vasilyok variety had the highest
setting (88%), but the stolons were set at later stages of development, which led to the formation of a 
fine fraction and a decrease in yield. In the varieties Vympel, Violet, Fritella, the set was low (49-52%), 
however, the rapid formation of tubers in the early stages and their mass led to an increase in 
yield.

4. Conclusion
Thus, according to the results of the study, the following conclusions can be drawn:

- In the western part of the Non Chernozem zone, test tube micro plants during the growing 
  season by phenotypic identification corresponded to the author's descriptions of the variety;
- When planted in the ground, micro plants of potato varieties had 100% survival rate and 
  during the growing season formed from 3.5 to 8.3 tubers / plant;
- The mass of tubers of one micro plant, depending on the variety, ranged from 43.8 to 84.3 g, 
  and the greatest was in the varieties Vasilek (88 g) and Gulliver (85 g);
- The biological productivity of micro tubers in potato varieties ranged from 5.5 t / ha to 
  10.5 t / ha. In terms of yield, the Gulliver varieties (10.5 g) stood out; Lighthouse (10.0 t / ha); 
  Grand (9.24 t / ha); Meteor (9.2 t / ha);
- The yield of the seed fraction of microtubers ranged from 61 to 90% and depended on the 
  variety and the presence of small tubers. By the yield of the seed fraction, the varieties 
  Gulliver (75%), Mayak (83%), Fritella (94%), Vympel (84%), Violet (90%) were 
  distinguished;
- For accelerated reproduction of new varieties of potatoes, it is necessary to additionally grow 
  micro tubers weighing less than 15-18 g during the autumn-winter period in the nursery of the 
  starting material.

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