The influence of agrotechnical methods on the formation of the harvest of potatoes of the early variety

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Abstract. The article presents the results of research on agrotechnical methods of growing potatoes of the early Meteor variety in the conditions of the Non-Chernozem zone. To obtain products in the early stages, the following were used: covering materials of various density and light transmission (white and black) 17 g·m\(^{-2}\) and 30 g·m\(^{-2}\), germination of tubers, the influence of the fraction of the planting material on the formation of the crop. The Moscow region is characterized by extreme weather conditions in the early spring period, which often leads to a delay in the development and formation of the harvest of early potato production. For the implementation of research tasks, an early potato variety "Meteor" for table use was used - with good taste and recommended for obtaining ultra-early products. The variety has a high declared yield, resistance to diseases widespread in research conditions. The aim of the research was to obtain an increase in yields without the use of growth stimulants and chemical fertilizers, which is important for the modern buyer. According to the research results, we noted the effect of the covering material in combination with the germination of tubers on the early emergence of seedlings and a long growing season before the first and second harvesting. The maximum difference in yield was noted at 15.07 in relation to the control in variants with a covering material of 17 g·m\(^{-2}\) and 30 g·m\(^{-2}\) in combination with germination, as well as in the variant: tubers of a large fraction in combination with germination that amounted to 27 ... 25%. The average increase for the first harvest was noted in variants with a covering material without germination of tubers that amounted to 8 ... 11% in relation to the control. When cleaning, the gap between control and options decreased by 2 ... 3% compared to the first harvest, and the total yield increased by 5 ... 8% in all variants of the experiment in relation to the first harvest.

1. Introduction

Obtaining potato products under the conditions of extreme agriculture in the Moscow region requires special attention to the selection of appropriate varieties and growing conditions [1-2]. The study and analysis of technological methods of early potato cultivation for obtaining products in the second decade of July remains relevant, since consumer demand is not fully satisfied [3]. In the last two centuries, potatoes have been strategically important in human nutrition due to their nutritional value, universal use in the food and technical industries, high yields and the ability to store for a long period [4-5]. Most of the people of the world cannot imagine their nutrition without potatoes, and due to its biochemical composition, it is used for the prevention of many diseases and serves as a source of vitamins: ascorbic acid, carotene, thiamine, riboflavin, pyridoxine, nicotinic acid, organic acids, etc., which is fundamental for inclusion in children's diets and people with impaired health [5-6].
Intensive technologies do not always allow one to obtain healthy products; the issue of healthy nutrition is acute, which excludes the use of increased doses of fertilizers, pesticides and plant growth stimulants [7-8]. Most of the agrotechnical techniques proposed for consideration in the article have a positive environmental component, but they contribute to increasing and accelerating the production of early products.

2. Materials and methods
We studied the effect of covering white material (Spunbond) 17 g·m\(^{-2}\) and 30 g·m\(^{-2}\), black opaque material 30 g·m\(^{-2}\), germination of medium and large fraction tubers on the development and formation of the yield of the Meteor variety.

The experiment was carried out in the period 2016 ... 2020 on the territory of the UNPC Vegetable Experimental Station named after V.I. Edelstein. In addition to the studied agrotechnical methods, the cultivation technology was used classical, the planting period was carried out in accordance with the biological characteristics of the culture at soil 6 ... 8 °C, the feeding area of one plant in all variants of the experiment was the same 0.26 m\(^{2}\), the area of one experimental plot was 25 m\(^{2}\). The experiment was carried out in triplicate; the variants were placed by a randomized method. For planting, tubers of the Meteor variety of medium and large fraction were used, germinated and not germinated, depending on the variant of the experiment. 1. Control (tubers of the middle fraction 40 ... 80 g without germination). 2. Tubers of the middle fraction + germination. 3. Tubers of the large fraction (80 ... 100 g) + germination. 4. Covering white material 17 g·m\(^{-2}\)+ germination. 5. Covering white material 30 g·m\(^{-2}\) + germination. 6. Covering black material 30 g·m\(^{-2}\) + germination. 7. Covering white material 17 g·m\(^{-2}\) (tubers without germination). 8. Covering white material 30 g·m\(^{-2}\) (tubers without germination). The care of vegetative plants included weeding, hilling and preventive treatment against diseases and pests.

3. Results and Discussions
According to the results of long-term research of the Research Institute of Potato Farming, it has been established that the soil temperature affects the duration of germination of potatoes and ranges from 12 ... 27 days [9-10]. The early spring period of the Moscow region is characterized by sharp temperature changes, and return frosts are possible until the first decade of June, which can lead to damage or death of potato plants. To exclude the influence of the temperature factor, the studies included options with covering materials of various densities; the period of use - until the emergence of shoots in the black material and until the optimum temperature was established for the white translucent material.

The weather conditions in the spring of 2016... 2020 were different, this influenced the duration of germination of tubers. Favorable weather conditions were observed in 2018 and 2020, which affected the minimum germination period, full shoots, on average, after planting came on 14 ... 25 days. In 2018, the period of tuber germination was the longest and amounted to 27 ... 38 days, depending on the variant of the experiment. On average, for five years of research, the difference in the duration of emergence of seedlings in relation to the control was from 4 to 13 days; the average duration of germination of tubers in the control variant was 30 days (Fig. 1).

Phenological observations established that the covering material of 17 g·m\(^{-2}\) and 30 g·m\(^{-2}\), in combination with the germination of tubers, had a significant effect on the onset of emergence of seedlings, in the listed variants the period ranged from 16 to 18 days, which is 14 ... 12 days earlier, in relation to control. In variants with covering materials without germination of tubers, the difference was 4 ... 7 days, in relation to control, in variants with tubers of medium and large fraction (germinated) shoots appeared 8 ... 10 days earlier than in control.

The shortest growing season, on average for five years, was observed in the control variant 42 and 58 days (before harvesting on the first period of July 15, and also on the second period on July 30) and in the variant with a covering material of 17 g·m\(^{-2}\) without germination of tubers for 47 and 63 days ... The longest period from the beginning of germination to harvesting was observed in variants with tubers of a large fraction + germination and the effect of covering material 17 g·m\(^{-2}\) and 30 g·m\(^{-2}\) (white and
black) in combination with germination of tubers, the difference in relation to the control was 9 ... 17 days.

Figure 1. Duration of the interphase period for potatoes of the early variety Meteor (average 2016 ... 2020), in days.

The purpose of the experiment was to confirm the hypothesis on the formation of potato production in the early stages and increase the yield, due to agrotechnical methods. Yield remains one of the main indicators of efficiency as a whole or for a particular cultivation method.

Average data for five years on yield for July 15 and July 30 are presented in Figures 2, 3. To accelerate germination, tubers were germinated in diffused light before planting in open ground. This technique made it possible to get seedlings in a short period, then to form a powerful horse system, the ground part and go into the phase of tuber formation. Light germination confirmed its effectiveness in variants with tubers of medium and large fraction on July 15, the increase in yield was 17% and 25%, respectively. An increase in yield was noted in the variant with a large fraction of planting material + germination in 2016, 2018 and 2020, the average increase in relation to the control was 5.6 t·ha$^{-1}$.

The maximum increase in yield in the early stages was noted in a multifactorial variant with the use of sprouted tubers of the Meteor variety + covering materials with a density of 30 g·m$^{-2}$ and 30 g·m$^{-2}$. When using white and black opaque material with a density of 30 g·m$^{-2}$ with germination, it increased the early yield on average for five years by 27% in relation to the control and by 17% in relation to options with covering materials without germination of tubers. Thus, germination of tubers in combination with covering materials in the early spring period shows a positive effect [7]. This is due to the long growing season and favorable microclimate in the soil with lower temperature drops during the night and daytime, the preservation of moisture and soil structure until the emergence of seedlings [8]. In the variant with the use of covering material without germination of potato tubers, the increase in yield on July 15 was: white covering material 17 g·m$^{-2}$ - 8%, white covering material 30 g·m$^{-2}$ - 10% and black opaque material 30 g·m$^{-2}$ - 11% in relation to control.

The increase in yield during harvesting on July 30 was due to the long growing season in all variants of the experiment. Additional 15 days after the first harvest helped to accumulate nutrients in already formed tubers of medium and small fraction and increase the mass to a large fraction (80 ... 100 g). The average increase in the yield of the second harvest in relation to July 15 was 1.7 t·ha$^{-1}$.

The yield on July 30 over the years had slight differences and depended on climatic conditions in the spring-summer period. The years 2016, 2018 and 2020 were the most favorable for early potatoes in terms of temperature conditions and amount of precipitation.
When harvesting potatoes of the Meteor variety on July 30 (Fig. 3), in the phase of technical ripeness, there was an increase in yield in all variants, including the control one by 7%. In the experimental and control variants, a reduction in the yield gap is observed; however, it remained as high as possible in the variants with covering materials + germination and in the variant: planting material of a coarse fraction + germination, the increase was from 25 to 27%. In the variant with the use of covering material without germination of potato tubers, the increase in yield on July 30 was: white covering material 17 g·m⁻² - 5%, white covering material 30 g·m⁻² - 9% and black opaque material 30 g·m⁻² - 10% in relation to control.

**Figure 2.** Influence of technology elements on the yield of potatoes of an early variety Meteor as of 15.07 (average for 2016 ... 2020)

**Figure 3.** Influence of technology elements on the yield of potatoes of an early variety Meteor on 30.07 (average for 2016 ... 2020)
4. Conclusions
Thus, the germination of tubers individually and in combination with covering materials of different density and light transmission contributed to the emergence of seedlings in all variants 4 ... 18 days earlier than control. An increase in the growing season by 7 ... 17 days before the first harvest period and 5 ... 19 days before the second harvest period gives an average yield increase of 18.5 and 16.6% in relation to the control at each harvest period, respectively. The yield in the first and second periods was influenced by the size of the planting material. In the variant coarse fraction + germination, the yield increased in relation to the control on 15.07 and 30.07 by 25% and 22%, respectively.

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