Resource-saving early potato cultivation technology

M E Dyikanova, O N Ivashova, I N Gasparyan, N F Deniskina and Sh V Gasparyan

Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, 49, Timiryazevskaya street, Moscow, 127550, Russia

E-mail: irina150170@yandex.ru

Abstract. To obtain environmentally friendly early production of potatoes, the use of a technological method in the cultivation technology - light germination was studied. The cultivation technology is standard, except for the studied technique. There is a varietal reaction to reception, responds well to germination of the Luck and Bullfinch varieties. In the variant with germination, the total costs increase, but in the cost structure there is a decrease in the costs of expensive fertilizers and seeds. The cost of machinery and agricultural production does not rise much. implements in connection with additional work related to the light germination, where it is necessary to take out the planting material from the storage. These costs are not significant and the reception provides a high net energy income, high coefficients, as well as a low energy cost, which allows you to save energy resources when growing early potatoes and get maximum income. There is an increase in net energy income by 5.9 ... 31.9%, energy cost coefficients by 6.3 ... 32.8%, as well as a decrease in cost by 0.09 ... 0.33 GJ•t⁻¹ of tubers.

1. Introduction
The ecological situation is deteriorating every year, more and more chemical methods are used to maintain soil fertility, the power of agricultural tools and propellers is increasing, etc. In this connection, environmentally friendly products are gaining more and more popularity. Organic farming is one of the directions for obtaining clean ecological products. Of the 230 countries of the world, organic farming is practiced in 181 countries [1], in recent years there has been a steady growth trend in the world market for organic products (from 18 to 97 billion US dollars according to data) [2]. The leader in terms of the market for organic products is the United States (43%), followed by the EU countries, China [3]. But in terms of per capita consumption, the leaders are European countries [4]. The market for the consumption of organic products in the EU is growing rapidly, production does not keep pace and the most promising in terms of supply is Russia.

In Russia, the market for environmentally friendly products has emerged quite recently. In 2000, organic products were 100% imported [4]. In recent years, it has begun to develop dynamically and is about 160 million euros, of which 15 ... 20% are domestic certified products. Now there is a steady growth in the volume of the Russian market (in 2017-2020 - more than 10% per year) [1].

2. Problem statement
An important point in organic farming is the rejection of the use of agrochemicals, pesticides, growth stimulants, with the exception of those permitted for use by the national, interstate and international standards in the field of organic production in force in the Russian Federation. And also the use of only
biological agents to combat harmful objects. But in potato plantings under our conditions, a large number of pests and diseases, especially late blight, develop [5]. The problem of late blight can be solved by early harvesting of early ripening varieties, since the disease develops in our zone in the second half of summer [6].

3. Research questions
The use of the technological method - light germination - allows you to get products at the earliest possible date (July 15 instead of August 1), which is very important for ensuring food security in our country. Reception requires additional costs for germination. Germination leads to the acceleration of the activity of enzymes in the tubers and the creation of an increased concentration of soluble nutrients in the area of the eyes, which further stimulates the germination of buds and the development of sprouts. The harvest can be obtained earlier. Early products are sold at a higher price.

Any change in technology further affects the performance indicators, the introduction of a particular technique should be justified and expedient.

4. Purpose of the study
The aim of the research was the energetic substantiation of the technological method - light germination in the technology of early potato cultivation.

5. Research methods
The research was carried out in 2017 ... 2018 years. on the site of the vegetable growing laboratory of the Russian State Agricultural University-Moscow Agricultural Academy named after K.A. Timiryazev. The cultivation technology is standard. The soil is highly cultivated soddy-podzolic heavy loamy. The experiments were repeated 3 times. The degree of supply with nitrogen is high (12.0 mg / per 100 g of soil), with phosphorus - average (8.4) and potassium - average (10.0 mg / per 100 g of soil). The variants in the experiment were placed by a randomized method. The area of one experimental plot is 25 m². Used varieties: Luck, Zhukovsky early, Bullfinch, Red Scarlet, Meteor. Planting dates - when the soil warms up to 6 ... 8 ° C. When determining energy consumption, we used the methodological recommendations of Posypanov G.S. and Dolgodvorova V.E. [7], textbook Matyuk NS, Polina V.D. [8] and the study guide Sutyagin VP, Tulikova AM, Sutyagina T.I. [9].

6. Findings
Light germination in diffused light led to the formation of apical and lateral ocelli. From them, short thick shoots of dark green color appeared. With early planting with germinated planting material, the plants created a powerful root system, developed tops, formed tubers earlier, reached maturity faster, which made it possible to start harvesting at an earlier date - July 15 (table 1).

| Variety       | Option     | Productivity (July 15) | % ± to control | Productivity (August 1) | % ± to control |
|---------------|------------|------------------------|----------------|-------------------------|----------------|
|               |            | t / ha                 |                | t / ha                  |                |
| Luck          | 1) Control | 23.5                   | -              | 26.1                    | -              |
|               | 2) Germination | 26.6               | +13.2 %        | 29.3                    | +12.2 %        |
| Zhukovsky early | 1) Control | 24.8                   | -              | 28.8                    | -              |
|               | 2) Germination | 26.2               | +5.6 %         | 29.4                    | +2.1 %         |
| Bullfinch     | 1) Control | 22.3                   | -              | 24.2                    | -              |
|               | 2) Germination | 25.1               | +12.5 %        | 27.9                    | +15.2 %        |
| Red Scarlet   | 1) Control | 24.7                   | -              | 27.8                    | -              |
|               | 2) Germination | 26.8               | +8.5 %         | 30.5                    | +9.7 %         |
| Meteor        | 1) Control | 24.4                   | -              | 27.4                    | -              |
|               | 2) Germination | 26.7               | +9.4 %         | 29.1                    | +6.2 %         |
When using germination, the yield is higher, depending on the variety, by 5.6... 13.2% when harvesting on July 15 and by 2.1... 15.2% when harvesting on July 30. It reacts well to germination of the Udacha and Bullfinch varieties. When cleaning in 1 term (July 15), the increase from the reception at the v. Luck was 13.2% of the control, in the v. Bullfinch 12.5% of the control, when harvesting in the 2nd period, the increase is slightly less in the v. Luck -12.2%, and v. Bullfinch yield increase increased and amounted to 15.2% of control. A low increase in yield from admission was shown by the Zhukovsky early variety, when harvesting in 1 period, the increase in yield was 5.6%, when harvesting in 2 terms - 2.1%.

This is due to the fact that plants obtained from germinated tubers use more fully the nutrients of the mother tuber, this contributes to the development of a powerful root system, which further affects the development of the plant as a whole. Earlier emergence of seedlings promotes the use of winter-spring reserves of soil moisture and plants make better use of the applied mineral fertilizers. According to B.A. Pisarev, the increase in yield can reach 40 ... 60%, and in the northern regions of the country it is 2 ... 3 times higher [10].

Any increase in production must be accompanied by a decrease in production costs and an increase in the profitability of production. With the additional implementation of the technological method of decapitation, production costs increase. The choice of a particular technique and a mechanized device for its implementation must be justified.

For an objective assessment of the technology of cultivation of early potatoes with the addition of decapitation, energy efficiency was determined.

The calculation of the energy efficiency of potato cultivation was carried out for the studied varieties when cultivated according to domestic technology, the total energy consumption (MJ·ha\(^{-1}\)) and its structure in potato cultivation (on average for 2017 ... 2020) are presented in table 2.

According to the studies carried out in the cultivation of potatoes, the total energy consumption will be 67857.7 MJ·ha\(^{-1}\) in the control variant and 68970.3 MJ·ha\(^{-1}\) in the studied variant, excluding buildings and structures. In the control variant, most of the energy falls on mineral fertilizers -22.82%, machinery and agricultural. guns - 20.96, planting material - 20.78%. The costs of fuels and lubricants and labor resources are not large, as well as low costs for electricity.

In the variant with germination, the total costs increase, but in the cost structure there is a decrease in the cost of fertilizer and seeds. The cost of machinery and agricultural production does not rise much. implements in connection with additional work related to the light germination, where it is necessary to take out the planting material from the storage. Also, people are involved in this operation, so there is an increase in labor costs, and also an increase in electricity.

According to a number of scientists, in terms of total costs, potatoes are one of the most energy-intensive crops [11-13]; in our studies, the cultivation of potatoes also requires high costs. According to the calculations, when cultivating potatoes using domestic technology, the total energy consumption is 67857.7 MJ·ha\(^{-1}\), with the addition of a technological method it increases by 1112.63 MJ·ha\(^{-1}\).

From the data in table 2, it can be seen that the energy received in the harvest exceeds the spent by 2.8 ... 17.4 GJ·ha\(^{-1}\), depending on the variety. The maximum amount of energy was obtained during the cultivation of the Red Scarlet variety using the method, the minimum amount of energy was obtained during the cultivation of the Udacha variety in the control variant.

| Indicators | Total energy consumed (GJ·ha\(^{-1}\)) | Productivity of the main crop, (t·ha\(^{-1}\)) | Energy received from main products, (MJ·ha\(^{-1}\)) | Clean energy factor, (MJ·ha\(^{-1}\)) | Planting energy efficiency factor | Bioenergy landing factor (efficiency) | Energy cost (GJ·t\(^{-1}\) tubers) |
|------------|--------------------------------------|---------------------------------------------|-----------------------------------------------|---------------------------------|-----------------------------|--------------------------------|-------------------------------|
| v. Luck    | 1) 67.9                               | 26.1                                        | 122.7                                         | 54.8                            | 0.81                        | 1.81                         | 2.60                          |
|            | 2) 69.3                               | 29.3                                        | 137.7                                         | 68.4                            | 0.98                        | 1.98                         | 2.37                          |

Table 2. Energy efficiency of early potato cultivation (on average for 2017 ... 20).
The net energy coefficient, depending on variety, is 54.8 ... 74.1 GJ·ha\(^{-1}\). Analyzing the varieties separately, one can see that when using the method, the net energy coefficient is higher than in the control by 5.9 ... 31.9%. The Snegir variety has an increase of 31.9%, a minimum increase is noted in the Zhukovsky Early variety.

The energy equivalent of products, obtained at the cost of a unit of total energy costs, is equal to 0.67 ... 1.02, depending on the variety. The maximum indicators for the Zhukovsky early variety with the addition of reception and the minimum indicators for the Snegir variety in the control variant.

With the addition of light germination in the cultivation technology, the energy efficiency coefficient increases by 6.3 ... 32.8% of the control. Also, the bioenergy coefficient has a positive value and is greater than 1.

Comparing varieties in the control variant, we can say that the minimum cost of the Zhukovsky early variety is 2.40 GJ·t\(^{-1}\) tubers. The maximum cost of the Snegir variety is 2.81 GJ·t\(^{-1}\) of tubers. With the addition of a technological method, the energy cost for all varieties is reduced by 0.09 ... 0.33 GJ·t\(^{-1}\) of tubers. The maximum reduction in energy costs with the addition of light germination is observed when cultivating the Snegir variety, the minimum - Zhukovsky early.

### 7. Conclusion

Thus, the addition of light sprouting of tubers in the technology of early potato cultivation does not require significant energy costs and provides a high net energy income, high coefficients, as well as a low energy cost. Such cultivation can be considered resource-saving.

### Acknowledgments

The authors would like to thank their colleagues for their contribution and support to the research. They are also thankful to all the reviewers who gave their valuable inputs to the manuscript and helped in completing the paper.

### References

[1] 2019 Organic Agriculture in Russia on the Eve of the Entry Into Force of the Law on Organic Products: Inform. Ed. (Moscow: FGBNU "Rosinformagrotech") p 48

[2] 2018 Organization of Organic Agricultural Production in Russia: Inform. Ed. (Moscow: FGBNU "Rosinformagrotech") p 124

[3] Korshunov S A, Asaturova A M, Khomyak A I and Volkova G V 2018 Formation and prospects of organic farming in Russia (review) Potatoes and Vegetables 11 pp 2-8

[4] Nekoval S N, Churikova A K, Belyaeva A V, Maskolenko O A, Chumakov S S and Tikhonova A N 2018 Prospects for the production of organic vegetable products in Russia Potatoes and Vegetables 11 14-6

[5] Soloviev A M et al. 2014 Application of Fertilizers in the Cultivation of Crops with High Technology (Moscow: Publishing House of the Russian State Autonomy and Agricultural Academy named after K.A. Timiryazev) p 132

[6] Gasparyan I, Levshin A, Ivashova O, Dyikanova M and Deniskina N 2021 Agrotechnical requirements for the cultivation of potatoes in a twocrop culture Research on Crops (special issue) 2 1-4
[7] Posypanov G S and Dolgodvorov V E 1995 Energy Assessment of the Technology of Cultivation of Field Crops (Moscow: Publishing House of the Russian State Autonomy and Agricultural Academy named after K.A. Timiryazev) p 21
[8] Matyuk N S and Polin V D 2013 Resource-saving Technologies of Soil Cultivation in Adaptive Agriculture: Textbook N.S. (Moscow: Publishing house of the Russian State Agricultural University named after K.A. Timiryazeva) p 222
[9] Sutyagin V P, Tulikov A M and Sutyagina T I 2008 System Analysis of Energy Flows in Agriculture: a Textbook for Graduation Design (Tver: "AGROSPHERE" Tverskoy State Agricultural Academy) p 140
[10] Pisarev B A 1986 Production of Early Potatoes (Moscow: Rosselkhoznadzor) p 287
[11] Ivashova O, Gasparyan I, Levshin A and Dyikanova M 2020 Justification of the possibility of cultivating in Moscow region two-crop culture of early potatoes Engineering for Rural Development 19 399-405
[12] Shpilko A V, Dragaytsev V I, Morozov N M, Kabanov P N, Mindrin A S and Tsoi L M 2001 Energy Efficiency of Agricultural Mechanization (Moscow: All-Russian Research Institute of Agricultural Economics) p 346
[13] Popkova K V and Kutsamanova I N 1999 Proceedings of the Scientific Conference of Young Scientists and Specialists (Moscow: Publishing house of ICCA) pp 49-54