Development of a machine model for planting potatoes for seeds with active bed formers

A E Novikov2, V A Motorin1,2,* and D S Gapich1

1Volgograd state agricultural university, 26, University Avenue, Volgograd, 400002, Russia
2All-Russian research institute of irrigated agriculture, Timirjaseva St., 9, Volgograd, 400002, Russia

*E-mail: vmotorin001@yandex.ru

Abstract. One of the main problems of the Russian agriculture is the production of agricultural products in the necessary quantities. In connection with exceeding the norms of impact on agricultural landscapes due to their long and intensive agricultural use, it led to a violation of energy and mass exchange between its components, the progressive development of degradation phenomena, a decrease in soil fertility and productivity of agroecosystems due to the action of abiotic and biotic stressors. The article considers the technique of planting seed potatoes with two-row placement of tubers in a row. The intensification of potato cultivation technology based on the use of modern science-intensive technical means is one of the main factors for obtaining these strategic agricultural crop high-resistant and high-quality yields. A machine for forming rows of loosened soil with simultaneous planting of sprouted and non-sprouted calibrated potatoes with a given pitch and depth of potato tubers seeding in order to increase the energy efficiency of potato production for seeds, reduce agrotechnological impacts, time, fuel and labor costs due to the simultaneous formation of rows by active cutter working bodies with the planting of potatoes in two rows was developed.

1. Introduction

Production of necessary quantities of agricultural products in arid climate conditions and making it sustainable is one of the main problems of agriculture in the Russian Federation. The guarantee of the crop production necessary volume obtaining stability in these conditions is irrigation in conjunction with agrotechnical land reclamation. However, exceeding the norms of impact on agricultural landscapes due to their long-term and intensive agricultural use, the use of working bodies with low relative wear resistance led to a de-harmonization of energy and mass exchange between its components, the progressive development of degradation phenomena, a decrease in soil fertility and productivity of agroecosystems due to the action of abiotic and biotic stressors and, as a result, environmental tension. In conditions of limited opportunities for traditional regulation of production processes in agroecosystems, it is necessary to find ways to increase their potential yield by rational use of excess man-made resources while observing environmental technologies of waste-free production.

In Russia, all the considered potato cultivation technologies are widely used at varied degrees, which, if the technological discipline is observed, ensure stable yields at the level of 25 t/ha. However, these technologies and a set of machines for their implementation are designed to produce food potatoes. Problem considered in this paper is the adaptation of the row-belt technology and the improvement of the complex of machines for its implementation in the seed potatoes cultivation [1-5].
The Volgograd region is one of the most economically developed regions of Russia with a balanced economical structure. Diversified agricultural production is combined with the industrial sector.

The development of resource-efficient intensive machine technologies, biotechnological and membrane processes are among the priorities of the state policy and Strategy of scientific and technological development of the Russian Federation. The article considers the technique of planting seed potatoes with two-row placement of tubers in a row. The intensification of potato cultivation technology based on the use of modern science-intensive technical means is one of the main factors for obtaining these strategic agricultural crop high-resistant and high-quality yields. The choice of technology should be consistent with zonal soil and climate conditions, plant variety characteristics, and the functional purpose of the got products [6-10].

In world practice, various technologies of potato cultivation are developed and applied, especially "Suvorovskaya", "Gollandskaya", "Shirokoryadnaya", "Gromovskaya" and "Gryadovo-lentochnaya".

2. Materials and methods

The main and actual problem of seed potato cultivation is to obtain high-quality healthy tubers of small and uniform size, but in a larger number relative to food-oriented plantings. In our opinion, it is necessary to approach from the point of view of adapting the row-belt technology, which ensures the uniformity of factors that have a positive impact on the required quality and quantity seed material production, and improving the complex of machines that implement it. This technology allows to increase the yield of seed potatoes by 10-30% higher compared to "Zavorovskaya", and when harvesting potatoes with combines, the separator receives soil by 30-40% less than when growing in beds. The distance between the bases of rows in this technology is 0.3 m, and a sufficiently large inter-row spacing is formed for the passage of tractor wheels. However, at the moment there is a problem of harvesting potatoes with single-row agricultural machines and, in general, there is no domestic complex of machines for the implementation of this technology.

3. Results

A machine (figure 1) was developed for forming rows of loosened soil with simultaneous planting of sprouted and non-sprouted calibrated potatoes with a given pitch and depth of seeding-down of potato tubers in order to increase the energy efficiency of potato production for seeds, reduce agrotechnological impacts, time, fuel and labor costs due to the simultaneous formation of rows by active working bodies of the cutter with the planting of potatoes in two rows.

![Figure 1. Solid organic fertilizer grinding machine, side view.](image-url)

It is achieved by combining the operations of loosening the soil, forming rows and planting potatoes for seeds in the row by planting devices with the regulation of the distance between them in the range of 50-75 cm.
Potatoes are loaded into bins with an inclined bottom 1 with adjustable flaps 2, the gap of which is adjusted depending on the size of the seed material for a sufficient amount of receipt in the feeding bucket 3, with the help of vibrating plates 4 and agitators 5, there is a continuous movement of tubers from the bin to the spoon-disc planting devices 6, the spoons 7 of which are captured (scooped) one tuber at a time. When the spoons exit the feeding bucket area, the fingers of the clamps 8 descend on the tubers and press them to the spoons. In the coulter area, the fingers of the clips move away from the spoons and the tubers fall through the tuber line 9 into the furrow opened by the coulter 10.

Fertilizers on the fertilizer spout 11 fall into the coulter 10. Potato tubers are covered with soil by covering disks 12. The working bodies of the planting device are driven from the tractor's power take-off shaft using a small gearbox 13 and a chain transmission 14. Potatoes are planted in rows formed by a rotary cutter 15 with knives 16 and the body of the cutter 17 and driven through the main gearbox 18 from the tractor's power take-off shaft with a protective casing 19. The rotary cutter 15 with knives 16 rotates in the opposite direction to the movement of the machine, grinds the soil to the required depth along with clots and plant residues. Then the grinded soil is fed to the grid 22, which is equidistant behind the rotary cutter, consisting of horizontal rods with a diameter of 13 mm at a distance of 50 mm from each other, where large clots and stones that have not passed through the grid are laid down and covered with a layer of sifted soil. After this, the shield 20, which is installed at the rear along the course of the protective casing, forms a row, with a seal by a packing wheel 21. As a result, the row is completely ready for sowing. It has 23 support wheels and 24 gauge wheels.

Figure 2. Scheme of planting potatoes for seeds by machine.

The planter is equipped with an automatic coupler and hydraulic markers. It is used for the formation of active working bodies and formers of two rows with the planting of potato tubers for seeds in them at a distance of 50 cm with simultaneous application of granulated mineral fertilizers into the furrows. The machine can be used for growing in beds and level planting with inter-row spacing of 50-75 cm (figure 2).

4. Conclusion
This method of planting potatoes for seeds can be used in arid and waterlogged areas. Due to the design of the machine for planting potatoes for seeds, it is possible to combine the operation of loosening the soil, forming seedbeds and planting potatoes for seeds in the row by planting devices with the regulation of the distance between them in the range of 50 - 75 cm. The volume row provides a high degree of water retention and reduces the risk of irrigation erosion.
Such conditions ensure uniformity of factors that limit the intensive growth and development of potato plantings, obtaining high yields. These facts should also be taken into account when cultivating potatoes for seeds.

References

[1] Larkin R P 2007 Griffin Control of soilborne potato diseases with Brassica green manures Crop Protection 26 1067-1077
[2] Kanatieva A V, Morozov D A and Kondrashov A V 2017 Analysis of potato cultivation technologies in difficult soil and climate conditions of the Russian Federation Young scientist 11.3 10-12
[3] Albegov K K, Sorokin I A and Sisek N A 1982 Tape-comb technology of potatoes cultivation and harvesting Moscow: Rosselkhoznadzor 26 p.
[4] Larkin R P and Honeycutt C W 2006 Effects of different 3-year cropping systems on soil microbial communities and Rhizoctonia disease of potato Phytopathology 96 68-79
[5] Elizarov V P, Ponomarev A G and Kabakov N S 1999 Methodical recommendations on the development of machine technologies of potatoes cultivation and harvesting Informagrotech 54 p.
[6] Kostyleva L V, Gapich D S, Motorin V A and Novikov A E 2019 Microstructure and abrasive wear resistance of heavy duty parts from high-strength cast iron in chisel plows Chernye Metally 3 37-42
[7] Kuznetsov Yu I and Burchenko P N 1993 Machine technology of potato production on rows without the use of herbicides 37 p.
[8] Novikov A E, Motorin V A , Lamskova M I and Filimonov M I 2018 Abrasive Deterioration Composition and Tribological Properties of Cutting Blades of Tillage Machines under Abrasive Deterioration Journal of Friction and Wear 39(2) 158-163
[9] Motorin V A, Kostyleva L V and Gapich D S 2020 Increasing Wear Resistance of Chisel Tools Working Bodies Based on Improving the Metallographic Structure of Grey Cast Iron Solid State Phenomena 299 652-657
[10] Maximov P L 2002 New working bodies and machines for the production of root crops: monograph Izhevsk: Publishing house Irgskha 80 p.