

EFFICIENCY RESEARCH OF THE PREPLANT LOCAL DEEP LOOSENING OF SOIL IN BIOLOGICAL POTATO GROWING

Summary

The article reflects the results of investigations into the improvement of a machine for soil tillage during the process of the preplant ridge formation of potatoes using the operative parts for local deep loosening in the root system area of potatoes.

Key words: potatoes; soil tillage; ridge formation; field experimentation

1. Introduction

A significant amount of pesticides and mineral fertilizers are applied when growing potatoes according to modern technologies. This leads to the accumulation of various chemical compounds in the tubers which are ecologically dangerous for the people. An alternative for such technologies is biological growing of food potatoes in which application of pesticides is excluded altogether but the use of mineral fertilizers is strictly limited by science-based norms. The demand for ecologically pure potatoes is growing; however, an apparent shortcoming of the biological ways of potato growing is the comparatively low crop yield and, consequently, high prime cost. An escape from this situation may be using the reserves to increase crop yields at the expense of improved agrotechnology and advanced methods of mechanized potato growing at insignificantly increased costs [1].

2. Methods of Research

The aim of the research is to determine the efficiency of deep local loosening of soil (in the area for the subsequent formation of a potato cluster) by combining the operation with the preplant ridge formation.

The condition of soil in the area where the potato tubers would develop was estimated by the density, as well as the hardness of soil. These characteristics are interconnected by a direct correlation. A series of authors consider that for the sod-podzol soils, which are widespread in the Baltic countries, an optimal density of soil for potatoes is 1100-1200 kg m⁻³ but

its hardness not more than 1.5 mPa [2]. Since the methods and instruments for the determination of the soil hardness are more convenient and they ensure rapid acquisition of a large amount of measurements without destroying the form of the ridges, this indicator was used by us for comparative estimation of the soil condition. Apart from the investigation of the soil condition, we have planned three-year field experiments during the vegetation period in order to evaluate the impact of the new technological variant upon the crop yield (in this article the data are from the year 2011).

In order to conduct investigations, an experimental ridge former in an ordinary set of parts (a basic variant) was used, which formed 4 ridges in one pass, and the same machine with additional deep loosening operative parts (an experimental variant). In both cases the machine was aggregated with a tractor MT3-920.3 the engine power of which was 84 HP and the service weight 4300 kg.

3. Results of Research

At the present time only small farms in Latvia are engaged in biological potato production, and they basically plant potatoes in preliminary formed ridges with an inter space width of 75 cm. Under the conditions of increased moisture the soil in such ridges warms up sooner, and planting can start 3-4 days earlier than in an even field.

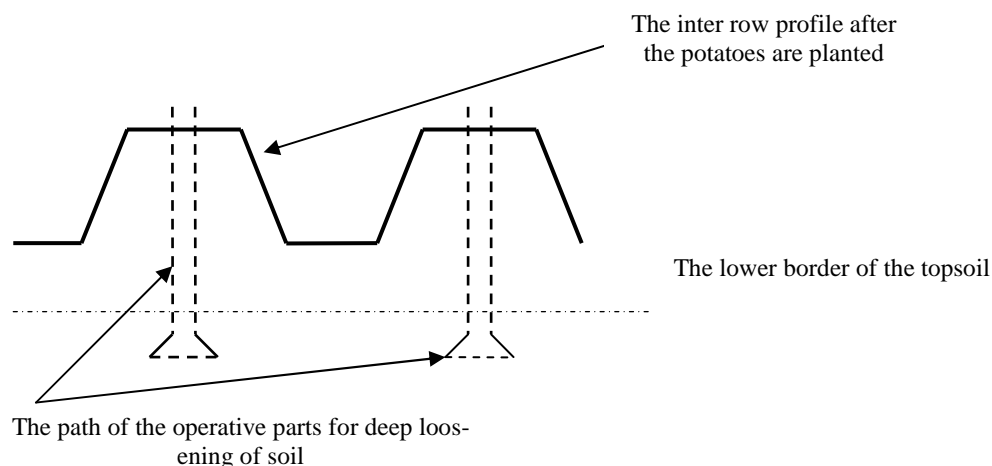


Fig. 1. A diagram of deep loosening of soil with ridges formed for planting potatoes

Besides, the furrows (trenches between the ridges) serve as guide tracks for the wheels of the tractor, which allows operation at higher speeds and creates a series of other advantages. Under favourable conditions the root system of potatoes spreads to the depth of 0.4 m, and active development of the tubers takes place in fine-grained soil with a density to 1300 kg m⁻³. In Latvia deep loosening of soil before potato planting has a positive impact upon crop yields. However, during the potato planting, as well as subsequent repeated weeding operations, soil loosening and hilling, the trenches (furrows) between the ridges along which the wheels of the tractor move are subject to a compacting influence of the tractor wheels. Depending on the operating width of the machines this part of the field which is compacted again constitutes about 25-50%, the efficiency of the previous overall soil tillage on these places is low but the consumption of energy is significant.

Deep loosening of soil requires great energy and monetary resources, and therefore a very important issue is how to choose a rational depth of tillage and frequency of arrangement of the operative parts. Further, acquisition of expensive deep looseners for stony soils of small farms is not economically very sound. A very efficient way is destruction of the densest part of the soil horizon – a layer 2-5 centimetres below the ploughing depth. This layer is compacted under the lower edge of the ploughshare; various compositions accumulate there preventing the movement of moisture and development of the root system. Often its loosening has not been carried out during the recent years at all. In the present research we proceeded from a hypothesis that overall deep loosening would be inexpedient and that it would suffice to perform local loosening of soil under the cluster of potato tubers 3-5 cm below the ploughing depth (i.e. to the total depth of 27-28 cm). Since a method of preliminary formation of ridges is applied in Latvia, there are technological possibilities for strictly oriented local loosening.

In the basic variant, loading of the tractor MTZ-920.3 by its capacity constituted only 42% but in the variant compared – 83%, which caused, in general, a relatively small (3.86 Euro ha⁻¹) increase in the operating costs, with the efficiency decreasing by 14% and the fuel costs increasing by 43%. By the way, the total increase in the costs, including depreciation and the additionally installed operative parts, constituted 8.12 Euro ha⁻¹.

During the entire vegetation period of potatoes in the area where the potato tubers would develop the soil density after its deep loosening was lower than without loosening. So, in 40 days after planting the soil density in the layer of 15-25 cm from the crest of the ridge was by 12% but in 80 days – by 7% lower than in the reference areas without loosening. This is an evidence of the fact that more favourable conditions remain after deep loosening during the entire potato development period although self-compaction of soil gradually takes place. The measurements of the soil hardness, too, in the centre of the ridge indicate essential difference in the soil condition in the compared variants. Figure 2 shows diagrams of the soil hardness 14 days after planting and before harvesting – 112 days after planting.

In comparison with the basic variant, during the first year (2011) of the field experiments the formation of ridges with local deep loosening of soil to the depth of 27-28 cm by means of an experimental machine ensured a 12% increase in the crop yields, the mathematically provable addition to the crop yield constituting 1.02 t ha⁻¹ but the minimal essential difference 0.31 t ha⁻¹.

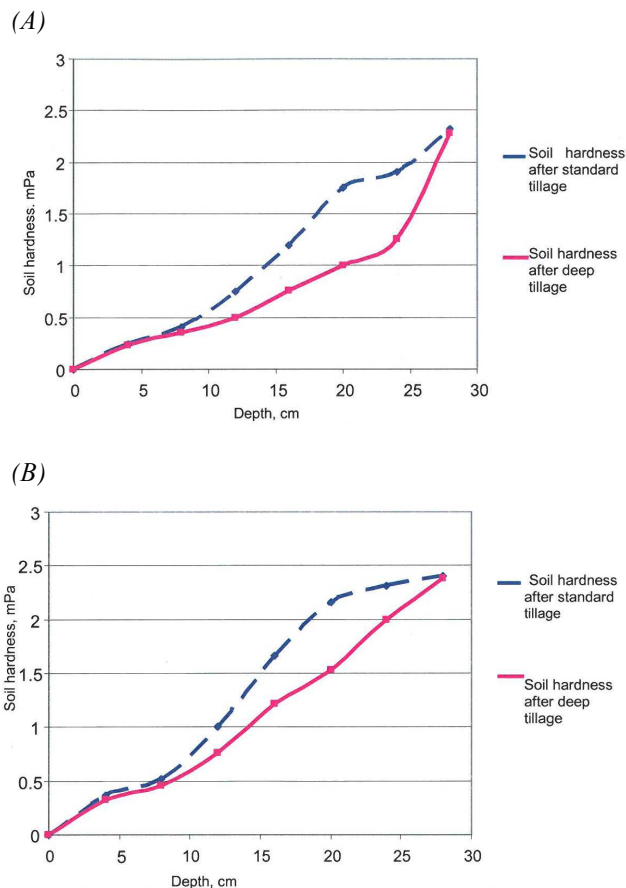


Fig. 2. Averaged diagrams of the soil hardness in the centre of the ridge 14 days after planting (A) and before harvesting – 112 days after planting (B)

4. Conclusions

1. In contrast to the overall deep loosening, application of the local deep loosening of soil with the preplant ridge formation diminishes the number of passes of the tractor across the field and ensures energy economy of 19-24%.
2. In contrast to the standard variant, application of the local deep loosening of soil with the preplant ridge formation increases total costs by 8.02 Euro ha⁻¹.
3. Loosening of soil to the depth of 27-28 cm ensures lesser hardness and density of soil during the entire vegetation period, i.e. it creates more favourable conditions for the development of the potato tubers.
4. In comparison with the ordinary variant, during the first year of the field experiments the formation of ridges with local deep loosening of soil to the depth of 27-28 cm ensured a 12% increase in the crop yields, the mathematically provable addition to the crop yield constituting 1.02 t ha⁻¹.

5. References

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