CROP PRODUCTION

DOI: https:/doi.org/10.23649/jae.2019.4.12.3

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Received: 08.10.2019; Accepted: 16.10.2019; Published: 16.12.2019

COMBINED TECHNOLOGY OF BASIC TILLAGE FOR DRY FARMING ZONE CONDITIONS

Research Article

Abstract

A new technology of basic tillage for the production of crops in dry farming. The technology includes a combination of loosening, chiseling, mixing the soil with mulching the surface of the arable land. The technical characteristic of the developed tillage implements aggregated with tractors of traction classes 3 and 5 is given. It is established that the use of frontal plows PBFR improves the performance of arable units, allowing to improve the quality of the main tillage in comparison with the known General purpose ploughshares PLN and PBS.

Keywords: technology, the main processing of the soil, front plow, loosening the working body, the working body chisel, the depth of the arable layer.

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Получена: 08.10.2019; Доработана: 16.10.2019; Опубликована: 16.12.2019

КОМБИНИРОВАННАЯ ТЕХНОЛОГИЯ ОСНОВНОЙ ОБРАБОТКИ ПОЧВЫ ДЛЯ УСЛОВИЙ СУХОГО ЗЕМЛЕДЕЛИЯ

Научная статья

Аннотация

Представлена новая технология основной обработки почвы для производства сельскохозяйственных культур в условиях сухого земледелия. Технология включает комбинацию рыхления, чизелевания, перемешивания почвы с мульчированием поверхности пашни. Дана техническая характеристика разработанных почвообрабатывающих орудий, агрегатируемых с тракторами тяговых классов 3 и 5. Установлено, что применение фронтальных плугов ПБФР улучшает эксплуатационные показатели пахотных агрегатов, позволяющих повысить качество основной обработки почвы в сравнении с известными лемешно-отвальными плугами общего назначения ПЛН и ПБС.

Ключевые слова: технология, основная обработка почвы, фронтальный плуг, рыхлительный рабочий орган, чизельный рабочий орган, глубина, пахотный слой.

1. Introduction

To obtain a stable yield of cultivated crops in areas with wind and water erosion of the soil, low rainfall, insufficient accumulation of moisture in the soil in the autumn-winter period, a soil treatment system is necessary, combining elements of known soil treatment technologies: dump, dumpless and chisel. Such a system should ensure the following agrotechnical conditions: create a leveled field surface that does not contain large lumps of soil; protect the topsoil from overheating; to promote the accumulation and preservation of moisture in the soil; to provide optimal density of soil composition for the growth and development of plants; to protect the soil from wind and water erosion; to reduce the number of weeds [1], [2], [3].

Taking into account the shortcomings of known technologies and tillage tools for deep and surface basic tillage [3], [4], [5], a combined tillage technology has been developed, the principle of which is based on successive multiple crumbling and mixing of the soil layer at different depths by loosening and chisel working bodies. Figure 1 shows the combined technological process of the main tillage, in which the initial loosening and movement of the upper part of the treated layer with the

formation of depressions is performed (figure 1, *1*), while a ridge is formed on the surface of the field. Then the process is repeated with the formation of the same recesses, the same ripping working bodies (figure 1, *2*).

Next, loosening of the soil with the formation of depressions and cracks chisel working bodies (figure 1, *3* and *4*). In this case, the intensity of soil mixing increases significantly due to the successive movements of the soil from the previously performed recesses and cracks. Depending on the state of the soil can vary the depth of the chisel working bodies relatively loosening. As a result, a fused mulch layer is formed on the surface of the arable land, under which a subsurface intensively crumbled layer is formed and the "plow sole"is destroyed.

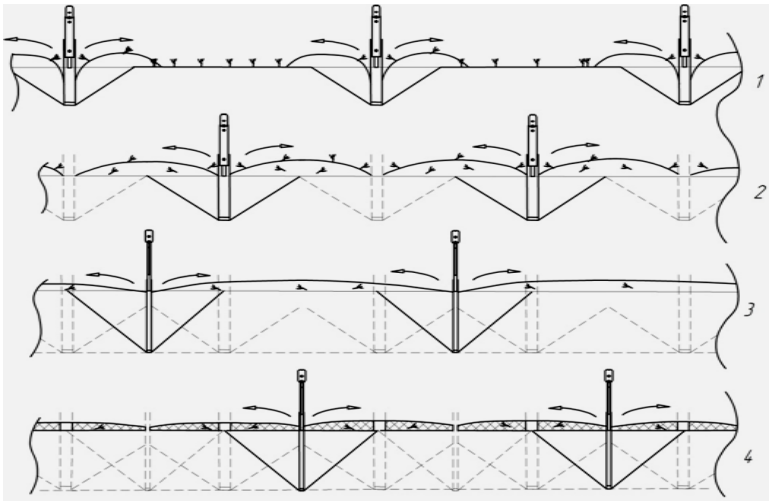

Figure 1 – Scheme of technological process of combined tillage

The scheme of a profile of the processed layer of soil on the combined technology with various depth of a course of loosening and chisel working bodies is presented in Figure 2.

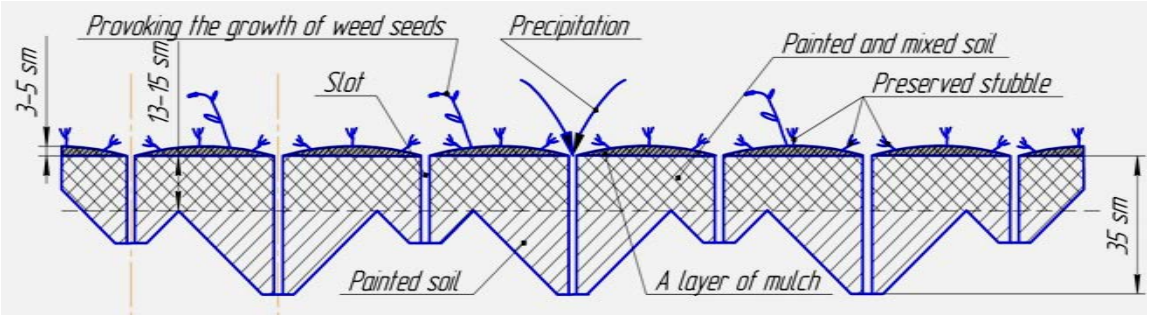

Figure 2 – Diagram of the profile of the treated soil layer

Mulch from crop and plant residues on the surface of the field reduces water evaporation, protects the soil from overheating, prevents water and wind erosion. Below the mulching layer in the crumbled soil, due to the free passage of air, the work of anaerobic bacteria and microorganisms, the decomposition of plant residues, roots, stubble turns them into humus. The formed depressions and crevices intensively penetrate precipitation, which accumulate in the subsurface horizon, in the spring in the absence of a" plow sole", moisture freely rises from the lower layers of the soil to the surface. As a result, reduced moisture deficiency in the growing season of plants. According to the density of addition, loose soil contributes to the favorable development of the root system of plants.

According to the proposed technology, the depth of cracks should be in the range of 25 to 45 sm, and to ensure a high degree of soil crumbling, the distance between adjacent cracks should be 30-40 sm. This technology served as the basis for the development of a plough-Ripper PBFR for tractors of different capacities (figure 3).

Figure 3 – Arable unit K-701+PBFR-5

Technical characteristics of the new front-Ripper plows are presented in table 1.

Table 1 – Technical characteristics of frontal plows

Front-Ripper	PBFR-3,8	PBFR-5
Width of capture, m	3,8	5,0
Number of working bodies, PCs: - loose - chiesel	 5 7	 7 8
Processing depth, cm: - loose - chiesel	 until 30 until 45	 until 30 until 45
Operating speed, km / h	until 10	until 10
Crushing of soil, %	82-92	82-92
The safety of stubble, %	25-30	25-30
Productivity, ha/ch	2,8-3,2	3,5-5,3
Fuel consumption, kg / ha	14-16	14-16
Aggregation with tractors with power, kW	150-200	220-260

2. Methods and material

To study the combined technology and tillage tools, the developed methods of operational and technological evaluation of the arable unit were used in accordance with GOST 24055-2016. Agricultural machinery. Methods of operational and technological assessment and GOST 33736-2016. Agricultural machinery. Machine for deep soil cultivation. Test method.

Studies of the performance of plows were carried out in the field after harvesting winter wheat. The non-grain part of the crop included shredded straw scattered on the surface of the field, plant and stubble residues in the form of vertically standing stubble with an average height of 18.3 cm, plant roots. The mass of plant and stubble residues per square meter is 415.0 g. Prior tillage in the field was carried out.

The relief of the fields was flat, the microrelief medium, and the type of soil and mechanical composition-ordinary Chernozem medium loam, not clogged with flagstones and stones. According to the results of the samples taken at the depth of the plow body the soil moisture was: in the layer of 0-15 cm 21.5% and the layer of 15-30 cm 23.2%. The soil hardness was 3.2 MPa in the layer up to 15cm.

3. Results and discussion

On the fields of AO"Agrofirma “Volga" Marx district of Saratov region compared the work of arable units performed by the technology of basic tillage ploughshares PNL-8-40 [3], PBS-8M [4] and frontal plow PBFR-5. Studies of the performance of plows were carried out in the field after harvesting winter wheat. The non-grain part of the crop included crushed straw scattered on the field surface, plant and stubble residues in the form of vertically standing stubble 18 cm high, plant roots. Combined tillage technology, performed by the frontal plow-Ripper PBFR-5. All tillage implements were aggregated with tractors of traction class 5, with a tractor K-701 engine power of 220 kW.

The surface of the field treated with a frontal plow-Ripper was smooth (figure 4) and did not exceed the permissible requirements of agricultural technology. The PBFR-5 plow could operate by Shuttle method without formation of dump and camber furrows that considerably increases productivity of the arable unit. Ripping working bodies intensively mixed crop residues with the soil in the upper part of the treated formation. Chisel working bodies destroyed plow sole, significantly painted soil and deepened arable horizon. As a result, a fused mulching layer with slits cut at a distance of 0.35 m was formed on the surface of the field.

Figure 4 – Surface of field treated K-701+PBFR-5

The analysis of dependences (figure 5) of productivity of arable units in function of speed of movement shows that all dependences change on nonlinear regularity.

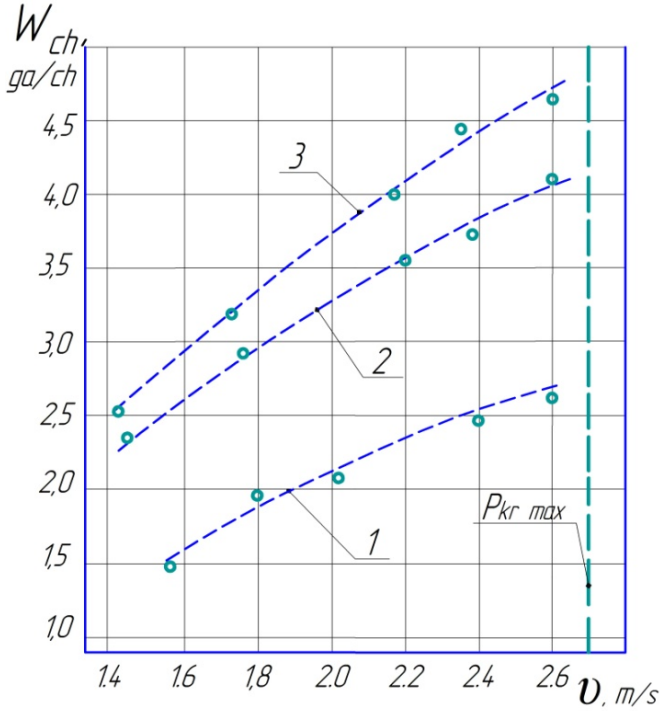

Figure 5 – The Dependence of the hourly productivity of W_{ch} on the speed υ of movement of the arable unit: *1*-K-701 + PNL-8-40; *2*-K-701+PBS-8M; *3*-K-701+PBFR-5. P_{kr}-the maximum pulling force of the tractor K-701

As a result of the analysis of dependences of productivity of arable units K-701+PNL-8-40 (figure 5, *1*), K-701+PBS-8M (figure 5, *2*) and K-701+PBFR-5 (figure 5, *3*) on speed of movement it is established that at a speed of 2,4 m/s productivity K-701+PNL-8-40 makes 2,5 ha/h, productivity K-701+PBS-8M - 3,7 ha/h and productivity K-701+PBFR-5 - 4.4 ha/h.

4. Conclusion

The results of experimental studies of technological parameters of the plough-Ripper, implemented technology of combined tillage in the region of dry farming showed that the bulk of crop and plant residues is located in the upper soil layer at a depth of 12 cm, and the other part is mixed with the soil, providing mulching and distributed evenly over the daily surface of After the work of the arable unit K-701+PFR-5, crumbling, mixing of the soil and deepening of the arable layer occurs at intervals of 0.35 m to a depth of 0.3 m.

Experimental studies of the operational performance of plows in tillage as part of arable aggregates K-701 + PNL-8-40, K-701+PBS-8M and K-701+PBFR-5 showed that the hourly productivity of K-701+PBFR-5 higher aggregates K-701+PBS-8M and K-701 + PNL-8-40, respectively, 22.7 and 43.2%.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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