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research, the Zhenichka variety provided an increase in yield relative to control of 2.0 t / ha, and the hybrid Sunny Delight F1 – 6.7 t / ha.

Conclusions and prospects for further research. Studies on the study of squash assortment indicate that the largest percentage of early harvest is provided by the varieties Perlinka and Sashenka. The highest percentage of late harvest is provided by Perlinka and Zhenichka varieties. On average, over the years of research, it was found that the most productive variety is Zhenichka – 35.0 t / ha and hybrid Sunny Delight F1 – 39.7 t / ha.

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PRE-SOWING AND INTER-ROW TILLAGE OF INDUSTRIAL CROPS

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Abstract

The article examines the main technologies and technological processes of pre-sowing soil tillage. Analysis of the main technical systems for performance of technological operations on pre-sowing tillage is carried out. It is justified that inter-row tillage does not lose its relevance due to capabilities to improve soil structure in row

spacing, effectively control herbicide-resistant weeds and apply solid and liquid fertilizers and plant protection products.

Keywords: pre-sowing tillage, soil structure, inter-row tillage, weed control, fertilization.

Formulation of the problem. World experience in tillage once again indicates that pre-sowing tillage plays a key role among the main agro-technical measures that guarantee high yields. Qualitative implementation of this operation creates optimal conditions for biological, chemical and physical processes, which increase the efficiency of all other measures taken in the process of growing crops. In modern agriculture, there are many tillage systems, the main of which are: the system of pre-sowing and inter-row tillage.

Early spring tillage before sowing of industrial crops is designed to destroy sprouts and weed seedlings and loosen the surface layer to a given, depending on the crop to be sown, to a depth of fine-grained condition to retain moisture.

Pre-sowing tillage is performed to the depth of seed production to create favorable conditions for its germination, the main among which is the density of the seed bed and the evenness of the depth.

Inter-row tillage should, among other things, saturate the soil with air, primarily carbon dioxide to activate nitrogen-fixing and other anaerobic bacteria.

Analysis of researches and publications. The set of factors that significantly affect the field germination of seeds includes temperature and humidity of the prepared soil, sufficient air capacity, the ratio between water and air content, the alignment of the structural and aggregate composition of the soil to the required values. Well-known scientists such as O. Blesniuk, M. Volokha, I. Vasylchenko, S. Ivanov, V. Kulyk, S. Marynin, V. Nadykto, A. Ogienko and V. Opalko, M. Ogienko, S. Pascuzzi, I. Rogovsky, Y. Rozamaga, V. Sinchenko, J. Spall, L. Titova, V. Trokhanyak, V. Tomchuk, O. Tsyliuryk, O. Shustik and many others made a significant contribution to solving these problems. Despite the large number of tillage works, there is a constant need for research in connection with climate change, the emergence of new machines and technologies to determine their most appropriate use.

Formulation of aims of the article. The purpose of these studies is to analyze the capabilities of tillage units of well-known manufacturers and recommendations for quality tillage before sowing of industrial crops, depending on the condition of the soil and the type of working bodies.

Exposition of the basic material of research. Tillage is an important component of agriculture. Much attention is being paid to this issue today. Tillage is a set of methods of mechanical action on the top layer of soil in order to optimize conditions for plant development and increase its fertility. Grinding of the arable layer can improve the water and air permeability of the earth, activate the activity of microorganisms, protect the field from weeds and diseases [1].

The choice of approach to tillage depends on the climatic features of the region, the biological characteristics of the crop and its demanding.

The main pre-sowing operations are early spring harrowing to cover moisture and cultivation. Harrowing is carried out as soon as the ridges dry out from plowing. Harrowing should be carried out for one or two days. Delay in the implementation of this agricultural measure leads to significant moisture loss and reduced yields.

In fact, harrowing is mulching without cover materials. This group of agricultural measures includes early spring harrowing of frost, early spring harrowing of winter and perennial grasses, cultivation of steam, layering between rows of row crops, destruction of soil crust after rains.

The effect is achieved by loosening the soil to a small depth in order to destroy the soil capillaries, which draw moisture from the lower horizons to the surface. That is, there is mulching of moist dry soil.

Early spring harrowing of plowed, threshed or loosened paw aggregates allows to achieve several agronomic advantages at once. First, it allows the primary leveling of the area. Secondly, to form a protective fine-grained layer on the surface of the field, which significantly slows down the evaporation of moisture. Third, destroy small weed sprouts in the white thread phase. An additional advantage of early spring harrowing is a more uniform and partial grinding of semi-decomposed straw, if it remains on the surface [2].

Early spring harrowing does not require significant fuel costs, even with the use of wide-reaching units. It should be emphasized that in regions with a sufficient level of moisture for carrying out early spring harrowing, toothed units are used, and in arid regions - needle units. The most efficient designs of such harrows include mesh-type units, in which each sector moves independently of each other. The ability to assemble hitches for early spring harrowing of a significant working width provides exceptional productivity and does not require the use of heavy-duty tractors.

Equally important is the destruction of spring soil crust, which sometimes leads to mass oppression and even the death of winter cereals in many regions of Ukraine. At the same time, the activation of microbiological processes in the soil and the improvement of moisture and air circulation are launched. According to quite realistic scientific and practical data, early spring harrowing of winter allows to increase future yields by 10–20% [3].

Early spring harrowing of winter and perennial grasses is carried out by spring harrows with a flexible spring tooth that vibrates during tillage. They are sometimes called "ecological cultivators" for their mild action and beneficial effects on the land,

Fig. 1. Pre-sowing tillage when sowing winter wheat

Source: formed by the author

and are said to provide so-called "dry irrigation". That is, breaking the top layer of soil, allow spring moisture and air to circulate as freely as possible.

Basically, spring harrows allow you to solve the following problems:

• harrowing before sowing to remove germinating weeds;

• destruction (grinding) and distribution of straw, plant residues in the field;

• closure of soil moisture;

• application of granular fertilizers;

• high-quality finishing of the soil;

• easy cultivation.

The wide width of capture of such harrows, high working speed, high-quality copying of a relief of a field provide high variable productivity with excellent agrotechnical indicators of work at insignificant fuel consumption. Timely and correct use of such tools contributes to high yields.

Compared to other types of tillage, the use of rotary harrows is probably the most expensive option for preparing the soil for sowing. However, as the experience

Fig. 2. Application of a spring harrow for pre-seed harrowing of crops

Source: [4]

of their use shows, it guarantees a quality result, ie the appearance of friendly seedlings and providing favorable conditions for their vegetation to form a high yield. For quality work of this harrow even difficult field conditions when other cars (with passive working bodies) in general are powerless do not interfere.

Today on the market of Ukraine there are rotary harrows, the design of which embodies one of two ways of moving the working bodies - with a vertical or horizontal axis of rotation. It is necessary to distinguish the essence of tillage with teeth with active and passive angle of attack: the difference is how the cultivated soil "behaves" using a particular type of working body. Thus, at the passive angle of attack of the tooth, the surface layers of the soil are directed downwards, and with them - all the crop residues that could remain on the surface from the previous technological operation. This principle of operation creates an optimal picture of mixing. As for the teeth with an active angle of attack - they tend to "lift" the ground. In this case, the mixing effect will be weaker, but large soil fractions (lumps) will be brought to the surface, which will further protect the field from water and wind erosion. In addition, such teeth undermine the soil, destroying shallow seals, and prevent their re-formation [6].

Fig. 3. Application of a rotary harrow on sunflower crops

Source: [5]

A new innovative solution in the market of liquid preparations was the American injector system SpikeWheel, for the introduction of liquid fertilizers and soil insecticides [7].

The innovative SpikeWheel system is characterized by one-pass application of liquid fertilizers and loosening the soil on the principle of a rotary harrow. In addition, this type of fertilizer ensures good development of the root system and is ideal for mulching and direct sowing, as liquid fertilizers act in the root zone and are not lost due to runoff or evaporation. Also, the effect of a rotary harrow has a positive effect, especially on clay soils. Due to the fact that fertilizers are not applied superficially, weed growth is also reduced [7].

Pre-sowing rolling is somewhat more efficient than post-sowing. This measure is necessary in the technology of growing sugar beets. Pre-sowing tillage is usually carried out when the physical maturity of the soil, without allowing a large gap

Fig. 4. SpikeWheel system for early spring winter feeding

Source: [8]

between pre-sowing tillage and sowing, as this will lead to a significant loss of moisture in the soil.

The best tools for pre-sowing tillage are combined units, cultivators and harrows. It is these tools that can achieve shallow and even loosening of the soil. To meet all the conditions to achieve this goal, it is necessary to have units that will help in this.

Some of them include several domestic counterparts.

Steam cultivator KPS-4. This cultivator is used for multi-tiered loosening of the soil before sowing and destruction of various types of weeds, while harrowing is carried out at speeds up to 12 km / h.

This model is available in two versions - trailed and mounted, there is also a device for attaching additional harrows. The working bodies of the cultivator are universal arrow-shaped legs, they have a width of 27 cm or 33 cm, the second element - loosening legs on a rigid rack, width of 35 to 65 mm, the last element - spring loosening legs, which have a width of 5 cm.

Paw racks are mounted on special grills, which are hinged to the cultivator frame. Universal arrow paws are arranged in two rows in a checkerboard pattern. Paws 27 cm wide are fastened in the front row of the cooling tower, and in the secondary row - paws 33 cm wide on the long cooling tower [9].

Fig. 5. Steam cultivator KPS-4

Source: [9]

Toothed harrow OR - 0.7 (70x60). The OR harrow - 0.7 is intended for loosening the soil, leveling the field surface, destroying weed seedlings. The width of capture is 0,70 m, and depth of processing varies within 2-4 cm. Weight makes 9 kg.

Fig. 6. Toothed harrow OR - 0.7 (70x60)

Source: [9]

BZSS harrow 1.0. The average harrow BZSS 1,0 is the hinged tillage unit by means of which carry out various works on tillage. Harrowing is performed before sowing. The unit is a very strong metal frame in the form of a lattice with teeth that are attached to the joints. The working bodies are located at the same distance from each other at a right, sharp or any other angle, depending on the required depth.

The harrow of BZSS 1,0 is intended for:

• field alignment;

• loosening the top layer of soil before plowing;

• breaking large lumps no larger than 5 cm;

• removal of young weeds that have been pulled to the surface by a plow [9].

It is aggregated with tractors of classes 0,9-5,0 TF, can also be used simultaneously with other types of units and agricultural machines.

Technologies for growing row crops using pesticides do not preclude mechanical care of crops. Quite often this is due to the emergence of weeds resistant to modern herbicides, unproductive moisture loss due to evaporation, as well as compaction and flooding of the soil after heavy rainfall during the initial phases of the growing season.

There are three main structural schemes of combined units: of several series-connected simple machines, each of which performs a separate operation; a machine with sequentially installed simple working bodies to perform several operations; machine with special combined working bodies for consistent execution of technological process. Depending on the condition of the soil environment (hardness, density and soil moisture), combined tillage units may have different sets of working bodies. In fields with high soil moisture, preference should be given to additional equipment of units with toothed harrows, cultivator legs, and in arid conditions - rollers of different types.

Combined units for pre-sowing tillage in one pass provide leveling of the field surface, loosening it to a certain depth, crushing to a certain fraction in size, compaction and preparation of the bed for sowing. The advantages of these tillage machines are: replacement of 5-6 single-unit units; reduction of labor and fuel costs by 30%; reduction of terms of performance of works; preservation of moisture in the soil; creating a homogeneous density of the seed layer of the soil. In the designs of modern combined units for pre-sowing tillage such working bodies as an arrow paw on an S-shaped spring rack, bar rollers, toothed leveling knives are introduced, which allows to improve the quality of work. Hard alloys are used to increase the wear resistance of the surfaces of the working bodies, which ensures their high reliability and durability [10].

In the combined tillage machines for surface tillage, including pre-sowing, the separation of working bodies and increase of the general width of capture is provided. Elastic working bodies with loosening (chisel-shaped) or arrow paws 30 to 200 mm wide are widely used, as well as rotary lump shredders with field surface levelers [10].

Because weeds compete with cultivated plants for batteries, limiting their harmfulness has been and remains a major problem in agriculture.

The most environmentally friendly method of control is weeding. Of course, the disadvantage of this method is obvious - it is very time consuming if a person does it. But this task can be entrusted to the robots. A combination of agronomic and chemical controls is most effective against weeds.

Inter-row tillage is performed to control weeds and loosen the soil. With the help of inter-row tillage, a mulching layer is created on the soil surface, which prevents the formation of soil cracks, through which moisture evaporates intensively. Mechanical tillage between rows increases water permeability and improves the air regime of the soil.

Inter-row tillage operations make it possible to maintain the top layer of soil in a small lump state. This contributes to the creation of the best water-air regime and the activation of microbiological processes.

Inter-row tillage of row crops begins after the appearance of 3-4 leaves on the seedlings. Two to five inter-row treatments are carried out during the entire care period. The depth of cultivation depends on the soil and climatic conditions of the zone and is: the first cultivation - 8 - 12 cm, the second - 6 - 10, the third and subsequent - 4 - 8 cm. Quite often cultivation is combined with fertilizing crops [11].

At interrow cultivation between plants in lines and the processed part of interrows leave a protective zone.

The latter is necessary in order, firstly, not to cut the cultivated plants during cultivation, and secondly, so that the soil particles that will rise and move with the paws of cultivators, do not sprinkle and do not injure the seedlings. The width of the protection zone depends on the phase of plant development and is 7 - 17 cm. The most used protection zones during the first, second and third treatments are 10, 12–13 and 15 cm, respectively [12].

Fig. 7. Processing of line protection zones

Source: [12]

There are two types of cultivators. Some of them provide only a variety of mechanical tillage between rows, and others, in addition to tillage implements, are also equipped with fertilizer spreaders and a system of feeding pellets under the paw and allow you to process the rows and apply granular fertilizers.

When inter-row tillage without fertilizing with mineral fertilizers, the working bodies of cultivators must completely cut weeds in between rows, do not tolerate a wet layer of soil on the field surface, do not damage plants more than 1-2%, do not deviate from the specified depth (for shallow tillage it is 1 cm, and for deep - 2 cm). When hilling the plants, the working bodies must form an even ridge of a given height, covering the bottom and walls of the furrow with loose soil.

When inter-row cultivation with simultaneous feeding of plants, cultivators, in addition to the above requirements, must provide the following. The deviation of the fertilizer application dose from the set one should not exceed 15%, and the uneven sowing of fertilizers between the fertilizer spreaders should be less than 5%. Deviation of depth of wrapping of fertilizers from the set to 3% is allowed, and damage of plants thus should not exceed more than 5%.

The frequency of inter-row tillage and their number depend on the structure and condition of the surface layer of the soil, the degree and type of crop contamination, biological characteristics of row crops, the duration of the growing season. In the conditions of dense soils, at strong weeding of crops and the long vegetative period the quantity of cultivations increases. Each subsequent inter-row treatment is carried out approximately 15-20 days after the previous one. The efficiency of cultivation increases if it is performed shortly after the rain.

Fig. 8. Interrow cultivation of sunflower: before and after the passage of the cultivator
Source: formed by the author

The depth of cultivation between rows of row crops depends on the timing, the phase of plant development and soil moisture. In arid areas, the first interrow tillage is performed to a depth of 10-12 cm, the second - at 8-10 cm, and the third (if necessary) - at 6-8 cm in places of sufficient moisture, this sequence is optional, because the probability of drying the soil is low.

Fig. 9. Rain erosion between rows of corn after loosening
Source: formed by the author

Intensive cultivation technology of row crops allows to significantly reduce the number of crop care operations, but does not preclude their use if necessary. If weeds appear on crops, they are destroyed by a combination of chemical and mechanical methods.

Depending on the tasks of cultivation, soil and climatic conditions, the method of sowing and the growing season on row cultivators, different working bodies are used.

The working bodies of row cultivators include various paws, hilling and furrow-cutting housings, feeding knives, needle discs, teeth of harrows, rotors, disc knives, etc.

Depending on the purpose of the paws are divided into weeding, loosening and hilling. Weeding paws include one-sided (razor paws), pointed flat-cutting paws and universal arrows, loosening paws - chisel-shaped or naralnikovy, and hilling paws - hilling paws and hilling bodies.

One-sided flat-cut paws are designed for pruning weeds and loosening the soil to a depth of 6 cm. The paw consists of a riser, a horizontal part with a blade and a cheek. The cheek prevents the soil from dusting

the plants. There are right and left paws. The first is installed on the right side of the line, and the second - on the left. The blade of the paws is sharpened from above at an angle of 8-10 °. The thickness of the blade should not exceed 0.5 mm. When moving the paw in the soil, its blade cuts the roots of the weeds, cuts the soil layer, which moves on the working surface of the paw, is crushed and partially mixed. The width of the paws can be 85, 120, 150, 165 and 250 mm [12].

Arrow flat-cutting paws are used for tillage to a small depth (up to 6 cm) and its slight loosening. Use paws with a width of capture of 145, 150 and 260 mm.

Arrow universal paws prune weeds and intensively loosen the soil to a depth of 12 cm, they are used for tillage between rows.

Loosening chisel-shaped paws are used for loosening between rows of cohesive and dense soils to a depth of 16 cm. The lower part of the paw is bent forward and has a pointed toe in the form of a chisel 20 mm wide. This paw is quite well sunk into the soil and when moving deforms and loosens the soil to its full depth without removing the wet layer on the surface of the field.

Hilling paws are used for hilling plants, pruning weeds in between rows and sprinkling weeds in the protective areas of the row. The paw consists of a riser, a double-sided shelf with sliding wings and a sock-pointed, pointed on both sides. During operation, the sock-cutter cuts the soil and moves it to the left and right working surfaces of the shelf, which direct it to the row area, forming a ridge. The height of the soil ridge is regulated by the movement of the wings in height.

The hilling corps with a lattice shelf has an arrow paw in the lower front part instead of a naralnik, and cutouts in the wings of the shelves. The pointed paw of the body cuts the soil between the rows and feeds it on the shelf. Part of the soil is scattered through the gaps between the paw and the front of the shelves and falls to the bottom of the furrow. The fingers of the wings of the shelves loosen the sides of the ridge and the walls of the groove. The bottom of the furrow becomes loose. One-sided hilling corps (depth of cultivation - up to 16 cm, height of the ridge - up to 25 cm) are used for cutting small ridges [12].

The furrow cutting corps is intended for cutting of irrigation furrows on depth to 20 cm with simultaneous introduction of mineral fertilizers. The case has a naralnik, a bilateral shelf, wings, a funnel for fertilizers and a riser.

The feeding knife is used for loosening between rows and wrapping fertilizers in the soil to a depth of 16 cm. It has the form of a loosening chisel-shaped paw, to which is attached a funnel for feeding fertilizers to the bottom of the furrow.

Spring teeth are used for loosening the soil in the protective zones and between rows. The frame with spring teeth is hinged to the cultivator holder.

Rotary needle discs are used to destroy soil crust and kill weeds. They have pointed teeth bent to one side. Diameters of disks - 350, 450 and 520 mm. During the movement of the discs in the rows and protective zones, the teeth sink into the soil to a depth of 9 cm, loosen it, destroy weeds [12].

Paws-shelves are used for pruning weeds, loosening the soil and sprinkling weeds with soil in the protective zone of the row. The paw consists of a riser and a curved shelf of left or right rotation. Paws-shelves are installed on the left and right side of the row at a distance of 25-27 cm from its axis. Depth of cultivation - up to 8 cm.

Weeding harrows are spring teeth attached to the frame. They are designed for loosening the soil between rows and protective zones. Harrows are installed on cultivators, hingedly attached to the bracket of the cultivator section holder in order to better copy the terrain.

A wide-reaching flat-cut paw prunes weeds and loosens the soil between rows. The angle of crushing the paw is 10 °. Paws are 250 and 360 mm wide. A weeding disk with knives is attached to the end of the paw. During operation, the disc rotates, the knives cut the weeds and loosen the soil. Depth of cultivation - 60-80 mm [12].

On most cultivators for interrow cultivation the working bodies are established by means of a parallelogram suspension bracket. Feature of a design of a parallelogram suspension bracket of section of working bodies consists that at decrease or increase in depth of the course of paws their angle of occurrence remains invariable. The beam moves parallel to its initial position. In front of the beam is a support wheel, which when moving copies the irregularities of the terrain.

Systematic tillage between rows of row crops is carried out to control weeds, if the farms do not have highly effective herbicides. Inter-row tillage also creates a mulched layer of dry soil on the surface, which prevents the formation of cracks on loamy soils, through which moisture evaporates intensively, and increases water permeability and improves the air regime of the soil.

The timing of inter-row tillage and their number depend on the density of the structure and condition of the soil surface, the degree and type of contamination of crops, the duration of the growing season and the biological characteristics of row crops. On dense soils, with heavy weeding of crops and a long growing season, the number of treatments increases, each subsequent is performed in 15 - 20 days after the previous one. If the treatment is carried out shortly after the rain, it is more effective.

The depth of inter-row cultivation depends on the timing of its implementation, the phase of plant development and soil moisture. In arid areas, the first row spacing is performed at a depth of 10 - 12 cm, the second - at 8 - 10 cm, the third (if necessary) - at 6 - 8 cm. If there is enough moisture, this sequence is optional, so that the probability of drying the soil is low.

Corn and sunflower. The working bodies of cultivators for cultivation between rows of row crops can be paws, razors, chisels, spring teeth, needle disks and their various combinations. For example, a symmetrical cultivator paw is installed in the middle of each section for corn or sunflower, and one-sided flat-cutting paws are mounted on the sides [12].

During the first inter-row cultivation, an untreated strip 5 - 7 cm wide should be left on both sides of the row, and 7 - 10 cm should be left for the next treatments. The larger the plants, the wider this protective strip should be, on which weeds destroyed by tape application of herbicides.

Practice has shown that with the mechanized technology of growing corn it is necessary to carry out two inter-row cultivations - the first with weeding harrows to a depth of 6 - 8 cm, the second - with paws to destroy weeds by 4 - 6 cm. In the case of compaction , swimming and cracking of the soil, only one inter-row tillage to a depth of 4 - 6 cm is effective.

Sugar beets. After the emergence of sugar beet seedlings, when the rows are clearly visible, the first inter-row tillage is performed with row cultivators equipped with protective disks, one-sided flat-cutting paws 15 cm wide, as well as 6-disc rotary batteries to destroy weeds and loosen the soil. Flat-cutting paws and protective disks are installed at a depth of 3 - 3.5 cm, rotary batteries in between rows - at 4 - 5 cm.

After the formation of crop density, loosening the soil between rows should be combined with fertilization. For this purpose the cultivator is equipped with chisels and flat-cutting paws. The soil is loosened to a depth of 6 - 8 cm. In case of unstable moisture, three inter-row cultivations are enough, which should be carried out before closing the leaves in the rows [12].

Potato. In the case of the ridge method of growing potatoes, the field is loosened on the 8th - 10th day after planting with cultivators equipped with arrow paws and razor legs. In the unit with a cultivator in the middle of a line start up reticulated harrows. The second time the soil is loosened to a depth of 10–12 cm, when potato sprouts germinate by 3–4 cm. If it rains, the soil is compacted and weeds germinate, then a third inter-row cultivation to a depth of 7–8 cm is required [12].

Oilseeds. During the cultivation of oilseeds, the number and intensity of inter-row tillage depends on the weediness of crops. On pure crops, one cultivation to a depth of 8–10 cm is sufficient during the growing season. Re-cultivation should be carried out on weedy fields. On medium and heavy soils, inter-row tillage is performed regardless of weed infestation.

In the southern regions, the first inter-row cultivation of sunflower and castor is carried out to a depth of 10 - 12 cm. During subsequent cultivations, the depth is reduced so as not to damage the root system of plants, which is located close to the soil surface. The depth of the second row spacing should be approximately 8 cm, the third and, if necessary, the next - 4 - 6 cm.

Soybean cultivation should begin during row formation, but not later than the unfolding of the first trifoliate leaf. Inter-row tillage for high-quality loosening of the soil is carried out by cultivators with arrow paws with minimal protective zones of rows (6 - 8 cm) to a depth of 6 - 8 cm. The next tillage is performed 12 - 15 days after the first to a depth of 5 - 6 cm. Rapeseed and mustard crops are cultivated to a depth of 4 - 5 and 6 - 7 cm, respectively [12].

Hilling of plants. Plants of row crops are pounded to sprinkle the soil on the base of the stems and at the same time loosen the top layer of soil. In particular, when pounding potatoes, the lower part of the stems is sprinkled with soil on all sides, in the presence of sufficient moisture it promotes the formation of stolons. In dry years, repeated hilling of potato plants is harmful, as it leads to increased evaporation of moisture from the loose soil.

Hilling of corn plants with moist soil enhances root formation. Sprinkling the lower part of the stems of some crops especially promotes their rooting on irrigated lands. Hilling in irrigated areas is useful for almost all row crops, especially for vegetables.

Hilling of oilseeds is performed when the height of weeds does not exceed 10 cm, and cultivated plants - 30 - 40 cm. They are most effective in wrapping weeds if they are installed at an angle of 30 ° to the direction of movement of the unit at depths up to 5 cm and speeds up to 8 km / h.

Crop care for the main soil and climatic zones of Ukraine is almost the same. The Institute of Potato Growing has two care systems:

1. The first includes pre-emergence and post-emergence inter-row tillage to loosen and control weeds. The care system also includes treatment of crops with pesticides against diseases and pests, watering in case of moisture deficiency.

2. The second system of crop care includes elements of resource-saving technology of potato cultivation, when 4-5 inter-row tillage is replaced by one method of ridge formation. Volumetric ridges are formed after planting the tubers when their sprouts appear near the soil surface by milling or disc row spacing cultivators. Weed control is carried out using highly effective herbicides.

In the Forest-Steppe and Polissya, post-emergence cultivation of potatoes is performed with hillers. At the same time, a 3-4 cm layer of soil is poured on the ridge, which prevents the tubers from being affected by late blight. During the third tillage, it is pounded 8-10 and 10-12 cm from the bottom of the furrow. If the soil is compacted, before each hiller set chisel-shaped paws to a depth of 10 - 12 cm. In case of lack of moisture in the soil instead of hilling spend shallow (4 - 6 cm) loosening between rows.

In regions with excessive moisture, the water-air and temperature regimes of the soil can be regulated by hilling plants. After hilling, the soil surface remains ridged, better heated by warm air and evaporates more moisture. Increasing the area of the evaporating surface after hilling helps to eliminate excess moisture, which ultimately improves the nutrient regime of the soil.

Now in European countries fire cultivators are becoming more and more popular. The use of fire reduces the population of weeds without the use of herbicides. It runs on natural gas or liquid propane. Carefully directed flames raise the temperature in the weeds, causing the destruction of their cells. This effect effectively destroys pests without damaging the crop. As a result of the use of fire cultivators, some farmers have found that the flame controls the presence of even weeds such as ragweed. The only downside is the impossibility of using combustion on crops such as soybeans, because the point of plant growth is above ground. Whereas fire

cultivators have shown the greatest efficiency in maize, where the point of growth is under the ground. In addition, humidity and wind strength should be controlled, as excessive moisture and strong winds reduce the effectiveness of the flame. After cultivating with a fire cultivator, the leaves of weeds look dull and it is easy to leave a visible fingerprint on their surface. In 2018, the Ukrainian company created the first fire cultivator. The new technology will save up to 80% on the purchase of plant protection products [13].

Of course, under normal conditions, having started a cultivator in crops, we are forced to take into account that a certain percentage of plants will be damaged. At the same time, if an insufficiently qualified operator will work at the wheel, and the settings of the unit will be made improperly, you can expect quite significant losses.

That is why accurate navigation will reduce the potential damage to plants to zero, and this may even apply to the removal of the crust by rotary harrows on winter crops.

In any case, accurate navigation will significantly expand the capabilities of the economy.

For example, in the case when the soil herbicide does not work for one reason or another.

A systematic approach to weed control is also popular. Spanish scientists have developed machines to control them. Small hoe robots, by receiving information from a real-time weed positioning map (GPS), automatically destroy weeds that grow between cultivated plants in a row. Advantages of the method in the accuracy of weed removal and recognition of a wide range of crops.

It is difficult to say which weed control method is best.

The decisions made by each farmer are based on his personal goals, experience and capabilities.

But we must not forget that the most important thing in weed control is a healthy ecosystem that needs to be improved and maintained.

This approach will increase the yield and sustainability of crops and significantly reduce the cost of controlling unwanted plants.

The new miracle technique was developed in the Department of Agricultural Robotics of the National Center for Precision Agriculture in Great Britain.

Today we are already developing such sensors and instruments that can be determined by soil and water conditions; the presence of pests and diseases; weeding and determining crop growth rates.

Robots will be able to actively improve growing conditions - for example, by removing weeds.

Fig. 10. Application of fire cultivator

Source: [13]

Conclusions. Thus, pre-sowing tillage for late crops should be timely and focused on preserving soil moisture, prevent erosion and be performed immediately before sowing field crops.

Pre-sowing treatment helps to preserve moisture in the soil and creates conditions for even wrapping of seeds to the required depth, which, in turn, improves its germination and further plant growth. This measure of land cultivation is so important that it further determines the entire development of the plant, including the uniformity of crop maturation and the quality of harvesting. It is performed to form a seedbed, evenly place the seeds in it and sprinkle loosenim soil.

The main mistakes during the pre-sowing tillage are too early start of work - in the phase incomplete maturity of the soil, an excessive number of working passages due to the fact that certain operations are performed by different aggregates, high working speed of aggregates, deep pre-sowing loosening.

A combination of agronomic and chemical controls is most effective against weeds.

The most environmentally friendly method of control is weeding. Of course, the disadvantage of this method is obvious - it is very time consuming if a person does it. But this task can be entrusted to the robots.

It is difficult to say which weed control method is best. The decisions made by each farmer are based on his personal goals, experience and capabilities. But we must not forget that the most important thing in weed control is a healthy ecosystem that needs to be improved and maintained. This approach will increase the yield and sustainability of crops and significantly reduce the cost of controlling unwanted plants.

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