Technologies for soil surface maintenance in perennials

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Summary: Perennials are an important strategic sector for agriculture in Bulgaria. In order to obtain good results from their cultivation, a scientifically based system for the maintenance of the soil surface is needed. Existing technologies have been analyzed to support the selection of an appropriate soil maintenance system. The size of the agricultural holdings in Bulgaria for the most widespread perennial plantations, which are the vineyards and are substantiated by economically expedient technologies and machines for soil cultivation suitable for the majority of the agricultural producers, is analyzed. The advantages and disadvantages of the technologies and the machines for their realization are presented.

KEY WORDS: PERENNIALS, TILLAGE MACHINES.

Introduction

A significant part of agricultural production is obtained from perennial crops. In order to obtain quality products, it is necessary to create conditions for the development of cultivated crops [2,3,4]. One of the most important measures to create favorable conditions for perennials is the maintenance of the soil surface. Perennials occupy a certain area for a long period of time and the maintenance of the soil surface is difficult compared to annual crops. The repeated passages of the machine-tractor units compact the soil and destroy its structure [5,6,7,8], which requires an analytical study of the technologies and machines for supporting the soil surface in the inter-rows of the permanent crops.

Modern trend of Bulgarian agriculture and importance of perennials

In recent years, there has been a tendency to reduce the number of agricultural producers and at the same time increase the area of agricultural enterprises. This concentrates agricultural production in a small number of producers who work with highly productive equipment, mainly grain production and industrial crops. The share of intensive crops is low, most of which are perennials. Stimulating these sectors could partially solve the employment problem, rural depopulation and other social problems. Self-produced and semi-market farms account for almost 90% of those employed in agriculture. The main number of farms are small, up to 10 decares, but they cultivate a very small part of the land. Much of the land is cultivated by a small number of farmers. The number of large farms in the typical mountainous and semi-mountainous areas is small, where the arable land is smaller and on sloping terrains, which are more difficult to unite, consolidate and apply modern management technologies and they are suitable for intensive permanent plantings.

Areas with fruit, nuts and berry plantations in agricultural holdings

in 2018 they occupy 68.3 thousand hectares. 39.8 thousand hectares were harvested. The produced production of fruits is 228.5 thousand tons. In 2018, 88% of the fruit-bearing areas occupied by fruit, nut and berry plantations were harvested. Due to climatic and other reasons, about 12% of the fruit-bearing areas with fruit species are not harvested. The total harvested areas in 2018 are 7.8% more than in 2017. The largest share is occupied by cherries - 25.2%, followed by plums and junipers - 18.5%.

According to the structure of agriculture in Bulgaria in 2016, from 201014 agricultural holdings 23966 specialize in the cultivation of perennials.

The preferred tillage is plowing or hoeing, applied to 71% of the area under orchards. Chemical decontamination is applied to 3% of the areas, mainly cherries, apples, plums and peaches.

Mixed perennials - the item unites mixed plantations of fruit species. The minimum area is 500 m2 (0.05 hectares), if the area is smaller refer to isolated trees or family garden according to the environment. Their area decreased by 6.0%.

The vineyards are the other main group of perennials, according to Agrostatistics [1] in our country 59 991ha vineyards from 45 179 farms are cultivated. The characteristics of the vineyards are shown in Fig. 1A depending on the number of farms and Fig. 1B depending on the size of the cultivated areas. It can be seen that 2/3 of the vineyards have an area of over 10 hectares on average 3 hectares and in the other groups they are 5-10%.

![A) According to the number of farms](image1.png)

**FIG. 1.** Distribution of vineyard farms in Bulgaria
The distribution of the areas depending on the age is shown in fig. 2. Most farms 89% grow old vineyards over 30 years. **FIG. 2A.**
Regarding the areas, 69% of the post office is occupied with vineyards of 30 and more years fig.2B.
All this shows the need for cost-effective technologies and high-productivity tillage machines suitable for most farmers.

**Importance of soil treatment in perennials**

Soil treatment improves the physical, water and air properties of the surface soil layer, thus creating favorable conditions for the development of trees and helping to increase their resistance to pests [3]. Through the main tillage the plant remains and weeds are buried and thus the process of leaf mass mineralization is activated and limits the infectious background from scabs on apple and pear, gray and brown spots on pear, white rust on stone species, gnomoniosis on apricot, mushroom ball and others. The process of mineralization begins in the fall, but along with lowering the temperature and freezing of the soil, it gradually subsides. When the main treatment is carried out with deepeners, the arable layer is deepened, creating conditions for the development of the root system of the trees. The increase of temperatures during the early spring period, together with the spring vegetation treatments, activate the mineralization process and lead to a reduction of the primary inoculum for the new vegetation period.

Proper treatment protects the soil from water and wind erosion, preserves soil moisture as it destroys soil capillaries and reduces evaporation from them. The row spacing of perennials is cultivated to a depth of 18-20 cm. Where possible, around the trunk of the trees is dug to a depth of 8-10 cm. In this way mechanically destroy some of the wintering forms of a number of economically important enemies, such as fruit octopus, mining moths, fruit wasps, cherry fly and others. Another part of them is exported to the soil surface, where they die from adverse weather conditions in winter. The autumn tillage of the soil not only improves the aeration and destroys the wintering period of the pests, but also increases the cold resistance of the fruit species. When weeds remain under the trees, even if they are dry, the danger of frost is greater because the radiation of low temperatures from the soil to the crown of the trees increases. Autumn cultivation is best done by plowing with inversion of the layer and deepening of the subsoil layer. And other plant residues, weed seeds are plowed deep if fertilizers are applied, they are also deep to be used intensively. The main tillage is carried out after the completion of all other agro-technical measures.

Technologies for maintaining the soil surface in perennials

Each soil maintenance technology aims to provide all the conditions described in the previous point, as well as to facilitate their cultivation practices. [4] In general, the systems are: black fallow, herbicide fallow, perennial turf and inter-row cultivation

**Black fallow** Traditional for fruit growing system, which consists of continuous tillage to control weeds and maintain soil moisture. The soil is cultivated to a depth of 15 cm four or five times during the growing season. It is suitable for all terrains and ways of irrigation. Its main disadvantages are related to the preservation of soil fertility. With long-term irrigation and tillage, the soil structure is destroyed, the porosity and water available to plants are reduced, the soil is depleted of organic matter and highly dusty. The compacted soil cannot return to its original structural condition even after 30 years, and the cultivation of the tracks up to 0.4-0.45 m has no effect. The reduced water permeability caused by the degradation processes due to the long-term maintenance of the soil in black fallow is often found in orchards. The roots of the trees do not have access to the compacted soil volume under the tracks, as well as to the most nutrient-rich surface soil layer. Maintenance in black fallow requires special preparation of the soil surface before harvesting, especially if the production is harvested mechanically.

**Herbicide fallow** This technology is only applicable to fruit species with a crown located above the ground in the case of shrubby plantations. Weed control in plantations is carried out entirely through herbicide treatments. It greatly reduces the risk of soil compaction in depth. The roots have the opportunity to develop in the fertile surface soil layer; the effect of fertilization also increases. Harvesting is facilitated. Due to the loss of tillage, surface irrigation is possible only by flooding. For this purpose, however, the soil surface must be leveled before planting the trees. The use of herbicides is expensive. It is believed that after several years of application the weeds will be suppressed and the consumption of herbicides will decrease. However, some weed species may be replaced by others resistant to certain herbicides. Herbicides can adversely affect the biological activity of the soil. There is a risk of soil and water contamination. Absorption of water can be difficult due to compaction and crumbling of the soil surface. When it rains, the water drops further destroy the soil structure. The solar energy reflected from the bare soil surface increases the risk of burns.

**Perennial turf.** Sprinkler and micro-sprinkler systems can be used to maintain a durable turf of perennial grasses in between rows, which is an effective means of preserving soil fertility. The role of perennial grassing against wind and water erosion is undeniable. As they grow, grass roots convert hard-to-reach forms of phosphates and potassium into easily digestible ones. Decomposed cut grass and dead roots enrich the soil with organic matter. The physical, chemical and water properties of the soil, as well as their microbiological regime are improved. The root system of the trees covers evenly the active soil layer, including the most humus-rich surface layer 0-20 cm. In cultural grassing the roots in the row spacing are twice as many as in black fallow. The mulching layer dissipates solar energy and protects the soil surface from overheating. Under irrigation conditions, grassing is an effective means of protecting the soil from gradual degradation and compaction. The volume of additional turf water consumption varies from 6% to 50% of the irrigation rate, with higher values associated with sprinkling and lower values with micro-sprinkling.
In addition to additional water, the grass needs additional fertilization during grassing, at least in the first years after the creation of turf. When placing the sprinklers, the micro-sprinklers and the irrigation wings in the rows of the plantation, the control of the weeds in the row is carried out through the periodic treatments with herbicides. Mulching with soil on an artificial or textilic basis is sometimes used, which, in addition to suppressing weeds, allows water from rainfall and irrigation, but prevents evaporation from the soil surface. The row strip can also be kept free of weeds and cultivation to avoid competition with the plantation. For this purpose, its width must be in accordance with the type and age of the plantations. Perennial turf should not include grasses that are hosts for pests, diseases and nematodes cultivated species. The turf facilitates the mechanized collection of the production, especially in the rainy days inherent in the autumn. It is necessary to provide nitrogen fertilization for the grass, especially in the first years after sowing. Maintaining perennial turf reduces the yield and quality of the fruit, if it is not combined with an irrigation and fertilization system.

**Interrow crops.** They are grown in between rows of young plantations, where the crowns of the trees still cover a small part of the soil surface, and it must be kept free of weeds anyway. For this purpose, some annual forage grasses such as peas, soybeans, turnips, green rye and cereal-legume mixtures are recommended, which release the soil in the plantations early. It is allowed to grow beans, early potatoes, peanuts, watermelons, melons, pumpkins, mint, carrots, turnips, onions, garlic. According to some authors, it is absolutely unacceptable to grow wheat, rye, oats, corn, sunflower, poppy, sesame, rapeseed, tobacco, cotton, hemp, flax and other crops that would compete with trees for water and nutrients. However, in the countries and regions of modern agriculture shows that the cultivation of corn and cereals, and probably all the others, can be successful if the needs of both crops are met, which is not a problem with an irrigation system. Perennials can also be used to compact other perennials, such as walnuts, which bear fruit after several years. In the region of Grenoble, France, raspberries are used for this purpose, and in the Institute of Fruit Growing - Plovdiv, an experiment with peaches is being conducted and the results so far are positive. The limitations in the choice of inter-row or compaction culture come rather from the possibilities for combining cultural practices. For example, the preparations used for plant protection treatments of the main plantation may be contraindicated for the intermediate crop or the time of spraying may coincide with its harvesting period. In any case, leaving a clean line would restrict interspecific competition.

**Combined system for maintaining the soil surface**

There are options for maintaining the soil surface through several systems, for example the row to be ground and the rows to be treated, while the row can be covered or covered with black polyethylene foil or other materials, plant residues, waste from the woodworking industry and others. Inter-rows can be maintained with intermediate crops or with green manure crops, black or herbicide fallow. There are many variants of systems for maintaining the soil surface in perennials. This issue is complicated and complex and cannot be solved unequivocally, so many factors must be taken into account when deciding on the technique and technologies for maintaining the soil surface in perennials.

**Conclusions**

1. A significant part of agricultural production is obtained from perennial crops, they are a strategically and economically important branch of agriculture in Bulgaria.
2. In order to obtain quality production from perennials, it is necessary to maintain favorable conditions for the development of crops and this is achieved by maintaining the soil surface.
3. The maintenance of the soil surface in perennials is a complex problem for which there are many solutions, it is the subject of many studies and can not be solved unambiguously, it is necessary to take into account all the features of crops, cultivation technologies, natural and social factors and to choose a suitable system for maintaining the soil surface according to the specific conditions.
4. The size of agricultural holdings in Bulgaria shows the need for economically viable technologies and machines for tillage with high productivity suitable for most farmers.