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# RATIONAL METHODS OF SOILS MAINTENANCE IN ORCHARDS

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***Abstract***

*The study of different maintenance methods of sloppy soils used under orchards through their influence on the physical and chemical soils proprieties, with the purposes of assessing the state, should be completed taking into account the factors that determine their degree of stability. Not least should be monitored soil-plant relationship and the final product exposed through quality and quantity of fruit harvested on different types of soil maintenance. In order to propose the most optimal maintenance methods of sloppy soil in the fruit plantations and even maintaining and improving the soil physical parameters were monitored several methods of soil maintenance in the orchard. As witness served the arable soil, most often used in orchards in Moldova, other maintenance methods investigated that were used is soil maintained in the row: 1. Grassed; 2. under pellicle; 3. the use of herbicides; 4. Herbicides + mulching. The results obtained demonstrate that the improvement and maintenance of soil physical and chemical parameters and quality and quantity of harvested fruit corresponds to variant 1 and 2.*

***Key words****: sloppy soils, arable soil, orchards, soils proprieties, soil maintenance.*

## INTRODUCTION

Sustainable development of the Moldova's economy broadly is conditioned by the efficient use and protection of soil resources. The relatively favorable climatic conditions and high productivity potential of soils offer the possibility of consequential development of the different braches of agriculture. However sustainable development requires ecological balance, a particular report between natural and human ecosystems. Such equilibrium is extremely important in the steppe area, which is characterized by an almost permanent moisture deficit.

Resistance to drought of trees is high enough in comparison with other agricultural plants.

The influence of soil water and air reduces the growth of shoots and leaves, amount and fruit quality, slows differentiation of fruit bud. As consequences only periodically fructifies and premature aging.

Soil work for a long time in orchards contribute to the worsening of the soil physical characteristics which ultimately influences negatively on growth and fruitfulness of fruit trees. Harvest losses due to the degradation of the soil physical properties through its compaction, is equal to increases in production due to irrigation and almost equal to those obtained from the use of fertilizers.

## MATERIALS AND METHODS

The research aimed to highlight changes of agrophysics soil characteristics of orchards in bearing on long term and proposing new soil maintenance methods that does not lead to its degradation: the control variant for all the experiences has served black field maintained clean of weeds by mechanical works between the rows and manual hoeing in rows. Depending on the moisture conditions and soil state were used a disc harrow, cutter or grower. There have been carried out 4-5 works during the period of the vegetation, as needed. The experience included 4 versions: 1. Temporary revegetation with perennial grasses, 2. Polyethylene foil, 3. Herbicidal-mulch, 4. Herbicides on the strip along the row width of 1.0 m. Alternation in time and space of these methods minimizes the expenses and ensure environmental protection.

Research was conducted in plum trees plantations 5 years, on the typical chernozems weakly humus, silty sloppy, which belongs to pedological-geographic district Forest Hills Codri. In order to characterize the soil cover and development status of the trees and harvest on the experimental polygons were placed main profiles from which samples were collected on the genetic horizons and corresponding measure of the vegetable development and harvest.

## RESULTS AND DISCUSSIONS

Settlement state of soil is generally determined by bulk density, which substantially influences the growth process and development of agricultural crops, whereas its values depend on aeration and hydric regimes, and various chemical and microbiological processes. The porosity depends on the capacity to retain water, the permeability and aeration. For its part it depends on the texture, structure and bulk density. In the moderate loosened soils the properties of the total porosity component are favorable, simultaneously, ensuring better condition for water retention accessible to plants, aeration and rapid movement of the water excess.

The compacted soils, except of certain coarse textures, the ratio of total porosity components is often less favorable (Canarache, 1990).

In the founding processes of industrial plantations for vineyards and orchards is performed soil stripping (deep plowing depth 50-60 cm). As a result the stripping disturbs the natural order of genetic horizons and brings to the terrestrial surface the soil underlying horizons with weak humus and high carbonate content. This leads to degradation of fertility layer 0-30 cm of the sloppy soil, the processes extremely pronounced in the case of stripping the soil moderately and strongly eroded (Ursu, 2000).

Every year is required to study the sloppy soils which form a group of anthropogenic soils. Therefore, we should be careful at the physical characteristics, for on time to detect the changes taking place in the soil as a results of the work.

In fruit growing space of arable layer and in 20-30 cm layer occur differentiations of total porosity parameters according to the increase of bulk density.

The data obtained (Table 1) show that the upper layers of soil (0-20 cm and 20-30 cm), as in the witness and in the four variants of soil maintenance bulk density parameters varies which indicates that conditions of soil maintenance in the orchards influencing bulk density parameters: in the case of witness where the soil is maintained as a black field at 20-40 cm is highlighted an increase in bulk density in comparison with 0-20 cm layer, reaching values form 1.46-1.49 g/cm$^3$, corresponding also in case of the variant with herbicides from 1.51-1.53 g/cm$^3$. These values characterize the typical chernozem silty as weak compacted soil.

At the grassy variant covered with polyethylene foil and herbicide mulch, this compaction is not particularly highlighted, for bulk density parameters corresponding values varies from 1.24-1.34 g/cm$^3$, characterizing the soil as moderate weak loosened.

The porosity depends on the capacity to retain water, the permeability, aeration. In its turn it depends on the texture, structure and bulk density. In the soils moderate loose the properties of total porosity components are favorable, simultaneously providing better water retention conditions accessible to the plants, aeration and the rapid movement of water excess. In compacted he soil with the exception of coarse texture, the ratio of total porosity components it is often less favorable. In the fruit growing space of 0-20 cm layer on the surface and in the 20-30 cm occur a differentiation of total porosity values corresponding to the increase of bulk density. The total porosity of 0-10 cm layer at witness is 52%, corresponding to the herbicide variant what characterize it a good and low porosity in the 20-40 cm layer. The other variants are characterized with good porosity. Characterizing the soil structure (Table 2) of the variants with different forms of maintenance of the orchards: is observed presence of moderately lumping, in the witness and the variant with herbicide at maintained covered by grass soil and in the polyethylene foil, and herbicides and the mulch variants soil is characterized by small lumps. The amount of meso-aggregates (10-25) also named as the

agronomical valuable aggregates have the highest weight at variant where soil is maintained covered by grass, herbicide-mulch variant and under polyethylene foil.

Table 1. Bulk density and total porosity

| Variant | Depth (cm) | Bulk density ($g/cm^3$) | Total porosity (%) |
|---|---|---|---|
| Witness | 0-10 | 1.25 | 52 |
| | 10-20 | 1.49 | 46 |
| | 20-30 | 1.46 | 47 |
| | 30-40 | 1.41 | 48 |
| Temporary revegetation | 0-10 | 1.36 | 49 |
| | 10-20 | 1.26 | 52 |
| | 20-30 | 1.24 | 53 |
| | 30-40 | 1.31 | 51 |
| Polyethylene foil | 0-10 | 1.19 | 56 |
| | 10-20 | 1.31 | 51 |
| | 20-30 | 1.32 | 51 |
| | 30-40 | 1.26 | 53 |
| Herbicidal-mulch | 0-10 | 1.09 | 59 |
| | 10-20 | 1.27 | 52 |
| | 20-30 | 1.34 | 50 |
| | 30-40 | 1.27 | 53 |
| Herbicide | 0-10 | 1.31 | 51 |
| | 10-20 | 1.30 | 52 |
| | 20-30 | 1.51 | 44 |
| | 30-40 | 1.53 | 43 |

An appreciation of the structure and the amount of hydrostable aggregates with a diameter >0.25 which characterize a good structure in the case when containing more than 40%, what is observed at soil and in the variants: covered by grass, herbicides-mulch and in the polyethylene foil. In conclusion it can be stated that the soil in variants: covered by grass, herbicides-mulch and under polyethylene foil have a tendency for the rehabilitation of structure of the upper part of sloppy layer.

From the data presented (Table 3) is observed that the content of all nutrients is higher in the 0-20 cm layer and 20-40 cm. In the 0-60 cm layer is observed that soil maintenance methods in the strip across the row of trees not negatively influenced on the nutrition trees with nitrogen, except for covered version with polyethylene foil, where is observed insignificant decrease. High nitrogen content is highlighted in herbicides variants and vegetable mulch. Concerning the phosphorus content is not observed essential decrease and its quantity is within the optimal limits.

The content of potassium in the soil has increased in revegetation and herbicides-mulch variants, namely there were processed cutting the grass and mulching with vegetable mass (weeds), which affected both the mobilization of potassium as well as the increasing content in the soil of it, ranging from 2.9-1.7 mg.

The analysis of data presented (Table 4) revealed that witness variant where weed control took place through mechanical work and in herbicides variant were applied systemic herbicides in the layer 0-60 cm soil moisture is lower than the witness variant, polyethylene foil and herbicides-mulch.

The quantity of moisture in the case of temporary grassing, polyethylene foil and herbicides-mulch is higher, respectively 0.47, 1.18 and 1.14%. At these variants the soil was into different measures covered which allowed minimizing water evaporation from the soil. In the case of the soil cover, the soil moisture is 1.8% higher and variable in herbicides-mulch 1.14% due to organic mulch layer from the surface. Temporary grassing retains moisture in the soil with 0.47% higher than at the witness.

Table 2. Structure (*dry sieving, **wet sieving)

| Variant | Depth (cm) | The aggregates diameter (cm) | | |
|---|---|---|---|---|
| | | >10 | 10-0.25 | < 0.25 |
| Witness | 0-10 | *39.60 | 52.70 | 7.70 |
| | | **- | 39.29 | 60.74 |
| | 10-20 | 31.40 | 61.60 | 7.00 |
| | | - | 36.06 | 63.94 |
| | 20-30 | 30.50 | 65.70 | 3.80 |
| | | - | 43.51 | 56.49 |
| | 30-40 | 36.60 | 61.50 | 2.00 |
| | | - | 55.21 | 45.85 |
| Temporary revegetation | 0-10 | 30.10 | 65.00 | 4.90 |
| | | - | 48.80 | 51.20 |
| | 10-20 | 20.40 | 71.50 | 8.10 |
| | | | 43.17 | 56.83 |
| | 20-30 | 28.20 | 65.90 | 5.90 |
| | | - | 49.64 | 50.36 |
| | 30-40 | 26.60 | 68.20 | 5.20 |
| | | - | 45.02 | 64.29 |
| Polyethylene foil | 0-10 | 30.60 | 55.40 | 14.00 |
| | | - | 38.25 | 61.75 |
| | 10-20 | 30.80 | 65.00 | 4.20 |
| | | - | 44.54 | 55.46 |
| | 20-30 | 25.90 | 67.30 | 6.80 |
| | | - | 48.03 | 51.97 |
| | 30-40 | 23.00 | 73.40 | 3.60 |
| | | - | 54.97 | 45.03 |
| Herbicidal-mulch | 0-10 | 18.00 | 70.60 | 24.40 |
| | | - | 48.32 | 51.68 |
| | 10-20 | 16.60 | 74.80 | 8.60 |
| | | - | 44.54 | 55.46 |
| | 20-30 | 23.80 | 70.80 | 5.40 |
| | | - | 48.03 | 51.97 |
| | 30-40 | 30.20 | 66.10 | 3.70 |
| | | - | 55.00 | 45.03 |
| Herbicide | 0-10 | 38.90 | 52.50 | 8.60 |
| | | - | 18.80 | 81.20 |
| | 10-20 | 30.50 | 64.70 | 4.50 |
| | | - | 33.17 | 66.83 |
| | 20-30 | 34.40 | 62.30 | 3.30 |
| | | - | 39.64 | 60.36 |
| | 30-40 | 30.80 | 66.00 | 4.20 |
| | | - | 45.02 | 54.98 |

Table 3. Action of maintenance methods of the soil on the content of nitrogen, phosphorus and potassium in the soil layer (mg/100 g dry soil)

| Depth (cm) / Variant | Witness (black field) | Temporary grassing | Polyethylene foil | Herbicide-mulch | Herbicide |
|---|---|---|---|---|---|
| Nitrogen content ($NO_3$) | | | | | |
| 0-20 | 2.36 | 1.96 | 2.11 | 1.89 | 2.17 |
| 20-40 | 1.87 | 2.28 | 1.85 | 2.00 | 1.92 |
| 40-60 | 0.68 | 0.78 | 0.84 | 0.97 | 0.81 |
| 0-60 | 1.97 | 1.67 | 1.60 | 1.98 | 1.66 |
| Phosphorus ($P_2O_5$) | | | | | |
| 0-20 | 2.13 | 2.66 | 1.98 | 2.42 | 2.01 |
| 20-40 | 1.32 | 1.44 | 1.39 | 1.28 | 1.47 |
| 40-60 | 0.68 | 0.67 | 0.58 | 0.66 | 0.61 |
| 0-60 | 1.38 | 1.59 | 1.32 | 1.46 | 1.36 |
| Potassium ($K_2O$) | | | | | |
| 0-20 | 24.3 | 26.9 | 25.4 | 22.6 | 24.7 |
| 20-40 | 20.7 | 25.7 | 23.9 | 23.4 | 21.2 |
| 40-60 | 17.5 | 18.1 | 18.0 | 17.1 | 17.9 |
| 0-60 | 20.7 | 23.6 | 22.4 | 20.0 | 21.3 |

Table 4. Dynamics of soil moisture at different maintenance methods (%)

| Depth (cm) / Variant | Witness (black field) | Temporary grassing | Polyethylene foil | Herbicide-mulch | Herbicide |
|---|---|---|---|---|---|
| 0-20 | 19.36 | 19.26 | 20.14 | 19.81 | 19.54 |
| 20-40 | 20.49 | 20.27 | 20.40 | 21.44 | 19.69 |
| 40-60 | 15.93 | 17.11 | 18.91 | 17.,90 | 16.41 |
| 60-80 | 15.12 | 16.14 | 16.17 | 16.31 | 15.49 |
| Mean 0-80 cm | 17.72 | 18.19 | 18.90 | 18.86 | 17.78 |
| Difference compared to the witness | 0 | +0.47 | +1.18 | +1.14 | +0.06 |

The versions studied demonstrate (Tables 5 and 6) that they have not acted significantly on the average fruit weight and production at a tree and per hectare is higher in variants with polyethylene 26.5% and herbicides-mulch 28%, which proves the fact that in these variants the soil moisture remained stable over a longer period.

Table 5. Average mass of the fruit and prune production

| Variant / Year | Number of fruit per tree (piece) | Average mass of a fruit (g) | Harvest | | % to witness |
|---|---|---|---|---|---|
| | | | At a tree (kg) | t/ha | |
| *2013* | | | | | |
| Witness (black field) | 345 | 43.0 | 17.0 | 11.3 | 100 |
| Temporary grassing | 385 | 44.8 | 17.5 | 11.7 | 103 |
| Polyethylene foil | 450 | 43.7 | 18.5 | 12.3 | 109 |
| Herbicide | 358 | 42.5 | 18.0 | 12.0 | 106 |
| Herbicide-mulch | 400 | 44 | 20.0 | 13.3 | 118 |
| *2014* | | | | | |
| Witness (black field) | 218 | 46.9 | 10.2 | 6.8 | 100 |
| Temporary grassing | 261 | 46.4 | 12.1 | 8.1 | 119 |
| Polyethylene foil | 292 | 50.2 | 14.7 | 9.8 | 144 |
| Herbicide | 268 | 45.0 | 12.1 | 8.1 | 119 |
| Herbicide-mulch | 222 | 42.4 | 12.0 | 9.4 | 138 |

Table 6. Average mass of the fruit and prune production (average years 2013-2014)

| Variant | Number of fruit per tree (piece) | Average mass of a fruit (g) | Harvest | | % to witness |
|---|---|---|---|---|---|
| | | | At a tree (kg) | t/ha | |
| Witness (black field) | 281 | 44.8 | 13.6 | 9.05 | 100 |
| Temporary grassing | 323 | 45.1 | 14.8 | 9.9 | 111 |
| Polyethylene foil | 371 | 46.9 | 16.6 | 11.05 | 126.5 |
| Herbicide | 313 | 43.7 | 15.0 | 10.05 | 112.5 |
| Herbicide-mulch | 311 | 43.2 | 16.0 | 11.35 | 128 |

## CONCLUSIONS

By using various maintenance methods of sloppy soil from orchards aimed to stop the degradation of physical and chemical parameters. It can be stated: sloppy soils are subjected easily to compaction and degradation of physical parameters (structure degradation, compaction, reducing porosity and permeability); revegetation is one of the best maintenance methods in terms of physical rehabilitation of sloppy soil; the use of pellicle in row solves the problem of moisture; soil cover in the strips across the row of trees with polyethylene foil and herbicide-mulch with phytomass resulting from mowing grass in the intervals between rows demonstrates the positive results in many aspects (moisture, food and production); in no versions have been observed any depressive aspect of trees. It has

been found that during the years 2013-2014 average production is higher in versions with polyethylene and herbicidal mulching (26.5-28%).

Temporary grassing and herbicides versions occupy an average position between witness and mulching versions.

In order to rehabilitate and maintain the optimal physical properties of the soil, and increasing the physiological state of the fruit trees, as well to maintain soil from orchards are needed temporary alternative methods: covering by grass, polyethylene and herbicides-mulching.

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