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REDUCING TECHNOGENIC IMPACT ON THE SOIL BY USING SMALL-SIZED TRACTORS

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ABSTRACT: The article covers the results of the increase in soil density because of the technogenic impact of agricultural machinery on the soil. Soil compaction in soil layers leads to soil degradation, resulting in reduced crop yield in the Central Asian region. In addition, the article provides recommendations on using electric tractors with small rubber tracks as one of the ways to reduce the factors affecting the soil

Keywords: Agricultural machinery, soil degradation, soil density, soil, air and heat mode, soil erosion, soil hardness, rubber crawler, small-sized electric tractor

1. INTRODUCTION

At present, the problem of soil degradation (destruction of the structure of the fertile soil layer, reduction of productivity) in agriculture is the cause of many discussions by the agricultural experts of the world. Along with the intensive development of this sector, the increase in the types and weight of agricultural machines is one of the factors of soil degradation. At the same time, failure of irrigation and drainage systems, failure to implement crop rotation is also a reason of soil degradation. A decrease in soil fertility may pose a serious threat to ecology and plants in the next 20-30 years. [1].

Soil density is a particularly important characteristic, it includes a complex of agrophysical factors such as water permeability, air and heat mode, which embody the conditions of biological activity of plants. According to research analysis, soil compaction leads to obstruction of water and air supply and complete closure of soil capillaries [1].

The importance of soil density is very large and versatile. The choice of soil tillage methods and, as a result, the selection of equipment for creating the horizon of the cultivated arable land subsoil is mainly determined by the density of the soil, the requirements of the cultivated crops and the possibilities of using the appropriate complex of soil cultivation methods.

2. LITERATURE REVIEW

The water-air mode and the biological activity of the soil and, as a result, the conditions for the growth and development of cultivated crops depend on the structure (soft or dense) of the soil.

I.B. Revut [2] points out two typical cases of soil compaction:

1. The soil consists of primary elementary mechanical particles, and if the pores are only between these particles, the density of the soil can reach 18 ... 20 kN/m^3, and the porosity reaches almost 26% of the entire volume of the soil. This density is observed in salt marsh, as well as in gel layers with gel soils and in some desiccated horizons.

2. If the soil consists of macroaggregates, then pores appear between primary particles and macroaggregates between microaggregates. Then the density is the lowest (1.1 ... 1.3 g/cm^3), and the porosity is high, up to 60% of the total volume.

In natural conditions, in addition to the listed cases of compaction, any softened soil is known to self-compact under the influence of gravity, precipitation, animals, people, the impact of tools and machines, drying and other factors.

Crop care requires 8 to 25 operations: plowing, leveling, harrowing, chiseling, threshing, planting, post-planting work, applying organic and mineral fertilizers, harvesting, etc.

In the research conducted by Haynes, a general study of soil degradation processes was carried out, in which the process of mineralization was mentioned [3]:

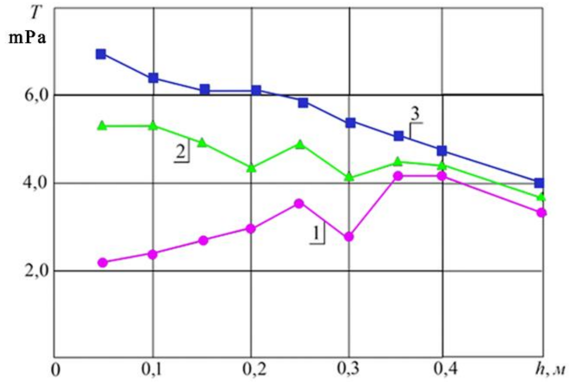

Fig. 1.1. Changes in the hardness of the soil after the passage of the MTZ-80X tractor

1- control; 2- 5 passes; 3- 8 passes

With 8 passes of these tractors, compaction reaches a depth of 0.5 m and more. In the next case, the density in the 0.20 ... 0.40 m layer was 16.0 ... 17.8 kN/m3 (Fig. 1.2). In the place that was overturned eight times by tractors, despite the soil being plowed, a high density (14 ... 14.5 kN/m3) was maintained in the 0.10 ... 0.30 m layer the following year. The smallest soil density is obtained with the passage of the T-4A tractor, and the largest is for the T-28x4 row tractor. As soil density increases, cotton yield naturally decreases (Fig. 1.2).

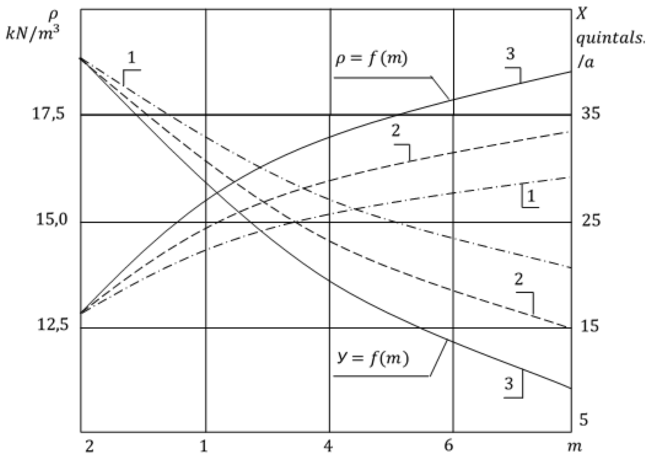

Fig. 1.2. Impact of the number of passes of tractor on soil density (ρ) and cotton yield (x)

1 – T-4A; 2 – MTZ-80x; 3-T-28x4

According to the data on changes in soil density before cultivation [5], it can be seen that soil density increases intensively both in cultivated areas and in subsoil horizons.

Moreover, shallow plowing the soil at a depth of 0.3 m each year led to the formation of a dense layer, which was called "plow bottom" and spread to a depth of 0.4 ... 0.45 m.

Compacted subsoil has a negative effect on the growth of plants and the yield of raw cotton. At the same time, it is very difficult for water to penetrate into the underground layer, so the moisture reserves in the soil are reduced, the air exchange in it worsens, and in general, the nutrition of cotton deteriorates and the yield decreases [6, 7].

Research of A.R. Normirzaev [8, 9] showed that during pre-planting treatment with a Magnum-8940 wheeled tractor, the density of the first layer of soil at 0-10 cm was 1.485 g/cm^3, and the density of the second soil layer at 10-20 cm was 1.571 g/cm^3, the third soil layer was 1.515 g/cm^3 at 20-30 cm. In research of Sh. Salomov it was observed that the soil density and soil hardness in all layers obtained from the tracks of the T-4A tractor are lower than those of the wheeled Magnum-8940 tractor, and the decrease in the average soil density of 0.096-0.069 g/cm3, and the soil hardness of 1.14-0.25 MPa was observed. The density and hardness of the soil in the driving pen (30-40 and 40-50 cm) was slightly reduced when it was treated with a T-4A tractor with a wheeled Magnum-8940 [9].

In addition, it was determined that the yield in the fields treated with the T-4A tractor was 4.9 quintal/ha more than in the areas treated with the Magnum-8940 tractor [10].

The weight of the Magnum-8940 wheeled tractor is 5-8 tons. When leveling irrigated lands, leveling with a 2-3-pass tractor will increase the density of the soil, especially in the cultivated fields of Bukhara and Kashkadarya regions, where the soil layer is gypsum.

When performing technological processes, the machine does not meet the requirements when taking into account soil compaction on the surfaces pressed by the wheels of the tractor aggregates.

In the upper layer of the soil, compaction under the tracks of the machine-tractor unit is kept up to 0.12 m, which in turn leads to the inability of cultivators to work at the specified depth, to decrease the planting depth in grain planters by up to 48%. The compaction formed in the soil increases the resistance to the traction force in the working bodies of the soil-cultivating machine-tractor aggregates, the quality of harvesting works decreases, the soil structure is disturbed, which in turn has a negative effect on the productivity of grain crops.

By maintaining the top layer of the soil at the standard level, the volumetric weight of machine-tractor aggregates (levelers) to the soil is reduced by 2…3 times, water consumption in irrigation by 30%, labor, energy, and metal costs by 1.4...1.6 times.

It is known that in the leveling of cultivated fields, various land reclamation and road construction machines working according to different pressure and production schemes are used. In addition, these works are carried out in different soil and weather conditions. In the process of land leveling, compaction occurs regardless of the initial state of the soil [11]. Piunovsky B.A. and Samsonova N. P. (1951) determined that during the leveling processes of black-chestnut soils with high moisture content, the volumetric weight of the soil increases by 1.1-1.2 times.

Amounts of permissible pressure of the agricultural machine on the soil are determined according to GOST 26955-86, GOST 26953-86, GOST 26954-86 [12; p. 22]

In the research conducted by J.S. Hewitt and A.R. Dexter, it is shown that it is one of the factors that cause the formation of soil erosion when processing different agricultural machines with different aggregates [15].

In agriculture, one of the factors to reduce the technogenic impact of the equipment on the soil is the widespread use of small-sized tractors. Cultivated areas in a large part of Bukhara and Navoi regions consist of small contours. It is feasible to use small tractors in these fields. small-sized tractors have very little effect on soil density in the 5-10 cm, 10-20 cm and 20 cm layers of the soil layer [12, 13, 14]. The weight of the small-sized gardening tractor, developed by the engineers of the Bukhara Engineering-Technological Institute, is 580 kg. Compared to wheeled tractors, crawler tractors exert less pressure on the soil.

In our researches, since the running part of the small-sized tractor is wheeled with rubber tracks, the impact of the tire pressure on the soil and the soil density was studied.

Since the increase of internal air pressure leads to an increase of its pressure on the soil, and because of the possibility of directly adjusting the air pressure in it, we will consider its effect on the density of the soil in the tracks. To do this, we can express the depth of the *h*-track by the density of the soil in the wheel tracks [16]:

$$h = N_1\left(1 - \frac{\rho_0}{\rho}\right), \qquad (1)$$

where N_1 is the propagation depth of soil deformation, N_1=0.35 m (experiments revealed the effect up to a depth of 35 cm); ρo is the density of the soil before turning the wheel, g/cm^3 (ρo=1.24 g/cm^3); ρ is the density of the soil after passing the wheel, g/cm^3.

We solve expression (1) with respect to ρ. Then the expression has a form:

$$\rho = \frac{\rho_0 N_1}{N_1 - h}, \qquad (2)$$

As can be seen from the graphs in Fig. 1.3, the increase in the width of the tract of the rubber track led to a decrease in the density of the soil due to a decrease in the pressure exerted on the soil.

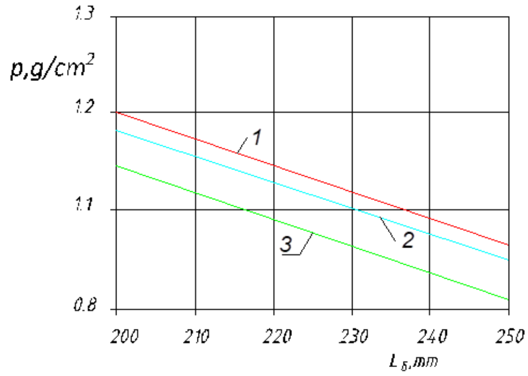

Fig. 1.3. the dependence of the width of the tract of rubber track on the density of the soil.

When this agricultural machine tilled the soil, the average density of the soil was 0.048-0.051 g/cm^3, and the hardness of the soil was 1.02-0.21 MPa. In this case, six wheels on three axles and rubber track chains installed on them lead to an even distribution of pressure on the soil (Fig. 1.4).

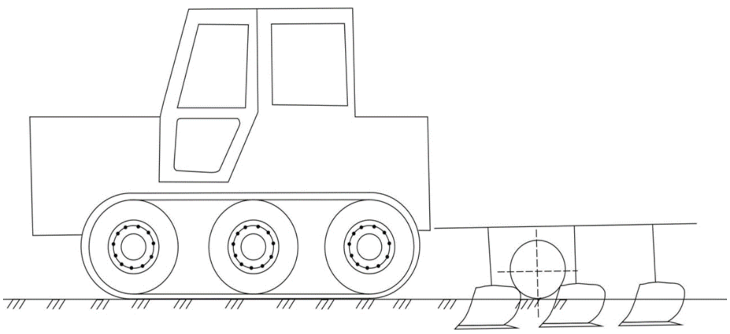

Fig. 1.4. Schematic view of a small-sized electric tractor

4. CONCLUSION

Most of the existing agricultural tractors are equipped with an internal combustion engine, and the construction consists of heavy frames. This, in turn, causes the machine to become heavier and the pressure acting on the soil to increase. It works on a small-sized electric tractor that is powered by a battery. The mass of the electric motor installed on the tractor is 80 kg. This is the main factor in reducing the total mass of the tractor and reducing the pressure applied to the soil. In addition, the conversion of these tractors to the type with rubber tracks leads to a decrease in the density of the soil in layers. This, in turn, leads to the optimization of the air-water mode for soil fertility.

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