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INFLUENCE OF MECHANISATION AND FERTILISATION ON SOIL DENSITY AT THE DIDACTIC STATION IN TIMIȘOARA, ROMANIA

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***Abstract**. The granulometric structure of the cambic chernozem in the apple tree intensive system plantation at the Didactic Station of Timişoara, Timis County, Romania, did not change significantly in the two experimental years (2014-2015) because of chemical (N, P, K) and natural (animal manure) fertilisation (applied in the fall of 2013). Between fruit tree rows, soil density changed very much compared to soil density per fruit tree row because of the setting of the soil caused by the repeated passage of maintenance and harvesting machines. Between fruit tree rows, soil apparent density was significantly higher than that on fruit tree rows. The lowest values of soil density in the two experimental years were in the variant fertilised with animal manure both per fruit tree rows and between fruit tree rows 0-20 cm deep; the highest values were in the variant* $N_{150}P_{100}K_{50}$ *on both fruit tree rows and between fruit tree rows 40-60 cm deep, but thee values did not change much compared to the control variant. The lowest values of apparent density were in the variant fertilised with animal manure, and the highest values were in the variant* $N_{100}P_{50}K_{20}$ *in both experimental years. Apparent density increases very much because of agricultural machines.*

Keywords: *physical propertie, density and bulk density, physical and chemical.*

INTRODUCTION

The plantation is located in northern Timişoara; it covers 15.43 ha, of which 7 ha are cultivated with fruit trees and 7 ha are cultivated with grapevine, while the rest of 1.43 ha are access roads and buildings. Though it is a didactic plantation, it could be considered profitable because it is close to Timişoara, which provides the opportunity of selling all its produce on the market at low costs.

The goal of this study was to identify soil types and soil physical features of the Didactic Station of Timișoara, Timiș County, Romania.

The goals of this study were mainly to characterise the studied area from the point of view of natural conditions, and to determine soil physical features (density and apparent density).

MATERIAL AND METHOD

Soil samples necessary to determine soil density were sampled 0-20 cm deep, 20-40 cm deep and 40-60 cm deep on both fruit tree rows and between fruit tree rows in both experimental years (2014-2015): most apple tree roots were found to have reached 60 m deep into the soil.

We monitored the changes in soil density after applying mineral and organic fertilisers at different rates on both fruit tree rows and between fruit tree rows and at different depths as shown in Tables 1 and 2 and in Figures 1 and 2 below.

Apparent density of the cambic chernozem in the apple tree plantation at the Didactic Station of Timişoara had different values depending on the mineral and organic fertiliser rates applied, on soil depth, and on position (per fruit tree row or between fruit tree rows).

The machines used to spread animal manure are made up of a bin with 2 or 4 wheels, a carrier with knives at the bottom of the bin, and spreading organs (drums with pallets or fingers, or horizontal or vertical worm screws) and working mechanisms on the sides.

The necessary flow depending on the nitrogen fertiliser rate per ha is determined with the formula:

$$q = B_e \text{ x } v_e \text{ x } N/10^4 (kg/s)$$

where:

B_e – machine working width (m);

v_e – machine working speed (m/s);

N – fertiliser rate (kg/ha).

Transport is regulated through pawl or worm screw mechanisms allowing speeds between 3 and 90 mm/s.

Because the spreading organs (drums or worm screws) are operated from the power socket of the tractor, it should be kept at nominal speed, i.e. the tractor speed can only be changed if we change the speed. The fertilising aggregate moves in the shuttle manner. To prevent damaging PTO couplings, the aggregate direction should be changed at low speed and without coupling.

RESULTS AND DISCUSSION

Soil was sampled before and after the passage of the fertilising machines to see the differences in density.

Table 1.

Influence of fertilisers on soil density per fruit tree row in the intensive system (g/cm^3)

Year	Depth (cm)	Factor B						Mean (g/cm^3)	Difference (g/cm^3)
		$N_0P_0K_0$	$N_{70}P_{30}K_0$	$N_{100}P_{50}K_{20}$	$N_{150}P_{100}K_{50}$	g.g.	g.g. + $N_{50}P_{30}K_{10}$		
2014	0-20	2.47	2.47	2.48	2.50	2.32	2.34	2.43	-0.04
	20-40	2.54	2.54	2.55	2.57	2.43	2.44	2.51	-0.03
	40-60	2.68	2.68	2.69	2.70	2.65	2.65	2.67	-0.01
2015	0-20	2.48	2.48	2.49	2.52	2.34	2.35	2.44	-0.04
	20-40	2.54	2.54	2.56	2.58	2.44	2.46	2.52	-0.02
	40-60	2.68	2.68	2.69	2.71	2.66	2.66	2.68	-

Table 2.

Influence of fertilisers on soil density between fruit tree rows in the intensive system (g/cm^3)

Year	Depth (cm)	Factor B						Mean (g/cm^3)	Difference (g/cm^3)
		$N_0P_0K_0$	$N_{70}P_{30}K_0$	$N_{100}P_{50}K_{20}$	$N_{150}P_{100}K_{50}$	g.g.	g.g. + $N_{50}P_{30}K_{10}$		
2014	0-20	2.52	2.52	2.53	2.55	2.41	2.43	2.49	-0.03
	20-40	2.57	2.57	2.58	2.60	2.46	2.50	2.54	-0.03
	40-60	2.68	2.68	2.69	2.71	2.66	2.67	2.68	-
2015	0-20	2.53	2.54	2.55	2.57	2.43	2.45	2.51	-0.02
	20-40	2.58	2.58	2.59	2.61	2.48	2.51	2.55	-0.03
	40-60	2.69	2.69	2.70	2.72	2.67	2.67	2.69	-

The values of soil density oscillated between 2.32 g/cm^3 and 2.71 g/cm^3 *per fruit tree row* and between 2.41 g/cm^3 and 2.72 g/cm^3 *between fruit tree rows*.

Per fruit tree row, compared to the interval between fruit tree rows, 0-20 cm deep, soil density was lower, 2.32 g/cm^3, when fertilising with animal manure, and higher than 2.53 g/cm^3, when fertilising with higher rates of mineral fertilisers, compared to 2.48 g/cm^3 in the control variant, with a mean of 2.43-2.45 g/cm^3.

In 2014, soil density *0-20 cm deep* was 2.32 g/cm^3 when fertilising with animal manure (b_4) and 2.50 g/cm^3 with mineral fertilisation with higher rates of NPK, compared to 2.47 g/cm^3 of the control variant (b_0); *20-40 cm deep*, soil density was 2.43 g/cm^3 in the variant b_5 and 2.57 g/cm^3 in the variant b_3, compared to 2.54 g/cm^3 in the control variant, and variant b_2, with a mean of 2.51 g/cm^3; *40-60 cm deep*, there was a slighter change of soil density depending on fertilisers, i.e. 2.65 g/cm^3 in the variants b_4 and b_5, 2.70 g/cm^3 in the variant b_3, compared to 2.68 g/cm^3 in the variants b_0 and b_1, with a mean of 2.67 g/cm^3.

In 2015, soil density *0-20 cm deep* was 2.34 g/cm^3 in the variant b_4 and 2.52 g/cm^3 in the variant b_3, compared to 2.48 g/cm^3 in the variants b_0 and b_1, with a mean of 2.44 g/ cm^3; *20-40 cm deep*, the values of soil density were 2.44 g/cm^3 in the variant b_4 and 2.58 g/cm^3 in the variant b_3, compared to 2.54 g/cm^3 in the variants b_0 and b_1, with a mean of 2.52 g/cm^3; *40-60 cm deep*, the values of soil density ranged between 2.66 g/cm^3 in the variants b_4 and b_5, 2.71 g/cm^3 in the variant b_3, compared to 2.68 g/cm^3 in the variants b_0 and b_1, with a mean of 2.68 g/cm^3.

Between fruit tree rows, soil density changed very much compared to that per fruit tree row because of the stronger setting of the soil caused by the passage of agricultural machines (maintenance and harvesting): the lowest value, 2.41 g/cm^3, was in the variant b_4, 0-20 cm deep; the highest value, 2.72 g/cm^3, was in the variant b_3, 40-60 cm deep.

In 2014, soil density *0-20 cm deep* was 2.41 g/cm^3 in the variant b_4 and 2.55 g/cm^3 in the variant b_3, compared to 2.52 g/cm^3 in the variant b_0, with a mean of 2.49 g/cm^3; *20-40 cm deep*, soil density was 2.46 g/cm^3 in the variant b_5 and 2.60 g/cm^3 in the variant b_3, compared to 2.57 g/cm^3 in the variants b_0 and b_1, with a mean of 2.54 g/cm^3; *40-60 cm deep*, there was a lower change of soil density depending on fertiliser: 2.66 g/cm^3 in the variant b_4 and 2.71

g/cm^3 in the variant b_3, compared to 2.68 g/cm^3 in the variants b_0 and b_1, with a mean of 2.68 g/cm^3.

In 2015, soil density *0-20 cm deep* was 2.43 g/cm^3 in the variant b_4 and 2.57 g/cm^3 in the variant b_3, compared to 2.53 g/cm^3 in the variant b_0, with a mean of 2.51 g/cm^3; *20-40 cm deep*, the values of soil density were 2.48 g/cm^3 in the variant b_4 and 2.61 g/cm^3 in the variant b_3, compared to 2.58 g/cm^3 in the variants b_0 and b_1, with a mean of 2.55 g/cm^3; *40-60 cm deep*, the values of soil density ranged between 2.67 g/cm^3 in the variants b_4 and b_5 and 2.72 g/cm^3 in the variant b_3, compared to 2.69 g/cm^3 in the variants b_0 and b_1, with a mean of 2.69 g/cm^3.

CONCLUSIONS

Soil density had different values depending on depth, fertiliser rate, fertiliser type (mineral or organic), and location (per fruit tree row or between fruit tree rows), with values ranging between 2.32 and 2.70 g/cm^3 in the intensive system, and between 2.34 and 2.70 g/cm^3 in the super-intensive system per fruit tree row, and between 2.41 and 2.72 g/cm^3 in the intensive system and between 2.44 and 2.71 g/cm^3 in the super-intensive system, between fruit tree rows. The lower values were when fertilising with animal manure 0-20 cm deep, while the higher values were in the variant with mineral fertilisers 40-60 cm deep. The lowest values were per fruit tree row and the highest values were between fruit tree rows.

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