THE EXAMINATION OF PENETRATION VALUES FOR LOAMY SOILS, AND THEIR CONVERSION INTO AN IDENTICAL HUMIDTY LEVEL

István Szőllősi Ph.D
College of Nyíregyháza, Faculty of Engineering and Agriculture,
College of Nyíregyháza 4400 Sóstói út 31/b.

Abstract: *Soil resistance is measured by penetrometer, which is one of the commonest ways of examining changes in the physical state of the soil in space and time, the position of the compacted soil layers. However, examining the effect of cultivation we conclude from the soil resistance into soil compactness, it is indispentable to know the humidity values of the soil. In Hungarian practice comparing various treatment, the nearly equal soil humidity values are compared, therefore a part of values is lost for evaluation. A new method to overcome this problem was invented, when the soil resistance values at various soil humidity are converted into the ones at identical humidity values.*

1. INTRODUCTION

Changes affected by soil compactness can be traced by examining soil quality changes. The test range from the soil structure effect, its mechanical composition, mass volume, resistance, porosity, humidity content to permeability. The above mentioned soil criteria were measured on location, or laboratories.

According to a FREITAG assessment by measuring the soil mass volume, soil compactness can be determined. Measuring soil compactness by penetrometer is a common way of examining soil compactness and changes in the physical state of soil in space and time (3). A number of researchers found, that measuring soil resistance by penetrometer is much more sensitive, than measuring the soil mass volume (1, 12, 13, 14).

A similar statement was made by VOORHEES when examining the effect of tractor tyres on the soil, he found, that the mass volume of the soil increased by 20% while the penetration resistance grew by 400%. This was proven both in the case of no till and conventional practices.

There were significant differences of soil resistance values related to various cultivation techniques, while there were no considerable differences in the mass volume of the soil (7, 11, 18). However, when examining the effect of the various cultivation forms, it is impossible to come to a conclusion and define soil resistance values without the knowledge of soil humidity. Various soil resistance values can't be compared at various soil humidity values (8, 9, 19). Therefore a number of researchers to avoid the effect of varying soil humidity content on soil resistance, compared the effect of tillage on soil compactness at a humidity content, filled to the arable land water capacity. This method has a lot of disadvantages. It is difficult and time consuming to fill up the comparable levels to the same humidity levels in case of various tillage practices.

At a humidity content which is close to the water capacity of the arable land, the soil resistance differences related to various tillage will be less, than in the case of dry soils, so it is difficult to demonstrate them.

In Hungary when comparing different cultivations, the soil resistance values measured at the same humidity values are compared. Thus, some measured values are lost for evaluation (2, 6, 15).

The team of environmental techniques at the College of Nyíregyháza has been engaged in studying the correlation between the mechanical and physical system of the soil and the soil cultivating aggregates. As a result of our research work a new way of comparing the soil resistance values belonging to various soil humidity content at the same humidity values was introduced.

A number of measurement series covering the whole vegetation period made possible to determine those connections, which are necessary for conversion. An open-air measuring system was created by Professor Sinóros-Szabó Botond.

MATERIAL AND METHOD

The determination of correlation between the soil resistance and soil humidity values were conducted in the "open air" measuring system.

The measuring system consists of 90 m long space, which is 2x1 m in diameter, separated by a concrete wall with drain pipes to measure the amount of water flowing through the pipes from a certain soil section.

A loamy soil from Megyaszó-Újvilágtanya area was filled into a 20 m long section of the measuring system. The soil from the arable land preserved its original quality and depth when it was placed in the measuring system, separated from other soils. A natural settlement of the soil occurred by the time the tests were started without any land cultivation. The duration of settlement lasted for 3 years. The soil in the measuring system had different layers, but was homogeneous in its area, which was proven by the 3t measuring system. During the vegetation period (March to October) there were 36 measurements made in an even distribution within 1 m^2. The soil resistance and humidity values were measured by the 3T soil tester. The equipment measures soil resistance up to 60 cm soil depth at every 1 cm sections (in KPa) and soil resistance (arable land water capacity, pF 2,5 mass volume %).

The RAM stores the data and they can be transferred into computer by interface (16, 17). To process the data an Excel table operating program was used. Along with soil resistance and humidity measurements the mass volumes values up to 0-60 cm in every 10 cm layer were determined. The mass volume values were measured in samples of original structure. The samples were in 100 cm^3 containers each layer in 3 succession. The mass volume was measured after drying it in a drying equipment from the mass of the dried soil and the volume of the container.

ACHIEVEMENTS

The firs step was to determine the function connections between the soil resistance and soil humidity (Table 1.).

Table 1.

Equations of functions fitted to the soil resistance and humidity values measured in loamy soil layers at every 10 cm.

Depth [cm]	Mass volume values (g/cm^3)	Equation	R	P (F)	P (t)
5-10	1,15	$y=80,173x^{-0,9174}$	0,8942	< 0,0001	< 0,0001
10-20	1,17	$y=111,63x^{-0,9813}$	0,9380	< 0,0001	< 0,0001
20-30	1,20	$y=216,13x^{-1,1142}$	0,9403	< 0,0001	< 0,0001
30-40	1,22	$y=136,54x^{-0,9695}$	0,9573	< 0,0001	< 0,0001
40-50	1,32	$y=306,34x^{-1,1151}$	0,9611	< 0,0001	< 0,0001
50-60	1,27	$y=139,58x^{-0,9400}$	0,9700	< 0,0001	< 0,0001

y = soil resistance [MPa]; x = soil humidity [pF 2,5 tf%]; p(F) = the significance of regression; p(t) = significance of paremeters

In the measured humidity range the power functions of negative exponent can be attached to the spreads in all layers. The conversion of soil resistance values at various humidity values into identical ones was carried out by using certain functions. As under cultivated soil conditions lesser and greater mass volume values can be measured in the open air measuring system, the number of functions was extended to further mass volume values (1,05; 1,1; 1,4; 1,5). Figure 2 shows the method of converting the soil resistance values at various humidity values into identical ones.

As the figure demonstrated, if 4,3 MPa is measured at 50% humidity value, then at the same point, 5,4 MPa at 40% humidity volumes will be the corresponding figures. The process of conversion is seen in the figure. Starting from a point determined by humidity and soil resistance values we find the nearest function (in this case p = 1,32 g/cm^3) by using a computer, then we come to the intersection of 40 mass volume% humidity value. So an estimated amount of soil resistance increase is obtained, to which the distance from the original point function is added – so we get new soil resistance value.

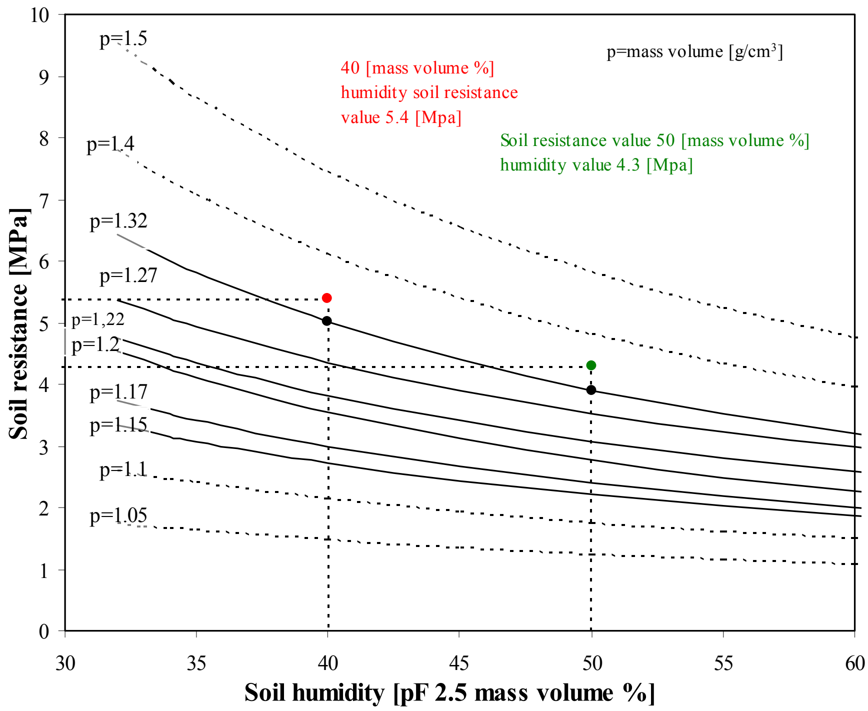

Figure 1. The method of converting the soil resistance values at various humidity values into identical humidity values.

CONCLUSION

From the above mentioned can be seen, that if the effect of various practices on soil compactness is demonstrated by soil resistance values, then the humidity values affect them considerably. Therefore the differences of the soil humidity values must be considered when making comparative analysis. The computer program of our team is capable of doing it for clay soils.

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