STUDY ON THE EFFECTS OF CONVENTIONAL SOIL TILLAGE APPLIED TO WINTER AND SPRING PEAS ON SOIL PHYSICAL PROPERTIES

Cosmin GHELBERE[1], Ilie NISTOR[1], Tudor George AOSTĂCIOAEI[1], Denis ȚOPA[1], Gerard JITĂREANU[1]

e-mail: ghelberecosmin@yahoo.com

Abstract

Tillage technology is especially important because it improves the physical, chemical, and biological properties of the soil, resulting in greater fertility and optimal crop growth and development conditions. This research aimed to determine the values of physical properties obtained from the technologies applied to two peas crops on an area of 10 ha, i.e. winter peas (5 ha) and spring peas (5 ha) during 2021-2022. The physical properties that have been analysed in this study are bulk density, penetration resistance and soil moisture, within the farm S.C. COMPANIA OPREA S.R.L., it is located in Munteni commune, Galați County. This was analysed as follows: bulk density was determined from three points located on the diagonal of the plot in three replicates over four depth intervals, penetration resistance was determined using the penetrologger to measure penetration resistance to a depth of 80 cm and for moisture determination soil samples were taken from 6 intervals up to a depth of 90 cm. The results obtained from the analyses were: the bulk density of the winter peas crop was between 1.26-1.44 g/cm3, while the values for spring peas were between 1.15-1.48 g/cm3. The penetration resistance of winter peas in the first 10 cm the soil has a medium resistance with a value of 2.60 MPa increasing slightly up to 15 cm, then it records a minimum value of 2.37 MPa at a depth of 30 cm. In the case of the spring peas crop, at the surface, the value is 1.48 MPa, and in the soil layer 20-40 cm depth the values are between 3.16 and 4.28 MPa. Moisture in winter peas ranges from 5.21% to 17.17% and in spring peas from 4.99% to 17.44%.

Key words: (tillage, peas, soil moisture, bulk density, penetration resistance)

Soil quality variability primarily impacts biogeochemical cycling, biodiversity, and agricultural productivity. Soil quality, on the other hand, cannot be explicitly ascertained but can be inferred by measuring soil physical, chemical, and biological properties (Casanova M. *et al*, 2016).

The physical condition of the soil is especially important for crop development and high yields. Crop growth and development, as well as water state and soil solution, are all closely linked to soil physical and hydrophysical properties (Cuconoiu C. *et al*, 2018).

Tillage type can have both negative and positive effects on soil physical properties. One of the main reasons for the continued use of plowing, particularly in cool and wet conditions, is that decreased tillage reduces yields. (Koch T. *et al*, 2009).

Increased pests and disease, poor rooting due to high soil bulk density, low nitrogen mineralization, and delayed spring soil warmth can all contribute to yield decline. (Alvarez R., Steinbach M.S., 2009).

Reduced yields can also occur as a consequence of straw residue problems (Ball B.C. *et al*, 1994), and the presence of straw close to the surface can decrease yields under reduced tillage. (Ball B.C., Robertson H., 1990).

A physical assessment of soil quality considers a variety of indicators such as bulk density, penetration resistance, soil moisture.

Bulk density is not an intrinsic soil property but depends on external conditions, with changes associated with a variety of factors and with various natural and anthropogenic processes (Zeng C. *et al*, 2013). Bulk density is also an essential factor for assessing soil carbon and nutrient stock (Ellert and Bettany, 1995), determining pollutant mass balance in soil, and determining the soils' packing structure in soil classification issues (Dexter, 1988). It also affects the soil biomass productivity and environment quality (Lal R., Kimble J.M., 2001).

Soil penetration resistance is the main soil property that determines water accessibility since it largely regulates root elongation rates. It therefore determines whether, how fast and at which

[1]Iasi University of Life Sciences, Romania

metabolic costs roots may reach soil water pools (Colombi T. *et al*, 2018).

Soil penetration resistance is positively correlated to soil bulk density. Soil penetration resistance is also strongly influenced by soil moisture as soil penetration increases upon soil drying (Bengough A. *et al*, 2011; Grzesiak F. *et al*, 2013).

Therefore, soil penetration resistance fluctuates during a cropping season due to precipitation events and evapotranspiration. Ultimately root elongation rates decrease in response to increased soil penetration resistance leading to restricted access to soil resources such as water and nutrients (Colombi T. *et al*, 2018).

The soil penetration resistance is a suitable variable for understanding the physical and mechanical condition of a seedbed due to its high sensitivity to changes in the physical properties of soil (Bayata H. *et al*, 2017).

Climate change has increased the variability of rainfall patterns, which can increase the occurrence of environmental extremes such as severe droughts and more regular floods (Basche A.D., Edelson O.F., 2017).

Soil moisture plays a major role in crop production, where water infiltration and drainage of the soil governs the soil moisture content (Bharati L. *et al*, 2002).

Excessive soil moisture content can restrict soil aeration, resulting in anerobic conditions for plant roots, whereas moisture deficits can result in crop stress conditions, with both extremes affecting crop yield (Tan M. *et al*, 2002).

The aim of this study was to determine the influence of cultivation technology in winter and spring peas on bulk density, penetration resistance and soil moisture in order to apply the most efficient solutions to increase yield and conserve soil quality.

MATERIAL AND METHOD

This study was conducted on an area of 10 ha cultivated with winter peas and spring peas in Munteni commune, Galați County and from a geomorphological point of view, it is located in the Tecuci Plain and is managed by S.C. COMPANIA OPREA S.R.L.

The area of 10 ha is located in physical block 24, topographic plot, and is divided into two parcels, 5 ha cultivated with winter peas and 5 ha with spring peas.

It is worth mentioning that the farmer applies the same cultivation technology to the whole area.

Thus, for the determination of bulk density, soil samples were taken from a depth of 0-40 cm in natural, undisturbed soil, using metal cylinders with a diameter of 5 cm and a height of 5.1 cm, sharpened at the lower end, with a volume of 100 cm^3 (*figure 1*). In the laboratory after oven drying (105°C) the samples were weighed and bulk density values were determined with the formula:

$$Da,\ g/cm3 = M/Vt$$

where:
Da - bulk density;
M - mass of absolutely dry soil;
Vt – volume.

Table 1
Interpretation of bulk density values
(Hazelton P. and Murphy B., 2016)

Da – g/cm^3	Interpretation
<1.0	very low
1.0 - 1.3	low
1.3 – 1.6	medium
1.6 – 1.9	high
>1.9	very high

Figure 1 **Bulk density sampling**

Penetration resistance determination was carried out using the Eijkelkamp Penetrologger. This was used to measure penetration resistance to a depth of 80 cm (*figure 2*).

Figure 2 **Determination of soil penetration resistance**

Table 2
Categories of penetration resistance values
(I.C.P.A., 1987, Bucureşti, vol III, values have been converted from Kgf to MPa)

Interpretation	Values	Growth restriction
Very low	<1.0	Natural root growth
Low	1.1-2.5	
Moderate	2.6-5.0	Partial root limitation
High	5.1-10	
Very high	10.1-15.0	Roots cannot grow
Extremely high	> 15.0	

For moisture, soil samples were taken from 5 points on each working variation in aluminum vials, the amount of soil being approximately 20-25 g in six depth intervals up to 90 cm, 3 replicates were taken on each interval (*figure 3*). Moisture determination was carried out in the laboratory by the gravimetric method, which is considered the standard method in calibrating moisture meters due to its high accuracy, based on the formula:

$$U\%\ g = A / S*100 = G_1 - G_2 / G_2 - t*100$$

where:
U% g - moisture content in % of soil mass.
A - water evaporated from the sample, in g.
S - weight of dry soil, in g.
100 - percentage reporting factor.
t – tare.

Figure 3 **Soil moisture sampling**

RESULTS AND DISCUSSIONS

To highlight the differences between the recorded values, it should be noted that the same tillage system was applied over the entire area. Therefore, the bulk density registered the following values (*table 3*).

Table 3

Average values of bulk density (g/cm^3)

Depth (cm)	Bulk density			
	Spring peas		Winter peas	
	Values	Interpretation	Values	Interpretation
0-10	1.15	Very low	1.26	Low
10-20	1.37	Low	1.44	Medium
20-30	1.41	Medium	1.34	Low
30-40	1.48		1.38	Low

As a result of soil penetration resistance determinations, it can be observed that in the case of the spring peas crop, the value at the soil surface is 1.48 MPa, which is considered a low value, and in the soil layer from 20 to 40 cm depth the values are between 3.16 and 4.28 MPa, with a medium penetration resistance due to the hardpan layer present in this depth range.

In the winter peas crop, the soil layer is present close to the soil surface, so according to the penetration resistance values starting at a depth of 10 cm the soil has a medium penetration resistance with a value of 2.60 MPa increasing slightly up to 15, then registers a minimum value of 2.37 MPa at a depth of 30 cm (Figure 4).

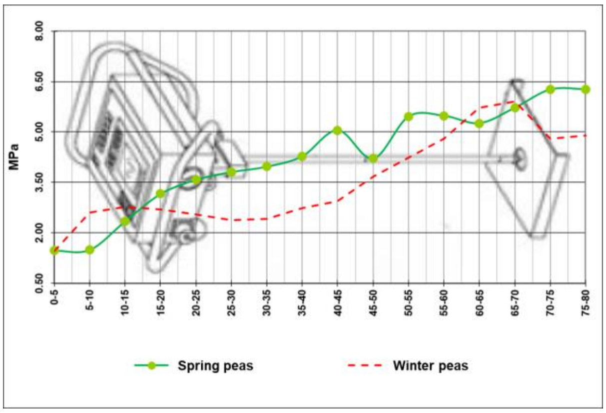

Figure 4 **Values of penetration resistance -**

On determining the soil moisture in the flowering phenophase, it can be observed that the lowest percentage of moisture is recorded at the soil surface, ranging between 4.99 - 5.21 %, which means a very dry soil, and the highest percentage of moisture is recorded in the interval 20 - 30 cm in the case of spring peas crop, 17.44 % and in the interval 30 - 50 cm with a value of 17.17 % in the case of winter peas crop (*table 4*).

Table 4

Soil moisture values

Sampling depth (cm)	Moisture (%)	
	Spring peas	Winter peas
0 - 10	4.99	5.21
10 - 20	12.90	9.63
20 - 30	17.44	15.17
30 - 50	14.99	17.17
50 - 70	14.52	16.72
70 - 90	11.88	12.52

CONCLUSIONS

The aim of this study was to determine the values of bulk density, penetration resistance and moisture following the application of the classical tillage system.

Thus, the bulk density in spring peas increases with depth having optimum values. For winter peas, the presence of hardpan at a depth of 10-20 cm is evident.

Regarding the soil penetration resistance, it was found that in spring peas, the value at the soil surface is 1.48 MPa, which is considered a low value, and in the soil layer from 20 to 40 cm depth the values are between 3.16 and 4.28 MPa, which is considered a medium penetration resistance due to the hardpan layer present, and in winter peas, the hardpan soil is present in the surface layer, so according to the values recorded from a depth of 10 cm the soil has a medium resistance to penetration with a value of 2.60 MPa increasing slightly up to 15 cm, then it records a minimum value of 2.37 MPa at a depth of 30 cm.

Soil moisture recorded the lowest percentage at the soil surface, ranging between 4.99 and 5.21 % which indicates that the soil was very dry, and the highest percentage of moisture was recorded in the range 20-30 cm for spring pea crop, 17.44 %, and for the range 30-50 cm with a value of 17.17 % for winter peas crop.

Based on the analysis of the data recorded by sampling and processing of soil samples from S.C. COMPANIA OPREA S.R.L with the land located in Munteni commune, Galati County, Plain of Tecuci, in order to contribute to the maintenance, even improvement of the physical condition of the soil, it is recommended to adopt a conservative system, to the detriment of the classic one.

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