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# Impact of seedbed preparation conditions on soil Porosity

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**Abstract**
Field experiment was conducted to investigate the effects of soil moisture content at plowing M (8.1; 17.1; 26.4% w/w), plowing depth D (10; 20; 30 cm) and plowing speed S (1.93; 10.33 $kmh^{-1}$) on the porosity of a clay loam soil during the summer season of 2015/2016. Chisel plow was used in seedbed preparation. The layout of the experiment was split- split plots using three replicates. The statistical analysis of the results at the 5% level could be summarized in the following:

a. the effects of the treatments M, S, D; the interaction M×S×D on soil bulk density, total porosity, macro pores and micro pores were significant,
b. the effects of the interaction: S×D were not significant on all the parameters mentioned above,
c. the effects of the interaction: M×D were significant on bulk density and total porosity only and
d. The effects of the interaction: M×S were significant on the macro pores only.

**Keywords:** soil moisture, plowing speed, plowing depth, bulk density, total porosity, macro pores, micro pores.

## Introduction

According To Vomocil (1965) The Geometry Of Soil Pore Is Just As Complex As its Solid Phase. Al-Ani and Al-Ani (2010) stated that the frequent passages of the farm machinery and heavy machinery on the agriculture land compact the soil and forms sole layer just below the plowed depth. This has negative effects on fluids movement in the soil, root development and land productivity.The views of Vomocil (1965), Greenland (1977), Pagliai et al. (1981), Pagliai (1988), Farkas et al. (2006) and Blazewicz-Woyniak and Konopinski (2013) concerning soil pores could be summarized in the following: 1) total porosity provides information of only limited utility, the pores differ greatly from one another in shape, lateral dimensions, length, tortuosity and continuity, 2) pores are classified according to their agronomic function as a) pores in the range of 0.5-50 μm called storage pores hold water and nutrients necessary for plant growth, b) pores ranging 50-500 μm called transmission pores are important because they regulate exchange of gases heat flow and retention and soil strength. Pagliai et al. (2004) stated that the continuity of soil pores coupled with their size and number are very important for infiltration and movement of both water and nutrients. They added that reducing pore size and number will affect negatively many physical, chemical and biological processes going on the pore system Soil losses operation especially plowing brings about considerable changes in soil characteristics. If no changes in soil management practices before and after deep tillage the soil will be recompacted within one to three years according to its type (Kooistra, 1987) Many authors have investigated the effects of soil moisture content, plowing speed and plowing depth on soil bulk density and total porosity (Gaber et al., 2009, Al-Ani and Al-Ani, 2010, Alam et al., 2013, Dina, 2016, Naser et al., 2016). Since these investigations stressed on soil bulk density and total porosity only the present piece of work aimed to study effects of the treatments mentioned above on pore size.

## Materials and Methods

A field experiment was conducted at the experimental station of the Soils, Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt as co-operative study between the National Research Centre and the Agriculture Research Centre. It was conducted during summer season of 2016 in split – split plot design with three replicates on clay loam soil. The main, submain, and sub-submain plots were occupied soil moisture content, plowing speed and plowing depth, respectively. Chisel plow was used for seedbed preparation. Each treatment was triplicated.

**Table 1:** Mechanical and Hydrophysica analysis of soil

| a) Mechanical analysis of soil | | | | |
|---|---|---|---|---|
| Depth | sand | silt | clay | texture |
| cm | (%) | (%) | (%) | |
| 0-30 | 30.6 | 35.8 | 33.6 | clay loam |
| 30-70 | 26.5 | 37.4 | 36.1 | clay loam |
| 70-120 | 30.2 | 35.8 | 34.0 | clay loam |

| b) Hydrophysical analysis of soil. | | | | | | |
|---|---|---|---|---|---|---|
| Depth cm | Bulk density $gm.cm^{-3}$ | Total Porosity % | Hydraulic conductivity $cm.h^{-1}$ | infiltration rate $cm.h^{-1}$ | Field Capacity* (%) | Wilting Percentage* (%) |
| 0-30 | 1.33 | 49.81 | 1.7 | 5.4 | 42.2 | 18.5 |
| 30-70 | 1.31 | 50.57 | 1.2 | 5.4 | 43.4 | 19.4 |
| 70-120 | 1.37 | 48.3 | 2.4 | 5.4 | 41.6 | 18.1 |

*on dry weight basis

The aim of this work is to study the impact of plowing conditions: three soil moisture content at plowing Ɵ1, Ɵ2; Ɵ3 (8.1, 17.1; 26.4% w/w), three plowing depth d1, d2; d3 (10, 20; 30 cm) and two plowing speed s1, s2 (1.93, 10.33 $kmh^{-1}$) on soil porosity properties. Mechanical and Hydrophysica analysis of soil are presented in table 1. Soil hydrophysical analyses were determined according to Klute, 1986. The data were statistically analyzed through analysis of variance (ANOVA) and least significant difference (LSD) at 0.05 probability level according to Gomez and Gomez (1984).

## Results and Discussions

Data of some soil characteristics are presented in table (1). It is obvious the ranges of sand, silt and clay fractions are: 26.5- 30.6, 35.8- 37.4 and 33.6- 36.1%, respectively. Also, the soil is clay loam in texture along the soil profile down to 120 cm deep. The hydro physical properties showed that soil bulk density and the total porosity vary 1.31- 1.37 $gm.cm^{-3}$ and 48.3- 50.5%, respectively. On otherworld, they vary inversely. Since the soil is clay loam, the total porosity occupies nearly 50% of the solid phase.

### The main effects of the treatments: (Table 2)

1. Soil moisture content (M), plowing depth (D) and speed (S) and their interactions M×S×D have significant effects at the 5% level on bulk density, total porosity, macro pores and micro pores.
2. The interaction: M×D has significant effects at the 5% level on bulk density and total porosity.
3. The interaction: M×S has significant effects at the 5% level only on the macro pores.
4. The interaction: S×D on all the studied characteristics was not significant effects at the 5% level.
5. The maximum bulk density (1.335 g $cm^{-3}$) was obtained in the interactions: $M_3 \times S_1 \times D_2$ and $M_3 \times S_2 \times D_1$ whereas, the minimum one (1.275 g $cm^{-3}$) in the interaction: $M_1 \times S_2 \times D_3$.
6. The maximum total porosity (51.89%) was fond in the interaction: $M_1 \times S_2 \times D_3$, while the minimum one (49.62%) in the interactions: $M_3 \times S_1 \times D_2$ and $M_3 \times S_2 \times D_1$.
7. The maximum macro pores (9.7%) were achieved in the interaction: $M_2 \times S_2 \times D_3$, but the minimum one (7.87%) in the interaction $M_3 \times S_1 \times D_3$.
8. The maximum micro pore (43.26%) was detected in the interaction: $M_1 \times S_1 \times D_3$ and the minimum one (41.1%) in the interaction: $M_3 \times S_2 \times D_1$.

Our results are in good agreement with obtained by (**El-**Gayer, et al., 1986, Al-Ani and Al-Ani, 2010, Dina, 2016, Naser et al., 2016).

**Table 2:** Effect of moisture content, plow speeds and plow depths on soil porosity

| Soil moisture (%) | Tractor speed (km/h) | soil depth (cm) | B.D g.cm$^{-3}$ | Total porosity % | Macro pores % | Micro pores | |
|---|---|---|---|---|---|---|---|
| | | | | | | WHP % | NUP % |
| M1 8.10% | S1 = 1.93 | d1 | 1.330 | 49.81 | 8.21 | 21.74 | 19.86 |
| | S1 | d2 | 1.300 | 50.94 | 7.99 | 21.99 | 20.96 |
| | S1 | d3 | 1.285 | 51.51 | 8.25 | 21.73 | 21.53 |
| | S2 =10.33 | d1 | 1.320 | 50.19 | 9.58 | 20.61 | 20.00 |
| | S2 | d2 | 1.285 | 51.51 | 9.58 | 21.20 | 20.73 |
| | S2 | d3 | 1.275 | 51.89 | 9.57 | 21.09 | 21.23 |
| M2 17.10% | S1 = 1.93 | d1 | 1.330 | 49.81 | 8.02 | 23.23 | 18.56 |
| | S1 | d2 | 1.315 | 50.38 | 8.45 | 23.13 | 18.81 |
| | S1 | d3 | 1.305 | 50.75 | 8.23 | 22.17 | 20.35 |
| | S2 =10.33 | d1 | 1.325 | 50.00 | 8.78 | 22.54 | 18.68 |
| | S2 | d2 | 1.310 | 50.57 | 9.50 | 22.08 | 18.99 |
| | S2 | d3 | 1.285 | 51.51 | 9.70 | 21.65 | 20.16 |
| M3 26.40% | S1 | d1 | 1.325 | 50.00 | 7.88 | 23.63 | 18.49 |
| | S1 | d2 | 1.335 | 49.62 | 8.03 | 23.27 | 18.32 |
| | S1 | d3 | 1.325 | 50.00 | 7.87 | 23.33 | 18.80 |
| | S2 | d1 | 1.335 | 49.62 | 8.53 | 22.79 | 18.31 |
| | S2 | d2 | 1.330 | 49.81 | 8.53 | 22.75 | 18.54 |
| | S2 | d3 | 1.320 | 50.19 | 8.60 | 22.40 | 19.20 |
| LSD $_{0.05}$ Soil moisture | | M | 0.007 | 0.27 | 0.27 | 0.31 | 0.33 |
| LSD $_{0.05}$ Tractor speed | | S | 0.005 | 0.22 | 0.27 | 0.25 | 0.27 |
| LSD $_{0.05}$ Soil depth | | D | 0.007 | 0.27 | 0.27 | 0.31 | 0.33 |
| M*S | | | ns | ns | 0.27 | ns | ns |
| M*D | | | 0.005 | 0.22 | ns | ns | ns |
| S*D | | | ns | ns | ns | ns | ns |
| M*S*D | | | 0.004 | 0.15 | 0.15 | 0.18 | 0,19 |

**Data obtained could be explained on following basis:**

a. Cohesion and adhesion force.
   Increasing water content at plowing increases the thickness of the water films bonding the solid particles. This leads to their relaxation and dissolving some bonds and subsequently to unstable structure.
b. Increasing plowing speed increased soil pulverization and vic versa.
c. Increasing plowing depth breaks the soil sole layer formed beneath the constant plowed layer. Also, it leads to pore continuity.

## Conclusions

**Based on the obtained results one could conclude that:**

1. Each of the treatment soil moisture content (M), plowing speed (S), plowing depth (D) and their interaction M×S×D have significant effect at the 5% level on bulk density, total porosity, macro and micro pores.
2. Seedbed preparation has to be done at M = 8.1% w/w, S= 10.33 km h$^{-1}$ and D= 30 cm.

## References


1. Alam, M.K., Salahin, N., Rashid, M.H., and Salam, M.A. 2013. Effect of different tillage practices and cropping pattern on some soil physical properties and crop productivity. Journal of Tropical Resources and Sustainable Science, 1(1): 51-61.
2. Al-Ani, A.N. and Al-Ani, F.S. 2010. The relationship between tractor practical velocity and different moisture on plowing soil layers. The Iraqi Journal of the Agriculture sciences, 41(3): 124-129.
3. Blazewicz-Woyniak, M. and M. Konopinski. 2013. Impact of cover crops and tillage on porosity of podzolic soil. Int. Agrophys., 2013, 27: 247-255.
4. Dina, S. Salama 2016. Design of combined machine for seedbed preparation for onion. M.Sc. Thesis, Department of Agric. Engineering, Faculty of Agriculture, Cairo University.
5. El-Gayer, A.A., R.M., El-Awady, A.A., Abd El-Razak and A.A. Wahdan. 1986. The effect of different types of plows on some physical properties of clay soil under growth of maize plants II. Hydraulic conductivity, soil compaction and pore size distribution. Annals Agric. Sci., Moshtohor, 24: 2305-2322.
6. Farkas, C., Csaba Gyuricz, C. and Birkas, M. 2006. Seasonal changes of hydraulic properties of a chromic luvisol under different soil management. Biologia, Bratislava, 61/ suppl. (19): 344-348.
7. Gaber et al. 2009. Studying the effect of soil moisture content and tractor speed using rotary plow on fuel consumption and some physical characteristics of silty clay loam soil. The Iraqi Journal of the Agriculture Science, 1(1): 215-220.
8. Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research. 2nd ed., Willey, New York, U.S.A.
9. Greenland, D.T. 1977. Soil damage intensifarable cultivation temporary or permanent. Philos. Trans., R. Soc. Lond., sev. B. 281: 198-208.

10. Klute, A.A. 1986. Methods of soil analysis, part 1- physical and mineralogical methods. 2 nd ed., American Agron., Wisconsin, U.S.A.
11. Kooistra, M. J. 1987. The effects of compaction and deep tillage on soil structure in a Dutch sandy loam soil. Soil micro morphology, AFES, Plaisir, France, pp. 445-450.
12. Naser, G.E., Tayel, M.Y., Abdelhady, Y.B., Sabreen Kh. Pibars and Dina S. Salama 2016. Technical evaluation of new combined machine for seedbed preparation. Intern. J. of Chem. Tech. Res.,Vol. 9 (5): 193-199.
13. Pagliai, M., 1988. Soil porosity aspects. Intern. Agrophysics, 4: 215-232.
14. Pagliai, M., Guidi, G., La Marca, M., Giachetti, M. and Lucamante, G., 1981. Effect of sewage sludges and composts on soil porosity and aggregates. J. Environmental Quality, 10: 556-561.
15. Pagliai, M., N. Vignozzi and S. Pellegrini. 2004. Soil structure and the effect of management practices. Soil &Tillage Research, 79: 131-143.
16. Vomocil, J.A. 1965. Porosity. Method of Analysis. Part 1. pp (299-314). (C.A. Black Editor in Chief), American Soc. Of Agronomy.