SUNFLOWER RESPONSE TO SOIL COMPACTION

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ABSTRACT

The studies were conducted between 1980 - 1990 on a leached chernozem, well drained, formed on loess, with 33 % clay content and 2,8 % organic matter in arable layer. The compaction treatments were performed on a plowed field by 1,2 and 3 successive passings of tractor, track by track, prior to seedbed preparation. The wheel pressure induced a soil compaction down to 40 cm depth, evidenced by an increase of apparent density and decrease of total and air porosities, below the minimum level accepted for a normal crop development. The poor soil aeration affected the seed germination so that the plant emergence was reduced and delayed.

The plant height and leaf area were reduced by compaction, as a result of the worsening of soil conditions for root growth; the root biomass was lower by 41 - 60 % in compacted soil, as compared to non-compacted one.

Among the yield components, the head number/ha and the seed weight per head varied with the compactness degree and determined a significant yield differentiation; yield losses caused by soil compaction ranged from 220 to 760 kg/ha.

Some recommendations are made in order to reduce the soil compaction: to diminish the vehicle traffic and the wheel pressure on the soil, to avoid the traffic and tillage when the soil is too wet, to apply minimum tillage methods and other technological measures.

INTRODUCTION

An intensive traffic with tractors and other farm vehicles on arable land leads to soil compaction. The wheel preassure causes a decrease of the soil porosity which affects the crop development. The degree of compactness depends directly on the magnitude of the pressure forces, soil type and its moisture.

The effect of soil compaction on soil fertility and on crop yield was studied by several authores (Barnes et al., 1971; Eriksson et al., 1974; Soane et al., 1982; Boone, 1986; Hakansson et al., 1988; Sin et al., 1989). The obtained data showed that the soil compaction determines a deterioration of soil properties regarding the water and air movement and nutrient regime, hinders the root growth and brings about yield losses. Although the compacted soil is loosened by plowing, the soil conditions can become unfavourable for plant growth because of subsoil compaction and structure worsening in arable layer.

The work presented here shows some aspects concerning the response of sunflower to different soil compaction degrees.

MATERIALS AND METHODS

The studies were conducted between 1980 - 1990 at the Research Institute for Cereals and Industrial Crops, Fundulea. The soil is a moderately leached chernozem, well-drained, formed on loess, with 33 % clay content and 2.8 % organic matter in arable layer.

The compaction treatments were made on a fall plowed field, by successive passings of tractor U-650 (of 3800 kg weight), in spring prior to seedbed preparation.

The various degrees of compactness were obtained by four wheel traffic treatments: a. - unwheeled (C_0); b. - one pass of tractor, track by track (C_1); c. - two passes of tractor (C_2); d. - three passes of tractor (C_3).

After the soil compaction, the seedbed preparation was performed by disking. The crop technology was normal, regarding sowing time (beginning of April), plant density (4,5 plants/m^2), fertilization ($N_{100}P_{75}$) and weed control (chemical and mechanical).

The soil samples were collected for determination of apparent density, immediately after the soil compaction and at harvesting; taking in calculation the values of apparent

density, the total and air porosities were indirectly determined.

Observations and measurements concerning plant emergence, plant growth, root development, yield components and oil content in seeds were also made. At flowering the root growth was appreciated using monolith method, by digging up a soil volume of 6o cm depth and 5o x 5o cm area round the plant, washing the roots and measuring them.

The experiment was stationary organized in a 6-year rotation (sunflower following after wheat) and designed in randomized blocks in 4 replications; the size of experimental plot was 12o m^2.

RESULTS AND DISCUSSIONS

The data presented in table 1 show that the wheel preassure determined a change of the soil state pointed out by the increasing of apparent density and the decreasing of porosity. The compactness degree, observed down to 4o cm, is directly corellated with the traffic intensity.

The reduction of soil porosity caused unfavourable conditions to the crop growth. In compacted plots the air porosity decreased below the minimum level accepted for a normal crop development. The poor soil aeration affected the seed germination so that the plant emergence was diminished and delayed (table 2). Later, the crop growth was differentiated deppending on compactness degree of the soil.

The compaction affects the soil properties and processes including air capacity and gaseous exchange, retention of the water and its movement, soil strenght and mechanical impedance to root growth, and induces deficiencies in plant nutrition. These effects differentiated the crop growth (table 3); the plant height and leaf area were reduced by compaction, as a result of the worsening of soil conditions for root growth. The data from table 4 show a reduction of root biomass by 41-6o % due to compaction. There is a direct correlation between the root development and the decrease of soil porosity, which affected the water and air regime.

Among the yield components, the head number/ha and the seed weight per head varied with the compactness degree, while the seed weight and the hectolitric weight had reduced changes (table 5). The plant density, done by the number of heads/ha, was lower in compacted plots as a consequence of the poor plant emergence. The higher plant density was not associated with a decreasing of plant productivity; this fact shows that the non-compacted soil offered better conditions for plant nutrition and yielding.

compactness degree, from 2570 kg/ha to 1910 kg/ha. Such yield losses (up to 26 %) induced by soil compaction can be met in practice as a result of too intensive traffic on land (inclusively soil tillage) especially under conditions of higher soil humidity.

To reduce and avoid the compaction process is a topical need in farm production which is possible by taking certain measures in crop technology.

CONCLUSIONS

- The tractor passings compacted the soil down to 40 cm depth, inducing the increase of apparent density and the decrease of total and air porosities.

- The compaction of soil delayed and reduced the plant emergence and slowed the plant growth. The roots development was most affected by soil compaction, which reduced the root biomass by up to 60 %.

- The seed yield decreased according as the compactness degree increased, yield losses ranging from 9 to 26 %.

- For reducing the soil compaction it is necessary to diminish the vehicle traffic and the wheel pressure on the soil, to avoid the traffic and tillage when the soil is too wet, to apply minimum tillage methods and other technological measures.

REFERENCES

Barnes K.K., Carleton W.A., Taylor H.M., Throckmorton R.I., 1971 - Compaction of agricultural soils ASAE Monograph. U.S.A.

Boone F.R., 1986 - Towards soil compaction limits for crop growth Neth. J. Agric. Sci. 34, 349-360.

Eriksson J., Hakansson I., Danfors B., 1974 - The effect of soil compaction on soil structure and crop yields. Sweed. Inst. Agric. Eng. Uppsala, Rep 354.

Hakansson I., Woorhees W., R. Hugh, 1988 - Vehicle and wheel factors influencing soil compaction and crop response in different traffic regimes. Soil Res. 11, 239-282.

Sin Gh., Ioniță St., Terbea M., Boruga I., 1989 - Einfluss der Bodenverdichtung auf Wachstum und Ertrag von Feldkulturen und auf einge Parameter beim Pflügen. Wiss. Tagung des FZB - Müncheberg, DDR, 181-188.

Soane B.D., Dickson, J.W. and Campbell, D.J., 1982 - Compaction by agricultural vehicles: a review. III. Incidence and control of compaction in crop production. Soil Tillage Res. 2, 3-36.