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Influence of Soil Compaction on Plants Growth of Spring Rape

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Introduction

Natural and artificial factors of soil compaction can cause a considerable decrease of harvest. It is very important to decrease the negative influences of those factors on soil fertility. They are caused by non-perfect soil tillage technology, first of all by the consequences of soil compaction by tractors running gears (Afanasiev et al., 1987; Trufanov, 1989; Kononov et Duben, 1993). During winter crops cultivation more than 30 percent of the total field area suffer from twofold compaction, up to 20 per cent suffer from six-time compaction and 2 per cent - from eight-time compaction (Kononov et Duben, 1993). Turning zones on the field edge are exposed to the strongest influence. Even after special measures of subsoil loosening - deep chiseling, considerable compaction and unevenness of soil hardness on the total field area as the result of influence during tillage can be observed (Klochkov et Duben, 2000).

The aim of this research was soil compaction influence on spring rape growth index by harvest time. A great attention is paid to rape cultivation in the Republic of Belarus.

Method

Measurements were carried out in August 2000 in the field where tillage treatments influence on soil compaction has been studied before (Klochkov et Duben, 2000). Interrelationship of soil hardness and spring rape indexes had been studied by harvest time.

Measurements of soil hardness P were carried out with the help of the Revyakin hardness measuring device on a depth up to 0.2 m. The spring stiffness of the hardness measuring device was 10^4 N/m, and the diameter of the plunger, a flat one, with a round basis, was 0.01 m. In total 25 measurements were made on each of four sites at different distance 5, 20, 35 and 50 m from the field edge (Figure 1).

The correlation between soil hardness at harvesting and spring rape indexes was studied. Plant selection for defining productivity was in the same place where diagrams of hardness were obtained. The following indexes of plants were controlled: height of stalk, h; length of roots, L; number of the first order branches, N; and number of pods, S. Based on these indexes the mass of seeds from one plant was calculated:

$M=S*nS*mS$,

where n_S - average amount of seeds in one pod, defined for 100 replicates (n_S=26.97);
m_S - average mass of one seed, defined by seeds weighing for 100 pods ($5 \cdot 10^{-6}$ kg).
Resulting processing of observations was carried out with the use of regression analysis methods.

Results and discussion

Measurement results and average values of controlled parameters are given in Table 1. For the analysis the obtained results were grouped in two ways.

In the first one, each measurement (indexes of controlled plant and soil hardness near the roots) was treated as a separate replicate of the experiment (Table 2). Coefficients of correlation R of soil hardness and plant indexes have small values (up to 0.301), showing there is a presence of factors that influence the growth of each concrete plant in a more essential way as compared to soil hardness. Among such factors can be density of plants, lodging degree, chemical and mechanical soil composition, requirements of power supply and other factors, defining heterogeneity of growing requirements at identical soil hardness. As shown in Figure 2, the quantity of pods, and consequently, the harvest from one plant, has a considerable scatter with the common tendency of reduction with increased soil hardness.

Table 1. Average values and coefficients of controlled parameters variation

Parameters	Average value	Coefficient of variation, %
Soil hardness P, MPa	2.626	26.2
Height of plants H, $\times 10^{-2}$ m	110.1	142.2
Length of roots L, $\times 10^{-2}$ m	11.1	24.1
Number of the first order branches N, pieces	5.58	31.7
Seed mass from a plant M, $\times 10^{-3}$, kg	9.55	54.7

The highest values of correlation coefficients correspond to the minimum depth (0...0.05 m), and the lowest to the average depth.

The correlation coefficient between rape height and root length, amount of the first order branches and seed mass is respectively 0.32, 0.437 and 0.627. The correlation coefficient between root length and amount of the first order branches and seed mass is respectively 0.339 and 0.407. The correlation coefficient between the amount of branches and seed mass is 0.633.

In the second kind of data processing the dependency of average plant indexes from average soil hardness was analysed (Table 3 and Figure 3).

As the results show, the increase of soil hardness affects all controlled indexes negatively. The strongest correlation of soil hardness - with root length (R= -0.997) and with seeds mass (R= -0.975).

Table 2. Correlation coefficients between soil hardness and separate rape plant indexes

Depth, m	0.025	0.050	0.075	0.100	0.125	0.150	0.175	0.200	0.. 0.200
Correlation with: stalk height H	-0.212	-0.214	-0.119	-0.069	-0.130	-0.186	-0.189	-0.174	-0.188
root length L	-0.266	-0.301	-0.240	-0.257	-0.221	-0.146	-0.113	-0.114	-0.233
number of branches N	-0.207	-0.200	-0.142	-0.173	-0.187	-0.156	-0.146	-0.207	-0.206
seed mass M	-0.263	-0.191	-0.072	-0.070	-0.123	-0.169	-0.196	-0.224	-0.188

Table 3. Correlation between soil hardness and indexes of rape harvest

Depth, m	0.025	0.050	0.075	0.100	0.125	0.150	0.175	0.200	0.. 0.200
Correlation with: stalk height H	-0.806	-0.885	-0.924	-0.907	-0.935	-0.918	-0.825	-0.614	-0.897
root length L	-0.960	-0.989	-0.997	-0.996	-0.988	-0.970	-0.865	-0.709	-0.977
number of branches N	-0.920	-0.897	-0.873	-0.801	-0.735	-0.674	-0.451	-0.256	-0.713
seed mass M	-0.982	-0.987	-0.979	-0.992	-0.969	-0.955	-0.860	-0.744	-0.975

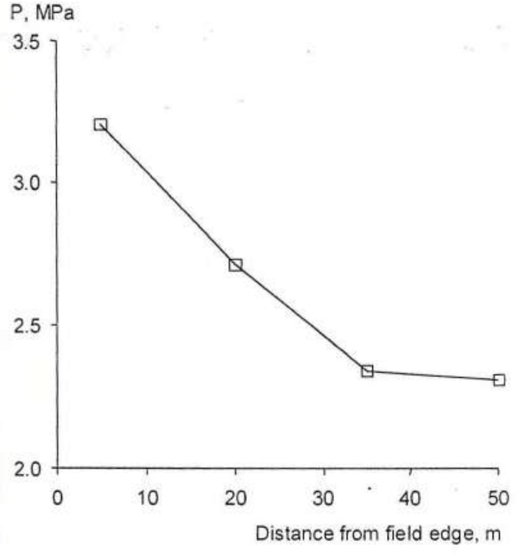

Fig. 1. Soil hardness at different distances from field edge.

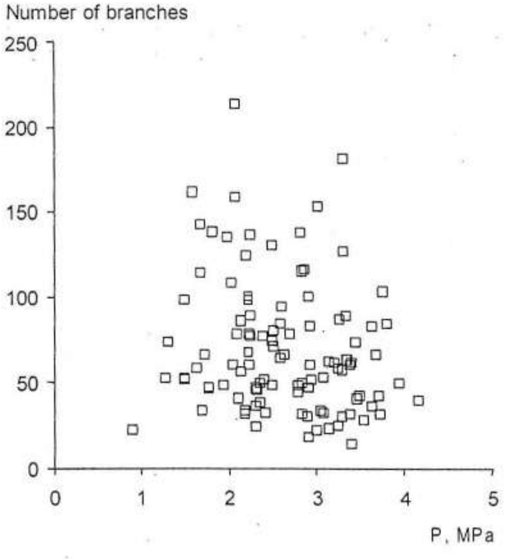

Fig. 2. Number of pods on rape plants and soil hardness.

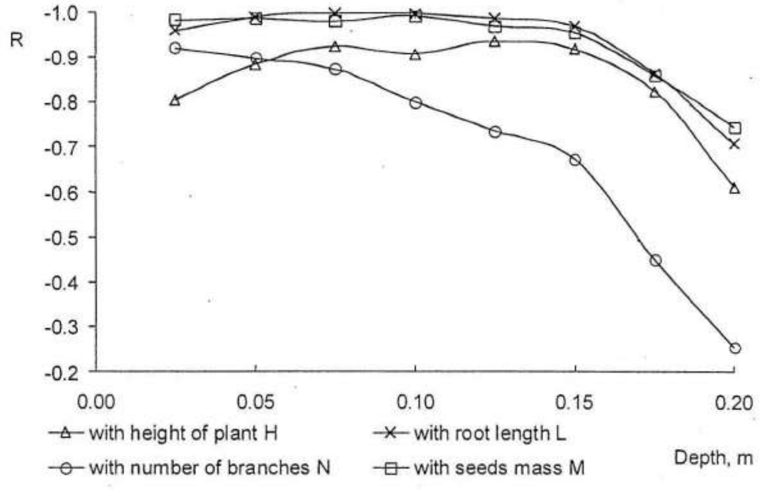

Fig. 3. Coefficient of correlation between soil hardness at different depth and plants indexes.

The greatest influence of soil hardness on plants is at a depth up to 0.15 m, as on this depth the main part of the rape root system occurs. The correlation of harvest structure indexes and soil hardness on a depth of more than 0,2 m is sharply decreasing.

The dependency of plant height parameters and seed yield from average soil compaction is given in pictures 4 and 5. The greatest values of soil hardness correspond to sites which are at a short distance from the field edge, i.e. the turning zone. A soil compaction increase to 0.1 MPa leads to a seed mass decrease from one plant to 5.0 ... 8.5 %. The tight correlation (R= -0.951) testifies the negative influence of soil hardness on one plant seed harvest and, consequently, on rape productivity as a whole.

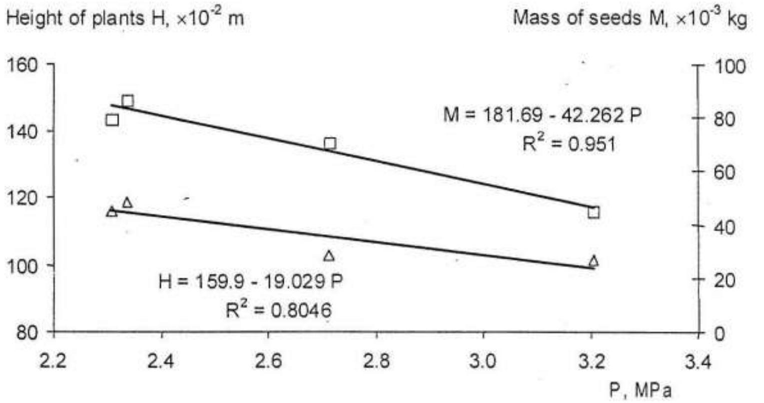

Figure 4. Dependency of one plant plant height H and seed mass M from the average soil hardness

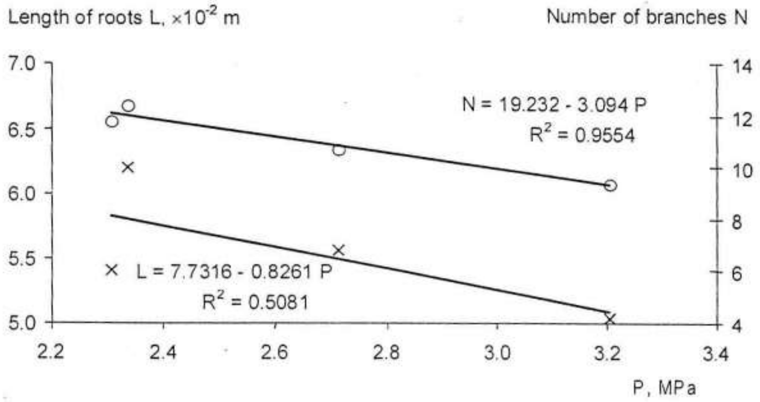

Figure 5. Dependency of average one plant height H and seed mass from soil hardness

Conclusions

Soil compaction conditions caused by rape cultivation technology is saved by harvest time. Soil density on the depth up to 0,15 m influences plants growth indexes and yield to the highest degree.

Experiment results prove the complex approach needed to solve soil compaction problems Decompaction special measures on those plots that are subject to compaction due to technological reasons are especially necessary.

References

Afanasiev N.I., Podobedov I.I., Orda A.I., 1987. Dernovo-pozolistye pochvy Belorusii. In: Pereuplotnenie pakhotnykh pochv. Printsipy, sledstvija, puti umneshenija. Moskva, Nauka: 46-59.

Klotchkov A., Duben I., 2000. Problems of soil compaction in Belarus. In: Supplement of 2nd Workshop and International Conference on Subsoil Compaction, Gödöllo (Hungary): 117-124.

Kononov A. M., 1993. Predposevnoe razuplotnenie pochvy. MinsK, Uradjhai, 104 pp.

Trufanov V. V., 1989. Glubokoe chiselevanie pochvy - Moskva, Agropromizdat, 140 pp.