THE EFFECT OF UNCULTIVATION AND GREEN MANURING ON SOIL RESISTANCE AND SOIL HUMIDITY

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SUMMARY

The objectives of our measurements were to study the effect of uncultivation and lupin green manuring on Westsik experimental plots considering soil compactness. The experiments were conducted on F1 and F2 experimental plots of the Nyíregyháza research centre of Debrecen University. The plots are sandy, located on a hill, representing the diversity of sandy soils of the Nyírség area. Potatoes were grown on the experimental plots. The F1 plot was uncultivated, the F2 plot was green lupin manured.
Evaluating the penetration resistance data we concluded, that soil resistance was bigger in uncultivated plots, than in green lupin manured plots. The soil resistance was less on green lupin manured plots, when the soil humidity figure were less, then on uncultivated plots.
It was proved, that besides increasing soil fertility, green manuring improves the soil structure as well. Working lupin into the soil improves soil structure, the ploughed green mass, and the decomposed roots diminish soil compactness.

INTRODUCTION, SURVEY OF LITERATURE

Data, indicating the decreasing humus content of Hungarian soils were published by Ángyán and Menyhért (1989). Comparing data by Baranyai (1987) and Ballenegger (1917) it was shown, that while in 1917 the average value of humus content of cernoziom and meadow soil was 5,22% and 6,28% in 1987, so high humus values did not occur. The mean values varied between 2,65 and 2,82%. The reduction of humus content was accounted for the less manuring and the decrease of the biological activity of the soils, the rare application of crop rotation, the losses by erosion and deflation. (Balla 1958, Láng 1960, Lőrinc 1978, Madas 1985).
The soil degradation is accompanied by worsening soil strucure, resulting in a bigger mass volume of the soils. From 1,1-1,3 g/cm^3 it has increased to 1,5-1,7 g/cm^3. (Sipos 1978, Láng 1987, Birkás 1989).
This is caused by the flack of organic matter, the reduced biological activity, and improper soil cultivation. (Hajdú 1987, Ángyán – Menyhért 1989).
Deep rooted plants increase soil cover, while rich-rooted plants improve the soil structure, permeability, and nutrition-economy.
The crops resist summer drought for a longer time, the danger of erosion is avoided. Organic matters in the soil increase the biological activity in the soils. A good crop rotation protects the soils. (Hawoord, 1985).
Leguminous plants in crop rotations improve water, air and nutrition content in the soils, we can increase organic matter content, including N, and they also have a beneficial effect on soil structure and cultivation. (Jenkinson 1977, Stinner-House 1987).

It is clear, de organic matters in the soils have a geat importance in protecting soil fertility and structure. It is even more important for sandy soils. Vilmos Westsik recognised it and started his experiments to improve sandy soils in 1929 on the outskirts of Nyíregyháza.
The experiments includes 14 crop rotations in 3 stages and 1 crop rotation in 4 stages is an unique modelling of the effects of uncultivation, manuring, green manuring and chemical fertilisers on soil fertility. In 1998 Lazányi, the head of the Nyíregyháza research centre enabled us to conduct penetration tests on experimental plots and use the measuement data for our research work. Our objectives were to tell the differences in soil compactness, as a result of different soil improving measures.

MATERIAL AND METHOD

Shifting sands comprises the experimental plot, located on sand hills. Comparing various treatments we should see to it, that samples have to be taken from the same sea level location. The measurements were completed for 15 crop rotations. However, only the 1st and 2nd crop rotation measurements are presented in this work.
The crop rotations are divided into 3 parts. In 1929, when the experiments started, statistical methods were not applied, so the treatments were not repeated, and each plant was sown every year.

I. crop rotation (F1) presentation
The 1st crop rotation is modelled on traditional cultivation. In the 3 phased crop rotation potatoes and rye were grown besides leaving the soil uncultivated.
The phases of the crop rotation:

1. uncultivated, weeds were ploughed in before their flowering,
2. rye, without mineral fertilisers,
3. potatoes, without mineral fertilisers.

II. crop rotation (F2) presentation
Soil improvement with lupin green manuring. Besides growing potatoes and rye lupin green manure was applied. Using most of the vegetation period to grow lupin, and plough it, when it is in its biggest green mass.
The phases of the crop rotation:

1. lupin green manure as main sowing with P, K mineral fertilisers,
2. rye with P, K mineral fertilisers,
3. potatoes, with N mineral fertilisers..

The measurements were made on the areas planted with potatoes.
9-9 spots were chosen for sample taking, with a distance of 15 m between them. 6 measurements were completed at each spot.
A 3T SYSTEM electronic equipment was used to measure the penetration resistance of the soil. It measures the soil resistance at 60 cm depth, at 1 cm intervals in kPa, and the soil humidity in the 2,5 volume percent of the soil water capacity. The values are stored in a RAM, and the data can be transferred to a computer with an interface (Sinóros, 1999).

For a comparative graphic presentation of the data the Excel program was used. To demonstrate the truth of various comparisons in a statistical way, a one factor variation analysis was applied (Barát, 1996).
In the two crop rotations comparisons were made at the sample taking locations. The 1st sample taking location of the F1 plot was compared to 2nd sample location of the F2 plot. This way, locations on the same sea level were compared. Out of the 9-9 sample locations 3-3 locations are evaluated. The N°3 sample location is situated on the western hillside, the N°5 sample location on the top of the hill, the N°9 is situated on the eastern hillside. During the comparisons the measurement values were averaged out at every 5 cm in the function of depth.

THE RESULTS AND THEIR EVALUATION

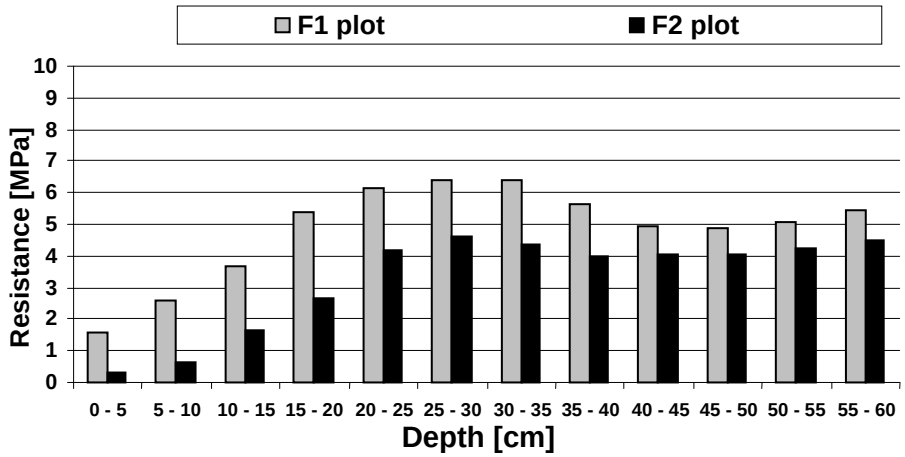

Fig.1. Soil resistance at N°3 sample location

Depth [cm]	F1	F2	Δ parc			SzD5%	SzD10%
0-5	1,59	0,30	1,29	*	**	1,16	0,79
5-10	2,61	0,64	1,97	*	**	1,88	1,28
10-15	3,65	1,63	2,02	*	**	1,25	0,85
15-20	5,37	2,66	2,71	*	**	1,49	1,01
20-25	6,16	4,19	1,97	*	**	1,55	1,05
25-30	6,41	4,60	1,81			3,08	2,09
30-35	6,39	4,35	2,03	*	**	1,91	1,29
35-40	5,65	4,01	1,64	*	**	1,01	0,68
40-45	4,92	4,08	0,84	*	**	0,59	0,40
45-50	4,86	4,07	0,79	*	**	0,35	0,24
50-55	5,06	4,22	0,84		**	0,88	0,60
55-60	5,43	4,51	0,93			2,01	1,37

* : significant differences, P = 5 % ** : significant differences, P = 10 %

Table 1. Results of the significant differences of soil resistance between F1 and F2 plots at N°3 sample location.

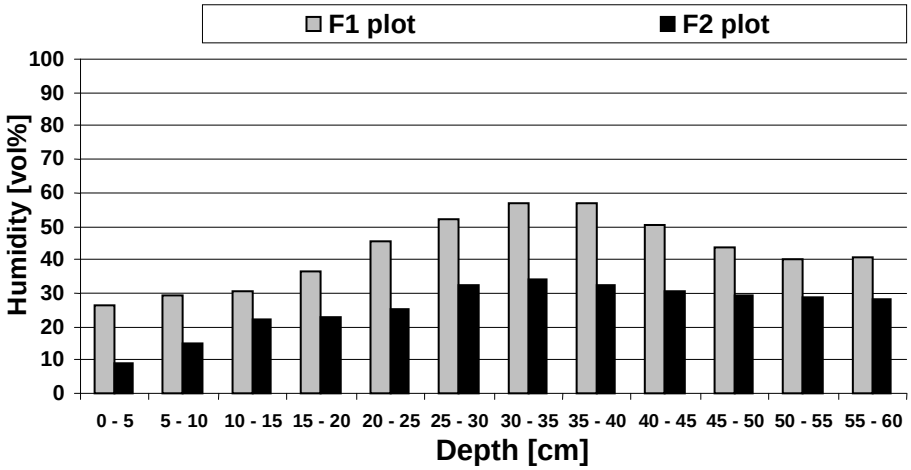

Fig.2. Soil humidity at N°3 sample location

Depth [cm]	F1	F2	Δ parc			SzD5%	SzD10%
0-5	26,07	8,87	17,20	*	**	13,45	9,13
5-10	29,07	15,13	13,93	*	**	4,62	3,13
10-15	30,80	22,20	8,60			12,77	8,67
15-20	36,27	22,87	13,40	*	**	9,97	6,77
20-25	45,33	25,20	20,13	*	**	2,50	1,70
25-30	52,07	32,13	19,93	*	**	3,23	2,19
30-35	56,67	33,93	22,73	*	**	4,02	2,73
35-40	56,93	32,53	24,40	*	**	10,76	7,30
40-45	50,07	30,73	19,33		**	20,61	13,98
45-50	43,60	29,33	14,27		**	18,70	12,69
50-55	40,00	28,80	11,20	*	**	8,48	5,75
55-60	40,73	28,13	12,60	*	**	1,72	1,17

* : significant differences, P = 5 % ** : significant differences, P = 10 %

Table 2. Results of the significant differences of soil humidity between F1 and F2 plots at N°3 sample location.

Fig 1 shows the soil resistance values at N°3 sample location in plots F1 and F2. Fig. 2. shows the soil humidity values at the same spot. Table. 1. gives the comparisons results for plots F1 and F2. referring to soil resistance, while Table 2 gives them referred to soil humidity at N°3 sample location. Fig. 1. shows that soil resistance values for both cultivations vary in a similar way in the function of depth. In the case of lupin green manuring soil resistance values are less, than for uncultivated areas. The least differences are at 45-50 cm depth is 0,79 Mpa, while the biggest difference at 15-20 cm soil depth is 2,70 Mpa. Fig. 2. shows, that soil humidity values for both ways of cultivation vary in a similar way. Calculated for the whole soil depth, soil humidity values are less, than on uncultivated areas. The least difference at 10-15 cm soil depth is 8,6 volume percent,

while the biggest is 24,4 volume percent at 13-40 cm soil depth. The above mentioned differences are considered significant for the whole soil depth range. Humus content of F1 plot was 0,48%, while it was 0,60% for plot F2 (Lazányi, 1994).
It is clear, that the greater organic matter contents can nourish a bigger mass of plants, which use a greater amount of water. This accounts for the less water humidity in plot F2. As even at less soil humidity values the soil resistance values are less, the soil compactness reducing effect of lupin as a green manure, is proven.

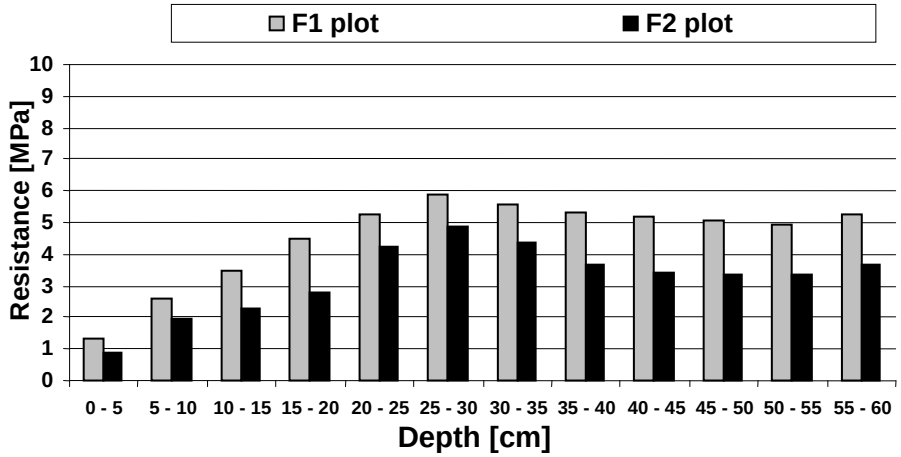

Fig.3. Soil resistance at N°5 sample location

Depth [cm]	F1	F2	Δ parc			SzD5%	SzD10%
0-5	1,33	0,87	0,47			0,95	0,65
5-10	2,57	1,97	0,59		**	0,79	0,54
10-15	3,51	2,30	1,21	*	**	1,02	0,69
15-20	4,52	2,81	1,71	*	**	1,54	1,05
20-25	5,25	4,25	0,99		**	1,02	0,69
25-30	5,89	4,87	1,03			2,45	1,66
30-35	5,55	4,36	1,19	*	**	1,15	0,78
35-40	5,29	3,67	1,62	*	**	0,50	0,34
40-45	5,21	3,39	1,81	*	**	0,34	0,23
45-50	5,05	3,38	1,67	*	**	1,01	0,68
50-55	4,93	3,37	1,55		**	1,64	1,11
55-60	5,26	3,67	1,59			3,23	2,19

* : significant differences, P = 5 % ** : significant differences, P = 10 %

Table 3. Results of the significant differences of soil resistance between F1 and F2 plots at N°5 sample location.

Fig 3. shows soil compactness values in plots F1-F2 at No5 sample location.
Fig. 4. shows soil humidity values at the same spot. Table 3 shows, the results of comparisons referring to soil resistance between plots F1 and F2 at No5 sample locations, while Table 4 gives data referring to soil humidity.

Fig. 3. shows, that soil resistance values at both cultivation types vary similarly in the function of soil depth. In case of lupin manuring the soil resistance values, referring to the whole soil depth are less, than on the uncultivated spot. The least difference is 0,47 Mpa at 0-5 cm soil depth, the biggest is 1,8 Mpa at 40-45 cm soil depth.

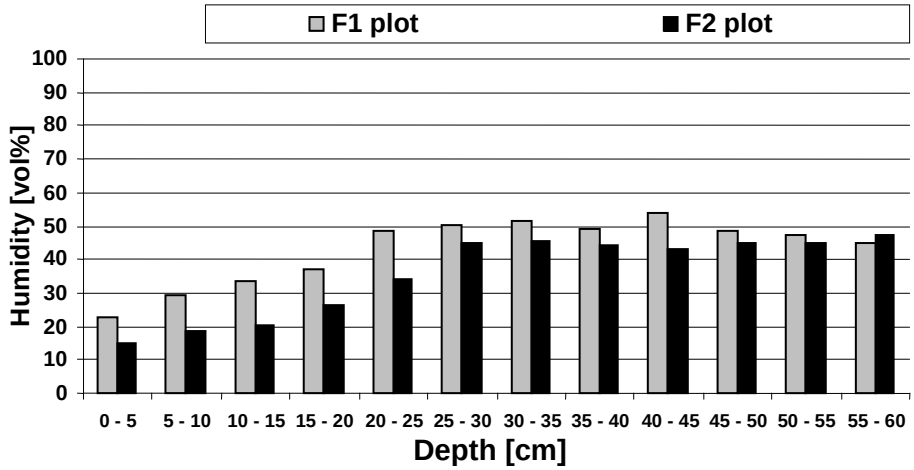

Fig.4. Soil humidity at N°5 sample location

Depth [cm]	F1	F2	Δ parc			SzD5%	SzD10%
0-5	22,87	14,87	8,00			16,15	10,96
5-10	29,60	18,33	11,27			18,12	12,30
10-15	33,60	20,40	13,20			31,39	21,30
15-20	36,87	26,13	10,73			31,86	21,62
20-25	48,27	33,87	14,40		**	19,87	13,49
25-30	50,40	44,80	5,60			31,30	21,24
30-35	51,33	45,40	5,93			33,97	23,05
35-40	49,13	44,13	5,00			24,78	16,81
40-45	53,87	43,27	10,60			33,56	22,78
45-50	48,67	44,87	3,80			24,28	16,48
50-55	47,20	44,73	2,47			16,67	11,32
55-60	44,87	47,13	2,27			5,82	3,95

* : significant differences, P = 5 % ** : significant differences, P = 10 %

Table 4. Results of the significant differences of soil humidity between F1 and F2 plots at N°5 sample location.

Fig. 4. shows, that soil humidity values vary similarly in the function of soil depth at both cultivation types. However, the differences are less, than in case of N°3 sample location. Apart from less humidity differences the soil resistance values for plot F2 are less, and in most cases they are considered significant.
So, lupin green manuring results in less soil compactness, lupin makes soil looser.

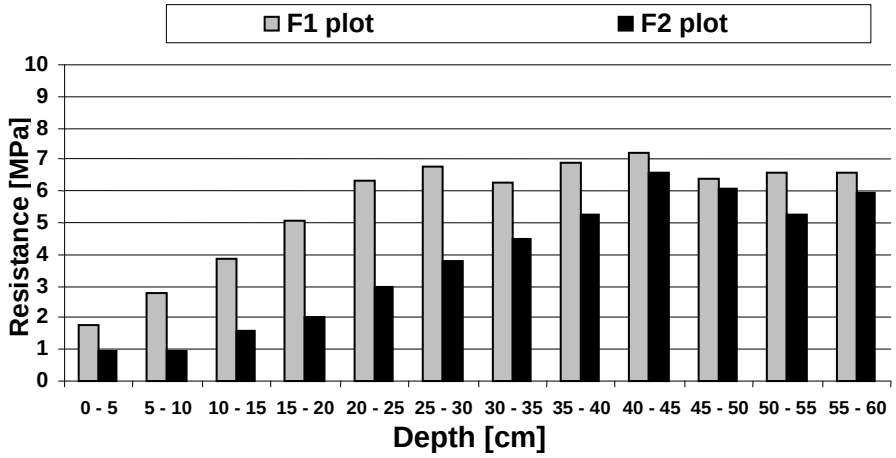

Fig.5. Soil resistance at N°9 sample location

Depth [cm]	F1	F2	Δ parc			SzD5%	SzD10%
0-5	1,80	0,93	0,87			1,66	1,13
5-10	2,80	0,97	1,83	*	**	0,41	0,28
10-15	3,83	1,56	2,27	*	**	2,04	1,39
15-20	5,08	2,00	3,08	*	**	0,05	0,03
20-25	6,32	2,97	3,35	*	**	1,17	0,79
25-30	6,79	3,79	2,99	*	**	1,82	1,24
30-35	6,29	4,50	1,79			3,91	2,65
35-40	6,91	5,26	1,65			3,93	2,66
40-45	7,20	6,57	0,63			3,89	2,64
45-50	6,41	6,08	0,33			3,90	2,64
50-55	6,61	5,26	1,35			3,28	2,23
55-60	6,55	5,97	0,58	*	**	0,52	0,35

* : significant differences, P = 5 % ** : significant differences, P = 10 %

Table 5. Results of the significant differences of soil resistance between F1 and F2 plots at N°9 sample location.

Fig. 5. shows the soil resistance values at 9 sample spot in plots F1 and F2. Fig. 6. shows soil humidity values at the same place. The Table 5 gives the comparative values between plots F1 and F2 referring to soil resistance, while Table 6 gives them referring to soil humidity.

Fig 5 shows, that the soil resistance of the uncultivated plots to 40 cm soil depth is significantly bigger than on green manured plots. The greatest difference at 20-25 cm soil depth is 3,35 Mpa. Over 40 cm soil depth the differences are less. The least difference at 45-50 cm soil depth is 0,33 Mpa. Significant differences can be found between 0,30 cm and 55-60 cm soil depth.

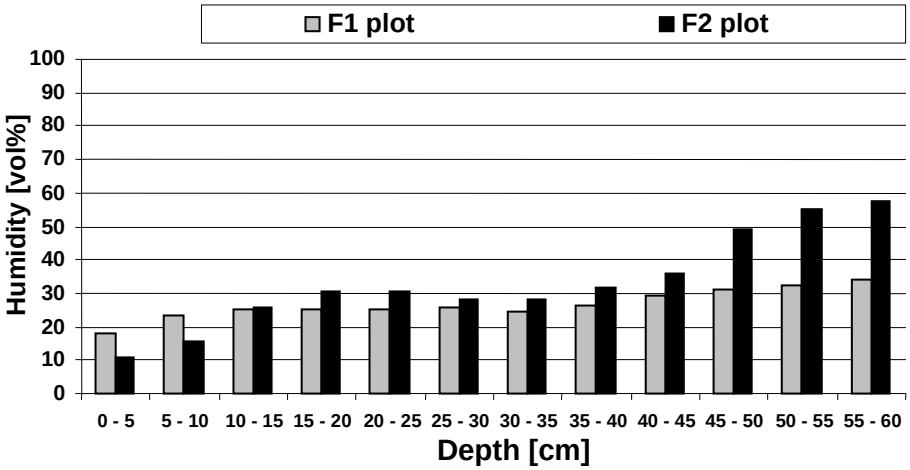

Fig.6. Soil humidity at N°9 sample location

Depth [cm]	F1	F2	Δ parc			SzD5%	SzD10%
0-5	18,07	10,80	7,27		**	9,06	6,15
5-10	23,33	15,87	7,47		**	10,06	6,83
10-15	25,40	25,93	0,53			14,66	9,95
15-20	25,00	30,73	5,73			18,89	12,82
20-25	25,20	30,80	5,60			25,08	17,02
25-30	25,93	28,33	2,40			12,92	8,77
30-35	24,80	28,40	3,60			7,74	5,26
35-40	26,27	31,93	5,67			16,53	11,21
40-45	29,53	35,93	6,40			21,50	14,59
45-50	30,93	49,13	18,20			30,09	20,42
50-55	32,47	54,80	22,33		**	23,44	15,91
55-60	34,00	57,53	23,53	*	**	3,59	2,44

* : significant differences, P = 5 % ** : significant differences, P = 10 %

Table 6. Results of the significant differences of soil humidity between F1 and F2 plots at N°9 sample location.

Fig. 6. shows, that the humidity of uncultivated plots is bigger only to 10 cm soil depth, than in the case of lupin green manured plots. However, below 10 cm soil depth, on lupin green manured plots, humidity figures are increasing. The greatest difference at 55-60 cm soil depth is 23,53 volume percent. Significant differences can be found only at 55-60 cm soil depth.

At N°9 sample spot soil humidity values on plots F1 and F2 show various tendencies in the function of soil depth. Between 0-10 cm soil depth on plot F1 was more humid, then F2. In spite of it, soil resistance values throughout the tested soil depth were less, than on uncultivated areas.

CONCLUSIONS

Evaluating penetration measurements it was concluded, that soil resistance values at all sample spots were bigger, than in lupin green manured crop rotation. Soil resistance values of lupin green manured plots were less, even when the soil humidity was less, than on uncultivated areas. It was proven, that green manuring besides improving fertility of sandy soils, improves the soil structure, too. Lupin green manuring improves soil structure, the ploughed in green mass, the decomposed root remnants diminishes the soil compactness.

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