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EVALUATION OF SELECTED PHYSICAL PROPERTIES OF SOIL IN THE VINEYARD

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Abstract

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There is registered approximately 18 000 ha of intensive vineyards in this time in Czech Republic. The intensive viticulture production is represented by high amount of working operations which are practised by using of mechanization. Frequency of passages by mechanization in interrow of descent is different by single variants of production processes. Their currently number varies about 20–25 per season. The soil compression is the highest in wheels tracked lines and middle of the interrow. If the compaction reaches over the critical limit, it can be this state escorted by weighty incidence (decrease of decree, increasing by power severity by soil cultivation and other). These contributions deal with analysis of soil compression in different areas in the region of the South Moravia. The used methods were undisturbed sample and penetration resistance with using of penetrometer.

vineyard, penetration resistance, penetrometer

The soil in the perennial plantations (vineyards, orchards) is a major problem of technogenic compaction. It is mostly evident in the vineyards, where mechanization performs each work operation during vegetation, passing through the soil surface and defined the lines (wheels tracks).

Many crossings of mechanization performed often under unsuitableof physical conditions of the soil (increased soil moisture) cause soil compaction, which is reflected in the convergence between soil particles (increased density of the soil). The degree of soil compaction depends not only on the weight of the machines per axle and secondary contact pressures on the land, but significantly on the actual resistance of the soil to compress. Certain soil load may have a different response of the soil during the year, depending primarily on the actual soil moisture and spatial distribution of organic matter, that is the degree of loosening or soil compaction (HŮLA, 1988).

Soil compaction is often associated with increase of cloding, increase of the tensile resistance of the soil, decrease of the soil edaphon etc. Concerning the vine plants, this situation may cause the limited uptake of certain nutrients and be followed by the development of chlorosis, in extreme cases the plants gradually die. Also the conditions of the produce worsen. Soil compaction is also associated with the serious environmental risks, such as increased surface water drainage causing water erosion, with subsequent potential for contamination of water resources (HŮLA, 2006).

The process of compaction and the measuring the degree of the soil compaction, were subjects of reaserch of many authors (BERAN, 1990; ŠAŘEC, 1997; POKORNÝ, 2008; HŮLA, 2008 and others). Accurate detection of carrying capacity of soil in the field conditions is problematic and depends on many variable and constant factors (humidity, structure, chemical composition, size of soil particles, etc.). The common and fast way of detection of terrain passability is measuring by penetrometer (ULRICH, 2004).

This paper aims to evaluate penetration resistance of soil in different soil types in the grassy alleyway and cultivated alleyways in vineyards.

MATERIAL AND METHODS

Experimental measurements were performed at three sites in the cadastral area of Lednice, Valtice and Velké Bílovice, in the second half of April 2010.

Locality 1: 18 years old vineyard, consisting of a variety (Blaufränkisch, Blauer Limberger), is grown at a high lines with a drawing, the spacing is 2.5 x 1.0 m, with a supporting structure of wooden posts of the height of 1,8 m. Every second alleyway is grassed. Soil type, according to estimated pedologic-ecological unit marked as 0.01.00, which represents the modal black soil. It is therefore a medium-heavy soil with no skeleton, very deep, mostly with favorable water regime. Slope of the land was 0–3% (flat). Average water content in topsoil was 20.9% of the weight.

Locality 2: vineyard 29 years old, consisting of a variety Irsay Oliver, is grown on high lines with two drawings in 2.8 x 1.0 m spacing, with a supporting structurs of concrete posts of the height of 2.0 m. Every second alleyway is grassed.

Soil type, according to estimated pedologic-ecological unit marked as 0.08.50, which represents the blacksoil pelic, carbonate. Soil is represented by loess, loess soils and slope soils, moderate and heavier, mostly without a skeleton and a higher sloping (5–10%). Average water content in topsoil was 19.4% by weight.

Locality 3: 9 years old vineyard consisting of a variety Pinot gris, is grown on a high lines with two drawings, the density of planting is 2.5 x 1.0 m, with a supporting construction of concrete pillars with a height of 2.0 m. Every second vineyard alleyway was grassed.

Soil type, according to estimated pedologic-ecological unit marked as 0.06.01, which represents a typical carbonated chernozem on marl (marlstone) and clay substrates. It is therefore a heavy soil with a lighter topsoil and heavy base, occasionally overmoistened Slope of the land was 0–3% (flat). The soil was blended with a weak skeleton. Average water content in the topsoil was 23% of the weight.

Penetration resistance of soil layers in the soil horizon was measured using a penetrometer (type PN 10). The device consists of measuring needle tip, tensometric load cell sensor, optical sensor measuring the depth with a ruler, evaluation electronics with a microprocessor and battery.

The measurement was carried out alternatively in a grassy and cultivated alleyway of vineyards. Individual punctures were performed in the rolling lines and in the middle of an alleyway. Control punctures were performed between the bushes on the axis lines.

In each variant was performed 20 punctures in a randomly chosen places. To evaluate the results were used standard statistical parameters (arithmetic average, standard deviation).

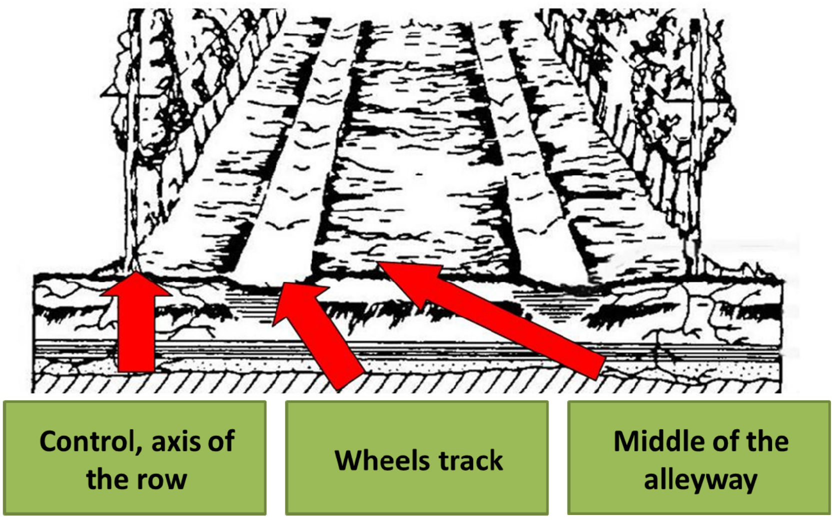
RESULTS AND DISCUSSION

The measured values of soil penetration resistance from all localities and experimental variations are presented in a tables I–III. Results of penetrometric curves are shown in Chart 1–5.

The results obtained showed that the highest increase in soil penetration resistance occurs at depths of up to 120 mm. Overall, higher values were measured at the location No. 3 (Velké Bílovice) with severe soil.

SVOBODA, ZEMÁNEK (2005) report that grass cover in the alleyway vineyard is able to dampen the intensity of soil compaction. Similarly, PEACOCK (1999) refers to the positive effect of grass cover, eventually artificially sown plants (eg barley, rye, oats) have favorable efect to the soil structure, which helps to reduce the extent of compaction.

The measurement results at localities 1–3 did not confirm this hypothesis (Chart 1 and Chart 2). The reason for this result might be given to using the grassed alleyway with regard to climatic factors (especially rainfall) for passage of machines and kits in previous years.



1: *Vineyards line showing location of measurements*

I: *Measured values of soil penetration resistance – locality Lednice*

Depth of measurement [mm]	Grassing alleyway		Black fallow		Control
	Wheels track	Middle of alleyway	Wheels track	Middle of alleyway	Axis of the row
	Penetration resistance of soil [MPa]				
40	1	1.4	0	0.2	0.7
80	2.4	2.1	0.1	0.5	1.5
120	3.9	3.2	1.4	0.8	2.3
160	3.7	2.8	3.2	1	2.4
200	3	2.7	4.6	2.8	2.3
240	2.9	2.7	6.1	3.5	2.2
280	2.9	2.6	6.4	3.7	2.3
320	2.8	2.5	6.8	3.8	2.5
360	2.4	2.6	6.7	3.9	2.5
400	2.3	2.5	6.7	4	2.3
440	2.1	2.3	6.4	3.9	2.2
480	2.1	2.1	6.3	4.1	2.1
520	2.1	2.2	6.4	4.2	2.2
Average	2.58	2.43	4.7	2.8	2.11
Standard deviation	0.72	0.417	2.51	1.49	0.47

II: *Measured values of soil penetration resistance – locality Valtice*

Depth of measurement [mm]	Grassing alleyway		Black fallow		Control
	Wheels track	Middle of alleyway	Wheels track	Middle of alleyway	Axis of the row
	Penetration resistance of soil [MPa]				
40	0.42	0.82	0.27	0.02	0.32
80	1.19	2.12	0.82	0.22	0.96
120	1.59	2.76	1.23	0.56	1.35
160	1.63	2.71	1.46	1.04	1.51
200	1.79	2.85	1.64	1.55	1.69
240	1.85	2.97	1.70	1.80	1.76
280	1.88	2.89	1.73	1.94	1.82
320	1.88	2.71	1.77	2.02	1.85
360	1.72	2.42	1.73	1.98	1.76
400	1.66	2.23	1.79	1.98	1.76
440	1.78	2.26	1.94	2.07	1.85
480	1.95	2.37	2.06	2.15	1.99
520	2.22	2.67	2.12	2.09	2.17
Average	1.65	2.44	1.55	1.491	1.60
Standard deviation	0.422	0.54	0.49	0.74	0.46

Another reason may be generally reduced the possibility of loosening and aeration of the soil in grassed alleyway.

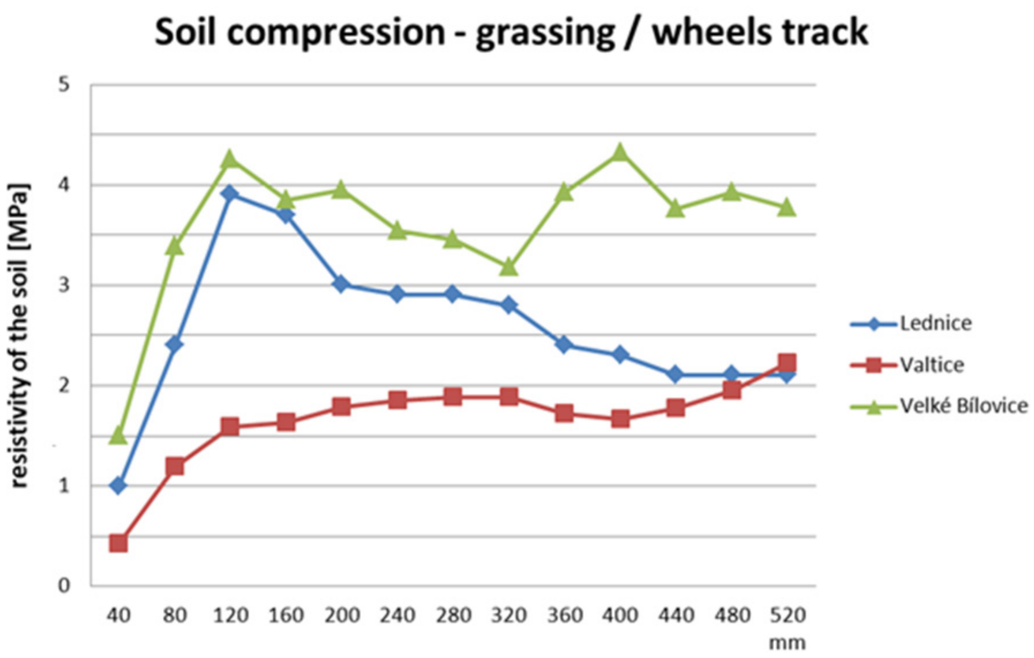
According NÉMETHY (2006) ground cover plants may in certain moments have a negative efect. The reason is as increased soil moisture, which is kept under the grass mulch and contributes to increased transmission of contact pressures often to greater depths.

The results show that at depths of 40–120 mm are shown to lower values of penetration resistance in cultivated alleyway, which is probably due to its regular digging through V-sweep or rotary hoes (Chart 3 and Chart 4).

POKORNÝ (2008) stated that the regularly cultivated soils can maintain a more favorable physical properties throughout the growing season. As critical limit penetration resistance considered a pressure 3.5 MPa. This value is closer to or exceeded the

III: *Measured values of soil penetration resistance – locality Velké Bílovice*

Depth of measurement [mm]	Grassing alleyway		Black fallow		Control
	Wheels track	Middle of alleyway	Wheels track	Middle of alleyway	Axis of the row
	Penetration resistance of soil [MPa]				
40	1.51	1.35	0.33	0.11	0.06
80	3.39	2.19	1.11	0.23	0.37
120	4.26	3.84	2.38	0.65	0.63
160	3.85	3.82	2.25	1.30	1.11
200	3.95	3.66	2.06	1.94	1.66
240	3.54	3.26	1.95	2.10	1.85
280	3.45	3.41	1.99	2.26	1.87
320	3.18	3.57	2.26	2.72	2.02
360	3.93	3.58	2.23	2.90	2.16
400	4.32	3.79	2.33	2.97	2.21
440	3.77	3.70	2.32	2.90	2.42
480	3.93	4.03	2.64	3.34	2.44
520	3.77	4.07	2.94	3.46	2.56
Average	3.60	3.40	2.06	2.06	1.64
Standard deviation	0.68	0.75	0.64	1.11	0.80



2: *Values of soil compaction – alleyway with grass, wheels track*

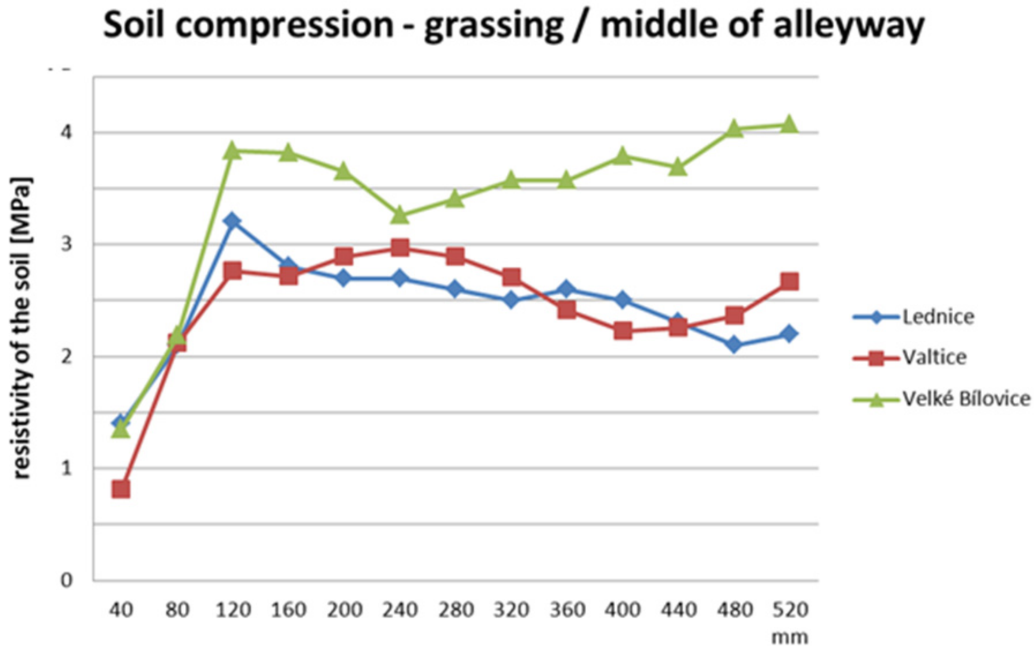
experimental variation of grassed interow at all investigated sites.

In a conditions of Hungary conducted the evaluation of soil compaction on light sandy soils Németh (2006). His results show that the penetration restistance in a wheels tracks reached soil compaction 2.1 to 3.8 times higher than in the axis line. In an alleyway of vineyards were then measured values from 1.2 to 1.5 times higher.

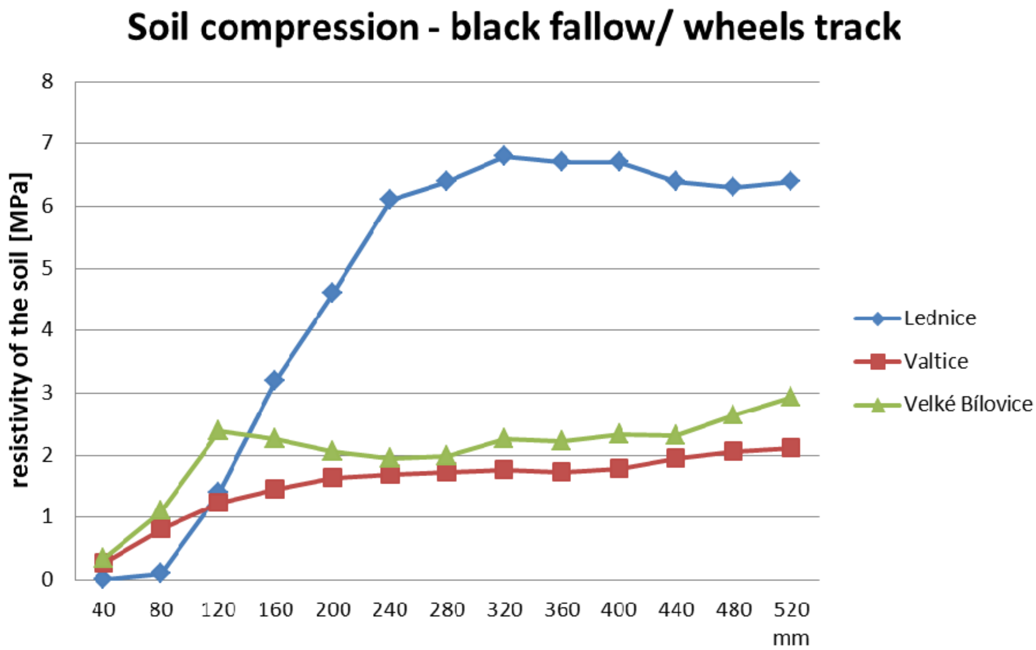
CONCLUSION

The obtained results show the negative impact of mechanization on the of soil compaction. Clearly confirm the higher value of soil compaction in the field of wheels tracks.

Soil compaction in wheels tracks, which are located with respect to the system of cultivation from 0.20 to 0.50 m at a distance from the axis line, affecting the roots of vine in line under plants, where most are extended to a depth of approximately 0.80 m.



3: *Values of soil compaction – alleyway with grass, middle of interrow*



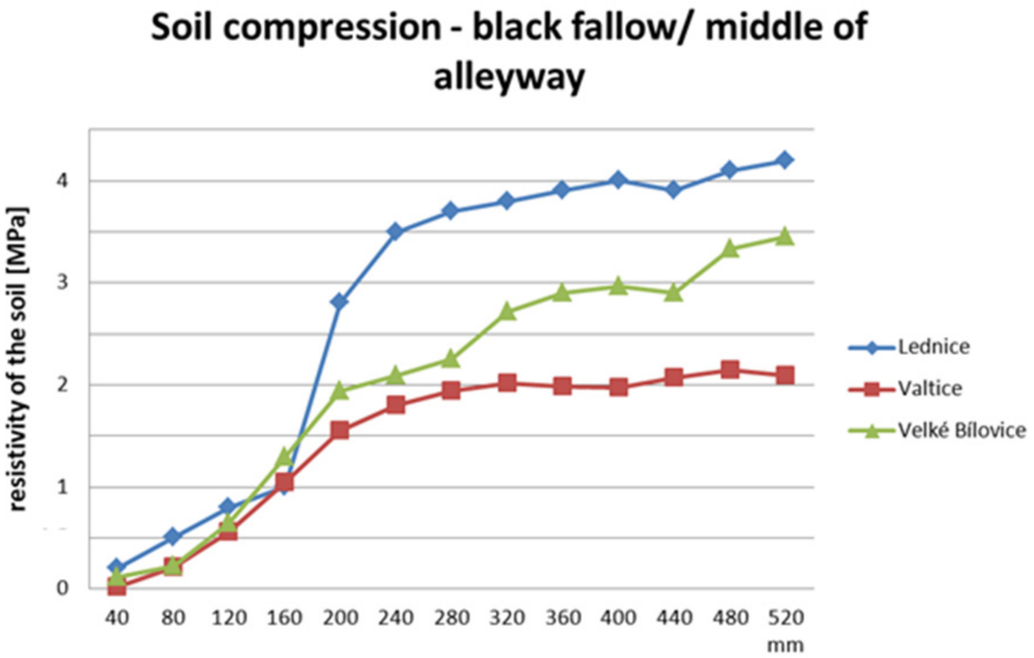
4: *Values of soil compaction – interrow with mechanic cultivation (black fallow), wheels track*

The results of research did not verify the influence of grassing on reducing soil compaction, neither showed significant differences in soil compaction of growing systems.

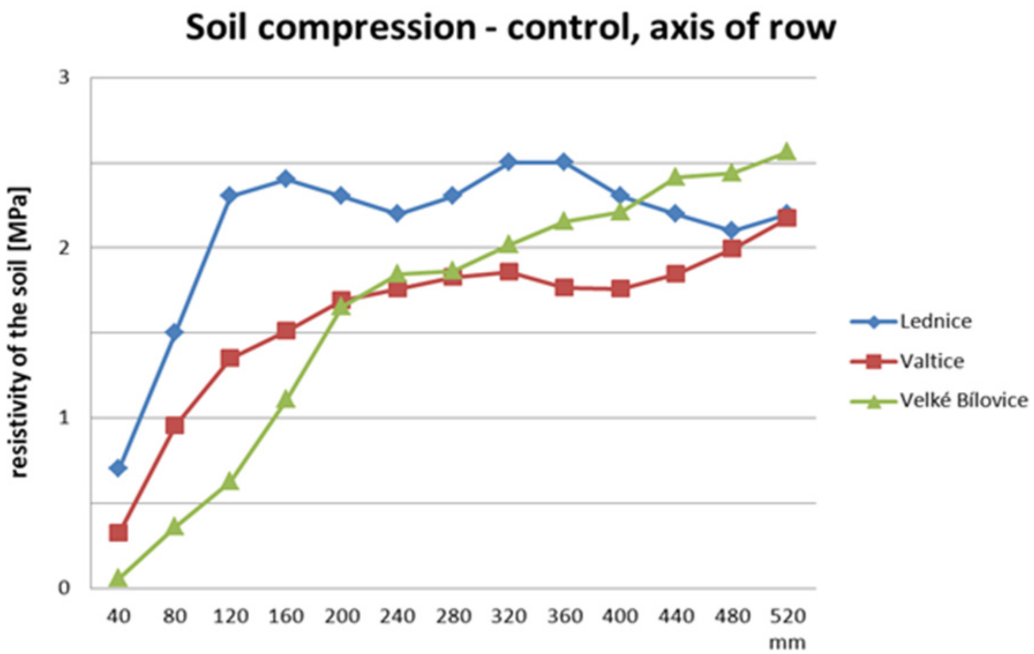
Reduce the soil compaction is possible by combining operations, what is able only if strict compliance with all the agro-technical measures, in addition, subject to sufficient capacity of the tractor engine.

You can not ignore the fact that on the one hand, reducing the number of passes thru alleyway, but on the other hand, increases the total weight of the machine (the transfer of pressure to greater depths).

The situation is associated with requiring the using of high quality tractor tires and four-wheel drive. Specific solutions, and current trends in advanced wine-growing countries to confirm the use of multiportal tractors, whose move the center of the alleyway and remain close to the area beneath the plants.



5: *Values of soil compaction – alleyway with mechanic cultivation (black fallow), middle of alleyway*



6: *Values of soil compaction – control, axis of row*

SUMMARY

Intensive production systems used in the cultivation of vines are associated with frequent use of automated equipment. The frequency of crossing through the alleyway vary, depend on options of technological processes during the growing and can reach up to 20 (25) passes per season.
Of this number accounts for the largest proportion of crossovers associated with chemical protection and harvesting of the grapes.In both cases, have used mechanization combinations higher overall weight (sprayer´s tank is filled with water, tractor trailer filled with grapes), which significantly in-

fluence the impacts on the soil compaction.The results show noticeable compaction of the wheels tracks. Exceeds the critical limit soil compaction of this condition may be accompanied by serious consequences (reduction in yield, increase energy efficiency in the processing compressed soils, dying of vine plants, etc.).The paper deals with the evaluation of soil penetration resistance at three different soil types in vineyards in the growing conditions of South Moravia. The results showed higher values of penetration resistance of soil in the wheels track than in the middle of an alleyway.
The contribution is based on the project No. QH81200 entitled "Optimizing water regime in the countryside and increase the retention capacity of the land by application of compost from biodegradable wastes on arable land and permanent grassland".

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