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WATER EXCESS DRAINAGE DURING OPERATIONS ON AGRICULTURAL LAND FITTED WITH DRAINAGE-DRAINING WORKS IN THE CATCHMENT AREA OF MOLDOVA RIVER, SUCEAVA COUNTY

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Abstract: *For valorising the yield capacity of the moisture excess lands from the hydrographical basin of the Moldova River, Suceava County, they were performed until 1990, dry-drainage out on an area of 8761 ha, of which 3059 ha with underground drainage works. Systems were designed under conditions of land exploitation on drying sectors. Because, as concerns the property rights, they had not in view the direction of suction drains and drying network, individual plots are situated perpendicular, parallel or at a sharp angle towards suction drains and/or drying channels. Soil tillage and especially, mouldboard ploughing on individual plots have resulted with time in land modelling in ridge strips, having variable widths, level differences and transversal slopes according to plot width, way of usage and used equipments. This land modelling has determined the change in the depth of placing suction drains; thus, it has decreased in the ditch area and increased on the ridgeline, having influence on the functional output of suction drains and the uniformity of water excess removal. In order to determine the technical elements of the strips with ridges, accurate elevation-height topographic survey was conducted by the method of radiation and leveling traversing combined with radiations, based on which the transversal and longitudinal profiles were drawn and in order to determine the momentary water component of the soil, samples of soil were collected using a tubular probe, in 10 cm layers, down to 0.8 m and to 1.00 m respectively. In case of land plots parallel to drainage lines, the best water excess drainage was registered when trenches were positioned over drains and the lowest water excess drainage in drains located below ridges. In plots perpendicular to drainage lines, we achieved a water excess drainage relatively closet o that of drains located below ridges. Furthermore, drains located below ridges provide the uniformity of water excess drainage from the drained surface, in plots oriented parallel to absorbing drains and absorbing drains oriented perpendicular to individual plots. Due to the slight likelihood of getting trenches above absorbing draining lines further to individual soil works, it results that the best water excess drainage is achieved on land surfaces where plots are perpendicular to absorbing drains.*

Key words: *excess humidity, underground drainage, individual land plots, ridge-plough land development.*

INTRODUCTION

Moisture excess is one of the most important limitative factors of soil fertility that can diminish very much or even reduce totally the soil fertility. The knowledge of moisture excess is very important, because it acts very rarely as a single limitative factor.

In Romania, the modernization and intensification of agriculture, by applying soil improvement works, are still representing one of the main ways for increasing the soil productive potential, leading to yield increases and, implicitly, to the improvement in standard of living and in people's healthy condition.

Numerous drying, dam-regulation, underground draining and soil erosion control works have been performed, which were designed to turn all the potentially fertile agricultural land, and especially the arable land, which represent about 178,502 ha in Suceava County (i.e. 20.8% of the whole agricultural land of the county), into actually cultivated and productive land (Moca V. et al., 2000).

After making hydro-ameliorative works, a special importance must be given to the mode of their exploitation and behaviour in time, as well as to the evolution of soil physical, chemical and biological characteristics.

MATERIAL AND METHODS

The natural characteristics of the Baia Piedmontese plain, located in the drainage basin of the Moldova middle river (figure 1), support the occurrence and maintenance of excess humidity both in the soil and at soil surface. The Moldova river meadow and strip-shaped 1.5 km wide terraces, which are almost parallel to the Moldova river bed and have mild 1-5% slopes, with plane areas and numerous small depressions, enhance water stagnation.

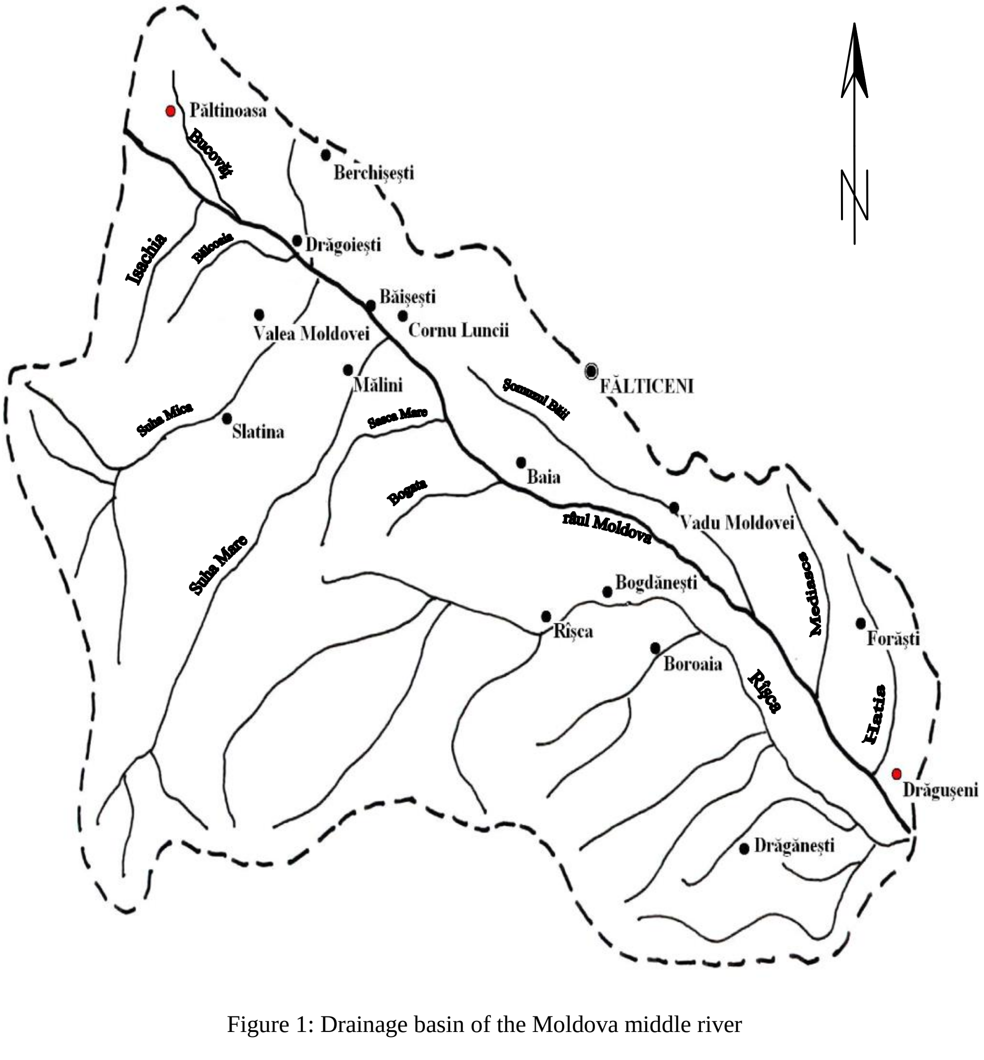


Figure 1: Drainage basin of the Moldova middle river

Excessive precipitations and/or ground water, as well as river system outflow water had various shape and intensity manifestations, both on horizontal land and on slopes.

Between 1978 and 1980, three drying-draining systems (Rotopăneşti-Rădăşeni-Fântâna Mare, Drăgoieşti-Berchişeşti, Bogdăneşti-Baia) and the Băişeşti-Dumbrava irrigation-drying system were developed in the Moldova river basin, in Suceava county, with an overall dried area of 8761 ha, of which 2559 ha enjoyed underground drying works. Between 1980 and 1985, 552 ha of the Băişeşti-Dumbrava drying system were restored and a 500 ha underground drying network was added.

The 126.85 km long drying canals network comprises collecting canals, discharge canals, interception canals, etc. Depending on the type and amount of excessive humidity, the 1575.12 km long underground draining network includes absorbing and collecting drains, designed to remove the excessive soil water.

The land improvements were designed to be used by drainage sectors, yet, beginning with 1991, since at the time, the implementation of laws regarding the establishing and re-establishing of ownership rights, did not take into account future drain lines and the drainage network, therefore the individual tracts of land were arranged either perpendicular, or parallel, or at a sharp angle from the absorbing drains and/ or the drain canals.

For determining the functional output of dry-drainage works, carried out in the meadow of the Moldova River, Suceava County, in the new conditions created after the passage to private landownership, we have conducted the investigations in two observation fields, situated in the Rotopăneşti-Rădăşeni-Fântâna Mare system. The area of this system has 5527 ha, of which 1806 ha have underground drainage works; it is situated on the left side of the Moldova River, including the meadow and terraces, as well as Şomuzul Băii and Şomuzel effluents.

The two fields are situated on the same soil type and are found under the same climatic conditions, being differentiated by the mode of orientation of individual plots to the suction drain lines, which are spaced at 21 m and placed at the depth of 1 m.

The observation field 1 (figure 2) includes six suction drains placed according to the longitudinal scheme, with water discharge directly in the “Dumbrava” Collecting Canal, while plots are parallel to drain lines.

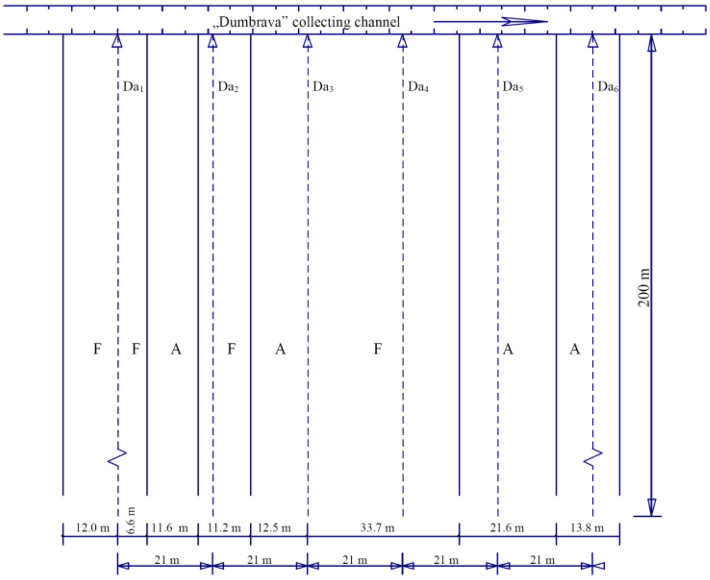


Figure 2: Observation Field 1

By establishing the property right, according to Law no. 18/1991, seven plots were created with widths comprised between 6.60 m and 33.70 m and their mean width of almost 16.00 m.

In the observation field 2 (figure 3), drain lines were placed according to the transversal scheme, almost parallel to the level curves, while individual plots are directed perpendicularly to the direction of suction drains.

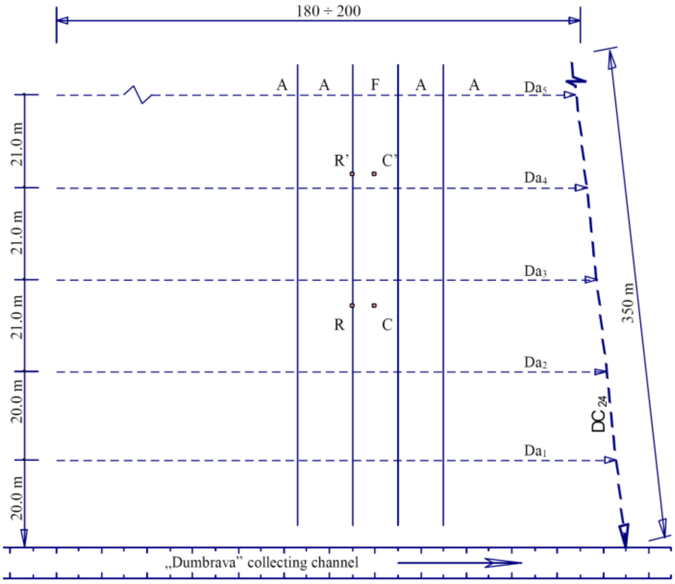


Figure 3: Observation Field 2

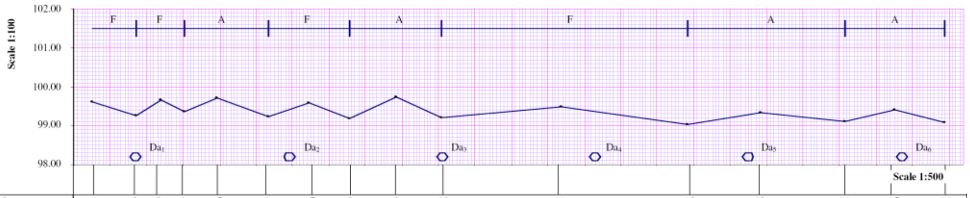
For determining the water content from soil, soil samples were taken at depths 0-80 cm (every 10 cm), by means of the tubular pipe, after a period of 2 days where 56 mm/m^2 rainfall amounts were recorded.

For pointing out land modelling in ridge strips, as an effect of soil tilling on individual dry-drained plots, under conditions of private land ownership, we carried out topographic measurements of accurate geometric levelment. On their basis, we have drawn transversal and longitudinal profiles of the individual plots.

RESULTS AND DISCUSSIONS

By soil tilling on the plots of the observation field 1, it resulted a ridge strip modelling with variable lengths, ditch-ridge level differences and transversal slopes, which varied according to the width of plots, way of usage and used equipments.

In figure 4, there are values of level differences between ditch and ridge, comprised between 0.225 m and 0.558 m and a transversal slope of ridge strips varying between 1.7 % and 11.8 %. We have also found that of the 6 suction drains, 2 drains (Da_1 and Da_3) were placed below ditches, Da_5 and Da_6 below ridges and Da_2 and Da_4 at the middle distance between ditch and ridge. The transversal slope of the ridge strip placed over the Da_4 drain had a lower value (about 2.0%).



Point number	Land elevation (m)	Level differences (m)	Distances (m) Partial	Distances (m) Total	Slope (%)
1	99.617			0.0	
		-0.367	6.0		6.1
2	99.25			6.0	
		0.04	3.4		11.8
3	99.65			9.4	
		-0.3	3.2		9.5
4	99.346			12.6	
		0.365	4.6		7.9
5	99.711			17.2	
		-0.48	7.0		6.8
6	99.232			24.2	
		0.348	5.6		6.2
7	99.580			29.8	
		-0.401	5.6		7.2
8	99.179			35.4	
		0.558	6.4		8.7
9	99.737			41.8	
		-0.539	6.1		8.8
10	99.198			47.9	
		0.274	16.4		1.7
11	99.472			64.3	
		-0.431	17.3		2.5
12	99.041			81.6	
		0.300	10.2		2.9
13	99.341			91.8	
		-0.225	11.4		2.0
14	99.116			103.2	
		0.301	6.8		4.4
15	99.417			110.0	
		-0.343	7.0		4.9
16	99.074			117.0	

Figure 4: Transversal profile through the observation field 1

By analyzing the soil water content values measured on control points spaced 3.50 m apart, on the surface assisted by the Da_3 absorbing drain, located beneath the channel, (figure 5), one may notice that the soil water content values are increasing starting at point P_4 situated upon the drain, and going towards the P_1 and P_7 points, located at 10.50 m (figure 6).

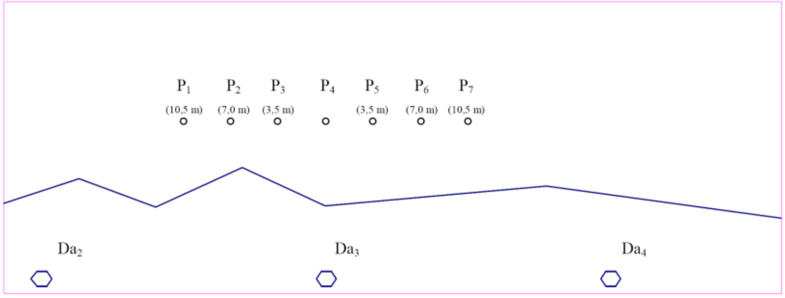


Figure 5: Placing the break points on drain Da_3, below the channel

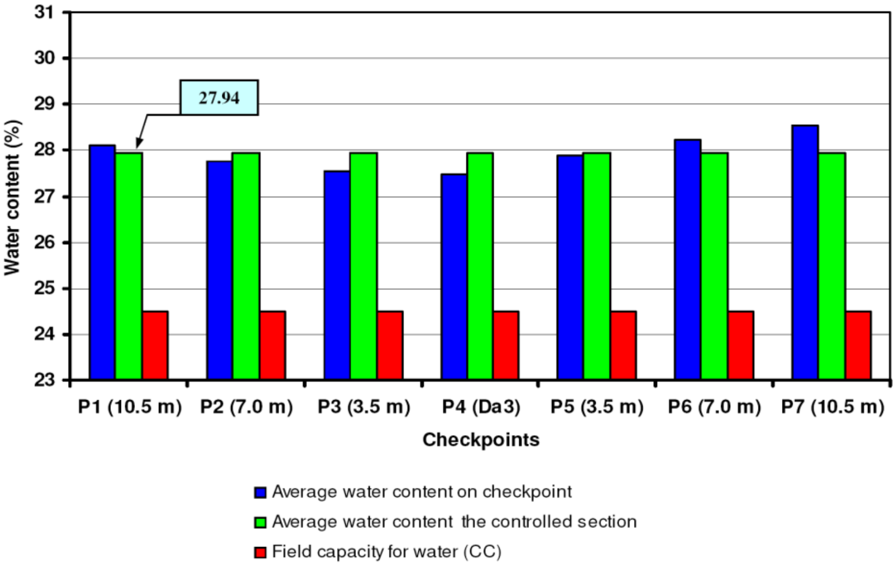


Figure 6: Average water content of soil checkpoints located on drain Da_3

The soil water mean value upon the control section of 27.94% was greater than the field water capacity value (24.50%), at the time the samples of soil were taken, Da_3 drain was still working, draining water in the „Dumbrava" collecting channel.

The amplitude of soil water content mean value upon control points from the section made upon the Da_3 drain, located beneath the channel, was 1.06 percentage units. Also, one notices that the soil water content mean value upon the surface related to $P_1 \div P_3$ control points is lower, of an average value of 27.80%, whereas on the $P_5 \div P_7$ control points the value is greater, 28.23% (figure 7).

That certain differentiation of soil water content values is due to the higher elevation of $P_1 \div P_3$ points, that surface being used as agricultural land, and being modeled in strips with ridges of 12.50 m width, the difference in elevation between the channel and the ridge being some 0.50 m, of a transversal slope of 8,8%, whereas the $P_5 \div P_7$ control points are located in the hayfield, its surface modeled in strips with ridges of 33.00 m width, and of a 1.7% transversal slope.

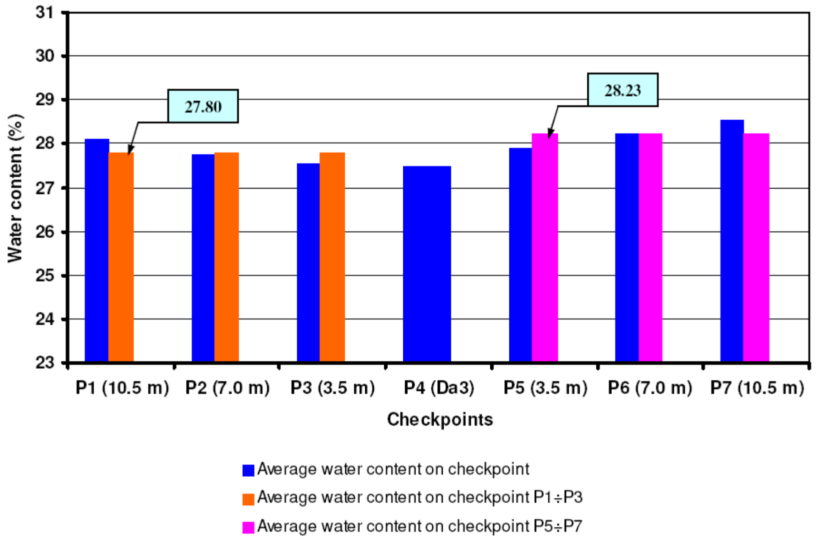


Figure 7: Average water content of soil checkpoints located on the left and right side of the drain Da3

The excess water drainage output performed by the drains located beneath the ridge was measured on the Da_5 absorbing drain, the control points being spaced at an even, 3.50 m distance (figure 8). In the case of Da_5 drain located beneath the ridge as well (figure 9), we detected that the soil water content mean values were increasing prom point P_4 (upon the drain), towards the points located halfway between drains (10.50 m). The soil water content mean values at P_3 and P_5, control points, located 3.50 m from the absorbing drain were close to the values recorded upon the drain, at point P_4, the latter being located upon the ridge formed at the time of modeling, the differences in elevation measured between the channel and the ridge being of some 0.30 m.

The soil water content mean value upon the control section was 29.42%, greater by some 1.5 percentage units than the value recorded on the Da_3 drain, located beneath the channel. The excess water drainage at the Da_5 drain, located beneath the ridge, takes longer to complete, due to an increase in the laying depth of the drain, caused by the modeling of the terrain, also due to the directing of potential surface water flow towards the median between drains, where the water content mean value is greater by some 3 percentage units than the value recorded upon the drain, at point P_4.

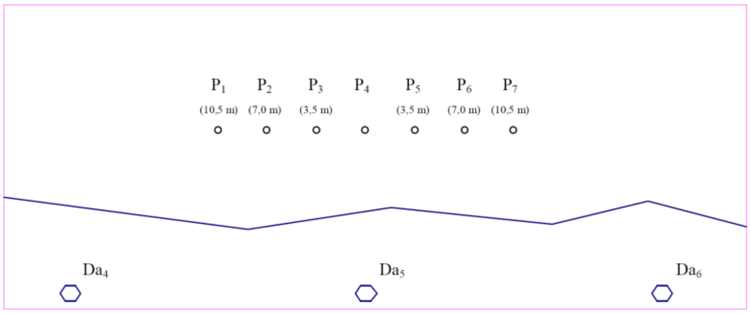


Figure 8: Placing the break points on drain Da_5, below the ridge

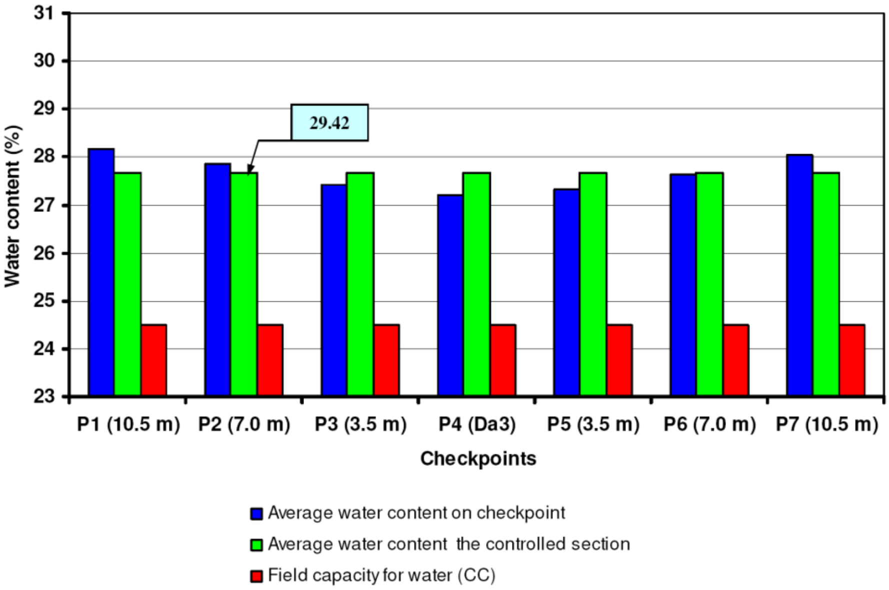
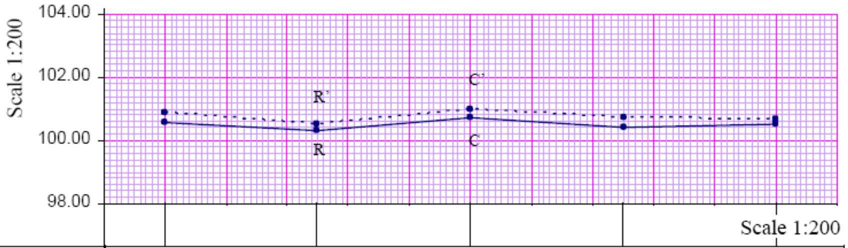


Figure 9: Average water content of soil checkpoints located on drain Da_5

By land modelling in ridge strips, as effect of applying Law no. 18/1991, we have also found variable values of level differences between ditch and ridge and the transversal slope of ridge strips, according to the width of plots and the way of their exploitation, in the observation field 2 (figure 10).

Soil sampling was done from the line of a ditch and a ridge, having the distance between them of 5.00 m and the level difference of 0.460 m at the upstream end and of 0.410 m at the downstream end. The value of the transversal slope between ditch and ridge is of 9.2 % at the upstream end and of 8.2 % at the downstream end, while the longitudinal slope of the plot is of 0.8 % on the ditch and of 0.9 % on the ridge.

In the case of land plots oriented perpendicular upon drain lines, soil samples were taken under the same circumstances as in the case of land plots parallel to drain lines, the control points being placed on either side of the Da_3 absorbing drain, spaced at 3.50 m apart, down to halfway between drains (figure 11). The modeling of the terrain in strips with ridges has caused a modification in the initial laying depth of the Da_3 drain (1.00 m), in the sense that it decreased upon the direction of the channel, the distance in depth measured being 0.834 m, and at the same time it increased at 1.266 m with respect to the direction of the ridge.



Point number		1		2		3		4		5
Land elevation (m)	R' – C'	100.870		100.535		100.995		100.695		100.760
	R – C	100.540		100.305		100.715		100.435		100.533
Level differences (m)	R' – C'		-0.335		0.460		-0.300		0.065	
	R – C		-0.235		0.410		-0.280		0.098	
Distances (m)	partial		5.0		5.0		5.0		5.0	
	total	0.0		5.0		10.0		15.0		20.0
Slope (%)	R' – C'		6.7		9.2		6.0		1.3	
	R – C		4.7		8.2		5.6		2.0	

Figure 10: Transversal profile on the plots from the observation field 2

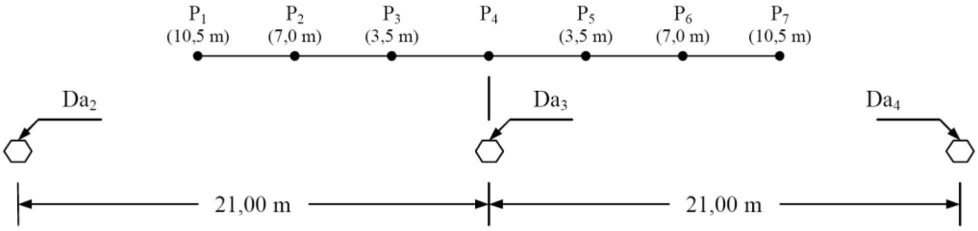


Figure 11: Placing the break points in the observation field 2

From the analysis of water content mean value determined a control points located upon the channel (figure 12), we established that it increases starting at point P_4, upon the draining trench, where the least value was recorded (27.20%), towards the median (halfway between drains). The water content mean values amplitude is low, at 0.96 percentage units, whereas the water content mean value upon the control section, of 27.66%, is lower than in the case of the drain located beneath the channel (27.94%). The measurements were taken upon the no. 1 observation field, whose individual land plots were parallel to the direction of the drains.

The soil water content mean values recorded on the ridge are increasing starting from the points located 3.50 m from the drain towards the median-halfway between drains, the gap in value recorded being of 0.8 percentage units (figure 13). The soil water content mean value upon the control section, of 28.85%, was greater than the value recorded upon the direction of the channel, as the water excess drainage is taking longer, due to the greater laying depth of drains on the direction of the ridge.

The soil water content mean value on both the ridge and channel direction, in the case where plots of land are perpendicular to the line of drains was 28.26%, lower by approximately 1 (one) percentage unit than those recorded at Da_5 drain, located beneath the ridge, and fairly close to the value recorded at the Da_3 drain, located beneath the channel, in the case of land plots oriented parallel to the line of drains.

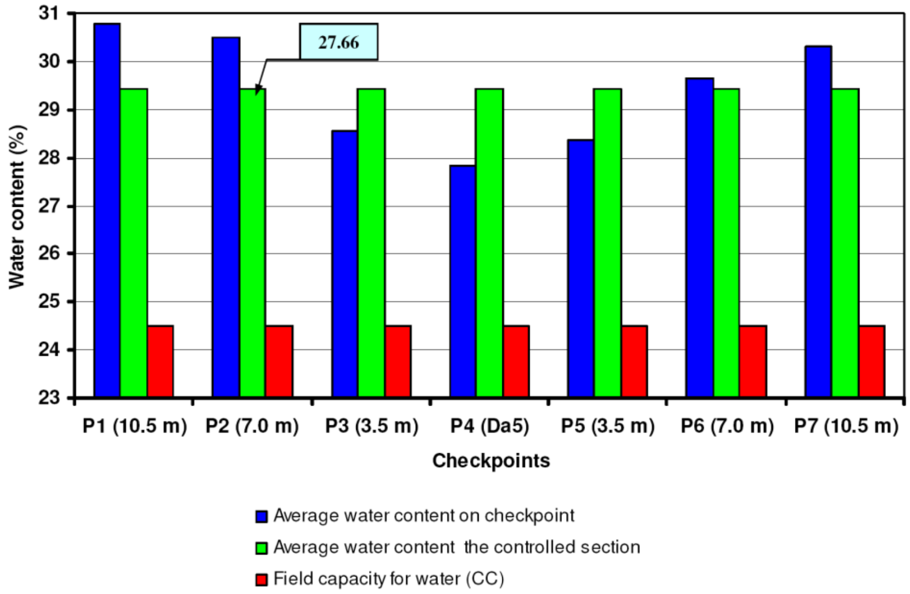


Figure 12: Average water content of soil checkpoints the channel line

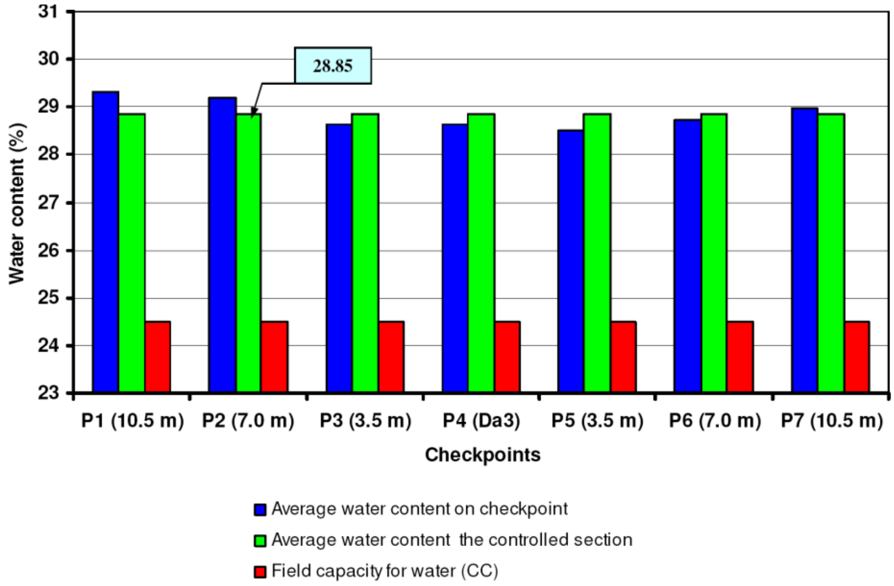


Figure 13: Average water content of soil checkpoints the ridge line

Due to the low probability that channels are created over the lines of drains following individual land improvement works, in the case of land plots oriented parallel to the drains, there derives that upon areas where the plots of land are perpendicular to the lines of drains, the water excess drainage is most efficient and uniform.

The increase trend of soil water content mean value recorded 48 hours after rainfall, that in general are greater than the value of water capacity in the field, towards the points located halfway between drains, reflects the functioning of absorbing drains. The Da_3 and Da_5 drains of the no. 1 observation field and the collecting drain that takes the discharge from the Da_3 drain located on observation field no. 2, at the time soil samples were taken, were draining water from the „Dumbrava” collector channel.

CONCLUSIONS

Soil tilling on plots with dry-drainage works determined land modelling in ridge strips, with variable widths, level differences and transversal slopes, according to the plot width, way of usage and equipments used for farming works.

Land modelling in ridge strips, as effect of soil tillage on individual plots determined the depth change of drain placing, by its decrease on the ditch line and its increase in the ridge zone. This change and the different positioning of ditches to suction drains lead to a non-uniform removal of water excess on the arranged areas.

The drains, which are placed below the ditch, achieve a better interception and removal of water excess. This water excess is removed in short time, because of the drain lower depth, of the great opportunity to intercept the heavy permeable layer by soil tillage and of directing water runoff to the drain line.

On the area on which are found the drains placed below ridges, water excess is removed in a longer period, because of the increase in the placing depth of suction drains and of directing water runoff to the middle distance between suction drains.

Land modelling in ridge strips in the plots with perpendicular orientation on suction drains has a favourable influence on water excess removal, because water runoff from the area of ridges toward ditches intercept easier suction drains that are placed in the area of the ditch at a lower depth than the initial one.

Due to the low probability that channels are created over the lines of drains following individual land improvement works, in the case of land plots oriented parallel to the drains, there derives that the water excess draining process works best upon areas where the plots of land are perpendicular to the lines of drains.

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