THE ASSOCIATED EFFECT OF AMELIORATIVE WORKS AND SOIL TILLAGE ON THE FIELD CAPACITY OF SOILS FROM COMPLEX SLOPE LAND OF URSULUI VALLEY-IASI COUNTY

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Abstract

The purpose of this study is to establish the associated effect of ameliorative works and soil tillage on the field capacity and on water distribution of the main soil units represented by cambic (i), cambic-coluvic (ii) and cambic-clinogleic (iii) Chernozems. The study of the capacity of soils to retain water was carried out on a slope with North-Eastern exposure of the Ezareni farm from geomorphological unit of Rolling Jijia Field where the mean annual temperature is 9,5 ºC and the mean annual precipitation is 544 mm. Soil samples were taken in the spring and summer of 2018. The first soil sampling was done immediately after the snow was melted, from 10 cm to 10 cm and on the depth range 0-100 cm. Soil samples were taken from the plowed strips of ground and strips of grass. During this period, it is considered that the soil moistening takes place up to the level of the field capacity, and losses of water through direct evaporation to the soil surface are insignificant. Soil sampling was also done during summer, one month before harvesting of sunflower. Study of soil water distribution at the end of vegetation is useful for highlighting the lateral movement of water and hence the heterogeneity of improved soil units. The main criteria of sampling sites selection were based on the slope category of the land. The obtained analytical data showed that under the same climatic characteristics, soils from slope land retain a smaller amount of water than those found on flat or low slopes lands. The data analysis revealed that following the processing of the obtained results it was seen as the retention of the water in the soil was influenced by the land use and soil characteristics such as soil texture and state of compaction. Two or more water accumulation peaks recorded on soil profiles are well correlated with the changes of size particles of soil horizons and lithological deposits.

Key words: field capacity slope, ameliorative works

Field capacity and permanent wilting point are two soil water constant which define the range of the intermediate water contents or available moisture content of soils essential for plants growth (Conea et al. 1977, Canarache 1990). These soil water constants represent the aproximate upper (field capacity) and lower (wilting point) limits of water that is held in soils and is available for plants.

Field capacity (*in situ field capacity* or *field water capacity*) is a soil moisture constant representing the amount of water a soil can retain, in in the field, for a comparatively long time, under free drainage conditions and in absence of ground water table or in the abrupt textural change (Canarache *et al*, 2006).

Field capacity is determined after an excessive water application and after drainage of gravitational water, usually after 24-36 hours (sandy and loamy sand soils), 36 -48 hours (soils with middle texture) and after 48 -60 hours in soil with clay content higher than 33% (Dumitru *et al*, 2009).

On the moisture characteristics curve, it corresponds in many soils to a suction of about 0,1-0,33 bar (pF = 2-2.5). Values of field capacity may vary between < 10% in sandy soils and > 40% in heavy non compacted soils, and much more in organic soils (Canarache *et al*, 2006).

Although field capacity is not a unique value, because equilibrium is never reached, soil water is dynamic; removal of water occurs due to drainage, evaporation, and transpiration and the water infiltration does not cease, but continues at a reduced rate for a long time, the term is useful for qualitative, not quantitative, understanding of water in the soil (Kirham, 2004).

The field capacity of the same soil is not constant in different times of the year.

After determining the capacity field of the same soil but in different seasons (spring, summer or autumn) different values were obtained.

The field capacity values of the same soil are influenced by previous soil water history (i), soil texture (ii) and structure (iii), state of soil compaction (iv), clay minerals (v), content of

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organic matter (vi), depth of ground water (vii), presence of layers with different values of hydraulic conductivity (Canarache, 1991)

There are several factors that influence the value of soil field water capacity. The upper range of field capacity depends on previous soil water history: a soil that is saturated and then dries has a higher field capacity than a soil that is being wetted (Kirham, 2004).

Texture and state of compactness are another factors that influence the water retention capacity of the soil. Field capacity increase with the clay content.

The increase of the bulk density in the soil with the same texture (loam or loamy clay) is associated with decrease of moisture mass and increase of moisture volume percentages (Florea *et al*, 1987).

Smectites minerals such as montmorillonite have the high capacity of water retention. The higher the content of montmorillonite is, the greater is the content of water corresponding to field capacity (Craciun, 2000; Ian, 2012).

Soil organic matter retains large amounts of water even if a large part is not available to plants (Canarache, 1998, Craciun, 2000).

In the same climate area, field water capacity is also influenced by the slope gradient, forms and the orientation that a slope is facing.

It is well known that soil variability is very high especially on the complex or irregular slope forms.

The soil variability increases after the implementation of conservation measures on the agricultural fields such as buffer strip cropping, agro terrasing of cropland (Filipov, 2012).

In order to reflect the influence of the state of soil compaction on the field capacity is more convenient to express the values as volumetric water content (% cm^3/cm^3) or as a continuous water layer expressed in millimeters.

We consider that the study on water retention capacity of soils from sloping land in the North East part of Romania after reclamation works such as leveling and terracing are useful in establishing a sustainable management of soil resources.

MATERIAL AND METHODS

The Ezareni farm is located in South-West part of Jijia Rolling Plain and belongs to the higher geomorphological unit of the Moldavian Plateau. The administrative territory of the Ezareni farm includes a slightly inclined plateau, with a slope of up to 5%, the slope with a high slope amplitude of the Ursului Valley and the small river field.

Our studies was carried out on a slope with the eastern North-Eastern exposure. From a hypsometric point of view, the range altitudes of the studied area is between 68 and 196 m.

In order to practice an efficient agriculture, on the slope of Ursului Valley were performed leveling and terracing works (*figure 1*). After topographic measurements with the STONEX GPS/GNSS receiver has been established the length, width and slope of strips and buffer strips with perennial grass.

Following the implementation of the conservative measures against soil erosion resulted five strips and four buffer stripes with perennial grass. The slopes with lower values than 5% are found especially on the strip of land from the lower part of Ursului Valley. The main characteristic of the foot slope is the presence of colluvic deposits accumulated on the concave slope position. Following the implementation of conservative works against soil erosion 12 soil profiles were developed, studied and designated. In this paper we present the results from 3 representative soil profiles located on different slopes (*figure 1*). After implementation of conservative measures against soil erosion (leveling and terracing) resulted strips with the lengths between 282 and 754 m. Strips with the lowest lengths (282 and 616m) are on bottom slope. The width of the strips varies between 40 and 64 m.

Characterization of soil formation factors and soil profiles was done following the instructions from guidelines for soil and land descriptions [13].

Soil samples were taken from the plowed strips of ground and from buffer strips with perennial grass. Soil samples were taken in the spring of 2017 and 2018, immediately after snow melting, from 10 cm to 10 cm on the depth range 0-100 cm. During this period, it is considered that the soil moistening takes place up to the level of the field capacity, and losses of water through direct evaporation to the soil surface are insignificant.

In the field, we took undisturbed and disturbed soil samples from each soil horizon or from 10 to 10 cm down to the depth of 100 or 110cm.

Laboratory analysis such as size particles, bulk density, gravimetric (Wg) water content were carried out according to the methodology for determining the physical attributes of the soil (Dumitru *et al*, 2009).

The volumetric water content (θv) was estimated based on the values of bulk density and gravimetric content of water.

In analyzing and processing the obtained data in the field and laboratory, we took into consideration the characteristics of the soil profiles remarked in the field and subsequently the study of the digital camera pictures.

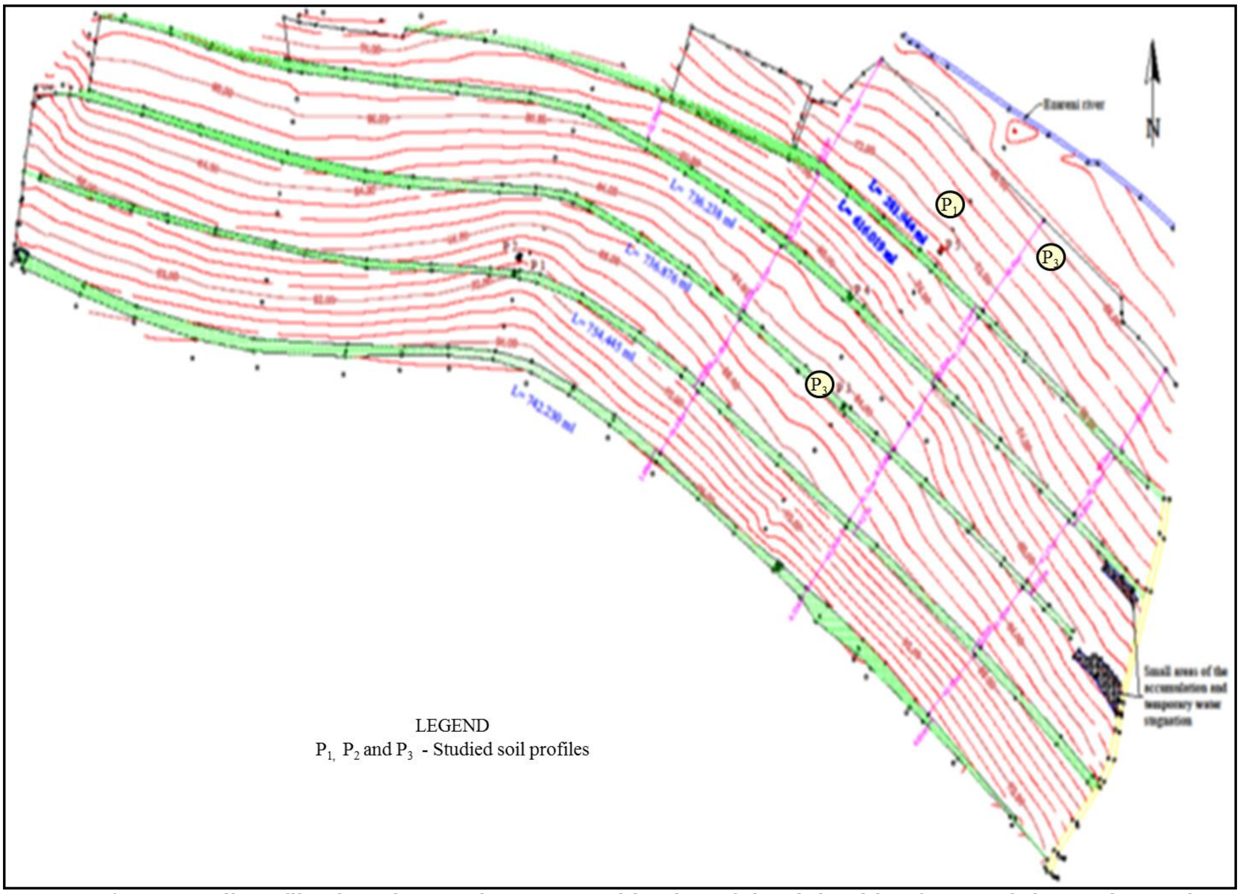

Figure 1 **Soil profiles location on the topographic plan of the right side of Ezareni river enhanced by terraces works**

RESULTS AND DISCUSSIONS

Complex slope forms of studied area favored erosional wash by gravitational action and moved down soil particles. The eroded soil has accumulated on gently sloping land especially in areas where the land gradient is diminishing.

The representative soil of the studied area is *cambic Chernozem* (after WRB-2014).

Following erosion processes and implementation of conservative measures against soil erosion (leveling and terracing) resulted soils where the thickness of the humus horizon diminished or increased due to the accumulation of eroded material or after soil cover by terracing works.

On the sloped lands we identified several types of soil such as *cambic Chernozems*, *colluvic cambic Chernozems* and *gleyic colluvic Chernozems* (*figure 2*).

Clay contents of *cambic Chernozems, colluvic-cambic Chernozems* and *gleyic-colluvic Chernozems* range between 37-40%, 27.2-43% and 34.9 – 40.2 %.

In the lower part of the first soil profile (*cambic Chernozems*) is evident an accumulation of the soft concretion of calcium carbonate.

Gravimetric and volumetric water distribution of soil profile 1 is shown in *figure 3*. The maximum value of gravimetric (24.42%) and volumetric (38.58%) water content is recorded on the depth range of 90 - 100 cm due to the considerable modification of the discontinuity of the mineral part of the soil and pore size. We consider that high frequency of soft calcium carbonate concretions is due to vertical and lateral water movement.

The more limited variation values of the gravimetric and volumetric water contents from profile 2 (*figure 4*) is due the textural uniformity and the narrower range of the bulk density values.

The analytical data showed that maximum gravimetric and volumetric water contents are recorded on the depth of 10-20 cm above plowpan or hardpan.

The volumetric soil water registered in the spring can be considered as the reference value of field capacity. During this period, ~~it~~ is considered that the soil moistening takes place up to the level of the field capacity, and losses of water through direct evaporation to the soil surface are insignificant.

After comparing the results obtained after the study of the soil water content recorded after the snow melting (early spring) with the water capacity values in the field estimated according to the clay content and the bulk density values, small differences resulted due to some local characteristics of relief, soil and lithology.

Following the results analysis, it was seen that the retention of the water in soil was influenced by the land use and by morphological, physical and chemical soil characteristics. Two water accumulation peaks recorded on soil profile are well correlated with the changes of size particles of soil horizons or lithological deposit.

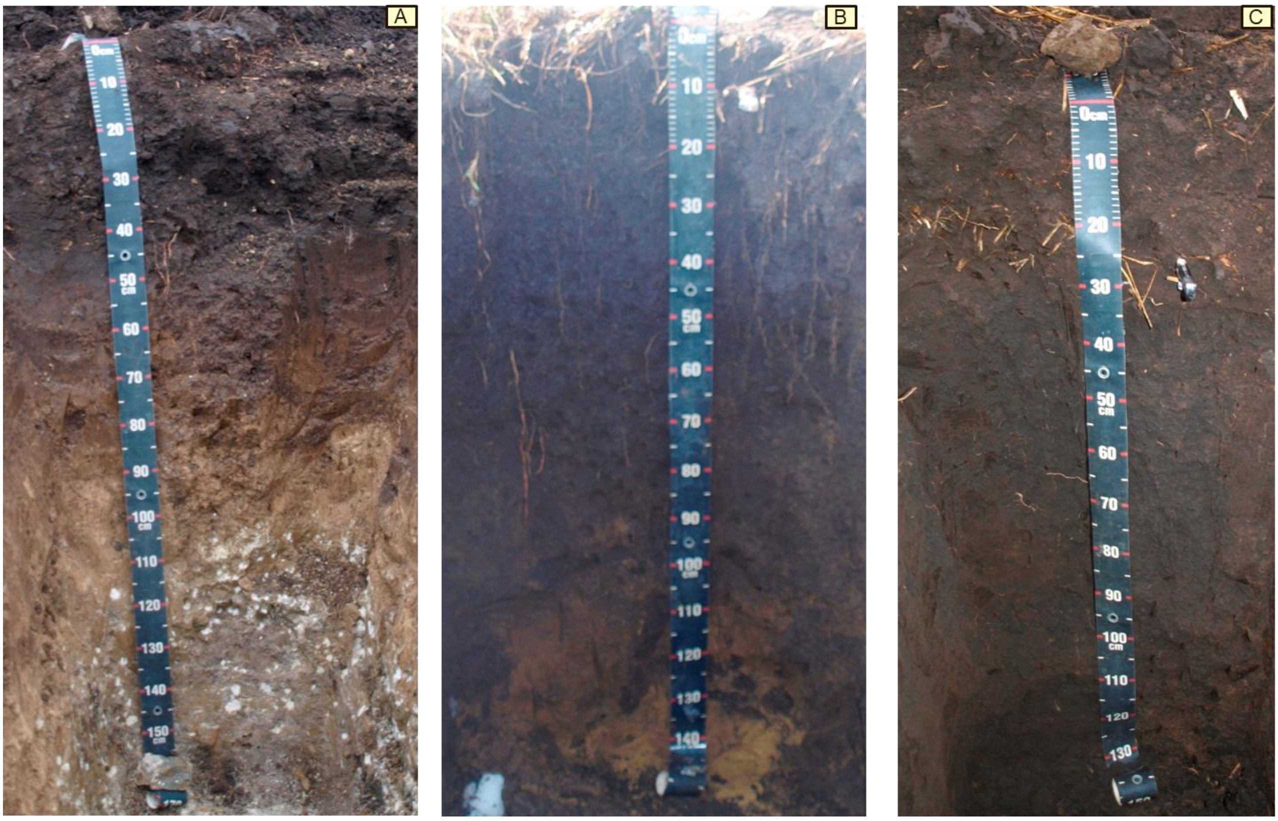

Figure 2. **Soil profiles in the eastern slope of the Ursului Valley (A: profile 1 - Cambic Chernozems; B: profile 2 - Colluvic cambic Chernozems: C: profile 3 - Gleyic colluvic Chernozems**

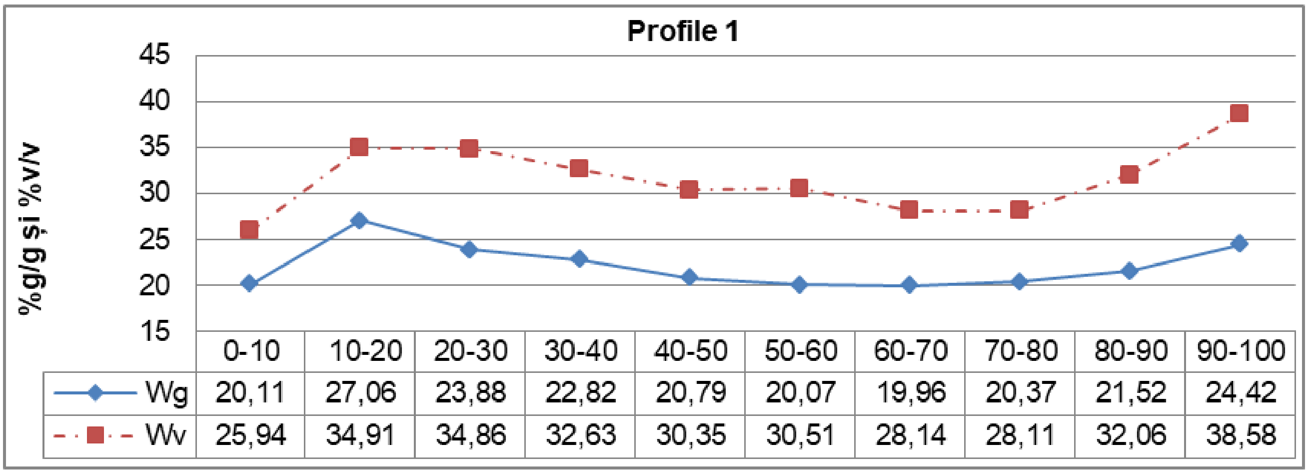

Figure 3 **The gravimetric and volumetric values of filed capacity from cambic Chernozems**

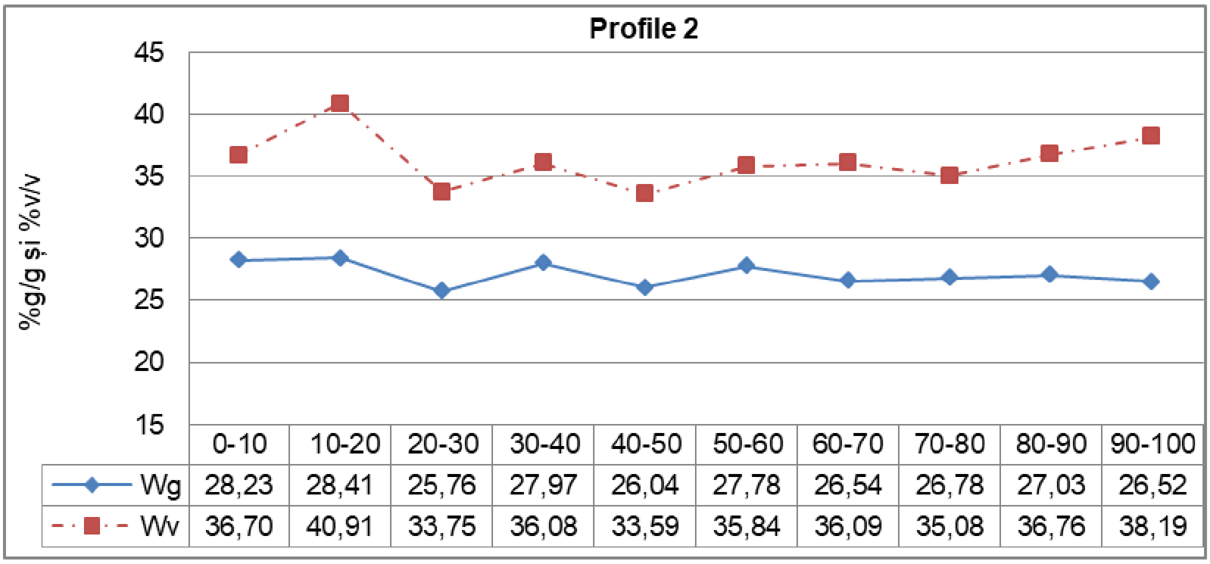

Figure 4 **The gravimetric and volumetric values of field capacity on cambic colluvic Chernozems**

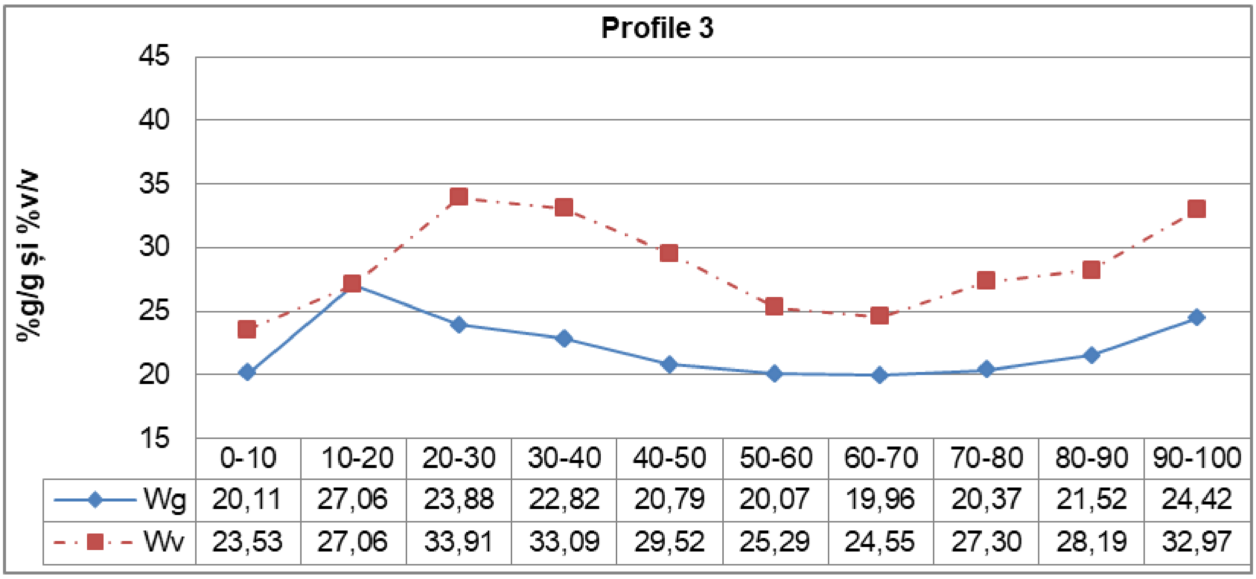

Figure 5 **The gravimetric and volumetric values of field capacity on the gleyic-colluvic Chernozems**

In order to improve methodology of establishing the water field capacity of soils from sloped land we recommend taking sample in the early spring after snow melting, to ensure that maximum soil expansion has occurred.

CONCLUSIONS

On the sloped lands we identified several types of soil such as *cambic Chernozems, colluvic-cambic Chernozems* and *gleyic-colluvic Chernozems*. Intervals of clay contents of these soils are 37-40%, 27.2-43% and 34.9 – 40.2 %.

The more limited variation values of the gravimetric and volumetric water contents on the *colluvic cambic Chernozems* is due to the textural uniformity and the narrower range of the bulk density values.

The maximum value of gravimetric (24.42%) and volumetric (38.58%) water content is recorded on the depth range of 90 - 100 cm due to the considerable modification of the discontinuity of the mineral part of the soil and the pore size. We consider that high frequency of soft calcium carbonate concretions is due to vertical and lateral water movement.

The volumetric soil water registered in the spring can be considered as the reference value of field capacity. Comparing the results of the soil water content after the snow melting with the water capacity values in the field according to clay content and bulk density, resulted small differences due to some local relief, soil and lithology characteristics.

In order to determine the capacity of land sloping field we recommend taking soil samples in the early spring, after snow melting, to ensure that maximum soil expansion has occurred.

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