CONSIDERATION UPON SOIL MOISTURE CONTENT VARIABILITY ON ARABLE SLOPING LANDS IN MOLDAVIA PLAIN

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Abstract

Stochastic distribution of precipitation in the area of reference and their insufficient revaluation on sloping lands make that the water is not provided to the physiological requirements of crop plants, irrigation being necessary even in some rainy years. The analysis of soil humidity in the period 2007-2011, allowed the adjustment of irrigation system components in a manner that will produce economically efficient crops, while maintaining the control of erosion process.
There were differences in the vertical variation of soil moisture content of different land use types, and the greatest variation of soil moisture content distribution was in 0-40 cm range of soil layer, it was a common feature of the profile distribution of soil moisture that amplitude of variation of soil moisture becomes smaller with the increase of soil layer depth.
Soil humidity deficit control in the phenophase of maize panic appearance - grain development, and in stages of 6-8 leaves and milk ripening, by distributing relatively low volumes of water (60 mm), determines the average production increases of 1400 kg / ha, with variations between 900-1700 kg / ha, producing a water stress between this stages, not influencing visibly the crops.

Key words: Moisture, soil erosion, soil humidity, yield

In the Plain of Moldavia, with predominantly sloping arable land, the precipitations in the vegetation season, usually lower to the evapotranspiration and stochastic generation of precipitations, often with a torrential character and inconsistent with the water requirement of crops, require the use of irrigation for an advanced agriculture.

Irrigating in the area without applying rigorous measures to balance the weight of vegetation factors and soil protection against erosion can become inefficient and destructive. Among the possibilities to maintain the erosion process in tolerable limits on irrigated slope lands, judicious adjustment of irrigation regime elements presents an important role, the analysis of soil humidity evolution providing clues that can not be neglected.

MATERIAL AND METHOD

The experiments conducted during 2007-2011 in the field of anti-erosional agrotechnics of Scobâlteni, S.C.D.A. Podu-Iloaiei, Iasi County, regarded the study of the evolution of water resources of the soil cultivated with maize, located on a hillside having an agroterrace having the average on a transversal direction of 10-11 %. The soil is a cambic kernozem, having a clay-loam texture, weakly eroded, having a good mineral fertility, the physical and hydrophysical features per 60 cm depth being expressed by the following indices: BD=1.37 g/cm^3, CO=12.8 % g/g, CC=25.2 % g/g and F_{ir}=13.5 mm h^{-1}. The dynamics of soil humidity was observed by collecting soil samples periodically, their water content being established by using the gravimetric method.

The detailed determination of water quantities come from precipitation's and watering as well as of those running of the soil surface in control plots (4 $\times$ 25 m) isolated from the rest of the area by metallic walls, having installations for flow fractionating and catchments basins, allowed the decade calculation of the water balance in soil. In the irrigated variant, the watering were applied by using some sprinkling installations I.I.A, having sprinklers A.S.J.-1M, (nozzle ø=6 mm).

RESULTS AND DISCUSSIONS

Analysis of soil humidity regime cultivated with maize shows that in conditions of non-irrigation, soil water content reduces frequently below the minimum threshold (PM) even in years when precipitations are much higher than average multi-annual values (2007 ÷ 2011), the crops level being largely influenced by the evolution of rainfall regime in relation to the development of

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phenophases. Thus, although in the early vegetation season humidity is adequate to the plant growth, except excessive drought years (2008), with the phases of vegetation the water supply diminishes to values incompatible with obtaining competitive productions.

For maize, soil humidity regime becomes unfavourable, usually in early June, most notable being the fact that during the research period, the humidity deficit widened just in the maize panic formation - grain development phases, which are the most important in crop development. This situation was due to the poor distribution of precipitations (in 2009 and 2010, for example, precipitations in September represented 333% and 42% of the total recorded during the vegetation period) and their insufficient capitalization due to surface leakage.

Correcting soil humidity deficit involves irrigation, but on sloping lands it should be subordinated to anti-erosional requirements, maintaining the soil humidity at higher levels causing potential conditions to amplify the liquid leakages and loss of soil on torrential rains. Therefore, admitting a decrease from the maximum possible harvest, was applied a suboptimal irrigation regime, resulted in reduced watering rules distribution that ensure soil humidity up to 40-50 cm depth, which is considered to develop 70 % of the roots. It was also stopped applying watering in intervals between main critical stages for water, for the same reason of reducing irrigation rules.

Thus, under the years 2007 (rainy) and 2009 (very rainy), application of watering rules of 40 and 50 mm respectively in the milk ripening phase, determined to obtain some production increases of 1300 and 1600 kg / ha.

Irrigation was necessary in the excessively rainy years also. In 2010, for example, watering applied on 10 June created favourable conditions for vegetation in stages of 8-10 leaves - eared. Also, as a result of this watering, subsequent precipitations led to maintain the humidity at levels above 75% Available water content (AWC) in the first 40 cm in July, which highlights the importance of correlation between watering applying moments and probable evolution of the rainfall regime.

Precipitations in 2008, with 126 mm lower than the multi-annual average, caused reduced soil humidity below the minimum threshold on almost all vegetation season. Consequently, the production made (4600 kg / ha) was at the lower bound of the hybrid potential (HS Oana) in the area. Favourable moisture conditions created by applying the second watering of 40 mm in 6-8 leaves - eared stages allowed to obtain a production increase of 35%, although since the last decade of July it has been created a water stress due to waiver of the application of another watering.

From the presented data presented a number of conclusions can be drawn concerning the manner of establishing the crop irrigation regime elements on slope lands in the area, in a manner that will produce profitable harvests, while reducing the need for irrigation water, its distribution expenses to crop but especially ensuring the agroproductive capacity protection of the soil of the adverse effects of erosion process.

In principle, on the slope lands, ensuring the optimum water as a vegetation factor increases the irrigation rules emerged from the calculation with the values of fluid leakages, which during the experiment period ranged between 25 mm (2009) and 115 mm (2010) on non-irrigated surfaces. Previous research (4) have shown that by the administration of such rules of irrigation, water, soil and nutrients losses occur , in the watering periods and in between watering, as a result of precipitations that may occur due to a high humid soil. For this reason, on the slope lands, increased erosion risk enforces to apply a deficit irrigation regime (suboptimal), by creating a water stress at certain times, implicitly acknowledging a reduction in crops.

To establish the effect of deficit irrigation on erosion and production, irrigation regime during experiments was studied in two ways, through different irrigation rules management (Σ m), representing between 29 and 64% of the optimum values (Table 1). Reduced irrigation rules was made by applying in both cases the same number of waterings, depending on their climatic conditions each year, with rules of differential watering by 20 mm, but smaller than those necessary for soil humidity throughout the depth of the active layer. It was also dropped the watering application in between main critical stages for water, even though soil humidity decreased to some extent below the minimum threshold set at 50% of AWC.

Table 1

Elements of irrigation regime in maize crop on sloping (I_t=11 %) lands, Scobalteni - Podu-Iloaiei

Year	Irrigation regime elements	Depth of irrigation (mm)	Watering numbers	Water applications momentum	Irrigation rate (mm)	Yield ($kg \times ha^{-1}$)
2007	optimal	70	2	18.VII; 2.VIII	140	-
	suboptimal	40 (60)	1	19. VII	40 (60)	9200 (9500)
2008	optimal	70	3	5.V; 19.VII; 3.VIII	210	-
	suboptimal	40 (60)	2	15.V; 9.VII	80 (120)	5900 (6300)
2009	optimal	70	2	17.VI; 1.VIII	140	-
	suboptimal	50 (70)	1	1.VIII	50 (70)	8100 (8900)
2010	optimal	70	2	29.V; 16.VI	140	-
	suboptimal	40 (60)	1	11.VI	40 (60)	7650 (8150)
2011	optimal	70	2	19.VI; 20.VIII	140	-
	suboptimal	30 (50)	3	10.VI; 25.VII; 12.VIII	90 (150)	10500 (10800)

The results showed that in the irrigated variants with the lowest standards, the fluid leaks didn't have an important evolution compared with those produced in non-irrigation, production increases were achieved between 800 and 1750 kg/ ha.

Rules for irrigation of up to 90 mm, distributed in two or three waterings, caused increased water volumes drained by 2.3% (2010) up to 31.2% (2011) corresponding, of course, to different evolution of rainfall regime. It should however be mentioned that these irrigation standards acceptable in terms of erosion control phenomena have been applied on an anti-erosion arranged slope by agroterrace work, exploited in the general direction of the contours, to a crop placed in rational rotation, fertilized with doses of N_{100} P_{100} fertilizers.

Application of watering rules of 40 mm, with aspersion rain intensity at about 10% lower than the final infiltration rate, which ensures the soil moisture at the depth to which the most part of the root mass develops, leads to, according to land coverage, suitable cropping technology and state of vegetation, leaks within 3 mm, the soil loss being negligible (0.16 t / ha in 2008). Increasing watering rules to 60 mm caused an average increase in fluid leaks (s) between 1.7 and 4.4 mm and soil losses from 0.15 - 0.38 t / ha, average values for one watering. Given the characteristics of the rainfall regime in the area, expressed by values of maximum precipitations in 24 hours of 128.4 mm and 100.7 mm respectively, corresponding to the calculations insurances of 5% and 10%, and the intensity of torrential nucleus ($t \geq 5'$) of 1.68 mm / min and 1.43 mm / min for the same insurances, the application of watering rules to achieve the humidity of all active layer of soil is likely to reduce the capitalization of precipitations that can produce thereafter but most of all to increase the risk of erosion from torrential rains.

Except the must to respect the anti-erosion requirements, the increase of the irrigation rates is not justified from the economical point of view. The distribution of some supplementary water volumes, if 200 or 400 m^3/ha didn't determine the significant increase of production, the gains of 4-6% being incapable to cover the corresponding expenses for increasing the irrigation rates and/or don't justify the losses of water, soil and nutrients. On the contrary, the application of some depths of irrigation lower than 30 mm doesn't appear to be rational because of diminishing the efficiency of watering in the field, of the uniformity of soil humidity and of increase of expenses from exploitation of irrigation management.

CONCLUSIONS

1. The analysis of humidity and hydrological balance of the cambic chernozem from the slope lands of about 11% in the Moldavia Plain, allows water to be assigned as the role of main limiting factor of crops, irrigation use being the prerequisite condition to practicing advanced agriculture.

2. On sloping irrigated lands, limiting water, soil and nutrients loss at tolerable levels enforces the need to strictly harmonize irrigation regime with the precipitations dynamics by reducing irrigation standards, reducing the watering rules and / or waive the watering intervals between main critical phases for the water.

3. For the climate of the area, at the slopes cultivated with grain maize, ensuring an optimum for water consumption - production - erosion protection requires the application of irrigation rules of maximum 90 mm, divided in 2-3 waterings.

4. Correcting soil humidity deficit in the phenophase of maize panic appearance - grain development, and in stages of 6-8 leaves and milk ripening, by distributing relatively low volumes of water (60 mm), determines the average production

increases of 1400 kg / ha, with variations between 900-1700 kg/ha, producing a water stress between this stages, not influencing visibly the crops.

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