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Review

METHODS AND FORMS OF DRYING OF WET TERRAIN BY EXCESSIVE PRECIPITATIONS AND WATER ACCUMULATION

Reseña

Métodos y modos de desecamiento de terrenos húmedos por excesivas precipitaciones y acumulación de agua

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ABSTRACT. Watering is of utmost importance in agriculture, as well as drainage activity. Drying should be understood as the fundamental way, by which excess water is evacuated from a soil outside the territory in drying. In the practice of drying, two terms, methods or modes have been firmly established. The choice of them in each particular case is determined by the excess moisture of the land, which is given by the litology structure of the soil and by the nature of the subsequent use of the dried land. The measures of agro-improvement indicated form in the arable layer a primary drain (elementary) that accelerates the drainage. The purpose of this review is to compile in a coherent manner what is related to the methods or modes of drying of agricultural soils that by excesses of precipitation and accumulation of water the preparation and conditioning actions of the same are difficult for the food production. In conclusion, drying is a valuable method to reduce or eliminate water that is in excess in the soil and that affects the proper development of crops; if this important activity is not done, it results in a significant impact on the productivity of agricultural crops. In the drying practice in different periods of the year, they require a complementary wetting. At such times the excess water accumulated in the lower layers of the soil considerably dampens the damaging effect of the drought and becomes sources of complementary water supplies for the plants.

Key words: water, drying, drainage, humidity, soil

RESUMEN. Regar es de suma importancia en la agricultura, así como la actividad del drenaje. El desecamiento debe entenderse como la vía fundamental, mediante el cual se evacua el exceso de agua de un suelo fuera del territorio en desecación. En la práctica de desecamiento se han arraigado sólidamente dos términos, métodos o modos. La elección de los mismos en cada caso en particular está determinada por el exceso de humedad de los terrenos, que están dados por la estructura litológica del suelo y por el carácter de la utilización ulterior de los terrenos desecados. Las medidas de agromejoramiento indicadas forman en la capa arable un desagüe primario (elemental) que acelera el drenaje. La finalidad de esta reseña es compilar de forma coherente lo relacionado con los métodos o modos de desecamiento de suelos agrícolas que por excesos de precipitación y acumulación de agua se dificultan las acciones de preparación y acondicionamiento del mismo para la producción de alimentos. Como conclusión, la desecación es un método valioso para disminuir o eliminar el agua que está en exceso en el suelo y que afecta el buen desarrollo de los cultivos; si no se hace esta importante actividad, trae como consecuencia una afectación sensible a la productividad de los cultivos agrícolas. En la práctica de desecamiento en diferentes periodos del año, requieren un humedecimiento complementario. En tales momentos los excesos de agua acumulada en las capas inferiores del suelo amortiguan considerablemente el efecto dañino de la sequía y se convierten en fuentes de abastecimientos complementarios de agua de las plantas.

Palabras clave: agua, desecación, drenaje, humedad, suelo

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INTRODUCTION

The water required by the crops is provided naturally by the precipitation, but when it is scarce or its distribution does not coincide with the periods of maximum demand of the plants, it is necessary to provide it artificially; that is, through irrigation (1). However, the excesses in this activity, as well as the excessive volumes of precipitation, must necessarily be drained from the land, so that they do not affect the productivity of the crop. The drainage activity is designed from the planning of the planting and the irrigation system to be used. In addition to this the drainage is carried out with the purpose of creating humidity conditions in the active layer of the soil, where the radical system is developed, a balance of water and air, capable of propitiating the crop, in combination with the other cultural works, the maximum economic returns.

Creating moisture conditions in the soil that maintain the microbial life of the soil and that allows the preparation of soil, when excess water occurs in the ground is achieved quickly with the application of drying methods. In the practice of drying, two terms, methods or modes of drying have been firmly established (2).

Under the concept of drying method should be understood those fundamental ways by which the excess water is evacuated from a soil outside the territory in desiccation (3). In this way, the regularity of the soil water regime, through the application of agro-technical measures, occurs without the formation of a primary flow and an evacuation of water outside the perimeter of the land in desiccation. As a result of the above, the arable layer dries quickly and the desired culture is established (4). Unlike the methods of drying, the drying methods consist of a set of technical means with which drying is guaranteed by a usual method, in order to make an economical use of resources in the field (5-9).

The purpose of this review is to compile in a coherent way what is related to the methods or modes of drying of agricultural soils, which by excesses of precipitation and accumulation of water make it difficult to prepare and prepare it for agricultural production. In addition, so that the specialists in Irrigation and Drainage, as well as Hydrotechnicians know that in the practice of drying, in different periods of the year, the sowings require a complementary wetting. At such times the excess water accumulated in the lower layers of the soil considerably dampens the damaging effect of the drought and become sources of complementary water supplies for the plants, becoming an effective measure to alleviate the current agricultural drought.

Drying Methods

The following drying methods are currently distinguished (2):

1. Acceleration of surface drainage (evacuation of water on the surface of the land in desiccation).
2. Acceleration of drainage by the horizon below the topsoil in the topsoil (evacuation of water through the topsoil by the horizon surface below the topsoil).
3. Acceleration of the internal drainage (evacuation of the water through the surface of strata of the soil that are below the arable layer).
4. Dissemination of the flow of water to the territory in desiccation coming from outside (protection of the desiccated land from submersion by flood waters from a river or runoff from a slope etc).
5. Acceleration of the penetration of water below the topsoil (acceleration of water infiltration in the sub-arable horizon).

The choice of any of the enumerated methods is determined in each particular case, by the causes of the excess moisture of the lands, which are given by the lithological structure of the soil and by the character of the subsequent utilization of the dried lands. The lithological structure is called the materials of geological formation and are classified according to their genesis or formation: rock, weathered rock (saprolite), soil and heterogeneous materials, which retain water to a greater or lesser extent (6).

Drying procedures are used rigorously in cases where there is an excessive influx of water from outside. These procedures are relatively simple and they stand out for their great effectiveness. In some cases, they are fully adequate to put an end to excess moisture and ground bogging.

I. When the method of accelerating the surface drainage is used, the drying of the land is usually carried out by means of the procedure of dividing the land to be drained in different slopes (primary) by means of the installation of a system of open or covered channels.

This mode of drying is relatively simple and cheap both for the installation and operating costs. However, according to the introduction of a network of channels too dense, it considerably complicates the mechanization of agricultural work. Due to this, this mode of drying is used, above all, in drying of meadows and pastures and likewise, in forested massifs, that is, in lands where the machinery is relatively little used. In the arable land this procedure is

not really used because the surface waters are rapidly inhibited in the arable layer and their circulation on the surface practically ceases.

In farmland, surface drainage usually occurs sometimes. But this happens when the ground is frozen or the arable horizon is completely saturated with water or when the absorption capacity of the soil is less than the intensity of water admission on its surface. However, in most cases, the arable layer absorbs surface water like a sponge, which, in turn, prevents its rapid drainage. Due to this, the execution time of the different agricultural tasks is prolonged and the plants are reduced. In this case, the method of drying will be the acceleration of the drainage through the arable layer.

II. The method of acceleration of the drainage by the horizon below the arable layer, the technique of acceleration of the drainage (mode of drying) will be different from that of acceleration by the surface of the soil. Here, the arable layer is generally subjected to the so-called aggravation treatment that is carried out in the direction of the slope whose contributions are (10):

a. Plowing in narrow bands.
b. Profiling on surfaces.
c. Furrowed (furrows).
d. Gallery of mole.

The measures of agro-improvement indicated form in the arable layer a primary drain (elementary) and accelerate drainages. To accelerate the evacuation of the runoff that forms outside the boundary of the parcel in desiccation, to these measures auxiliary lines that complement them are added: these lines are traced transversely to the slope.

Auxiliary lines are usually constructed (10):

- In the form of deep temporary furrows (traced every 100 - 200 m) which are leveled before sowing and after harvest the plowing is traced again.
- In the form of permanent "covered" channels, filled in at the bottom with permeable materials covered with soil up to the limit of the arable layer (to avoid the destruction of the filling during the preparation of the soil). These channels are also plotted every 100-200 m.

Let us briefly see the essence of the main modes of drying indicated above, corresponding to the method of accelerating the drainage through the arable layer.

The piling up is another drying process (3), which consists of artificially raising the surface of the land that is dried by the directed sedimentation of the water silts enriched with particles in suspension. The country of origin of this drying process is Italy. However, in Russia it is used for the drying of the lowlands of the Kóljida region and the flood valleys of the Dnieper river (3).

The piling up is applied when:

- In the vicinity of the land to be dried there is a river that drags a lot of silts.
- The economic conditions determine the activities of agro-improvement in the preparation of the land to dry and this can be done during a period of time dilated, even of tens of years.
- The protection against flooding of a given land is linked to the execution of expensive works of large volume.

It is necessary to indicate that, the pilling up is used, not only to raise the surface, but also, to increase the fertility of the so-called skeletal soils (stony, sandy soils, etc.). During the filling process, such soils are enriched with silt particles and increase their fertility.

For the execution of the grocery store the following works are required (3):

- Water source, rich in azolvings
- Installation of a water intake
- Feeder channels of different orders
- Identification of the plots to be filled.
- System of download channels.
- Receiver.

The piling up can be carried out in two ways:

1. Piling up from time to time in the area
2. Piling up of continuous flow of water

The formation of the layer is carried out in such a way that its lower horizons are composed of large particles and the upper ones, on the contrary, are formed by silt particles (fertile). This is achieved by managing the speed of the water flow.

The total duration of the grocery store can be determined by the following formula (5):

$$T = \frac{F \cdot h \cdot \gamma}{Q \cdot t \cdot \rho \cdot \alpha} \quad en\ años$$

where:

F _ Land area, in m^2

h _ Required average height of the area, in m

g _ Weight of the unit of volume of the sediments in t m^{-3}

Q _ Expenditure of the piling up channel, in $m^3\ s^{-1}$

t _ Channel operating time in the year, with the expense indicated above, in second.

p _ Turbidity of water, in t m^{-3}

α _ Coefficient of sedimentation of the azolvings (always smaller than the unit)

Plowing in narrow bands

The plowing in narrow band is done in relatively narrow and long strips (with a width of 15-20 m and a length of 1000-1200 m) (11). For this the plowing is done by folding down from the edges towards the center of the strip, forming as a result the so-called "open furrows" (Figure 1), which are the primary elements of the regulating section of the drying system.

For the rapid evacuation of the excess water from the parcels in desiccation, the plowing is carried out; usually, in the direction of the slope of the terrain. But, in this case, the depressed furrows only work when their lengths are shortened (100-200 m). With this, immediately after the plowing, transversely to the slope (acute angle to the contour lines), auxiliary grooves are drawn, as indicated above, that go from the permanent channels to the collectors (12,13).

Profiling the surface of the plot

This measure of agro-improvement consists in creating in the plot narrow and long bands of permanent convex profile that help to accelerate considerably the drainage. Profiling is usually done by repetition of plowing in narrow strips in the same terrain for several years in a row. As a result of the above, the upper layer of the soil gradually mixes towards the center of the strip, forming a convex profile with two waters. In the profiled terrain the evacuation of excess water from the arable layer is faster than in the plowing in narrow strips.

The profiled strips, as in the narrow strip plowing, are crossed with auxiliary furrows which accelerate the evacuation of excess water from the land in desiccation. It should be noted that the profiling of the land surface hinders the execution of transversal work for this reason, when crops are intercropped, this measure has limited application.

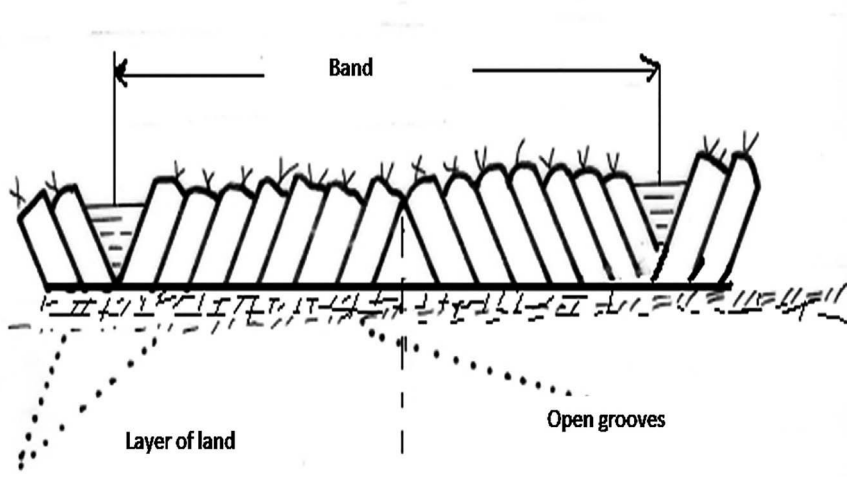

Figure 1. Arrangement of the layers in the plowing down

Plowing

Furrowing land on drying, as the measures listed above, are used to quickly evacuate excess water from the ground, usually performed with mechanical implements currents (monoplow furrow, paired, etc.).

The layout of the furrow network is made along the slope, with a distance between furrows that varies depending on the type of soil (13-16):

- 4-6 m, at most in heavy soils.
- 10-12 m, maximum in soils of light mechanical composition.

Gallery of mole

This procedure consists of the construction of a network of free cavities at a certain depth (from the ground surface), with the help of special machinery. In light soils this procedure is not carried out due to the possibility of an easy landslide in the galleries and the rapid use of them. The mole gallery is made together with the plowing or separately.

If a small amount of surplus surface water arrives at the surface that is drained, in this case the method of accelerating the penetration of water under the arable layer is used. This is achieved by fluffing sub-arable horizons to a depth of 50-60 cm (3-5). This agrotechnical measure contributes to a new temporary distribution of the excess water in the soil on account of its accumulation in the lower mollic horizons (4).

III. If the source of the excess moisture is the soil and subsoil waters, in that case the internal drainage acceleration method is used. This method contemplates the drainage of excess water, through the construction of covered drainage systems or in the form of drains of different types, which make it possible to reduce the level of groundwater up to safety levels and create in the middle layer of the soil an optimal water-air regime. In this specific case, by type of drainage, it should be understood as drying procedure. It should be noted that, in the practice of drying, the type of drainage with the greatest diffusion is vertical and biological drainage.

IV. In cases where the excess moisture of the land is due to the influx of surplus water from outside, the method of drying is to protect the land from the influx of water from outside.

The external waters generally come from the upper part of the slope (surface runoff of high parts with respect to the land to be dried) or from a river, where its waters exceed the limits of its channel. If the over-wetting is due to the flow of water from the upper parts of the slope then (17-26):

In the presence of surface water, hillside channels are constructed (Figure 2).

V. In cases where the excess moisture of the land is due to the inflow of surplus water, below the topsoil, the drying method consists of protecting the land from the inflow of groundwater runoff (17-26).

In the same way that lateral channels are constructed, to avoid the excess of water in the agricultural production areas, when the path of excess water in this land comes from underground runoff, it is possible to achieve the desiccation of the land the entrance, building an interceptor channel.

In the presence of underground flow, interceptors are constructed (Figure 3).

In the presence of mixed water inflow (surface runoff plus groundwater), combined type channels are built.

The fundamental task of the slope channels and the interceptors is to intercept the superficial and underground waters, which flow from the contours and evacuate them outside the limit of the land in desiccation. If the desired land is exposed to submergence by flood waters, in this case it is necessary to resort to the construction of dams along the parcels exposed to the flood (Figure 4).

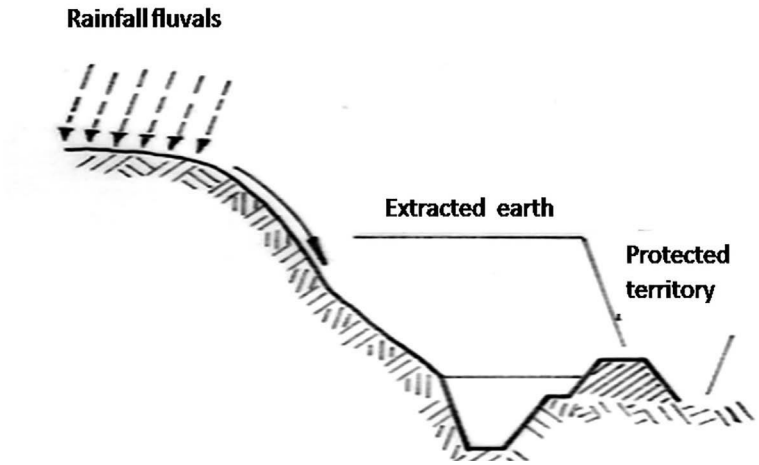

Figure 2. Side groundwater to evacuate water by runoff and avoid wetting the land to dry

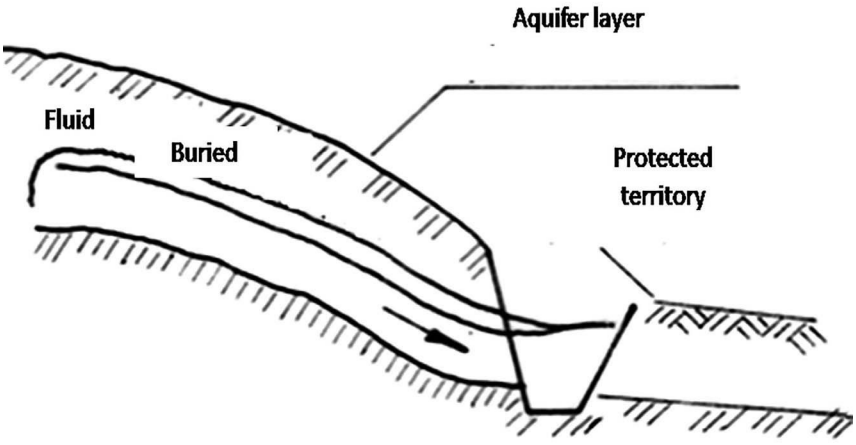

Figure 3. Groundwater interceptor channel to avoid wetting of the land to be dried

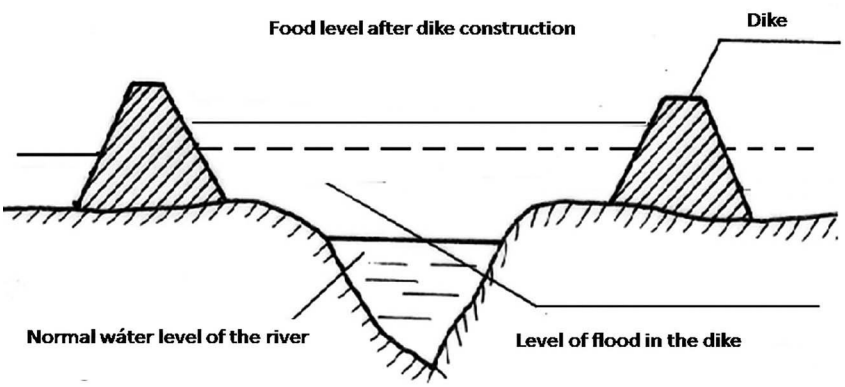

Figure 4. Contouring of a river by dams to prevent overflow of the water and wetting soil to dry out

The distance between dams, their heights and other parameters are determined by the water treatment and the possible volume to be evacuated.

CONCLUSION

The desiccation is a valuable method to reduce or eliminate the water that is in excess in the soil and that affects the good development of the crops; if this important activity is not done, it results in a significant impact on the productivity of agricultural crops. The time of year in which this activity takes place is crucial for its effectiveness; if it is done in the rainy season, it is sometimes difficult due to the high water content in the soil profile, if it is not an emergency, it must be done in the dry season to be effective and enable a better work of the equipment destined to this activity.

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