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Effect of Fertilizers and Irrigation on Distribution of Mobile Forms of Mn, Zn and Cu in Typical Chernozems of the Republic of Moldova

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Abstract. The paper presents the study results of mobile forms of Mn, Zn and Cu in irrigated fertilized and unfertilized chernozems typical. Irrigation affects the content and distribution of mobile forms of trace elements, increasing their removal beyond the 150 cm of soil layer. The fertilization increase the migration of Cu until 130 cm, fixed Mn and Zn in 0-60 cm of the irrigated soils. During irrigation constitutes a danger of soil contamination with Mn, Cu and Zn.

Key words: heavy metals, mobile forms, chernozem, irrigation, fertilization

Introduction

By geographical location the Republic of Moldova is falling within the countries with insufficient humidity. In the northern part of the country, the average annual rainfall is below moderate, in the southern - very low. Frequent droughts create a large deficit of humidity in the soils and air; its consequences are substantial decrease or loss the agricultural production. In these conditions the irrigation is one of the most effective measures to optimize the soil humidity regime and crop plants.

Irrigated area at the 01.01.2012 consists 225.24 thousand ha (6.65% of total area of country). Volume of irrigational fund depends on a number of factors, the main being pedological, hydrogeological and lithogeomorphological.

An important role in determining the size of irrigation its water sources those are very limited in the Republic of Moldova. The main sources of water irrigation are trans-boundary and interior rivers, accumulation local pools.

The soil cover is characterized by high complexity of soils. On the surface with fertile soils are spread the little areas of halo- and hydromorphed, eroded and affected by landslides soils. These forms of degradation are limitative factors to include the soils in the irrigational fund structure. Regarding these the soils are grouped according to suitability for irrigation.

Profound negative changes occur in the soil adsorption complex and influence the chemical and physical properties.

Mineralized waters cause secondary salinization, argillisation and influence the content of chemical elements in irrigated soils (Filipciuc, 2007; Leah, 2005).

Materials and Methods

The studied was located in the North part of Sylva-steppe Province of Republic Moldova on the typical chernozems. These chernozems were characterized with the best favorable properties and high natural fertility. Trey were includes in II group of suitability for irrigation. The common particularity of II group of soils is the absence of carbonates in superficial horizons. For this group the used water must have the favorable ionic composition, in special the ratio of mono- and bivalent cations, which formed the chemical compounds with heavy metals in the irrigated soils. Also the water for irrigation must have a mineralization less than 0.7 g/l (Leah, 2005).

The content and distribution of mobile forms of Mn, Zn and Cu has been studied in unfertilized and fertilized $(NPK)_{90}$, without irrigated and irrigated soils. Irrigated water has mineralization – 0.3-0.7g/l. Determination method of heavy metals mobile forms was atomic absorption, in buffer solution of ammonium acetate at pH 4,8.

Results and Discussion

Irrigation - the anthropogenic factor, which creates the ecological situation and affecting the general properties of the soils and the distribution of trace elements in the soil profiles. Throughout the profile of the chernozem

typical fertilized showed a higher content of Mn, Zn, Cu, than unfertilized. In the 0-10 cm of soil layer of unfertilized and without irrigated variant found, mg/kg: Mn – 33.0, Cu и Zn – 0.4; in fertilized variant, respectively: 50.0, 3.0, 0.6 mg/kg .

It was observed enrichment of soil-forming parental rocks in these elements, even in the no irrigated unfertilized and fertilized soils: their content is high and ranges in limits: Mn - 113-155 mg/kg, Zn - 3.1-3.7 mg/kg; Cu - 0.8-1.3 mg/kg.

The same legislation of content and distribution of trace elements observed in the chernozem typical fertilized without irrigated and irrigated. The distinguishing feature is that in the unfertilized irrigated chernozem the middle part 60-100 cm of the profile contains a minimum content of Mn and Zn, while the maximum is located at a depth of 100-110 cm. At this depth the soil soaking in irrigation and resets the trace elements. In the irrigated and fertilized soil there are two maximums content of Zn: one at the depth of 30-50 cm and the other at the depth of 110-150 cm of soil layer.

Distribution of Cu in the profiles of the two variants is the same: at the depth 90-100 cm observed maximum concentration especially in the fertilized and irrigated soil (2.2 mg/kg). In a typical chernozem irrigated compared with no irrigated the concentration of Mn and Zn in parental rocks in the 1.5-2.0 times lower, due to deep penetration of soil moisture and the removal of these elements beyond the depth of study 150 cm layer, as well as their removal with the harvest of agricultural crops (Fig. 1, 2, 3).

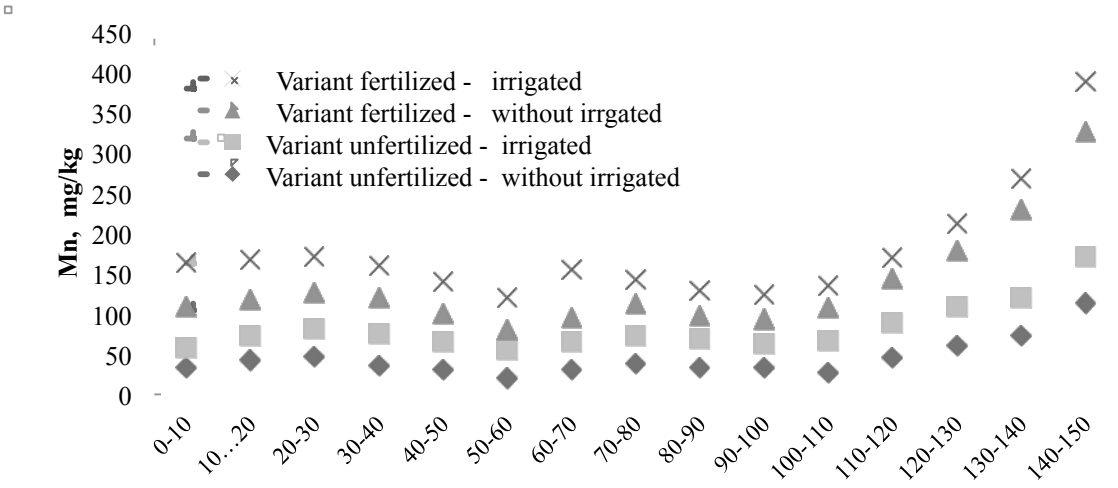

Fig. 1. Effect of fertilizers and irrigation on the content of Mn (mg/kg) in the profile of typical chernozem

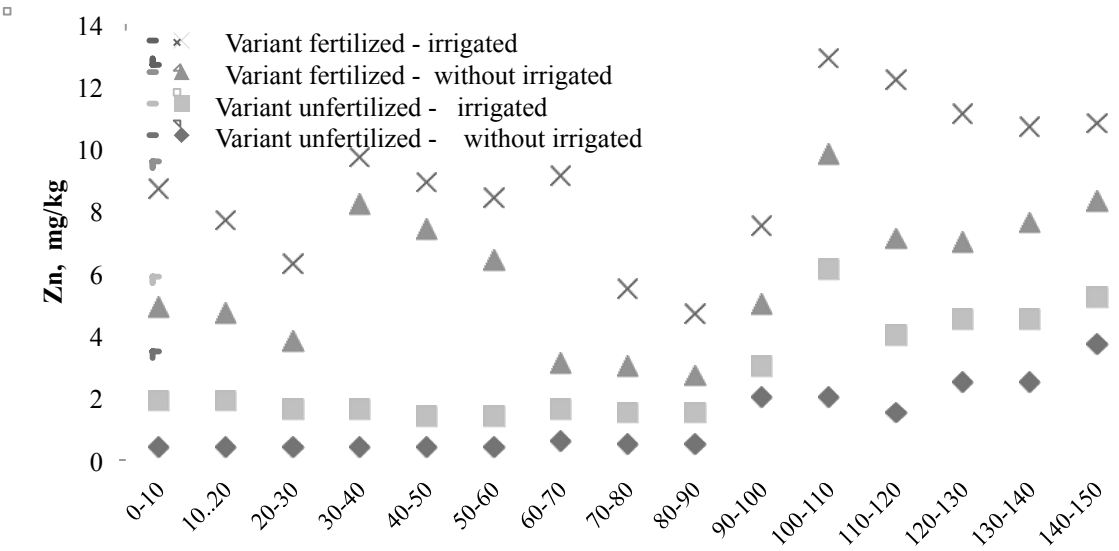

Fig. 2. Effect of fertilizers and irrigation on the content of Zn (mg/kg) in the profile of typical chernozem

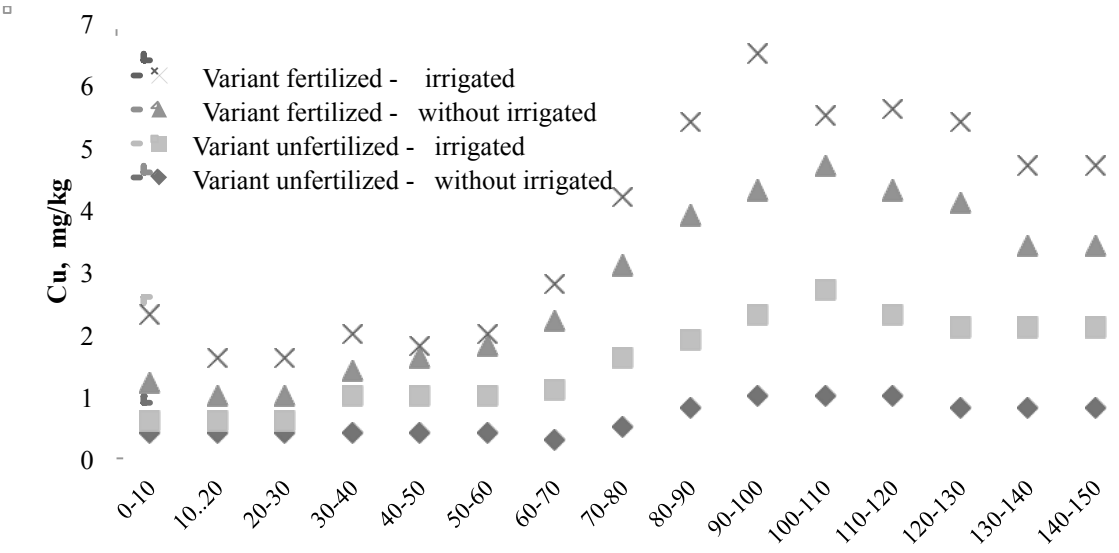

Fig. 3. Effect of fertilizers and irrigation on the content of Cu (mg/kg) in the profile of typical chernozem

Irrigation changes the most active part of the soil – the clay and colloids, with accumulated the trace elements. The irrigation contributes to the partial release of trace elements from mineral and organic compounds and transfers them in the clay fraction. Irrigation significantly changes the distribution of the mobile forms of elements in the profile increasing their take-out, respectively, detected by the lack of these elements for crops. Chemical fertilizers increase the migration of Cu, and fixed Mn and Zn in the irrigated soils. The irrigation creates a risk of contamination of soil with Mn, Cu and Zn.

Conclusion

Distribution of mobile forms of Mn, Zn and Cu in soil showed that irrigation with mineralized water, less than 1g/l stronger influence unfertilized soils. The content of heavy metals depends of fertilization; distribution was influenced by irrigation. The content of Mn, Zn and Cu were accumulated in 0-10 cm layer of the fertilized soils. The irrigation distributes the concentration of heavy metals in whole profile and had two maximum of accumulation in fertilized variants. The concentration of heavy metals in studied soils does not exceed the maximum allowable and at moment it is no dangerous for this subtype of chernozem.

To prevent adverse effects in irrigated soils it is necessary to use irrigation water that meet standards. To prevent soil degradation is not recommended the water with high mineralization degree over 1g/l salts and unfavorable cation composition. In case of acute drought the irrigation with high mineralization will be carried out concurrently with pedoameliorative works (gypsum amendment, fertilization improvement). To maintain the fertility of irrigated soils and prevent physical and chemical degradation (inclusive heavy metals pollution from fertilizers) should be included in crop rotation the perennial grasses – 20-25%.

Water quality used for irrigation must be correlated with soil properties. Concentration of toxic elements and compounds (heavy metals, fluoride, pesticides) in the water not exceed the level provided by sanitary drinking water standards. For expending the irrigated area in the bases to use the local sources of water is necessary to provide require corresponding surveys for the prevention of soil degradation.

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