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ОВОЩНИ КУЛТУРИ

INVESTIGATIONS ON FERTIGATION OF PEACH ON THREE SOILS - INFLUENCE ON THE DISTRIBUTION OF Mn, K, AND pH

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Localized application of fertilizers and water undoubtedly influences the direction and the intensity of processes taking place in root zone. Depending on the reduction-oxidation conditions in the soil, manganese turns easily from one valency to another, thus changing its solubility and its availability for plants. Plants absorb mostly bivalent manganese, occurring as a soil solution component or being adsorbed by the soil mineral phase, while the higher valencies manganese oxides (Mn3+ and Mn4+) become available after their reduction. Therefore, not only the exchangeable manganese (Mn2+) but also the active manganese, represented mostly by easy-reducing manganese oxides (Mn3+), is essential for plant nutrition.

Drip-irrigation systems are regarded to offer an inexpensive and effective approach for correction of potassium deficit allowing multiple application of low fertilization rates [Rolston et al., 1986]. Uriu et al. (1980) reported a twofold increasing of potassium content in the leaves of plum trees under fertigation, compared to other ways of fertilization.

The introduction of some fertilizers by irrigation water can result in soil acidification in the volume of wetting [Branson et al., 1981]. According to Bar-Yosef and Sheikholslami (1976), the accumulation of phosphates lowers pH in vicinity of the dripper, which can affect the root activity and can create prerequisites for their additional adsorption, i.e. it can still limit their availability.

This article treats the changes in soil characteristics (the content of active and exchangeable manganese, the content of potassium, as well as the soil reaction) occurring in root zone as a result of fertigation with urea and phosphoric acid. The irrigation water redistribution in the soil, with a view to the application efficiency and the root water uptake spatial distribution, as well as the nitrogen and the phosphorus migration and localization were discussed in previous articles [Koumanov et al., 1998; Stoilov et al., 1999a, b]. Present results were obtained at the Plovdiv Institute of Fruit-Growing during the period 1994-1997.

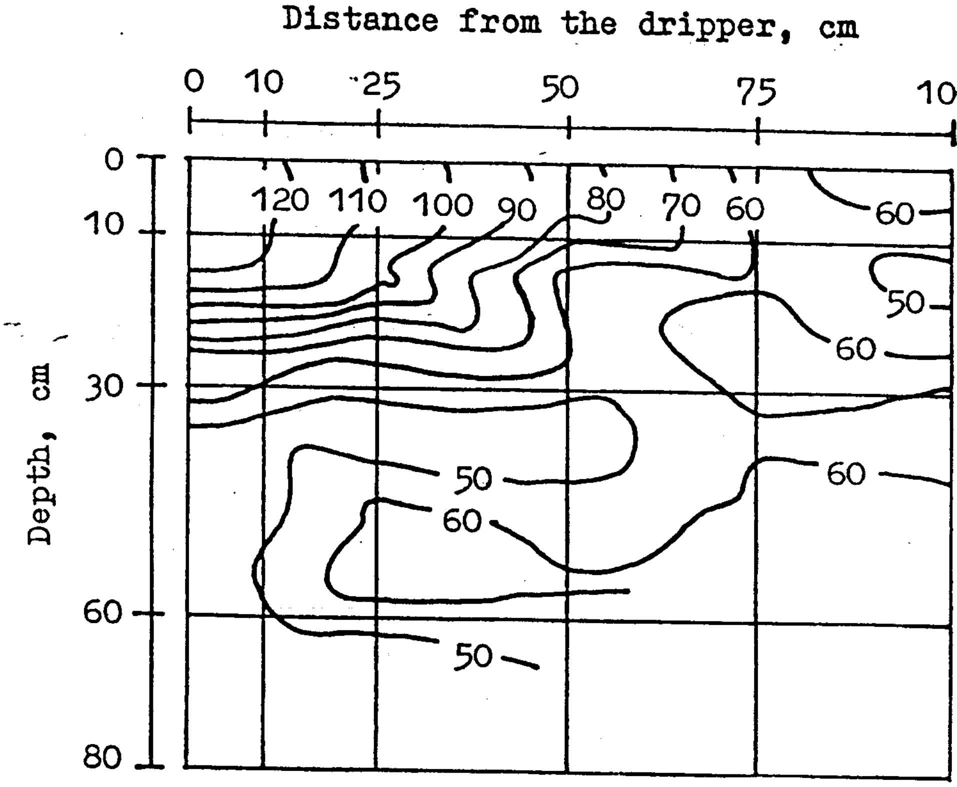
MATERIAL AND METHODS

The experimental work was carried out in concrete lysimeters with cells 2,00x3,00 m, filled up to 1,00 m with soil [Koumanov et al., 1998], and on three soils: alluvial-meadow soil (Fluvisol), cinnamon-forest soil (Luvisol), and smolnitsa (Vertisol). According to their texture, these soils were determined respectively as sandy loam, clay loam, and clay, after the USDA-classification (Soil Survey Staff, 1975). Water, physical, and chemical characteristics of the soils investigated were described in previous articles [Koumanov et al., 1998; Stoilov et al., 1999a, b].

In the spring of 1994 single peach trees (cultivar "Redhaven" on GF-677 rootstock) were planted in each one of the lysimetric cells. Plants were supplied with water and fertilizers through a drip-irrigation system: one emitter per tree, with an average discharge of 4,6 l/h and located at 0,75 m from the tree trunk.

Urea [$CO(NH_2)_2$] and phosphoric acid (H_3PO_4) were used to provide annual fertilization rates of 165 g N/tree and 84 g P_2O_5/tree, the annual fertilizer amounts being partitioned to monthly doses [Stoilov et al., 1999a, b]. Nutrient solution was injected in the irrigation system by an automatic dosing pump (DOSATRON INTERNATIONAL, Bordeaux, France) thus providing concentrations in the irrigation water of respectively 0,4% $CO(NH_2)_2$ and 0,9% H_3PO_4.

Fertigation impact on the active and the exchangeable manganese, on the potassium and on the soil reaction was examined by soil sampling 20 hours after the last water application. In 1996, soil sampling was done by drilling radially from the dripper at 10 cm, 25 cm, 50 cm, 75 cm, and 100 cm, and by layers of 10 cm. In 1997 soil samples were taken



Фиг. 1.

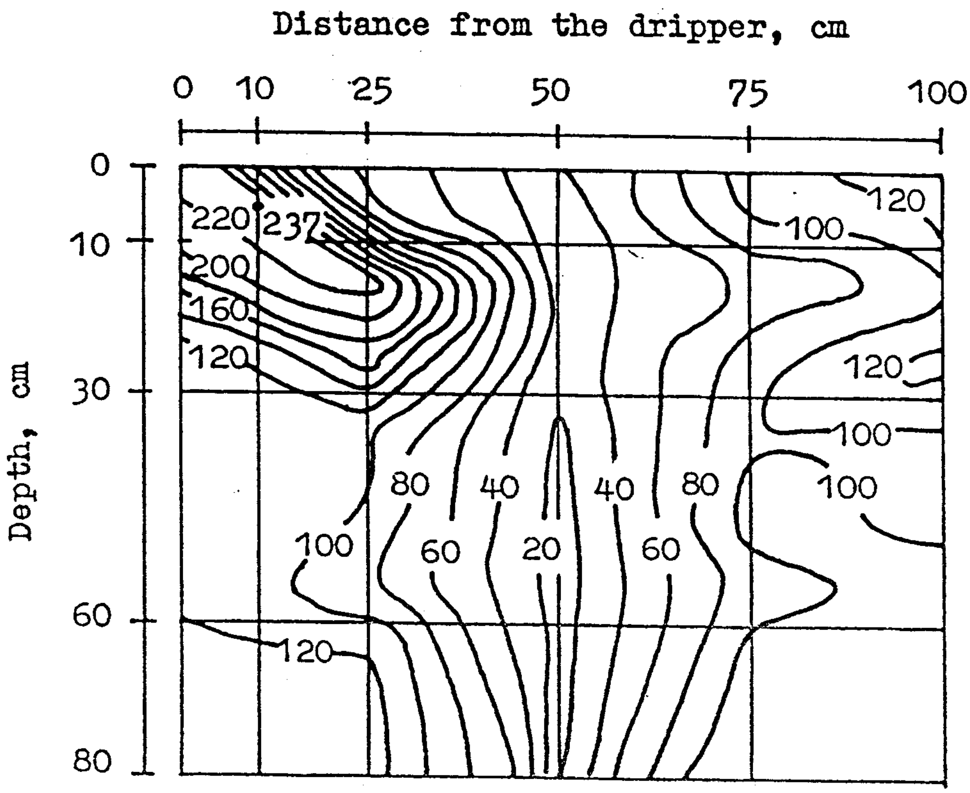
Зона на активния манган в алувиално-ливадна почва, две седмици след прилагането на максималната доза на торене 10.07.1996, mg/kg

Fig. 1.

Field of the active manganese in the alluvial-meadow soil two weeks after applying of the maximal fertilization dose; 10.07.1996, mg/kg

from a soil profile in 10 cm square grid, after digging a trench along the line tree-dripper.

The mobile potassium (K_2O) content in the soil samples was determined in lactate extract (DL-method) by a flame-photometer. The mobile forms of manganese (active and exchangeable) were analyzed

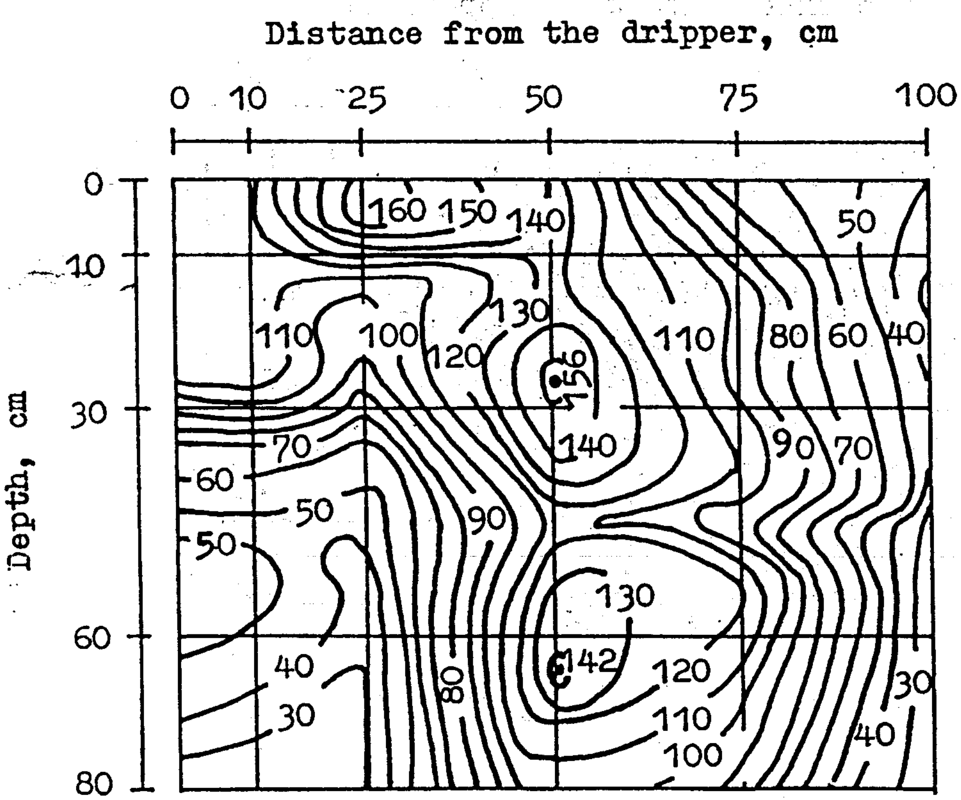


Фиг. 2.

Зона на активния манган в канелено-горска почва, две седмици след прилагането на максималната доза на торене 10.07.1996, mg/kg

Fig. 2.

Field of the active manganese in the cinnamon-forest soil two weeks after applying of the maximal fertilization dose; 10.07.1996, mg/kg

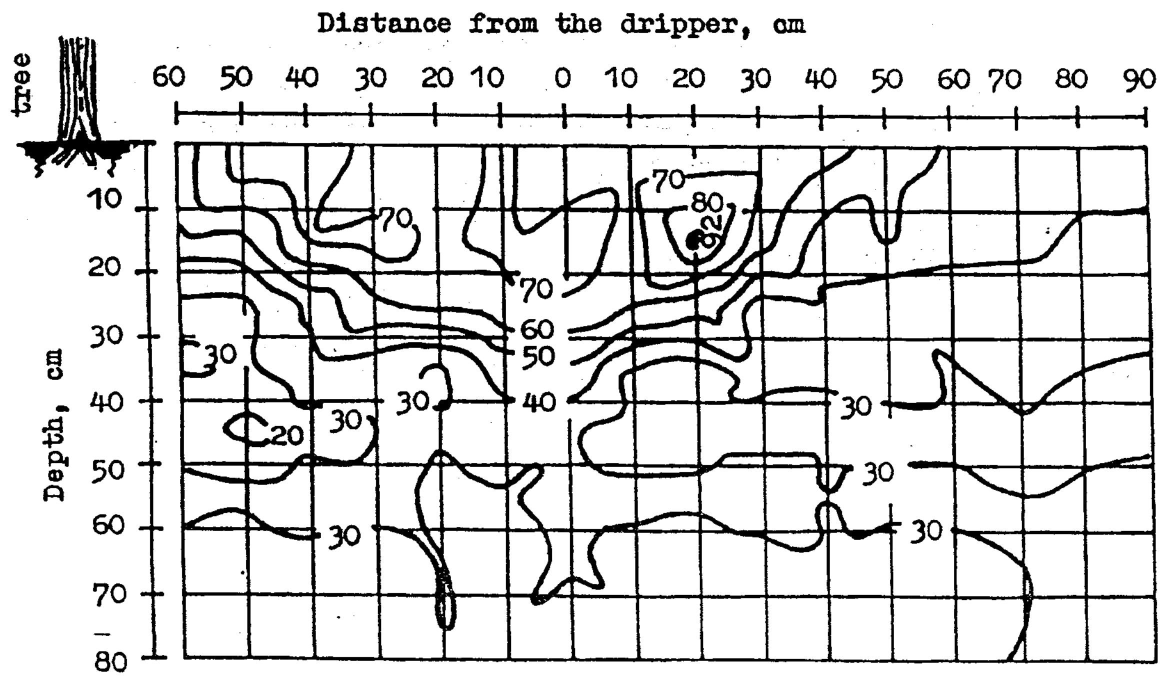


Фиг. 3.

Зона на активния манган в смолница, две седмици след прилагането на максималната доза на торене 10. 07. 1996, mg/kg

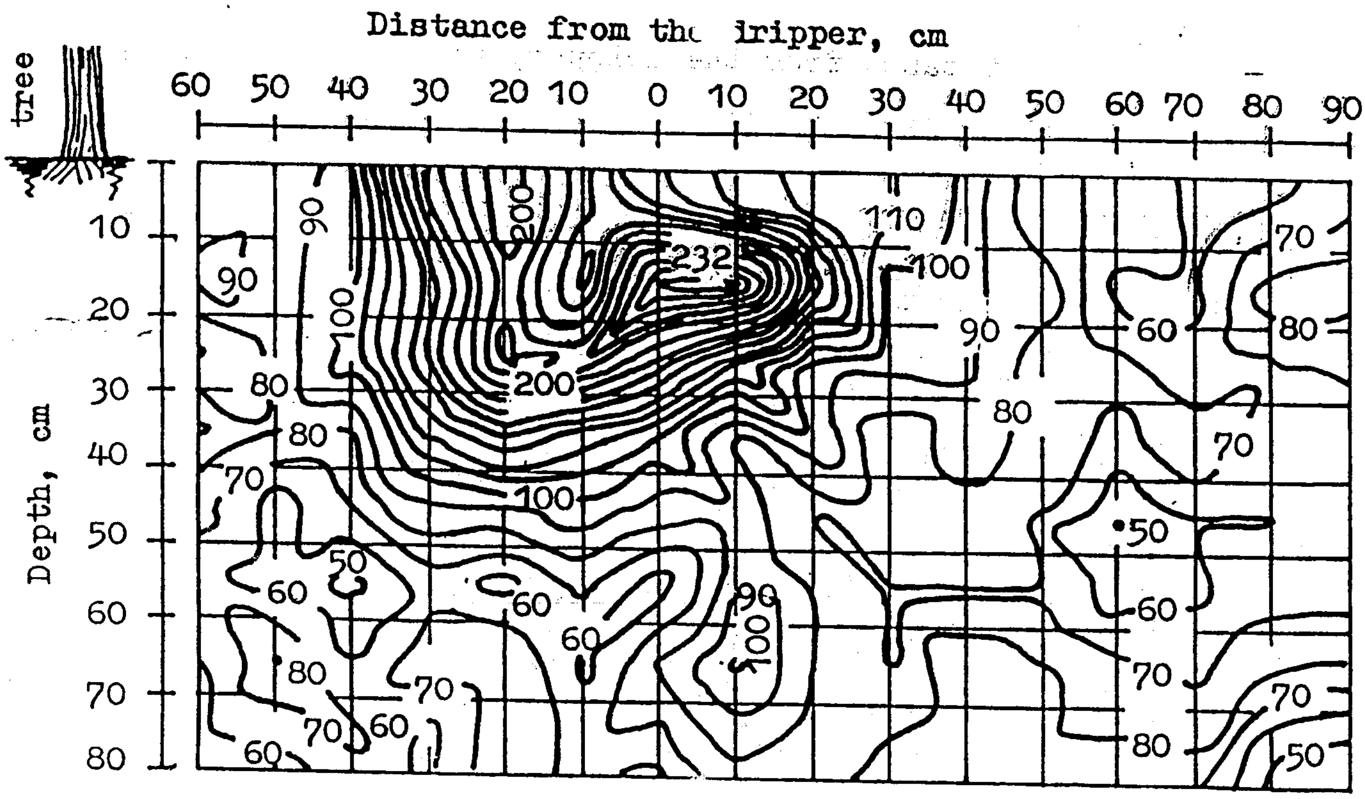
Fig. 3.

Field of the active manganese in the smolnitsa two weeks after applying of the maximal fertilization dose; 10.07.1996, mg/kg



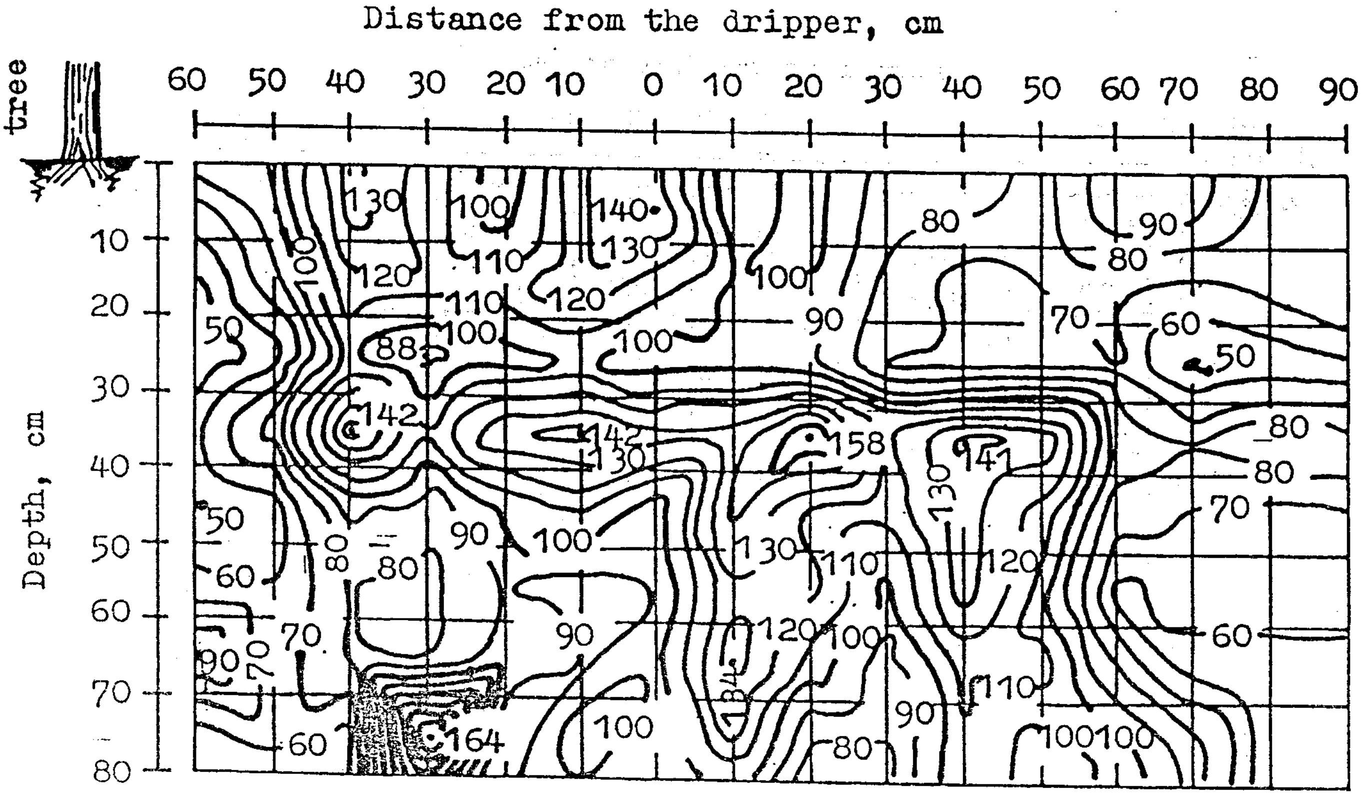
Фиг. 4. Зона на активния манган в алувиално-ливадна почва, две седмици след прилагането на максималната доза на торене 04. 08. 1997, mg/kg

Fig. 4. Field of the active manganese in the alluvial-meadow soil two weeks after applying of the maximal fertilization dose; 04. 08. 1997, mg/kg



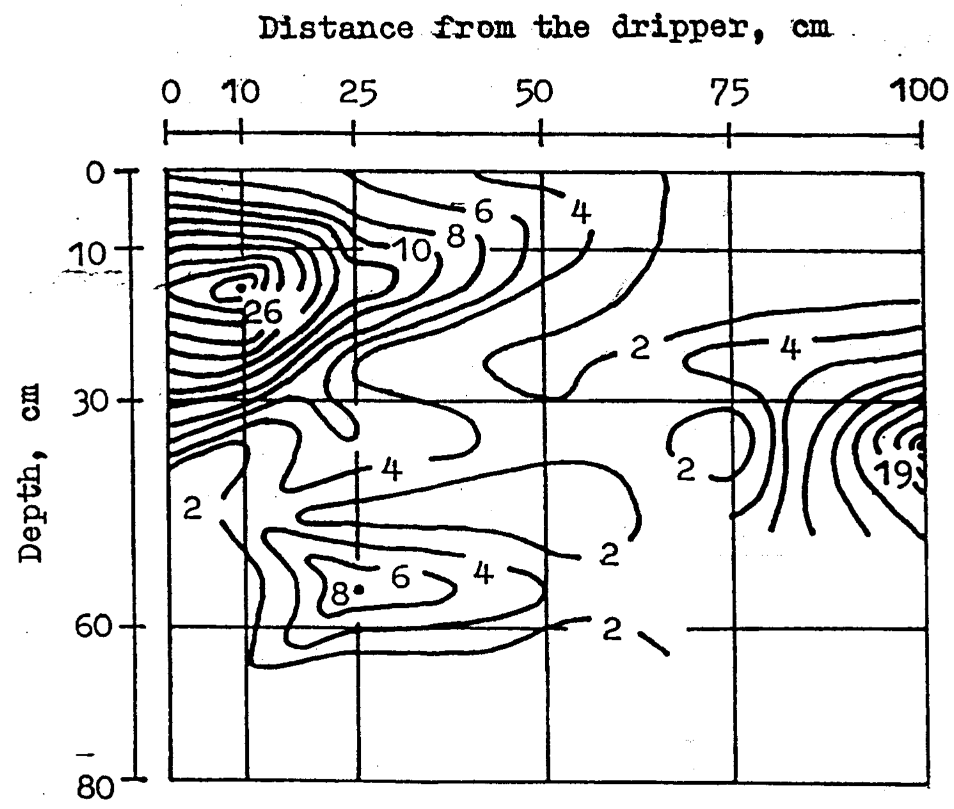
Фиг. 5. Зона на активния манган в канелено-горска почва, три седмици след прилагането на максималната доза на торене 15. 07. 1997, mg/kg

Fig. 5. Field of the active manganese in the cinnamon-forest soil three weeks after applying of the maximal fertilization dose; 15. 07. 1997, mg/kg



Фиг. 6. Зона на активния манган в смолница, три седмици след прилагането на максималната доза на торене 14. 07. 1997, mg/kg

Fig. 6. Field of the active manganese in the smolnitsa three weeks after applying of the maximal fertilization dose; 14. 07. 1997, mg/kg



Фиг.7.

Зона на обменния манган в алувиално-ливадна почва, две седмици след прилагането на максималната доза на торене 10.07.1996, mg/kg

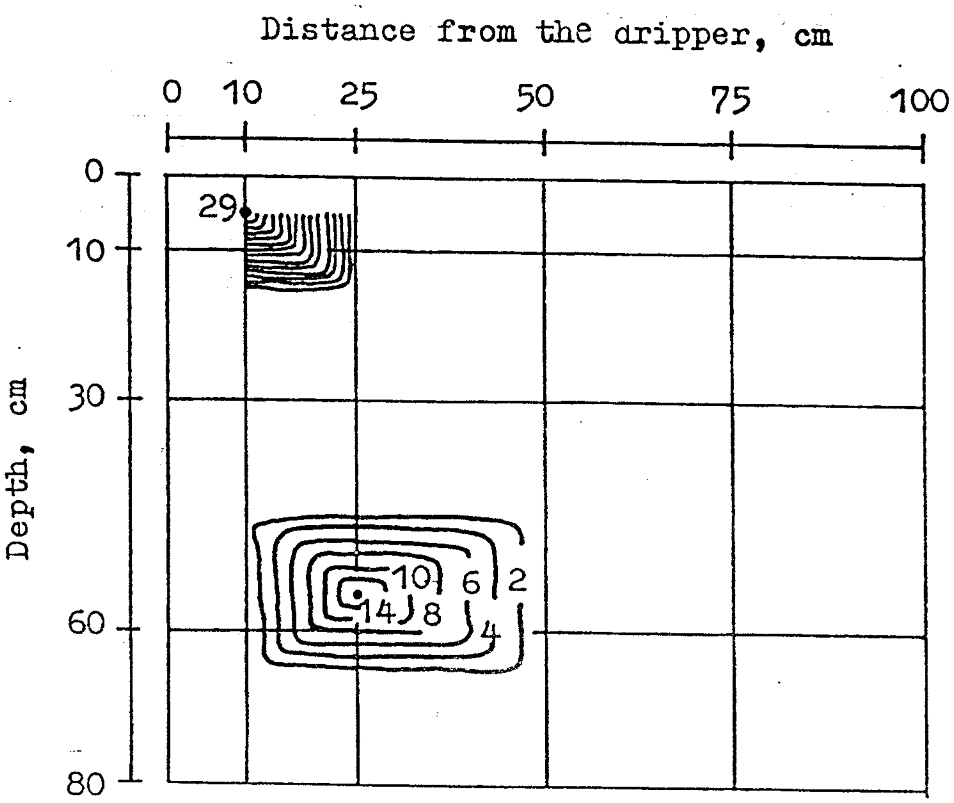
Fig.7.

Field of the exchangeable manganese in the alluvial-meadow soil two weeks after applying of the maximal fertilization dose; 10.07.1996, mg/kg

according to Schachtschabel (1957), and the soil reaction (pH) - potentiometrically, in water extract.

RESULTS AND DISCUSSION

The active manganese content and distribution in root zone, found two weeks after the urea and phosphoric acid maximal fertilization dose application in 1996, are presented

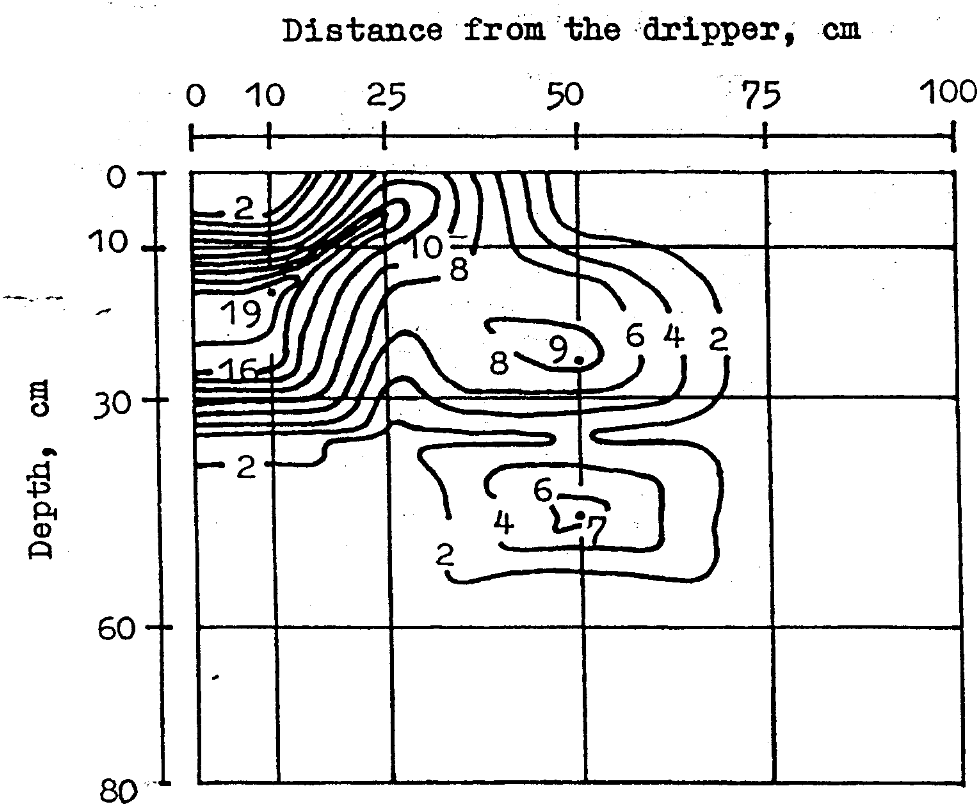


Фиг.8.

Зона на обменния манган в канелено-горска почва, две седмици след прилагането на максималната доза на торене 10.07.1996, mg/kg

Fig.8.

Field of the exchangeable manganese in the cinnamon-forest soil two weeks after applying of the maximal fertilization dose; 10.07.1996, mg/kg

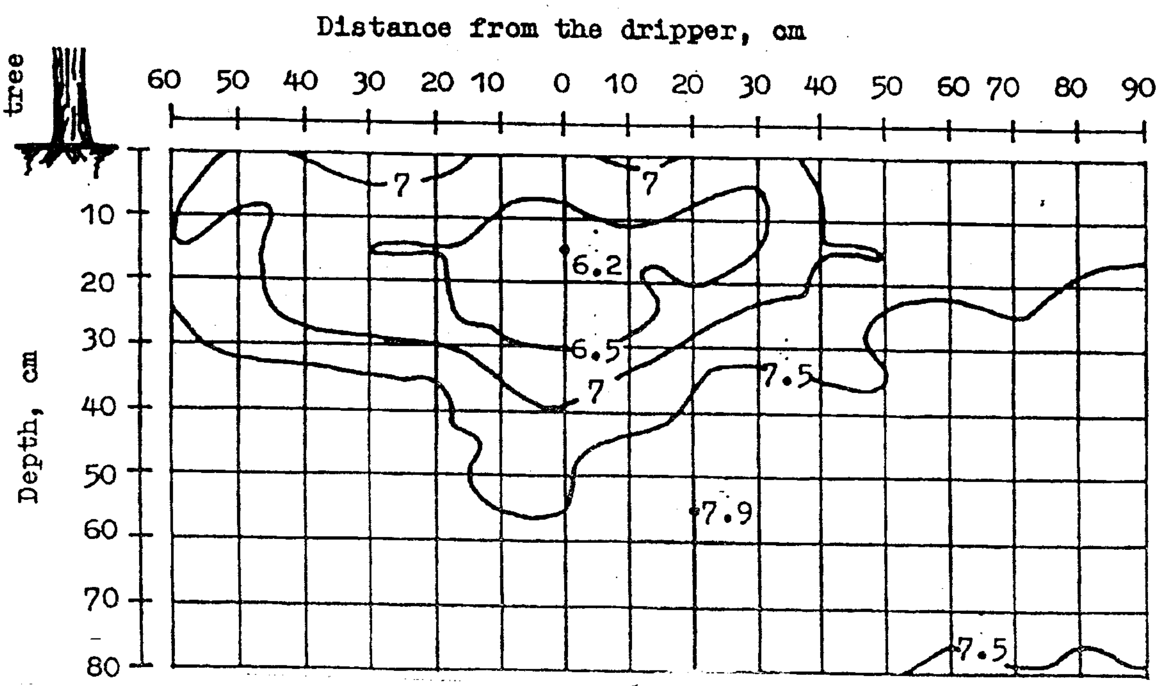


Фиг. 9.

Зона на обменния манган в смолница, две седмици след прилагането на максималната доза на торене 10.07.1996, mg/kg

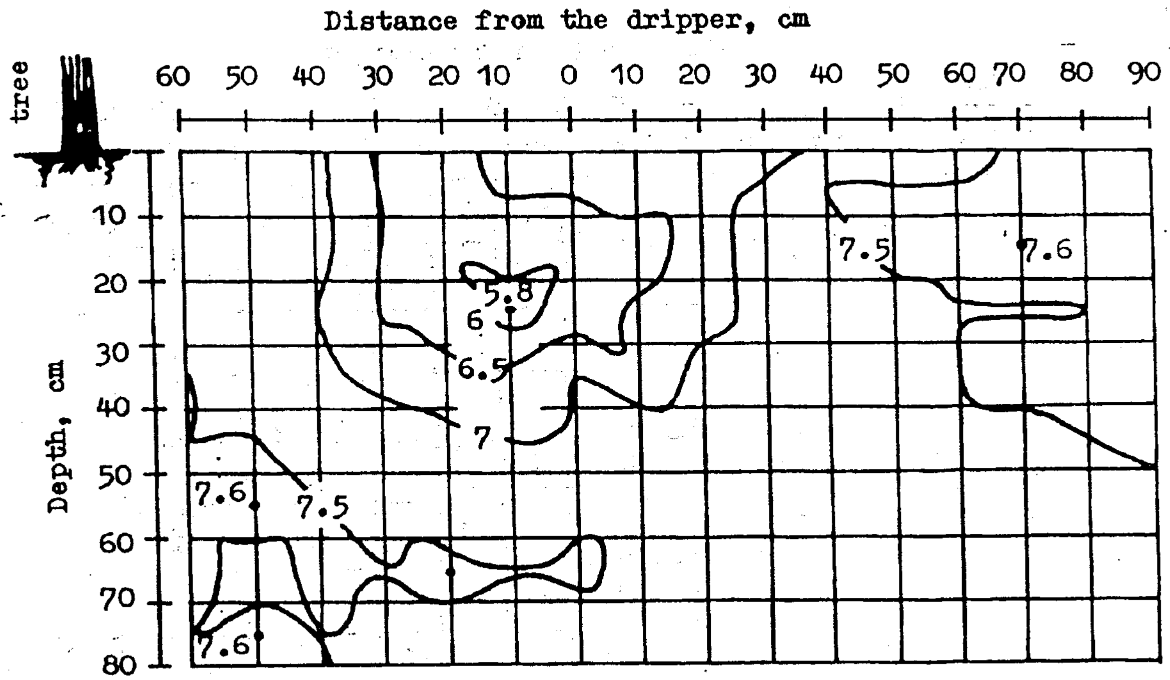
Fig. 9.

Field of the exchangeable manganese in the smolnitsa two weeks after applying of the maximal fertilization dose; 10.07.1996, mg/kg



Фиг. 10. Зона на почвената реакция в алувиално-ливадна почва, две седмици след прилагането на максималната доза на торене 04.08.1997 pH

Fig. 10. Field of the soil reaction in the alluvial-meadow soil two weeks after applying of the maximal fertilization dose; 04.08.1997, pH



Фиг.11. Зона на почвената реакция в канелено-горска почва, три седмици след прилагането на максималната доза на торене 15.07.1997 pH

Fig.11. Field of the soil reaction in the cinnamon-forest soil three weeks after applying of the maximal fertilization dose; 15.07.1997, pH

graphically on Fig.1 to 3 for the three soils respectively. The results obtained three weeks after the maximal fertilization dose in 1997 are illustrated on Fig.4 to 6. The content and the distribution of exchangeable manganese, found in 1996, are shown on Fig.7 to 9.

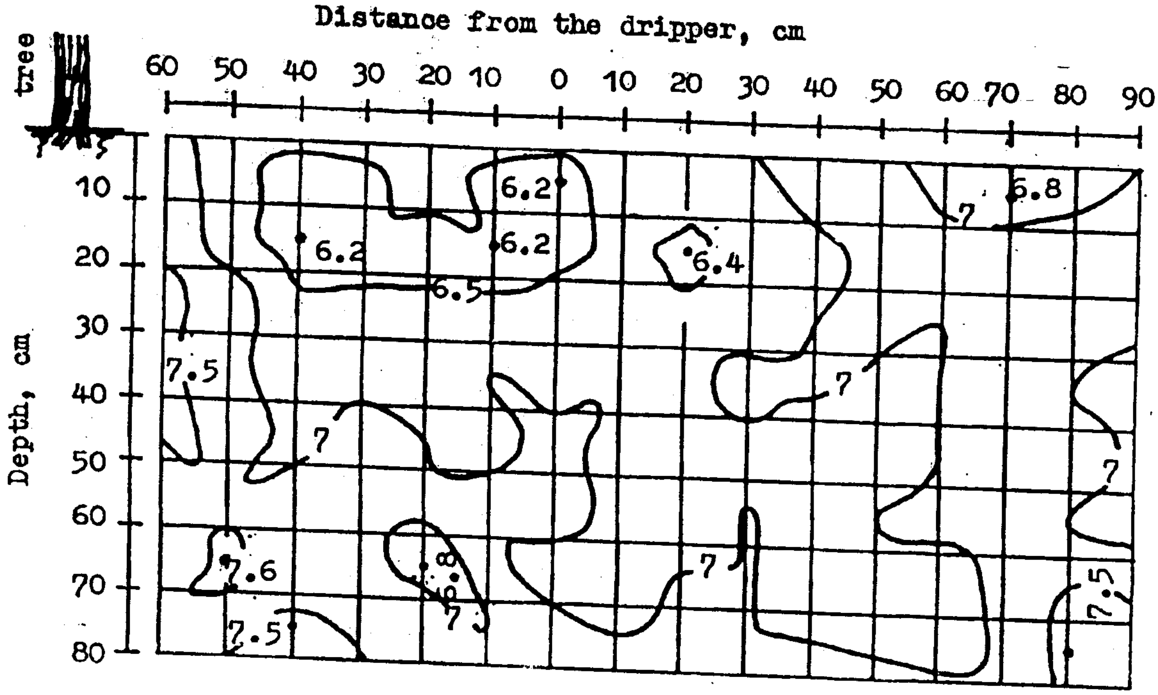
According to Fig.1 to 6, an increased content of active manganese was found in the wetted soil volumes of all three soils, i.e. fertigation resulted in an increased mobility of the soil manganese. Essential evidence was the appearance of its bivalent forms (exchangeable manganese) in the zones of high soil moisture, which could not be found in non-wetted areas of the root zone. Bivalent (exchangeable) manganese was found in relatively small soil volumes mainly under the point of dripping, probably because of the relatively short-lived influence of fertigation, Fig.7 to 9.

Fertigation did not change the initial content of mobile potassium in the soils investigated (data not presented).

However, the introduction of urea and phosphoric acid with irrigation water resulted in a common, for the three soils, tendency to lowering of pH-values in zones under the dripper, Fig.10 to 12. In these zones soil reaction was estimated as slightly acid, i.e. in the optimum range for peach plants. Next applications of fresh irrigation water spread out the acidification to larger soil volumes but in the same time diminished its magnitude. Also, the fertigation impact was attenuated by the time. Soil reaction remained unchanged in the non-wetted areas, varying between soil types from neutral in the cinnamon-forest soil to slightly alkaline in the alluvial-meadow soil. It should be noted that, in the three soils investigated, the urea and phosphoric acid application did not lowere pH-values below the optimum for peach plants.

CONCLUSIONS

♦ Despite of some quantitative differences occurring among the three soils, it was distinguished a common mode of impact on the investigated soil characteristics when urea and phosphoric acid were applied in the root zone with the irrigation water. The active manganese augmented in zones of high soil moisture, thus increasing the soil-manganese mobility. Bivalent (exchangeable) manganese was found in relatively small volumes, mainly under the point of dripping. The mobile potassium content and



Фиг. 12. Зона на почвената реакция в смолница, три седмици след прилагането на максималната доза на торене 14.07.1997 pH

Fig. 13. Field of the soil reaction in the smolnitsa three weeks after applying of the maximal fertilization dose; 14.07.1997, pH

distribution did not practically change throughout the soil profile. Soil reaction changed to slightly acid in zones under the dripper but without reaching pH-values below the optimum for peach plants. Next applications of fresh water spread out the acidification to a larger soil volume but in the same time diminished its magnitude. Also, the fertigation impact was attenuated by the time.

Acknowledgements

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ИССЛЕДОВАНИЕ УДОБРИТЕЛЬНОГО ОРОШЕНИЯ ПЕРСИКА НА ТРЕХ ПОЧВАХ - ВОЗДЕЙСТВИЕ НА РАСПРЕДЕЛЕНИЕ Mn, K и pH

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(Резюме)

Опыт провели в лизиметрах на трех почвах: аллювиально-луговой (Fluvisol) - sandy loam, коричневой лесной (Luvisol) - clay loam и смолнице (Vertisol) - clay.

Опытные деревья, по одному в каждом лизиметре, орошали капельным способом при помощи единичных капельниц с дебитом 4,6 l/h, расположенных на расстоянии 0,75 cm от ствола. Удобрения - мочевину ($CO/NH_2/_2$) и фосфорную кислоту (H_3PO_4) вносили через систему орошения, причем норму подавали месячными дозами.

Несмотря на наличие известных различий между основными характеристиками трех почв, можно наметить общую модель воздействия на исследовавшиеся почвенные параметры при внесении мочевины и фосфорной кислоты с поливной водой.

Содержание активного марганца в зонах повышенной влажности возрастает, повышая усвояемость почвенного марганца.

Двухвалентный (обменный) марганец можно обнаружить в сравнительно небольших объемах в основном под точкой микроводовыпуска. Содержание и распределение подвижного калия практически не изменяется. Реакция почвы в зонах под точкой микроводовыпуска изменяется до слабокислой, но величина pH не падает ниже оптимальной для деревьев персика.

INVESTIGATIONS ON FERTIGATION OF PEACH ON THREE SOILS - INFLUENCE ON THE DISTRIBUTION OF Mn, K, AND pH

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(Summary)

The experiment was carried out in lysimeters on three soils: alluvial-meadow soil (Fluvisol) - sandy loam, cinnamon-forest soil (Luvisol) - clay loam, and smolnitsa (Vertisol) - clay.

Each trees, one plant per lysimeter, were irrigated by single drippers with discharge of 4,6 l/h, located at 0,75 m from the trunk. Fertilizers - urea [$CO(NH_2)_2$] and phosphoric acid (H_3PO_4), were supplied through the irrigation system, the annual amounts being partitioned to monthly doses.

Despite of some quantitative differences between the basic characteristics of the three soils, it was found a common mode of impact on the soil parameters investigated when urea and phosphoric acid were applied in the root zone by the irrigation water. The active manganese content augmented in zones of high soil moisture, thus increasing the soil-manganese mobility. Bivalent (exchangeable) manganese was found in relatively small volumes mostly under the point of dripping. The mobile potassium content and distribution did not practically change throughout the soil profile. Soil reaction changed to slightly acid in the zones under the dripper but without reaching pH-values below the optimum for peach plants.