

Water Dynamics in Plant Production, 2nd Edition

Questions and Discussion Points

Chapter 17 – Controlling the Soil's Water Balance by Soil Management

Section 17.1

1. Please explain the statement 'With respect to water, soil needs to be managed so that it acts like a trap'.
2. Explain the fine difference between evapotranspiration efficiency (ETE) and water use efficiency (WUE).

Section 17.2

1. Specify the main objectives of improving soil infiltrability.
2. Describe the on-site and off-site damage that can result from inadequate infiltration.
3. What is the 'secret' of soils with high infiltrability?
4. Define the soil science term 'soil crumb'. Soils consisting of crumbs have two special features that influence the soil water regime. Please explain.
5. Discuss the statement: 'Any tillage system aimed at soil loosening causes a dilemma in relation to structural stability and the water dynamics'.
6. Describe the effect of soil loosening by tillage and soil compaction by traffic on porosity, pore size distribution, soil structure and infiltrability (Fig. 17.1).
7. During a thunderstorm 40 mm of rain pelted down during the short time of 20 min. Calculate the infiltrability in cm day^{-1} , necessary to avoid any runoff.
8. Present some management options to increase aggregate stability and to protect the soil surface from raindrop impact.
9. Please explain how waterlogging can be caused by the presence of a plough pan.
10. Discuss the influence of biopores on saturated hydraulic conductivity (Fig. 17.3).
11. Which aims are served by primary and secondary tillage?
12. Explain the technical terms 'conservation tillage' and 'zero-tillage'.

Section 17.3

1. Soil loosening may be helpful not only in infiltration control but also in reducing evaporation. Explain the underlying principles.
2. Roughness and openness of the topsoil is a principle objective for infiltration control. This is also true for evaporation control but for different reasons. Please explain.
3. Why is the water saving effect of soil loosening dependent on time (Fig. 17.5)?
4. Stubble cultivation may not only increase water infiltration, but it may contribute also to the 'self-mulching effect'. Explain the mulching and self-mulching effect related to soil evaporation.
5. Stubble mulch tillage combines the effects of tillage and mulching on soil evaporation control. Please explain the different principles underlying the control mechanisms.

Section 17.4

1. How do you assess the possibility of increasing the available field capacity by any tillage system?
2. Explain the generation of plough pans in tillage systems using the mouldboard plough.
3. What is subsoil compaction? How can it be generated in modern agriculture?
4. Please explain the concept of the 'least limiting water range'. How does it change as the result of soil compaction (Fig. 17.8) and what is its influence on the rootability of the soil?

5. Derive conclusions for the effective rooting depth and the amount of extractable water in a non-compacted and a compacted arable soil.

Section 17.5

1. Explain the difference in tillage operation between a mouldboard plough and a winged blade cultivator. Describe the appearance of the soil surface. How do these two operations affect aggregation, aggregate stability and surface slaking?
2. At least two technical-industrial innovations were prerequisite for the introduction of zero-tillage. Please explain this statement.
3. There are situations, where the zero-tillage system will not perform adequately to achieve good yields. Present some facts relating to these difficulties and suggest why minimum or reduced ('scratch') tillage could prove to be preferable.
4. Interpret Table 17.1. Why is precipitation during the fallow period greater than the annual average? What is fallow efficiency? Which two items have been changed in tillage during the 20th century? What caused the increase in wheat yield?
5. Describe the effect of reduced tillage as compared to mouldboard ploughing on soil structure by making reference to Fig. 17.10.
6. Omitting 'inversion' tillage and switching to reduced tillage enhances not only the activity of microorganisms but also the abundance of earthworm species. Explain the beneficial effect of earthworms on soil properties and crop growth.
7. For water infiltration, earthworm channels can be effective with an open port at the soil surface. Discuss this aspect, when comparing the percentage area of channels in total with those having surface connection, as influenced by conservation tillage (Fig. 17.12).
8. Discuss water uptake by maize roots in a sandy loam as modified by the tillage system and subsoiling (Fig. 17.14).

Box 17.1

1. Explain the 'Zaï' technique, well known south of the Sahel, which was improved by Yacouba Sawadogo in Burkina Faso. What has the Zaï technique in common with the 'tiger bush', which forms under natural conditions in that area?
2. Discuss the astonishment we may feel on learning that a man without scientific or financial support from outside, who encountered the opposition of his fellow countrymen and resistance from state officials, succeeded in fighting famine for his family and fellow citizens.