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Water Use Efficiency under Different Tillage and Irrigation Systems for Tomato Farming in Southeastern Brazil

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In the northwest part of Rio de Janeiro state water availability is one of the main limiting factors for human development and crop productivity. In the same way that shortage of freshwater is one of the main problems, the tomato production systems waste water and highly degrade the environment. The search for the water use efficiency is a challenge in tomato sustainable development production systems. This study aimed to contribute towards the development of sustainable production systems for the tomato farming in the northwestern part or Rio de Janeiro state, as well as increase water use efficiency and the improvement of our understanding on the role played by soil and water management practices on soil hydrology, especially on the amount of water available for the plants.

The study was carried out at an experimental watershed in the city of São José do Ubá, in the northwestern portion of Rio de Janeiro state. This city has one of the worst human development index (HDI = 0718) of the state, occupying one of the last 6 positions (85 in 91), with serious problems of education, sanitation, water supply and public health. This area is characterized by an extensive steep hilly topography constituted by long convex-concave hillslopes separated by flat valley-bottoms. The original Atlantic Forest was continuously removed for the introduction of farming and grazing activities, which currently dominate the landscape of the region. The combination of such topographic and land-use characteristics tend to generate a variety of erosional processes, including rill and interrill erosion, gullies and even landslides. The average annual rainfall in the area is about 1,171 mm, with most of rain concentrated during the summer season, making December the wetter and July the drier months. The water balance is negative for most of the year, with the exception of the period from November to January. The cultivation in the area is traditionally done using production systems that highly degrade the environment, applied without practices of soil and water conservation. Such production systems are associated with a variety of environmental problems, such as soil erosion, the extensive pumping of groundwater, the partial obstruction of surface drainage to form artificial lakes, the contamination of groundwater, among others. The environmental impacts generated by all these problems assume a greater importance due to the complete absence of monitoring the continuous lowering of the water table and the changes in water quality.

We consider that the main management strategies for developing sustainable production systems for the tomato farming in this area should be based on monitoring water use efficiency, increasing water availability in the root zone and also preventing runoff, leaching and evaporation of water from the soil. Therefore, techniques were applied as green manures with legumes without incorporation of the biomass, non-mechanized and curve-level soil preparation, planting in level, soil cover with crop residues, fertirrigation with solid fertilization of low value, the conduct of tomato especially supported by plastic string attached to a trellis, drip irrigation, and monitoring soil water potential (SWP) with Watermak sensors. At the end of the tomato cycle, water use efficiency and the productivity were compared at 8 micro-plots installed in the 3 studied production systems: conventional tillage (CT-H), minimum tillage (MT-H), both with "wetting irrigation with garden hose", and no-tillage with drip irrigation (NT-D). For each production system, soil physical properties were characterized and soil water potential (SWP) and soil temperature were continuously monitored at different depths (20, 40, 60 and 80 cm), as well as the total water volume used in each irrigation. In parallel, we also compared the development of the root system and the final productivity for each one of the three production systems.

The results obtained in this study did no suggest significant modifications on soil physical properties among the three systems. The no-tillage system (NT-D) presented the lower values for average soil temperature and amplitude and supplied more water to the plants, favoring groundwater recharge on the long-term, while preventing runoff,

leaching or evaporation of water from the soil. On the other hand, conventional (CT-H) and minimum tillage (MT-H) systems generated water stress conditions, especially during fruiting, maturation and harvest periods. Besides, 75% of the root system is concentrated on the first 30cm of the soil profile while in the no-tillage system with drip irrigation (NT-D) is observed an increase of water availability in the effective root zone (60 cm). The results obtained here also suggest a 50% increase in the production of tomato for the no-tillage system with drip irrigation (NT-D) when compared to the conventional system. Therefore, the results attest that the implementation of simple soil and water conservation practices play an important role toward an improvement of the environmental sustainability of the tomato farming in this area.