Geophysical Research Abstracts
Vol. 17, EGU2015-14710, 2015
EGU General Assembly 2015

Impact of Soil Resistance to Penetration in the Irrigation Interval of Supplementary Irrigation Systems at the Humid Pampa, Argentina

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The Avellaneda District, located in northeastern of Santa Fe Province, Argentina, has an average annual rainfall of 1250 mm per year, but with a high variability in their seasonal distribution. Generally, the occurrence of precipitation in winter is low, while summer droughts are frequent. The yearly hydrological cycle shows a water deficit, given that the annual potential evapotranspiration is estimated at 1330 mm. Field crops such as soybean, corn, sunflower and cotton, which are affected by water stress during their critical growth periods, are dominant in this area. Therefore, a supplemental irrigation project has been developed in order to identify workable solutions. This project pumps water from Paraná River to provide a water supply to the target area under irrigation. A pressurized irrigation system operating on demand provides water to a network of channels, which in turn deliver water to farms. The scheduled surface of irrigation is 8800 hectares. The maximum flow rate was designed to be 8.25 m^3/second. The soils have been classified as Aquic Argiudolls in areas of very gentle slopes, and Vertic Argiudolls in flat and concave reliefs; neither salinity nor excess sodium affect the soils of the study are. The objective of this study was to provide a quantitative data set to manage the irrigation project, through the determination of available water (AW), easily available water (EAw) and optimal water range (or interval) of the soil horizons. The study has been conducted in a text area of 1500 hectares in surface. Five soil profiles were sampled to determine physical properties (structure stability, effective root depth, infiltration, bulk density, penetration resistance and water holding capacity), chemical properties (pH, cation exchange capacity, base saturation, salinity, and sodium content) and morphological characteristics of the successive horizons. Also several environmental characteristics were evaluated, including: climate, topographic conditions, relief, general and slope position, erosion, natural vegetation and agricultural crops. Indeed the computed available water (AW) content and easily available water (EAw) content values depended on bulk density, field capacity and permanent wilting point, but also they were affected by the soil penetration resistance measured to a depth of 80 cm; this parameter limits the extent of the soil volume explored by plant roots and therefore EAw content. Moreover, soil penetration resistance enables to take into account the concept of optimal water interval, which indicates how soil compaction limits the levels of easily available water that really can be extracted by the crop. The estimated values of EAw water ranged from 74 to 133 mm for the profiles studies. When including the concept of mechanical resistance to penetration to obtain the value of the optimal water interval, the above values decreased, ranging between 34 and 57 mm; this was mainly explained on the basis of the true depth of exploration by plant roots of the soil profiles. Based on the recorded values of the soil mechanical resistance to penetration, it was concluded that sunflower and corn crops will be mostly affected on their growth and root development. Subsequently, and for a maximum consumptive use of 10 mm/day, the commonly used irrigation interval of 13 days, should decrease to 6 days, if the new methodology is used i.e. if the limitations of soil depth exploration by crop roots are taken into account. This result is consistent with those from current practices under non irrigated conditions, where it has been shown that crop yields are affected by water shortage provided that an important precipitation doesn't occur among such interval.