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Soil water and nitrate distribution under drip and furrow irrigation regimes for corn

Gerard Arbat (1), Albert Roselló (2), Francesc Domingo Olivé (2), Jaume Puig-Bargués (1), Elena González Llinàs (2), Miquel Duran-Ros (1), Joan Pujol (1), and Francisco Ramírez de Cartagena (1)

(1) University of Girona, Department of Chemical and Agricultural Engineering and Technology, Girona, Spain (gerard.arbat@udg.edu, 34972418399), (2) IRTA Mas Badia, Mas Badia, 17134 La Tallada d'Empordà (Girona)

Furrow is the irrigation system most commonly used nowadays by corn producers in Alt and Baix Empordà (Girona - North East Spain) and in many other production areas around the world. Drip irrigation can save more water than furrow irrigation. Moreover, with this system the wetted soil volume can be reduced and nutrient leaching, especially nitrate, diminished, resulting in a decrease in the risk of aquifer pollution.

The objectives of this study were: (1) to compare soil water distribution under furrow and drip irrigation using information obtained from field studies and simulations with the HYDRUS-2D model, (2) to estimate the amount of deep percolated water in each irrigation system, (3) to determine soil nitrate distribution and leached nitrate in a drip irrigated corn field under different fertilization treatments, and (4) to compare grain yield and water productivity in furrow and drip irrigated corn under different fertilization strategies.

Field studies were conducted at Mas Badia Experimental Station (Girona, Spain) during the period 2008-2010 in two different fields with an Oxyaquic Xerofluvents (SSS, USDA, 2010) soil type. In 2008 the studies consisted of monitoring irrigation water doses, advance and recession times and soil water distribution, and obtaining grain yield from a furrow irrigated corn field. Each plot was approximately 130 m long and 4.5 m wide, with six furrows spaced at 0.75 m. In 2009, three different treatments were compared: furrow irrigation and drip irrigation with two emitter spacings (0.3 and 0.5 m). Driplines were spaced at 1.5 m and corn rows at 0.75 m, and the emitter flow-rate was 4 L/h. Irrigation water dose and grain yield at harvesting were measured for all the treatments, and advance and recession times were monitored in the furrow irrigated treatment. Each plot was approximately 100 m long and 4.5 m wide, with three replications of each. In 2010 studies were carried out in the same field as in 2009. The whole field received the same irrigation amount, using 4 L/h flow-rate emitters spaced at 0.5 m. Twenty different fertilization treatments were carried out, two at pre-planting and ten during the growing season. The two pre-planting treatments received 0 and 120 kg N/ha from pig slurry, and each of them was subject to ten different fertilization treatments during the growing season. Doses from 0 to 300 kg N/ha were applied, split into different crop growth stages through the drip irrigation system.

Soil water distribution for furrow irrigation and two drip irrigation treatments that received 0 and 120 kg N/ha before planting and 75 kg N/ha after planting were monitored weekly using Time Domain Reflectometry and soil sampling. Soil water content was measured at different depths ranging from 0 to 1.50 m and at three different positions from the dripline, in order to obtain detailed soil water distribution information. Nitrate was analyzed in the same soil samples as those in which water content was determined. In treatments that received 120 kg N/ha before planting and 0, 75 and 300 kg N/ha after planting, leaching water was periodically sampled at a depth of 1.0 m using suction cups, and nitrate concentration was analyzed for each fertilization strategy.

Results show that during the irrigation campaign soil water content from a depth of 0 to 1.20 m was perceptibly greater for drip irrigation. Between 0 and 0.30 m this system maintained soil water content near to field capacity throughout the entire irrigation season. Mean nitrate concentrations collected for the 0, 75 and 300 kg N/ha post-planting fertilization treatments were 45.6 mg/L, 38.0 mg/L and 104.9 mg/L respectively. In 2009, water productivity in the same experimental field increased from 2.79 kg/m3 with furrow irrigation to 3.37 kg/m3 with drip irrigation.