Anexo 3

Componente 1. Caracterización, tipificación y zonificación de cultivos en el área geográfica de influencia.

Actividad 1.5. Medidas lisimétricas.

WATER BALANCE IN COLOMBIAN ANDEAN SOILS WITH CONVENTIONAL AND ORGANIC PASSIONFRUIT CROPS UNDER THE "EL NIÑO

WATER BALANCE IN COLOMBIAN ANDEAN SOILS WITH CONVENTIONAL AND ORGANIC PASSIONFRUIT CROPS UNDER THE "*EL NIÑO*" PHENOMENON.

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INTRODUCTION

The effects of climate instability have been steadily increasing in recent years in Colombia, resulting in a rise in the economic and social vulnerability of small and medium-sized farmers. The adaptability of agriculture in regions affected by the negative effects of climate change depends to a large extent on the intensity, frequency and duration of extreme events. In this sense, the development of strategies should include not only the study of alternative crops that are more resistant to the new conditions, but also the implementation of technology in order to improve the resilience of the traditional ones. Either way, it is essential to advance the knowledge of soil-plant-climate relationships, since water needs and availability are the main factors in determining the adaptive capacity of any crop. This study shows an approximation to the water balance in two passionfruit orchards.

METHODS

Commercial plots were on volcanic soils (Ando soils) and located between the towns of Manizales and Chinchiná (Caldas, Colombia). Full-productive three-year passionfruit (*Passiflora edulis*; local name *maracuyá*) was cultivated in both orchards, one of them with conventional methods and the other with organic ones. In each one of them, a G3 Gee Passive Capillary lysimeter and two 10HS moisture sensors (Decagon Devices, Pullman, WA, USA) were installed in order to monitor the evolution of soil moisture and drainage every hour. Moisture sensors were placed at 40 and 80 cm depth. The lysimeter, connected to an Em50G data-logger (Decagon Devices, Pullman, WA, USA), was used for hourly direct monitoring of drainage water below the root zone at a depth of 1 m, as well as for monthly extraction of drainage water when drainage occurred for leachate analysis. The volcanic texture allowed the lysimeter to be installed using the ''intact soil monolith'' installation method (Decagon Devices, 2014), which leaves part of the soil profile undisturbed. A weather station (with relative humidity, temperature, wind speed, precipitation and radiation sensors) (Decagon Devices, Pullman, WA, USA) was installed for ET_0 calculation through the Penman-Monteith method (Allen et al., 1998), which allowed estimating ET_C. Both fields were managed as usual by the farmer.

The daily soil water balance, is described by (Allen et al., 1998):

$$P + I = ET_C + D + \Delta H$$

where P is the precipitation (mm); I stands for irrigation (mm) ET_C is the crop evapotranspiration (mm); D is the drainage (mm); ΔH is the variation in soil water storage (mm). Runoff was not included in the soil water balance equation, because there were no runoff events because these soils had good infiltration (>100 mm h^{-1}).

Precipitation values (P) were obtained from the meteorological station, while in the crops considered there was no irrigation (I = 0). The volume of drained water (D) was obtained from the lysimeters, and the variation in soil water content (ΔH) was calculated by difference.

RESULTS AND DISCUSSION

Meteorological condition and drainage were monitored for the period September 2015 - August 2016. The first remarkable point is that, during this period, rainfall was 46% lower than the average of the location (Guzmán-Martínez and Baldión-Rincón, 2003), with eleven out of the twelve months registering lower precipitation values (Table 1). Indeed, the "El Niño Southern Oscillation" (ENSO) phenomenon in these months has been thoroughly reported to be one of the most severe drought episodes in recent times in Colombia, causing several problems related to water availability and agricultural productivity.

Table 1. Drainage, rain, average rain at the location (historical means from Guzmán-Martínez and Baldión-Rincón, 2003), ET_C and water balances. All values are in mm.

	Drainage		Rain	Rain average	ETc	Water balance	
	Conventional	Organic				Conventional	Organic
sep15	0	0	53	191	94	-41	-41
oct15	86	93	210	306	100	24	18
nov15	26	53	158	260	86	45	19
dec15	0	0	3	185	97	-93	-93
jan16	0	0	51	147	109	-57	-57
feb16	0	0	48	147	99	-51	-51
mar16	0	0	87	201	111	-24	-24
apr16	132	81	324	279	88	104	155
may16	90	64	199	280	90	20	46
jun16	46	52	109	191	89	-25	-31
jul16	0	24	74	155	92	-18	-42
aug16	0	0	35	168	106	-72	-72
Total	380	367	1351	2510	1161		

Attending to the results, this episode was especially severe from December 2015 to March 2016, resulting in four months with continuous negative balance. This four-month low-rainfall period led to a continuous decrease in soil volumetric water content at 80 cm, as shown in Figure 1. During this time, rain events resulted in small increases in water content at 40 cm, but water did not reach the lower depth, showing that water was either consumed by the plants or retained in the soil profile at upper levels.

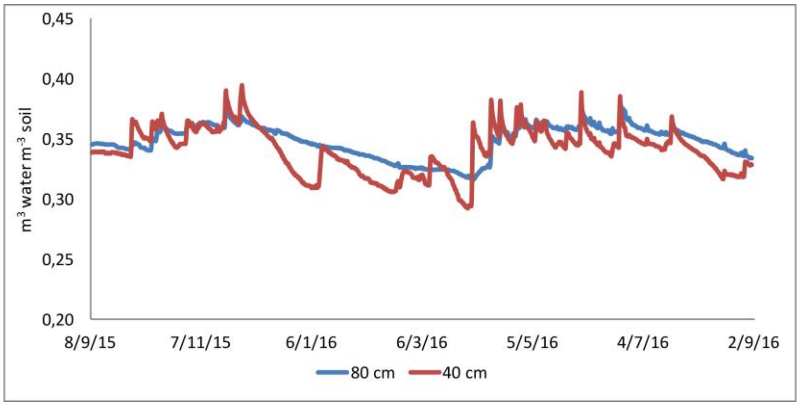

Figure 1. Soil volumetric water content at two depths (40 and 80 cm) in the conventionally-grown passionfruit plot.

Passionfruit produces a continuous crop, with flowering and fruit set happening at the same time as the first fruit ripens. This extends the harvest season of passionfruit over the entire year. Due to the lack of irrigation, yield must have been affected by such negative balances. According to Menzel et al. (1986), even mild soil moisture stress can severely limit vegetative growth and potential yield in passionfruit, especially during flowering. Consequently, passionfruit productivity may have been impaired up to six months after the stress finished. In this preliminary study, no remarkable differences were found between the organic and the conventionally-grown orchards.

CONCLUSIONS

As an important fact to highlight, the influence of the *El Niño* phenomenon was remarkable, and it subjected the crop to some periods of water stress during 8 out of the 12 months, 4 of which continuously. With this kind of climatic scenario getting more likely, it is necessary to raise the need of implementing support irrigation systems, selecting drought-resistant cultivars and including better soil and water management and conservation techniques.

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