USE OF THREE IRRIGATION STRATEGIES IN A GREENHOUSE-GROWN GREEN BEAN CROP IN THE ALMERIA COAST

González A.M.[1]; Bonachela S.[2]; Fernández, M.D.[1]and Gazquez, J.C.[1]

[1] Estación Experimental "Las Palmerillas" Cajamar (Caja Rural Intermediterránea). Autovía Mediterráneo, Km. 419. El Ejido, Almería. España. [2] Universidad Almería, Almería. España

Introduction

The Mediterranean greenhouse horticulture is a very competitive sector in Spanish and European agriculture, but it is facing a severe competition within and outside the EU market. Thus, in Mediterranean areas with limited water resources such as the Almería coast, the development of irrigation scheduling practices for minimising water use and lixiviates, and improving vegetables yield and quality is of primary importance.

For improving the irrigation scheduling practices, evapotranspiration of the main horticultural crops of the region was determined using the FAO method (Fernández *et al.*, 2001). Later, models for estimating daily values of crop evapotranspiration using real-time (ET_c) or historical climate data (ET_h) were developed (Fernández *et al.*, 2001). Irrigation of green beans, one of the main greenhouse crops in Almería, occupying an area of about 4800 ha, is mainly based on local farmers' experience without a scientific basis. This work was aimed to study the influence of three irrigation strategies on growth and production of a greenhouse green bean crop.

Methods

The experiment was conducted at "Las Palmerillas" research station (Almería), in an unheated greenhouse (58 m by 24 m) of metallic structure and symmetrical roof (12.5 % slope), covered with 0.2 mm-thick thermal polyethylene sheet. Green bean seeds (*Phaseolus vulgaris* L. ssp. Volubilis, cv. Donna) were sown on 12/09/2001 and the crop cycle finished on 2/01/2002. Plants, in rows 2 m apart and 0.5 m within rows, were vertically supported to a height of 2 m. Irrigation water (electrical conductivity of 0.4 dS m^{-1}) was supplied through a drip system. The soil was the typical "enarenado" soil, commonly used in greenhouses of the region. Three irrigation strategies, arranged in a randomised complete-block design, were studied:

Reference irrigation scheduling (C): Irrigation started when the soil water potential (SWP) was around -25 kPa. The water applied was calculated as the real-time green bean evapotranspiration accumulated from the previous irrigation ($ET_c = ET_o \times K_c$.). The reference crop evapotranspiration (ET_o), was calculated with a radiation method (Fernández *et al.*, 2001) using real time data of daily solar radiation and greenhouse transmissivity estimates. The crop coefficient (K_c), was calculated from leaf area index values (LAI), which were estimated as a function of thermal time.

High frequency irrigation (HF): Irrigation started when the SWP was within -10 and -15 kPa. The amount of irrigation water was calculated like that of the reference irrigation treatment. Local growers used this irrigation strategy for improving water and nutrients availability.

Phenology-base irrigation (P). Irrigation started at progressively lower SWP was kept within vegetative phase, ending at 50 kPa when first fruits were set. Hereafter, the SWP was keep within -10 and -15 kPa. Data of historical green bean evapotranspiration accumulated from the previous irrigation were first calculated ($ET_h = ET_{oh} \times K_{ch}$). Daily values of historical reference evapotranspiration (ET_{oh}) were calculated using average solar radiation from a data set of 14 years, and greenhouse transmissivity estimates (Fernández *et al.*, 2001). Historical daily values of crop coefficient (K_{ch}) were calculated from LAI values, estimated as a function of thermal time, calculated using average temperatures from a data set of 11 years. Finally, the water applied at each irrigation event was chosen within the $ET_h \pm SD$ (standard deviation of ET_h data) interval for

keeping the SWP within the fixed thresholds. Local growers use this irrigation strategy for controlling plant vigour.

Soil water potential was measured with four tensiometers per treatment, installed at 0.12 m below the sand layer near the plant. Total and marketable fruit production, and vegetative, generative and total aboveground biomass were collected in 6 m^2 surface per experimental plot.

Results

Soil water and applied irrigation water

For the three irrigation strategies, the SWP values maintained within the fixed threshold values along their whole crop cycles (Fig. 1). The lowest SWP values, of –50 to –60 kPa, were measured in the P irrigation strategy when first fruits setting occurred (Fig. 1).

Total irrigation water applied throughout the crop cycle was similar for the three irrigation management strategies: 99 mm, 102 mm and 111 mm for the C, HF and P irrigation strategies, respectively.
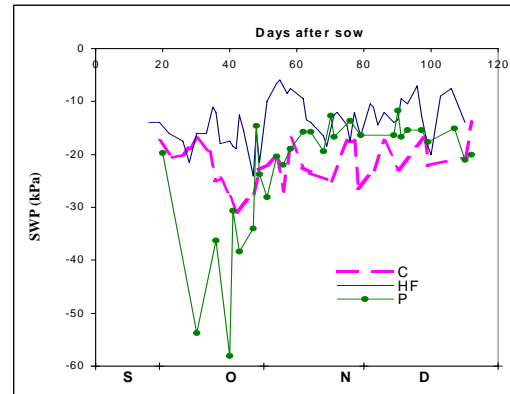

Figure 1. Seasonal evolution of soil water potential (SWP) at 0.12 m depth for a greenhouse green bean crop under three irrigation strategies.

Aboveground dry matter and productivity

No significant differences in total and marketable yields were found between irrigation treatments (Table 1). The fresh weight of marketable green bean fruits ranged from 2713 to 2834 g m^{-2}, values within the optimal range for the region. No significant differences in vegetative, generative and total aboveground biomass were found between irrigation strategies (Table 1), although the total and vegetative biomass of the HF irrigation strategy was slightly higher than those of two others treatments, and the opposite occurred for the generative biomass (Table 1). Finally, the harvest index for the C and P irrigation strategies was significantly higher than that of the HF treatment (Table 1).

Table 1 – Total and marketable fresh weight of green bean fruits; vegetative, generative and total aboverground dry matter and harvest index of a greenhouse green bean crop. Almería. 2001/2002.

	Yield (g m^{-2})		Abovergroun biomass (g m^{-2})			Harvest index (g g^{-1})
	Total	Marketable	Vegetative	Generative	Total	
Reference irrigation scheduling (C)	2714 a	2619 a	450 a	197 a	647 a	0.30 b
High frequency irrigation (HF)	2713 a	2601 a	400 a	208 a	608 a	0.34 a
Phenology-base irrigation (P)	2834 a	2710 a	416 a	209 a	525 a	0.33 a

Means values followed with the same letter are not significantly different (P<0.05)

Conclusions

The phenology-base irrigation strategy, used for local growers to induce more generative growth, produced similar fresh weight of green bean fruits than the reference irrigation strategy.

The high frequency irrigation produced similar fresh weight of green bean fruits than the reference irrigation strategy, but allocated relatively less dry matter to the fruits and more to leaves.

References

Fernández, M.D.; Orgaz, F.; Fereres, E.; López, J.C.; Céspedes, A.; Pérez, J.; Bonachela, S.; Gallardo, M. 2001. Programación del riego de cultivos hortícolas bajo invernadero en el sudeste español. Edita: Cajamar (Caja Rural de Almería y Málaga). 78 pp.