Reduced Fertigation of Soilless-greenhouse-grown Peppers Improves Fruit Yield and Quality

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Abstract

In a fall to summer crop, soilless-greenhouse-grown pepper plants were irrigated with five irrigation schedules and given different volumes of nutrient solutions per irrigation event. Plants that received 74 mL per irrigation event, irrespective of irrigation frequency or nutrient concentration, had similar marketable fruit yields (9 kg·m^2). By contrast, in plants with 37 mL per event, fruit yields decreased from 9.1 to 3.7 kg·m^2 when number of irrigation events decreased from 62 to 9. With half the concentration of nutrients and 74 mL per irrigation event at 12 and 16 events per day, plants yielded 9 kg·m^2 of marketable fruit with half the total amount of fertilizer (297 and 396 g per plant, respectively) and water (214 and 282 L/plant, respectively) than those delivered with a complete nutrient solution. With these same irrigation schedules, disorders such as cracking and blossom-end rot were reduced. It was possible to identify fertigation practices which would lead to reduced fertilizer and water use in low-cost soilless media greenhouse-grown peppers.

INTRODUCTION

In Florida, USA, high quality bell pepper fruits are produced in plants grown in soilless media irrigated with a complete nutrient solution inside passive-ventilated greenhouses (Cantliffe et al., 2001). Quantity and timing of delivery of water and nutrients affect water availability to plants and salinity levels in the media and, thus, directly affect fruit yield and fruit quality, production costs, and environment in still used drain-to-waste irrigation systems. Irrigation management in the near future will require drained water and nutrients to be minimized or reused in the same or secondary crops.

Currently, the development of irrigation management strategies that lead to high marketable fruit yields while using small amounts of fertilizer and water and that lead to reduced incidences of irrigation-related fruit disorders is significant for much needed

recommendations on irrigation practices for soilless-grown peppers in Florida. In these experiments we investigated the effects of different frequencies of irrigation events, volumes delivered per irrigation event, and nutrient solution concentrations on fruit yield and fruit quality of soilless-greenhouse-grown pepper plants.

MATERIALS AND METHODS

The experiment was conducted in a passive-ventilated polyethylene-covered Top Greenhouses structure, located at the Horticultural Sciences Protected Agriculture Center of the University of Florida (http://www.hos.ufl.edu/protectedag/). Red sweet pepper 'HA3378' (Hazera Seeds Ltd.) seedlings were transplanted 9 October 1999 into 11.4-dm^3 pots with perlite, pine bark, or a peat-vermiculite-perlite mix. Plants were pruned to form two main stems which were trellised to the "V" system. Plant population density was 3 plants per m^2.

A data-logger processor (CR10X) connected to a pyranometer (LI200X) registered and scheduled irrigation events according to integrated solar radiation inside the greenhouse. Five levels of solar radiation integrals determined the irrigation schedules. The mean set-point values of the solar radiation integrals were 1.6, 3.6, 5.6, 7.6 and 9.6 kW-min·m^{-2}, which generated mean numbers of irrigation events per day of 62, 26, 16, 12, and 9, respectively, in the 250-day crop. The number of irrigation events per day varied with daily and seasonal climate changes. In addition, either one volume (S) or a double volume of nutrient solution (S+W) was delivered to the plants at each irrigation event (mean values 36.7 and 73.5 mL, respectively). Both of these volumes of nutrient solutions delivered the same amount of nutrients per irrigation event.

In a second and simultaneous experiment, pepper plants were grown under the same five irrigation schedules and three types of media but with double amounts of water and fertilizer at each irrigation event (S+S; mean volume 73.5 mL).

The target nutrient concentrations for the complete nutrient solutions (S and S+S, with EC values between 2-2.5 dS·cm^{-1}) were adapted from those formulated for greenhouse-grown hydroponic tomatoes (Hochmuth, 1991; Jovicich, 2001). Volumes of solution and amount of fertilizer used are presented in Figure 1. Red fruits were harvested 9 times, starting on 4 February and with the last harvest on 15 June 2000.

The experimental design for the main experiment was a split-split plot replicated in three blocks. Analysis of variance (ANOVA) was performed on yield variables (SAS, 1989) and appropriate error terms for the *F* tests of interactions were calculated separately. Comparisons of means were performed using the Duncan's multiple range test ($\alpha = 0.05$). Yield data presented are combined for media treatments.

RESULTS AND DISCUSSION

Plants that received 74 mL per irrigation event and half the nutrient concentration had similar marketable fruit yields, averaging 9 kg·m^2 (Table 1). Increase of nutrient concentration with 74 mL per irrigation event did not seem to increase marketable yields. By contrast, in plants with 37 mL per event, fruit yields decreased significantly from 9.1 to 3.7 kg·m^2 when number of irrigation events decreased from 62 to 9. It was suggested

that under the climate conditions of these experiments, water and not nutrients limited marketable fruit yield in plants under low number of irrigation events per day.

With half the nutrient solution concentration (S+W) and 74 mL per irrigation event at 12 and 16 events per day, plants yielded an average of 9.3 $kg \cdot m^2$ of marketable fruit with half the amount of fertilizer (297 and 396 g per plant, respectively) than those same irrigation frequencies where 74 mL of a complete nutrient solution (S+S) was delivered per irrigation event. Delivery of half the nutrient solution concentration (S+W) and 74 mL per irrigation event at 9 irrigation events per day resulted in a low production of extra large fruits compared to 12 and 16 events per day (data not presented).

High efficiencies in the use of fertilizer and water (as used water and used fertilizer per kg of marketable fruit produced) were obtained with the irrigation schedules with half the nutrient solution concentration (S+W) and 74 mL per irrigation event at 12 and 16 events per day (70 and 90 $L \cdot kg^{-1}$, and 100 and 120 $g \cdot kg^{-1}$, respectively).

With half the nutrient solution concentration (S+W) and 74 mL per irrigation event at 12 and 16 events per day, fruit production was similarly or less affected by disorders such as russeting, cracking, and blossom-end rot (data not presented). With these irrigation schedules, lower amount of nutrients drained from the pots without excessive salt accumulation in the media.

In passive-ventilated greenhouses with occasional use of heaters, pepper plants in soilless media produced marketable fruit yields of 9 $kg \cdot m^2$ with reduced use of fertilizer and water. Irrigation schedules averaged 12 to 16 events per day (every 40-30 min in an 8h period) and delivered 74 mL of half the nutrient concentration typically used by local growers.

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Literature Cited

Cantliffe, D.J., E. Jovicich, J.C. Rodriguez, I. Secker and Z. Karchi. 2001. Passive Ventilated High-roof Greenhouse Production of Vegetables in a Humid, Mild Winter Climate. Acta Horticulturae 559:195-202.

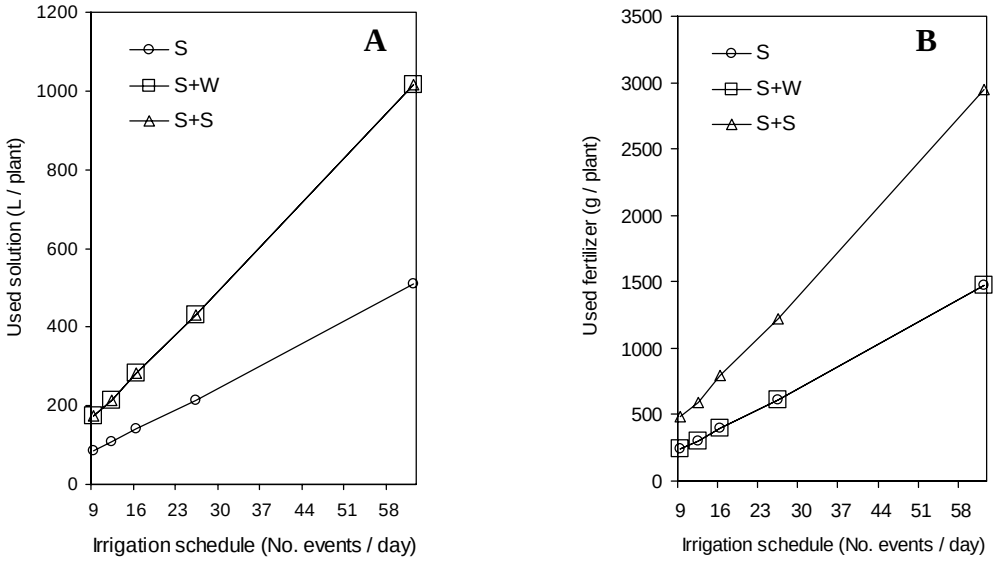
Hochmuth, G. J. 1991. Fertilizer Management for Greenhouse Vegetables. p 13-31. In: G. J. Hochmuth (ed.) Florida Greenhouse Vegetable Production Handbook Vol. 3. Univ. of Fla., Inst. of Food and Agr. Serv., Circ. SP 48.

Jovicich, E. 2001. Hydroponic Greenhouse Pepper in Florida: Practices of Plant Trellising, Population, Transplant Depth, Soilless Media and Irrigation. M.S. Thesis, Univ. of Fla., Gainesville, FL, USA.

SAS Institute. 1999. SAS/STAT User's Guide V8 Vol. 1-3. SAS Inst., Cary, N.C.

Figure

Figure 1. Total volumes of solutions (A) and weights of fertilizer (B) used to irrigate soilless-greenhouse-grown pepper plants. Irrigation treatments consisted in different number of irrigation events per day, volumes, and concentrations of nutrient solutions at each irrigation event. At each irrigation event the solutions delivered were: S (37mL) and S+S (74mL) both complete nutrient solutions, and S+W (74mL) which was ½ the concentration of the complete nutrient solutions.



Table

Table 1. Effects of the irrigation schedule and volume of nutrient solution per irrigation event on the marketable fruit yield, nutrient solution and fertilizer amounts used per unit of marketable fruit yield harvested.

Irrigation schedule (Irrigation events / day)	Marketable yield ($kg \cdot m^{-2}$)		
	S [37mL]	S+W [74mL]	S+S [74mL]
62	9.1 a	9.8	9.9 a
26	8.1 a	8.5	9.7 a
16	6.7 b	9.6	8.7 ab
12	4.9 c	9.0	8.3 b
9	3.7 c	7.9	8.2 b
	**	NS	**

*,**, NS Significant F test at $P<0.05$ and 0.01 and nonsignificant ($P>0.05$), respectively. Means followed by the same letter within a column are not significantly different based on Duncan's Multiple Range Test ($\alpha=0.05$). Comparisons of means within irrigation schedule are not presented.