Reduction of irrigation water consumption in the Colombian Floriculture with the use of tensiometer

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INTRODUCTION

In 1998, Jaramillo reported that water consumption per hectare in the chrysanthemum cultivation cycle (3 months) under greenhouse conditions in Bogota plateau (Colombia) was frequently 5 to 6 million liters. Some growers argued that had reduced consuming of water down to 2,5 million liters per hectare per cycle.

This research work started in 1998 with the objective to reduce even more the irrigation volume with the use of tensiometer. The preliminary results of the research achieved in 1999 showed that consumption was reduced to 1,4 million liters. The work was focused on reduction of water consumption and keeping or improving chrysanthemum quality and production.

MATERIALS AND METHODS

Experiments were conducted in a commercial production greenhouse in Bogota plateau, Colombia in 2001 and 2002 (Table 1). The control represents the farm traditional irrigation without use of the tensiometer, with 4 drip irrigation laterals per bed with 2 $L \cdot h^{-1}$ Agrifim® drippers, with 30 cm spacing. This treatment used manual irrigation hose for the first 21 days of crop development. For the rest of the stage, the crop was drip irrigated for 20 minutes, three times per week. Treatments with tensiometer had 5 Chapin® drip tapes per bed with 20 cm outlet spacing and 0,75 $L \cdot h^{-1}$ emitters. Drip tape treatments used Naan Dan® fogger irrigation with different number of pulses per day along the first three development weeks. Soil water tension was monitored with tensiometers 10, 20 and 30 cm below soil surface. There were taken into account field capacity values reported in 1990 by Boswell and in 2002 by Soilmoisture® from data presented by Wateright®.

Table 1: Treatments:

Treatment	Description
Control: Farm	Initial stage (21 days): Manual irrigation hose each other day without use of the tensiometer. Second stage (67 days): Traditional drip irrigation three times per week without use of the tensiometer.
T1	Initial stage (21 days): One fogger pulse each other day without use of the tensiometer. Second stage (67 days): Drip tape irrigation three times per week with use of the tensiometer.
T2	Initial stage (21 days): Two fogger pulses per day. Second stage (67 days): Drip tape irrigation three times per week with use of the tensiometer.
T3	Initial stage (21 days): Three fogger pulses per day. Second stage (67 days): Drip tape irrigation three times per week with use of the tensiometer.
T4	Initial stage (21 days): Five fogger pulses per day. Second stage (67 days): Drip tape irrigation three times per week with use of the tensiometer.

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RESULTS AND DISCUSSION

Reduction of water irrigation consumption

Treatments T2 to T4 saved irrigation water since the first week of cultivation (Fig. 1 and 2) showing advantages of use of the tensiometer.

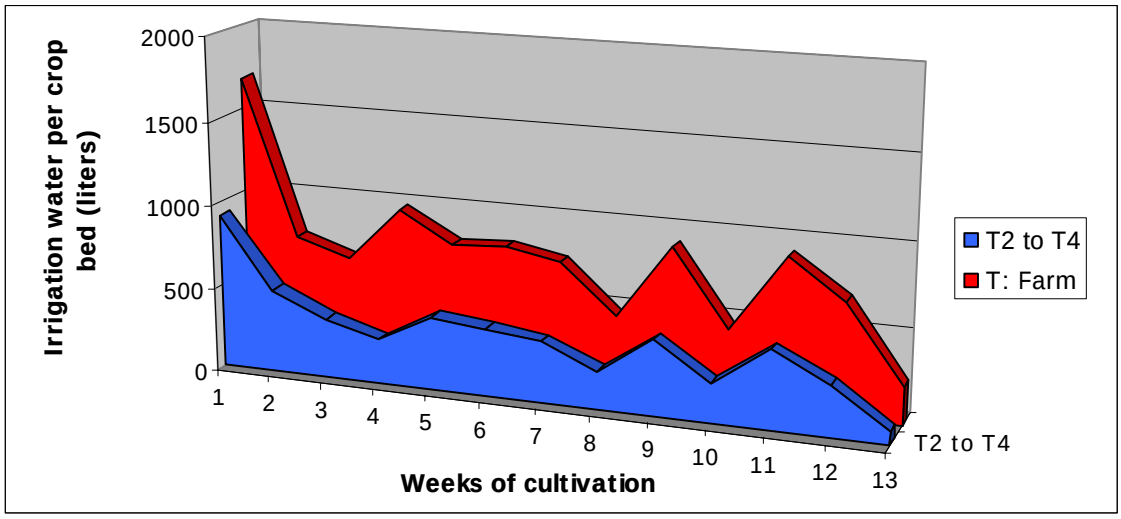

Figure 1. Irrigation water consumption (liters) per crop bed (36 m^2) for every week of cultivation

Farm treatment irrigation consumption totaled 9995 liters per 36 m2 bed, in 13 weeks of cultivation cycle. Treatments T2 to T4 with tensiometer support showed consumption of 5061 liters. Consumption went down from 3,15 (control) to 1,6 L · m^{-2} · day^{-1}. Savings of water reached 49,4%. Class A evaporation pan was installed inside of the greenhouse. Evaporation was 1,2 mm · day^{-1} (average for the 88 days cycle of cultivation). Water irrigation consumption obtained in this research work was smaller than requirements between 5 and 7 L · m^{-2} · day^{-1} reported by Fides in 1999.

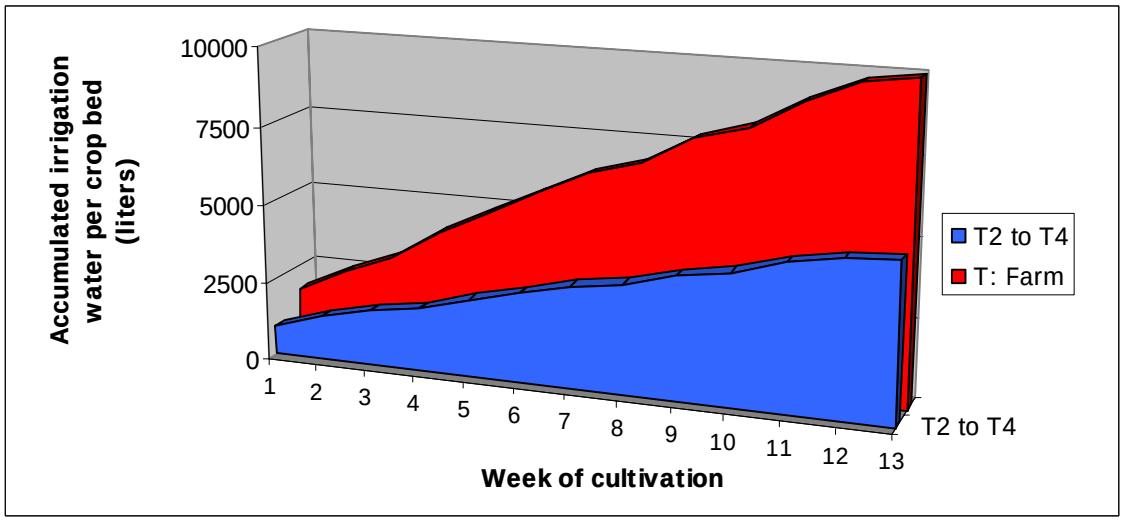

Figure 2. Accumulated irrigation water (liters) per crop bed (36 m^2) for every week of cultivation

Through all cultivation cycle, from 0 to 30 cm deep, farm untreated plot kept an average tension below field capacity, confirming over watering. Treatments T2 to T4 registered oscillating tensions between 10 to 35 centibars.

Vase life

Significant differences were found between treatments (Fig. 3), but no one was different from the farm treatment.

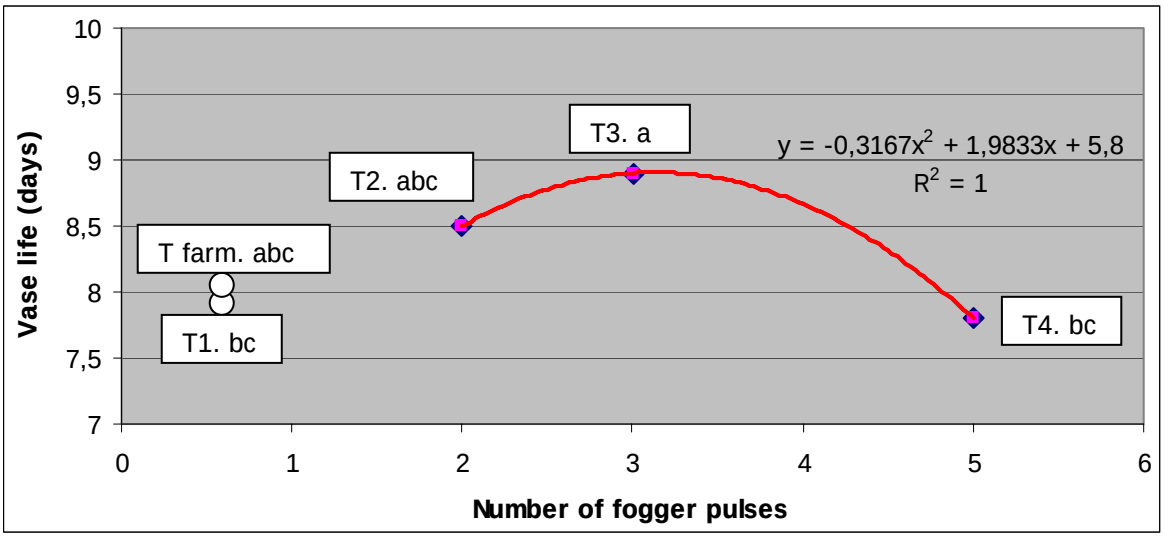

Figure 3: Effect of number of fogger pulses on vase life (days). Treatments with the same letter are not significantly different according to Duncan Test (p=0,05)

T3 treatment showed a better trend of vase life compared to the farm treatment. It can be seen in the following paragraph that T3 treatment had the better impact on root fresh weight.

Root fresh weight

There were found no differences among the treatments for the root fresh weight for 0 to 10 cm (Fig. 4). For 0 to 20 cm, highly significant differences were found between treatments. For 10 to 20 cm, T3 treatment virtually doubled the root fresh weight compared to the farm treatment (Fig. 4). T3 treatment showed an increase of 44,7% total root fresh weight (0 to 20 cm) compared to farm treatment.

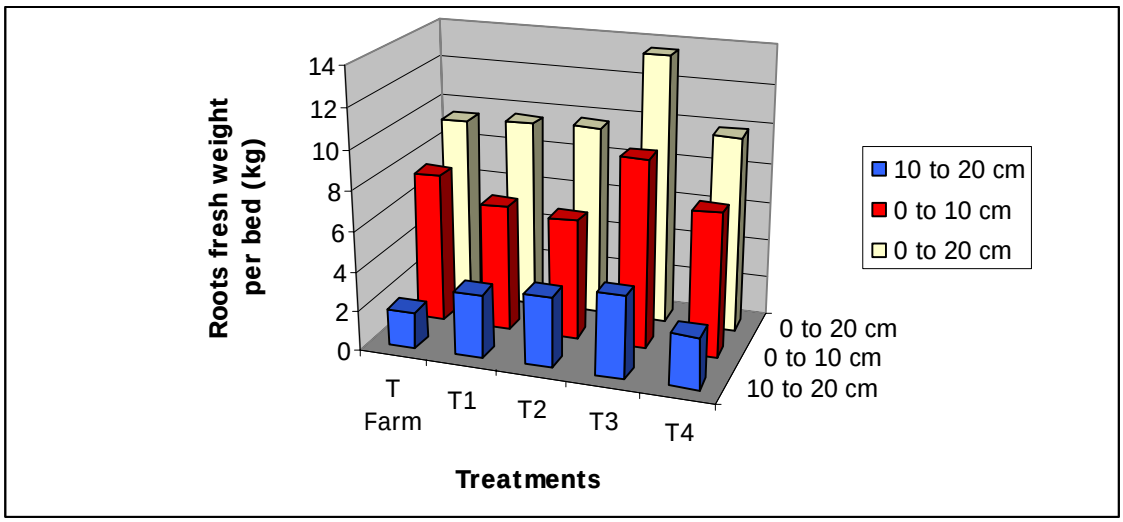

Figure 4: Effect of treatments with different number of fogger pulses on root fresh weight per bed (kg).

The excess of irrigation water applied in the farm treatment reduced the root system development compared with treatments with less irrigation water. Lack of oxygen in the soil diminished root system growth.

Number of bunches per bed

Significant differences were found between treatments (Fig. 5). The treatments T3 and T4 were significantly different from the control farm treatment and achieved an increase of 7,6 and 4,7%, respectively.

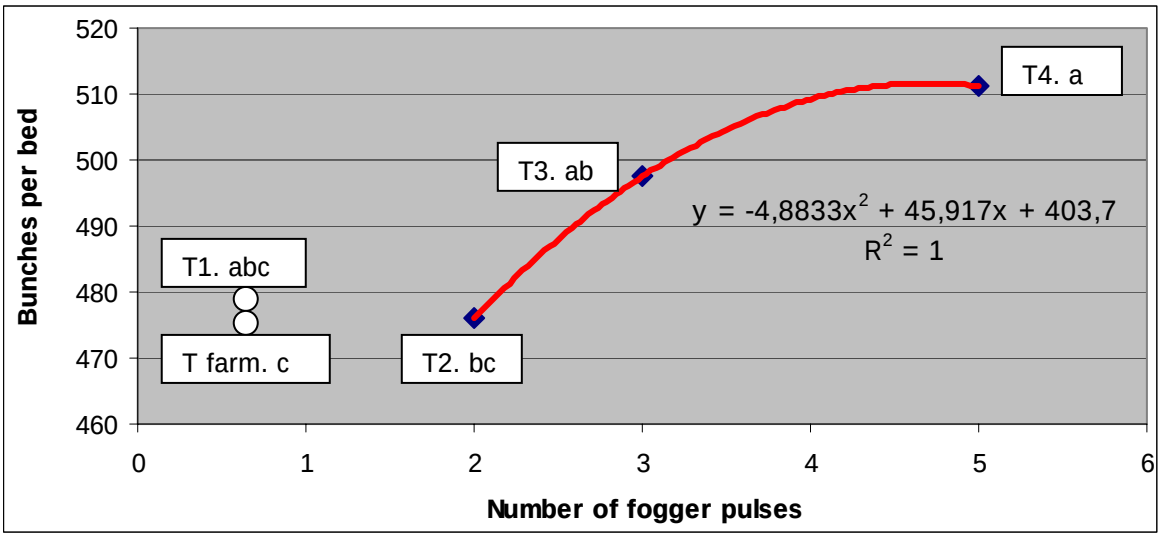

Figure 5: Effect of number of fogger pulses on bunches per bed. Treatments with the same letter are not significantly different.

Double ceramic tensiometer as innovation

At the final stage of this research work, an inexpensive double ceramic tensiometer (Fig. 6) was designed and proposed as innovation. The patent of this tensiometer model is pending on behalf of the Universidad Nacional de Colombia.

Figure 6: Double ceramic tensiometer. The independent vacuum gauges present information from two independent coaxial porous ceramics.

Conclusions

The greenhouse chrysanthemum growers in the Bogota plateau, Colombia can reduce water irrigation consumption to approximately 900.000 liters · ha^{-1} per crop cycle of 3 months. For the studied production area, water savings were approximately 50%.

Through combining benefits of use of the tensiometer to regulate moisture conditions to ideal levels and improving ways of water application with fogger and drip tape irrigation systems, the chrysanthemum grower gains production and quality advantages, compared with manual hose and traditional drip irrigation.

A trend of flower vase life improvement was observed with reducing consumption of irrigation water and employing of fogger with drip tape irrigation systems compared with that one when manual hose and traditional drip irrigation were used. The distribution and fresh weight of roots were also enhanced.

Allowing grower to take appropriate decisions on how much and when to irrigate, the tensiometer makes it possible to realize significantly increased chrysanthemum yields per hectare.

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