Autonomous Irrigation of Ornamental Pepper (Capsicum annuum)

Dr. Mollie Sacks, Ministry of Agriculture, Extension Service, Israel

Introduction

An irrigation experiment was carried out on a cultivar of ornamental peppers grown for the production of specialty cut flowers and marketed as a leaf-less shoot with a cluster of terminal fruits (Fig 1). The aim was to optimize commercial yield and water use efficiency.

Experimental

The irrigation experiment was carried out in Kfar Varburg, in the coastal plain of Southern Israel (31.716874 34.732954). Seedlings were purchased from a commercial nursery and were planted on beds in an open field, on both sides of 2 adjacent Rivulis Irrigation (John Deere Water / Plastro) Hydro PCND 12mm white drip lines spaced 20 cm apart (sets of 4 planted rows per bed). The spacing between beds was 2 meters and the spacing between the plants in each row was approximately 25 cm (Fig 2). Drippers (1 l/h) were spaced 25 cm along the laterals. Planting was on April 1, 2014. Sixty grams of slow release fertilizer (15-9-12+2 MgO Osmocote Exact Standard) applied under each dripper a few days after planting caused initially uneven development of the inner 2 planted rows (Fig 2). After two weeks fertigation was started to apply a uniform fertilizer concentration to all plants. After 4 weeks of growth plants were cut back to force shoot proliferation.

Treatments included a control and two TevaTronic LTD irrigation controllers (www.tevatronic.net). Each treatment was replicated twice on 40 m^2 (total of 80 m^2). Water gauges were installed for each treatment and daily irrigation volume was recorded. The control treatment was irrigated according to the previous practice on the farm. The TevaTronic controllers were positioned at the edge of the root system of the seedlings (ca. 5 cm from seedling stem), between 2 drippers. The autonomous controllers were irrigated for 8 days manually according to the control to establish the seedlings and then set to irrigate at a threshold of 10 centibars to a depth of 25

centimeters. The tension was raised during the period of 23.6.2014 –5.7.2014 to 20 centibars on both controllers.

Plants were selectively harvested at 2.7.2014 and 9.7.2014. An insignificant number of shoots remained after the second harvest and were neglected. Shoots with full size colored fruit, without flowers, were considered mature for harvest. At each harvest the number of shoots were counted, shoot total length (including growth extending above the fruit cluster, Fig 3), and shoot length up to the fruit cluster was measured and the number of fruits counted. Only marketable quality shoots, with a cluster of at least 5 fruits, were taken into account for calculating the results. Three replicates of 1 m length of 4 adjacent rows were harvested for yield measurement. The number of plants in each replicate was counted and data expressed per plant, calculating the SE of the three replicate measurements.

Results and discussion

Irrigation. The daily irrigation records showed a few cases of unintentional excess irrigation, mainly in the control and the TevaTronic High treatments (Fig 4). The control treatment was irrigated more frequently, based on past empirical experience of the farmer. The TevaTronic High treatment received 13 days after planting an excess irrigation (valve close failure) and from then on it irrigated much more than the TevaTronic Low treatment, although the threshold set for irrigation of both treatments was the same (Fig 5). The TevaTronic controllers irrigated from planting at a threshold tension of -10 centibars until 11 days before harvest when it was changed to -20 centibars. The tension at -10 centibars threshold was maintained steadily. The tension to -20 centibars was raised when the plant size and leaf area were almost fully developed and water consumption was close to maximum. At this consumption the tension rose 3-5 centibars above the set threshold before water reached 15 cm depth in the soil where the controller was positioned. Compared to the control, the cumulative irrigation of The TevaTronic High and the TevaTronic Low treatments were 98% and 61%, respectively (Fig 6).

Yield. During the early growth period, there was a developmental delay in the plants irrigated by the TevaTronic tensiometers, especially the TevaTronic Low treatment,

compared to the control. After 11 weeks, no visual difference could be detected between treatments (Fig 7).

Harvest was selective; collecting only shoots with mature, colored fruit. There were slightly more shoots removed in the first harvest (2.7.2014) as compared to the second harvest a week later (Fig 8). There were no differences in the other measured parameters between harvest 1 and 2.

The combined data of the two harvests showed more shoots per plant in the TevaTronic Low irrigation treatment as compared to the other two treatments (Fig 9). The differences between treatments in the marketable shoot length, the number of fruits per shoot and the terminal growth were not significant.

Discussion. The TevaTronic controller successful operation is dependent on the development of a dense and fibrous root system in the immediate vicinity of the controller. Therefore at planting time the TevaTronic controllers were set to irrigate at a low tension of -10 centibars and positioned at the edge of the root system of the small seedlings. The intention was to apply two levels of tension after the seedlings establishment. A valve failure caused early on (day 13 from planting) a high volume irrigation in one of the controllers and subsequently a high rate of water consumption in that treatment (TevaTronic High). Plants irrigated with the other TevaTronic controller (TevaTronic Low) were under slight stress at the early stage of growth and subsequently consumed considerable less water. As a result of the great difference in water consumption the original intention to maintain two tension levels was abandoned and both controllers were left to operate at the same level of tension. The slight early stress probably caused in addition to water saving (61%, fig. 6) a greater shoot initiation after the main stem of each plants was pinched (around a month after planting) (Fig 9.).

Concluding remarks. The results indicated that empirical practices of irrigation for this crop can be replaced successfully by autonomous irrigation based on soil water tension sensed by the plant root system, coupled to precise irrigation depth control to apply the required volume of water without human intervention.

Fig. 1. Ornamental pepper 12 days after harvest

Fig 2. Planting layout

Fig 3. Lateral shoot growth extending above the fruit cluster. Shoots are marketed after the leaves and the top growth are removed.

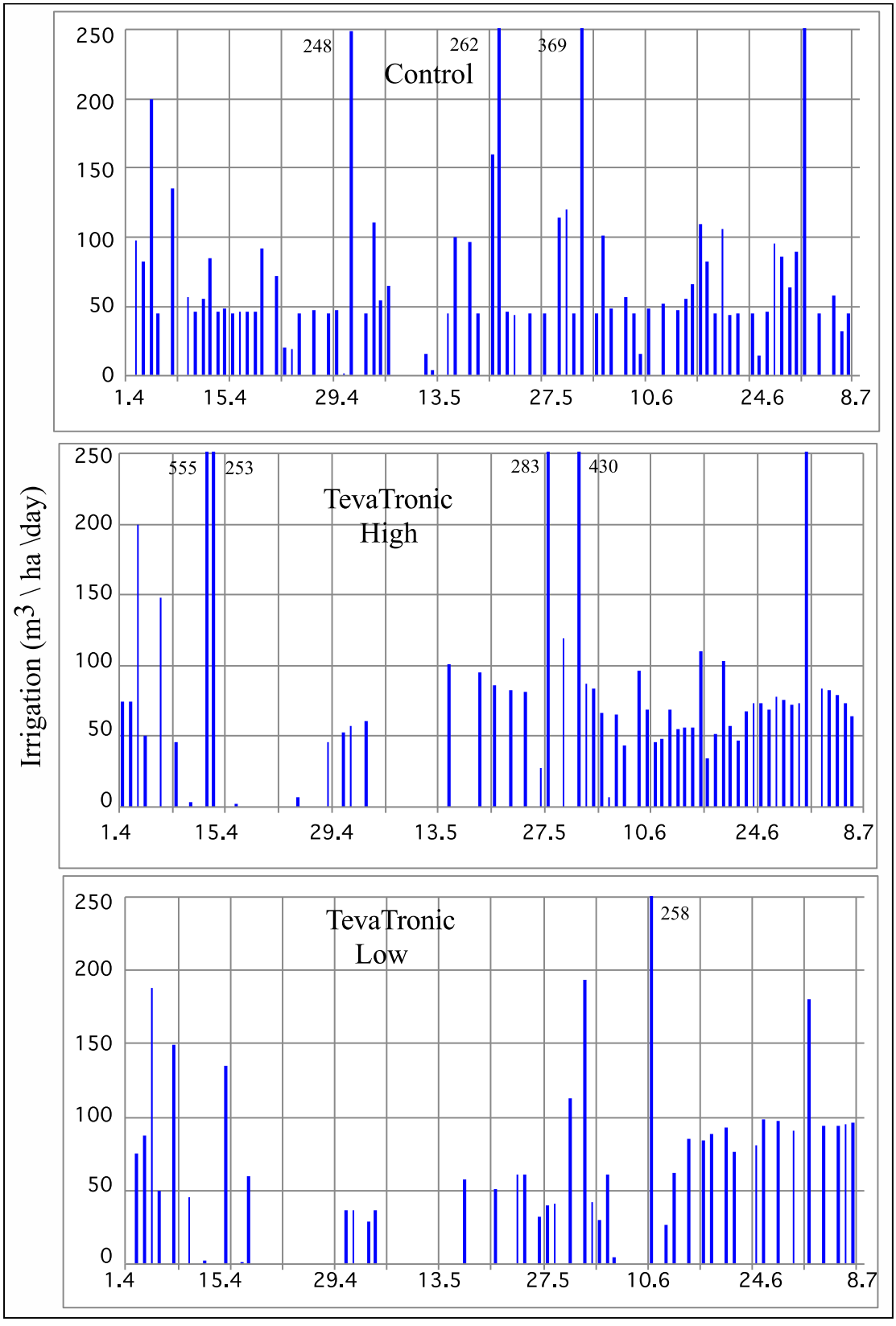

Fig 4. Daily irrigation from planting until the end of harvest. 2014

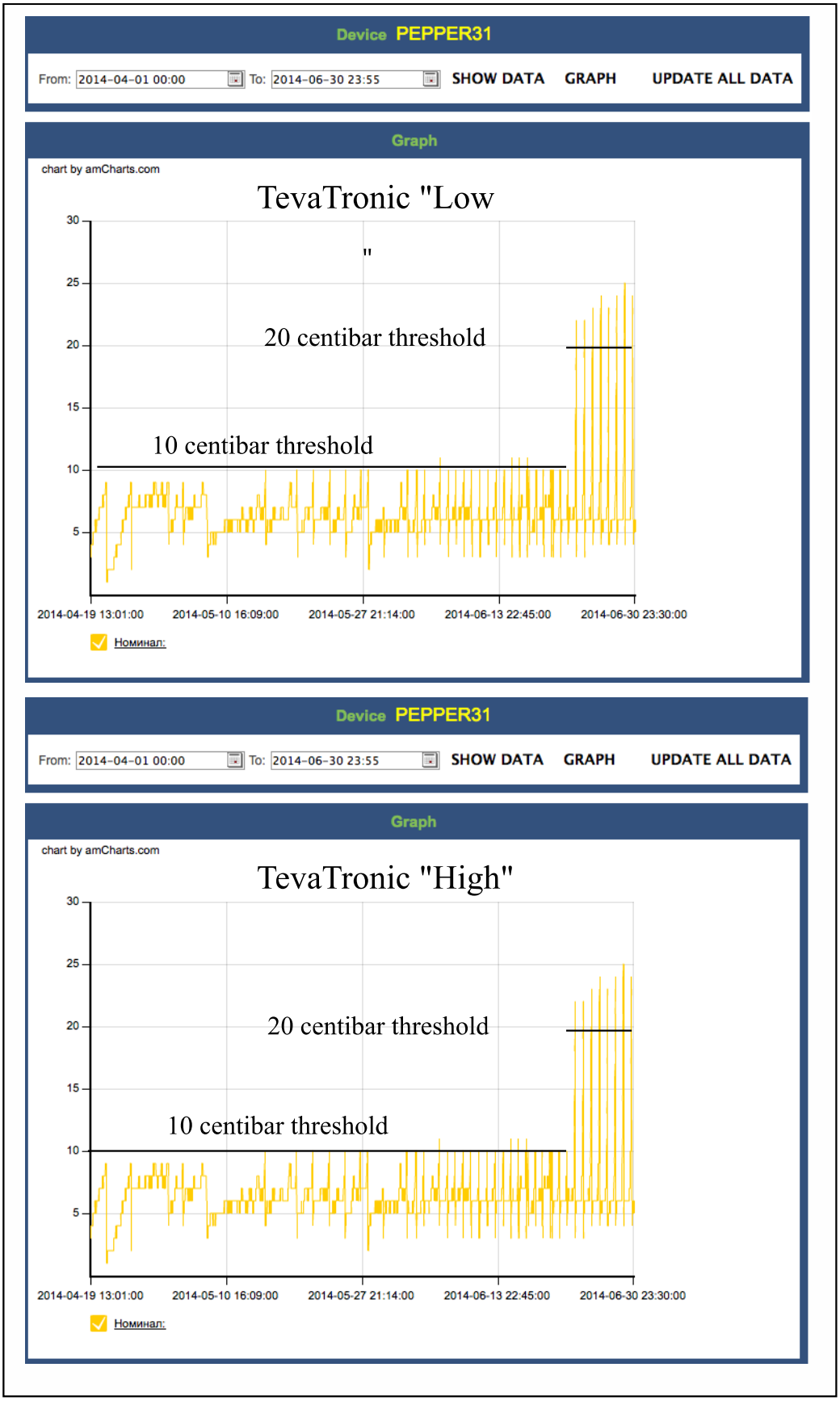

Fig 5. Record of tension at 15 cm depth of the soil in the proximity of the plant, maintained by the TevaTronic irrigation controller.

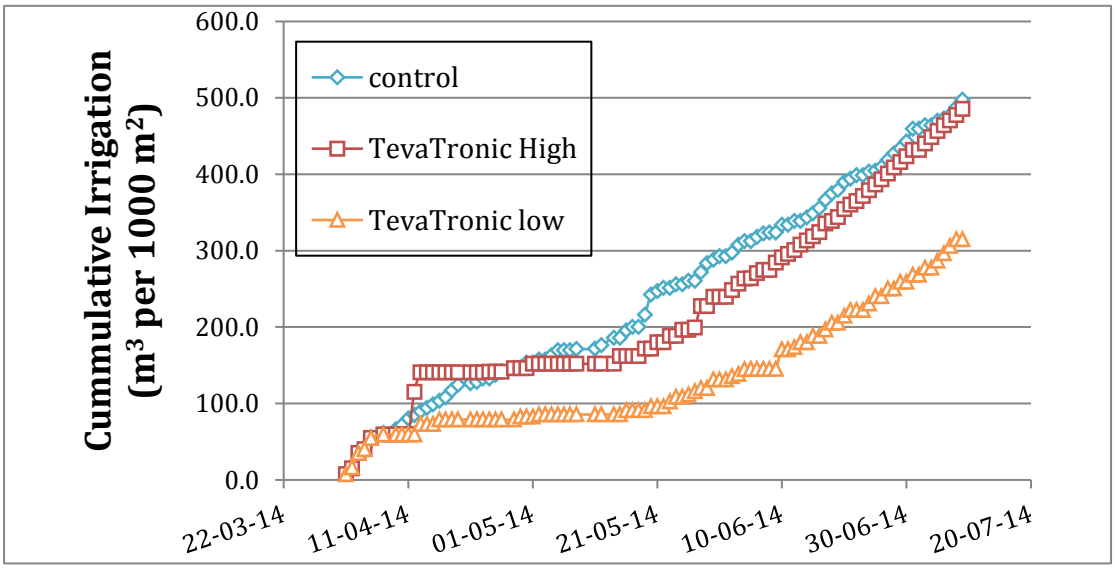

Fig 6. Cumulative irrigation.

Control Tevatronic Low rate

Tevatronic High rate Control

Fig 7. Vegetative growth 11 days before harvest (21.6.2014)

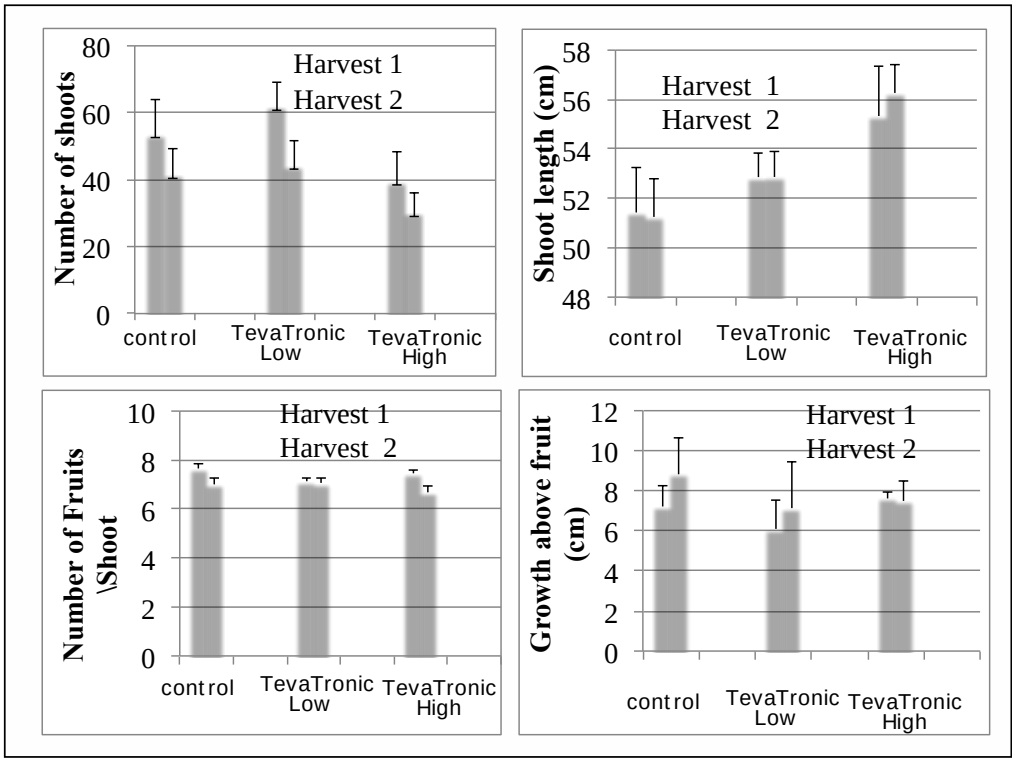

Fig.8. Number of marketable shoots per 2 m^2, shoot length, number of fruits in the cluster and shoot growth above the cluster in harvest 1 (2.7.2014) and harvest 2 (9.7.2014). ±SE

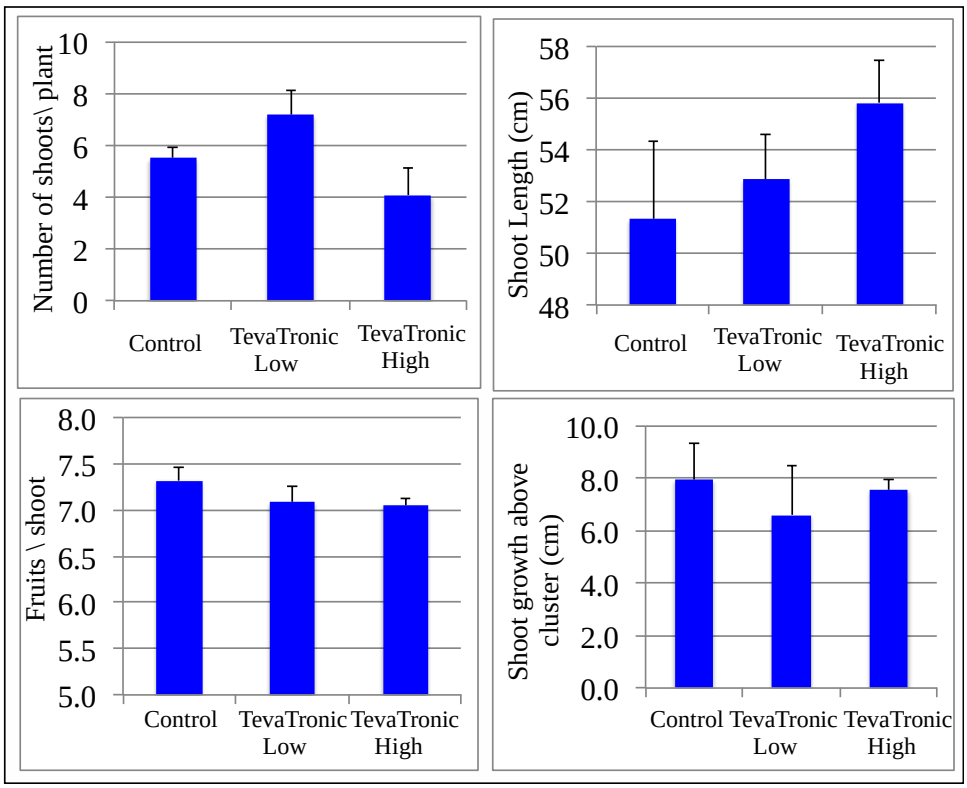

Fig 9. Total Number of marketable shoots (stems), shoot length, number of fruits in the cluster and shoot growth above the cluster. ± SE