IRRIGATION CONTROL OF CONTAINER CROPS BY MEANS OF TENSIOMETERS

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The cultivation of ornamental and horticultural crops needs elevated water amount. Since the problem of water shortage and water quality becomes more and more important year-by-year, new solutions have to be introduced to rationalize water consumption avoiding water shortage periods and water quality worsening (e.g. increasing water salinisation).

The usual practice of irrigation for container crops does not take into account real plant water requirements, entrusting the control to simple systems like timers.

The detection of soil water potential in pots is one of the possible techniques to adapt water supply to real plant exigencies, reducing water consumption, without negative effects on the plants.

MAIN AIM

✍ To verify the potentialities of tensiometers to automate irrigation of container crops in order to optimize water use (to save water without affect plant growth)

SECONDARY AIMS

✍ To define the methodology of water providing

✍ To define the best positioning of tensiometer in the container respect to trickler position

Some information about <u>Materials and Methods</u>

- Container volume: 9 litres
- Substratum: peat and pumice (1:1)
- Species of ornamental plants:

Cupressus macrocarpa Var. Golden crest (high growth rate and low water exigencies. Resistant to long dry period)

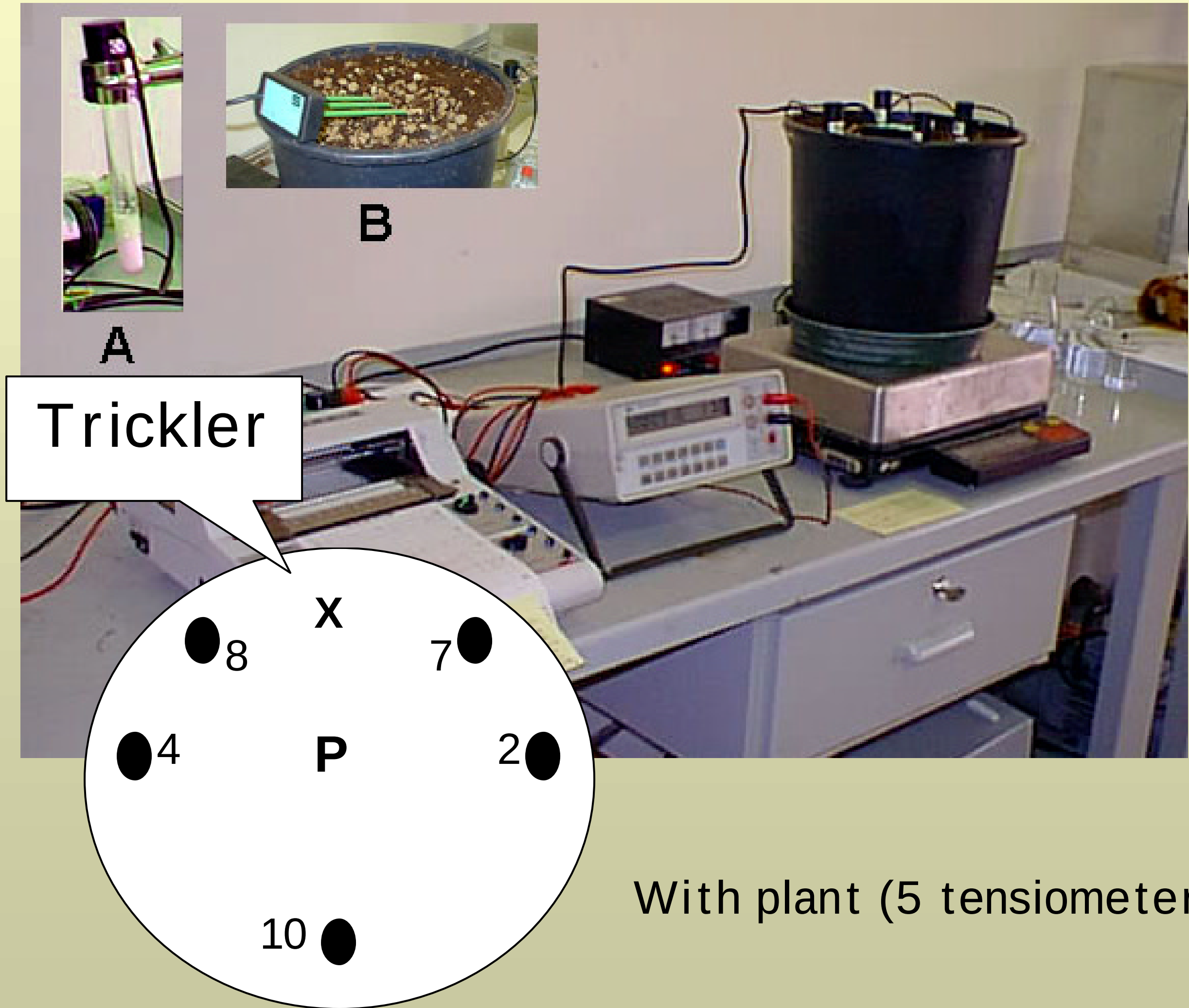
Cornus alba Var. Sibirica (very high growth rate and very high water exigencies. Extremely sensitive to dry period)

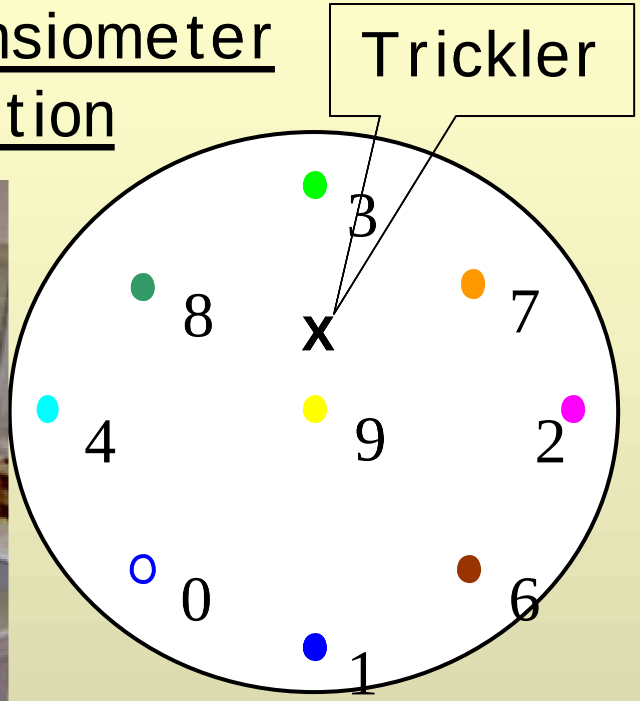
- Tensiometer size:

length: 100 mm diameter: 13 mm

Laboratory tests

Definition of the best positioning of tensiometer in the container respect to trickler position





Without plant

(9 tensiometers on two levels)

With plant (5 tensiometers on two levels)

Definition of methodology of water providing

- ✍ Threshold of soil water potential for watering activation: 70 hPa
- ✍ Water amount to be distributed to restore field capacity: 1.5 litres

Distribution of water according to the following procedures:

- ✍ in a single watering
- ✍ two watering of 0.75 L each at an interval of 10 min
- ✍ three watering of 0.5 L each at an interval of 10 min

(six repetitions for each watering cycle)

Field experiments

✍ Two years of experiments: 1999 and 2000

✍ Two treatments for each species:

- reference treatment: irrigation controlled by timer (two daily irrigations at 9:00 and 18:00; water amount of 1.5 L distributed in a unique dose. A third daily irrigation was introduced late in the season when plants, for their dimensions, could suffer water shortage)

- treatment with the irrigation controlled by tensiometers (water amount of 1.5 L distributed according to laboratory experiment results)

✍ Twelve plants per treatment

✍Soil water potential of three plants per treatments was measured in continuum by tensiometers. Only the readings of one tensiometer were used to active irrigation.

✍Threshold value of soil water potential for watering activation: 70 hPa

The tensiometers dedicated to watering control were connected to an electronic card, developed on purpose, able to read tensiometers values and to start/stop irrigation according to threshold value and protocol introduced in card software, turning on/off relative electric valves.

The protocol foresaw three watering of 0.5 L each at an interval of 10 min. Each irrigation cycle was followed by a control of soil water potential. If the value was higher than 25 hPa (stop threshold) new waterings were applied until stop threshold was reached.

The other tensiometers were connected to a datalogger.

Measurements taken on 12 plants per treatment during the growing season to verify plant conditions:

- plant height
- collar diameter
- leaf temperature (by IR thermometer)
- stomatal resistance (by a steady-state porometer)

Final measurements:

- fresh and dry biomass

At the beginning of growing season ......

A - Cipresso (13 maggio '99)

B - Cornus (20 maggio '99)

C - Cipresso (13 agosto '99)

D - Cornus (13 agosto '99)

....after three months

Results

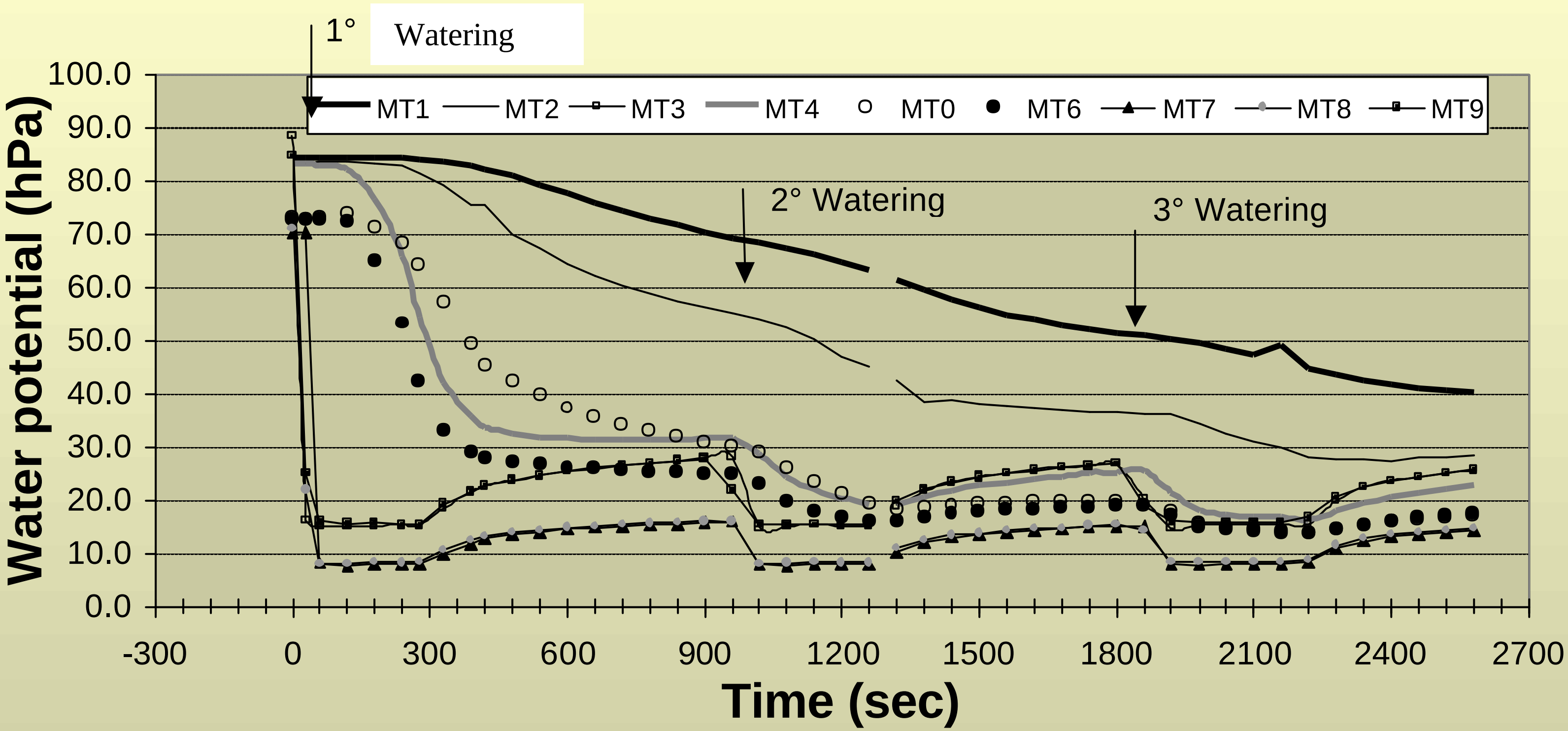
Methodology of water providing

Water amount stored and lost during each watering for the three tests (mean±sd).

Test	Water amount distributed (L)	Water stored for each watering (L)	Total water stored (L)	Total water lost (L)
1°	1.5	0.740 ± 0.1	0.740±0.1	0.760
2°	0.75+0.75	0.612±0.07 + 0.144±0.02	0.756±0.1	0.744
3°	0.5+0.5+ 0.5	0.476±0.04 + 0.276±0.08 + 0.104±0.04	0.856±0.1	0.644

Water distribution in three watering determined a higher water storage and, consequently, less water lost by leaching.

The positioning of tensiometer in the pot respect to trickler position



Considering that the substrate has to be maintained in a precise range of humidity near the field capacity, the positioning of the tensiometers in the upper layer of pot seems more suitable for irrigation control because the sensors are affected by dry/wet periods shorter than the tensiometers located at a depth of 20 cm, and, consequently, they trigger a higher number of watering avoiding possible water shortage. Moreover the positioning of the tensiometer in the upper layer is easier and avoids any alteration of the container.

Consequently, in the field experiment, tensiometers were placed in the upper layer with an angle of 90° respect to trickler.

Field experiments

1999	Cupressus			Cornus		
	Height (cm)	Dry weight (g/plant)	Total water distributed (L/treat.)	Height (cm)	Dry weight (g/plant)	Total water distributed (L/treat.)
TIMER	116.7±2.2a	382.5±14.7a	12921	208.6±1.97a	322.2±14.8a	13813
TENS	123.4±1.4a	356.8±11.9a	10952	220.1±2.04b	336.2+24.5a	14485
2000	**Cupressus**			**Cornus**		
	Height (cm)	Dry weight (g/plant)	Total water distributed (L/treat.)	Height (cm)	Dry weight (g/plant)	Total water distributed (L/treat.)
TIMER	152.1±9.1a	489.6±59.8a	16154	231.4±9.17.a	425.3±55.0a	13049
TENS	156.3±5.9a	494.1±28.7a	8923	226.9±13.4a	388.8±53.6a	7849

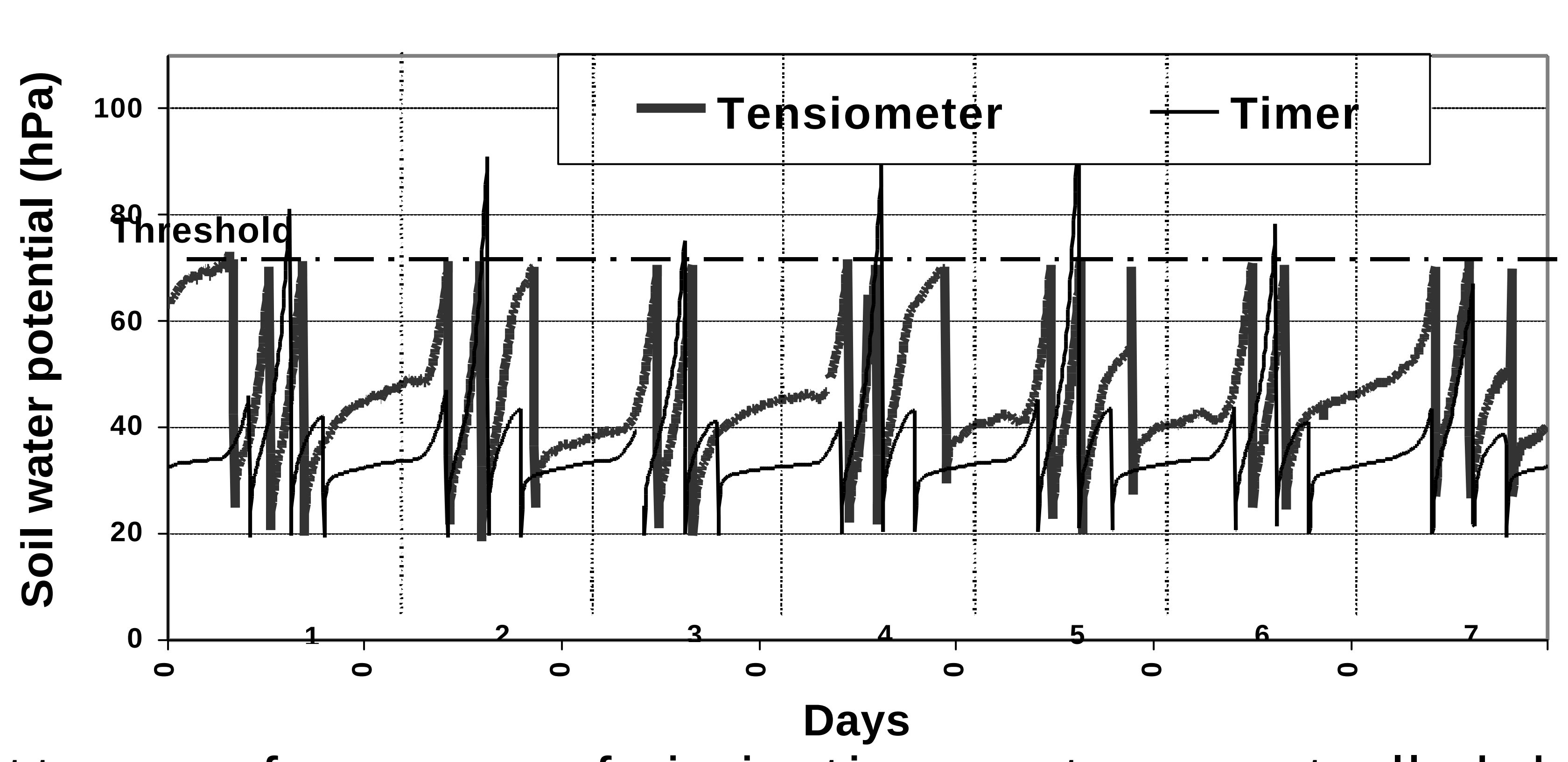
✍ During the 1999 experiment, for both species, the water amount distributed during the growing season in the treatments controlled by tensiometers was about the same of that of reference treatment as a consequence of a malfunctioning of the irrigation system.

✍During the 2000 experiment a further control was introduced in the irrigation management software to avoid the problems of the 1999 experiment. It concerned the maximum daily water amount that could be distributed and a warning system requiring a technical intervention.

With this control, notwithstanding sensor malfunctioning that occurred also in 2000 experiment, no useless water losses occurred and total water amount distributed in the treatments controlled by tensiometers was 40% lower than that one of reference treatment controlled by timer.

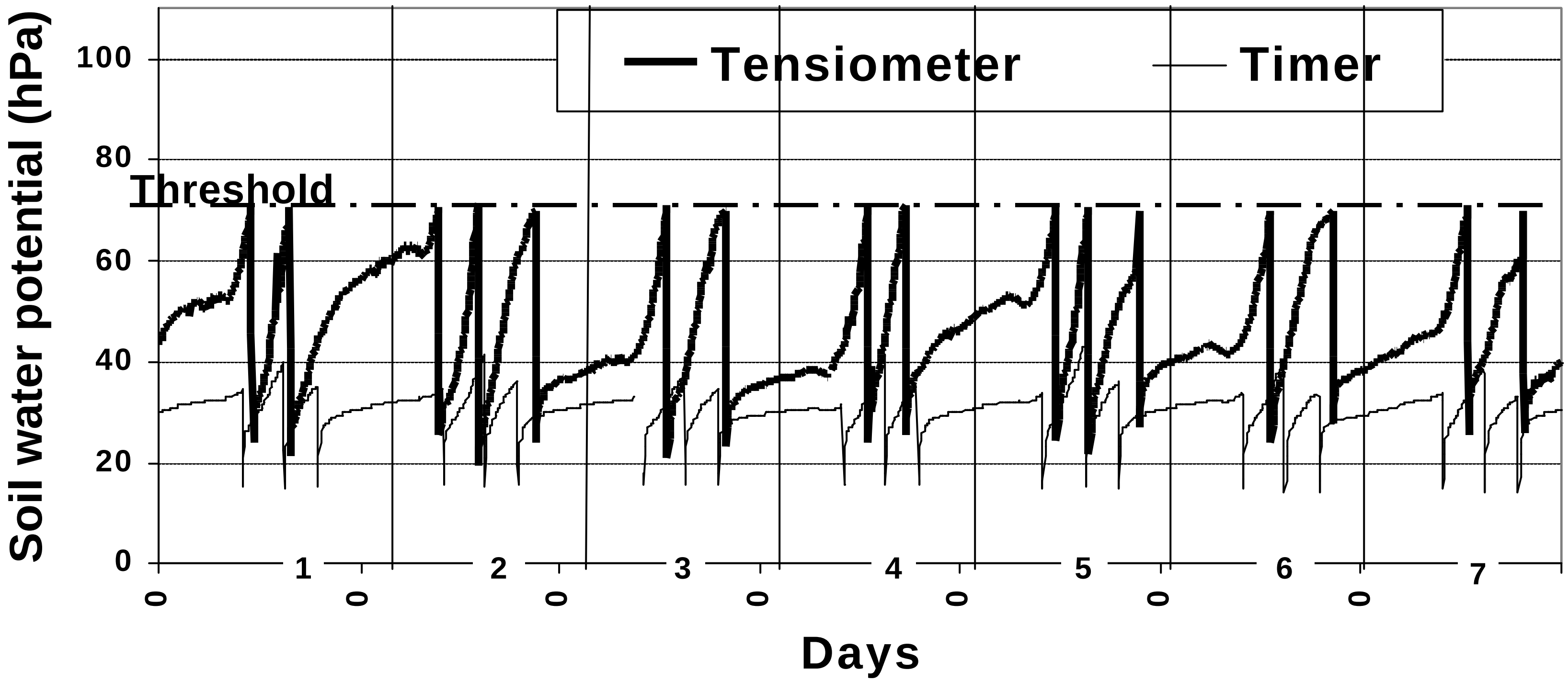
No significant differences of plant growth were detected among different treatments.

Cornus: species with high water requirements



Better performance of irrigation system controlled by tensiometers in comparison to timer control. In fact, while the soil water potential of reference treatment, sometimes during the season, reached values until 100 hPa, the soil water potential of the treatment controlled by tensiometers ranged always between 70 and 20 hPa.

Cupressus: species with low water requirements



During the days with low water requirement, the system controlled by tensiometers activated only two cycle of watering, while the system controlled by timer activated the irrigation three times according to its programme.

Conclusions

An irrigation system controlled by tensiometers can really optimize water distribution, avoiding even short plant water stress, and it can really reduce water consumption

BUT

- ✍ the utilisation of more than one tensiometer to activate the irrigation is recommended (higher costs);
- ✍ the development of a dedicated and high *performant* electronic/software control apparatus needs;
- ✍ a periodical calibration and maintenance of tensiometers is fundamental to ensure reliable measurements and a good control of the irrigation.