## Progress Report and Proposal - Pear Research Review, 2000

**TITLE:** Pear Rootstock and Regulated Deficit Irrigation Plot

**PERSONNEL:**

Principal Investigator: Peter G. Sanderson, WSTFRC, Wenatchee, WA
Cooperator: Randy Smith, Cashmere, WA

Oversight Committee:
Robert Gix, Blue Star Growers, Inc.
Raymond Schmitten, Orchardist/Cashmere Fruit Exchange, Cashmere, WA
Timothy Smith, WSU Cooperative Extension, Wenatchee, WA
Fred Valentine, Dole-Wells and Wade, East Wenatchee, WA

**JUSTIFICATION:**

Old Home X Farmingdale (OH X F) rootstocks, especially OH X F 97, have become the standards for the pear industry in the Pacific Northwest. Although they have demonstrated some precocity over seedling rootstocks, they are only minimally size controlling. Labor efficiency, environmental and pest management concerns drive the push for smaller trees. Better cropping efficiency and earlier returns on investment require more precocious trees.

Regulated deficit irrigation (RDI) systems have been used in stone fruit and apples to reduce tree size and promote the change from a vegetative to a reproductive growth mode. RDI trials in Australia on Bartlett canning pears on *Pyrus calleryana* D6 rootstocks also have shown tree vigor control along with yield increases in bearing trees (8th leaf).

The purpose of this plot is to:

- determine if RDI can be used to regulate tree size through reduced vigor, and
- enhance precocity in promising OH X F clones with Bartlett, Anjou and Bosc tops.

Other benefits of the plot include:

- a demonstration plot under typical Washington growing conditions of OH X F rootstocks that are not scion rooted,
- the development of a better understanding of pear water use for refining crop coefficients for irrigation scheduling, and
- the set up for studying the response of pear trees to water stress (e.g., postharvest disorders such as cork and alfalfa greening).

**Objectives for 2000 season**

- Install TDR sensors to monitor soil moisture
- Adjust irrigation coefficient (*k*) to match water usage during the growing season and with growth stage of trees
- Apply early season water deficit to control tree size & vigor
- Evaluate performance of selected OH X F rootstocks
- Monitor stem water potential and transpiration rates as indicators of water stress

## PROGRESS:

### Objectives for 1999 season

- Monitor soil moisture depletion during spring
- Apply early season water deficit to promote fruiting and control tree size & vigor
- Evaluate performance of selected OH X F rootstocks
- Monitor stem water potential and transpiration rates as indicators of water stress

## PROCEDURES:

- Apply deficit during early season by withholding irrigation until soil moisture is at about 66% of field holding capacity. Maintain deficit until rapid growth stage of fruit (cell enlargement). At this stage, apply full irrigation (about 120% of net evaporation) until harvest.

### Treatments

1. Full irrigation (120% of pan evaporation)
2. 25% of pan evaporation
3. 50% of pan evaporation

- Assessment of RDI and rootstock effects
    - Yield components
    - Growth
        - shoot elongation

## RESULTS AND DISCUSSION

### Irrigation

Soil moisture in the plot was monitored at 6" and 12" using Watermark (Irrometer Co., Riverside, CA) sensors. Sensors were located in between each of four trees in one replicate group of Bartlett trees on OH X F 97 in each treatment of each block. No irrigation was applied to any treatment until June 1 at which time soil water potential was between about 0.5 bar and 0.9 bar (Fig. 1). Deficit irrigation treatments were applied until about 5 July when all treatments were given a 24 hr irrigation set to replenish the soil profile. Trees were watered on a weekly schedule thereafter.

Irrigation timing was set using the amount of water lost to evaporation measured by an atmometer (ET Gage, Loveland, CO) over a 3 day period multiplied by a factor *k*. *K* was somewhat arbitrarily set at the outset to account for water loss by transpiration. It appears from data shown in Figure 1 and from the appearance of the soil in the orchard that the amount of water applied for the full irrigation treatment was excessive. The soil remained near field holding capacity at the end of each 3 day cycle. By about June 24, the soil at 6" also had been rewetted in the deficit treatments. In contrast, soil moisture at 12" in both the 50% and 25% deficit treatments decreased steadily over the course of the deficit period.

The Irrometer Co. claims that their Watermark sensors are useful up to 2 bars of tension. However, our experience and the published paper in which the calibration algorithm was given suggests that these sensors are not capable of accurate measurement beyond 1 bar and probably a bit less. In most circumstances that is acceptable because tensions above 0.5 bar are fairly dry soils. However, for accurate soil water measurement for this experiment, they are probably not suitable.

**Shoot growth**

Shoot growth was measured on a weekly basis beginning May 26. Vigor of Bartlett trees appeared to be affected by both rootstock and irrigation treatments. Shoot length of trees on all rootstocks subjected to irrigation deficits (50% and 25% of evaporation) was less than that measured in trees given full irrigation (Fig. 3), but there was no apparent difference among deficit treatments. Shoot length was greatest in trees on OH X F 69 and OH X F 97 regardless of treatment (Fig 3). However, shoot growth of both Anjou and Bosc was similar among rootstocks and irrigation treatments and no discernable pattern of vigor control was detected (Fig. 2 and Fig. 4, respectively).

The effects of the deficit treatments were not readily apparent during the first flush of growth (Figs. 2-4), but developed during a second flush of growth. Anjou and Bartlett trees developed a second flush of growth about July 14 whereas Bosc trees began a second flush 2-3 weeks later, around the first week of August.

**Secondary bloom**

Secondary bloom was relatively heavy during the second flush of growth in all cultivars, but especially on Bartlett trees. To determine if the deficit irrigation treatments had promoted this potentially serious effect, secondary blossom clusters were counted on Bartlett trees. Neither treatment nor rootstock significantly affected numbers of secondary blossoms that developed in the second flush of growth. All secondary flower clusters developed from buds that had formed and then broke during the season. If ways could be found to either prevent early cessation of growth or the second flush in a season, it may be possible to eliminate this problem.

**Yield**

A killing freeze hit the Wenatchee Valley about two weeks after petal fall and severely damaged fruit in the plot. At harvest, most of the fruit that remained on trees was marked. Total yield, fruit size (diam.), and trunk cross-sectional area (TCSA) were recorded and fruiting efficiency was calculated (yield/TCSA). Data from the plot show interesting trends, but may be misleading because of the effects of the freeze and especially because of the low yields of Bosc and Anjou fruit.

*Anjou.* Fruit yield was significantly affected by rootstock ($P<0.001$), but not by irrigation treatment ($P=0.322$). Yield on OH X F 87 (9.4 kg/A) was significantly greater than on either OH X F 69 (2.7 kg/A) or OH X F 97 (1.2 kg/A), which were not different from each other. This is similar to reports from test plots in Hood River. Fruit size was not affected by either irrigation treatment or rootstock ($P = 0.564$ and $P=0.584$, respectively).

TCSA was significantly less in trees on OH X F 69 (32.9 cm$^2$) than trees on either OH X F 87 or OH X F 97 (41.7 cm$^2$ and 38.3 cm$^2$, respectively) ($P<0.001$). Fruiting efficiency followed a similar pattern to yield, in which trees on OH X F 87 (0.069 kg/cm$^2$) were significantly more efficient than those on either OH X F 69 (0.024 kg/cm$^2$) or OH X F 97 (0.010 kg/cm$^2$) ($P<0.001$).

*Bartlett.* Yield of Bartlett fruit averaged 291.8 kg/A across rootstocks and irrigation treatments. Neither rootstock nor irrigation treatment significantly affected yield ($P=0.401$ and $P=0.331$, respectively) in 1999. Fruit size was differentially affected by irrigation treatment and rootstock ($P=0.001$). Fruit size was greatest on trees grown on OH X F 40 and OH X F 69 in both the full irrigation treatments and the 50% deficit treatment (Fig. 5). However, the size of fruit on OH X F 69 in the 25% irrigation treatment were the smallest of all rootstock and irrigation treatment combinations.

TCSA was significantly affected by rootstock (*P*<0.001), but not irrigation treatment (*P*=0.277). Trees on OH X F 87 were significantly smaller than trees on the other rootstocks (TCSA=29.0 cm$^2$) followed by OH X F 97 (TCSA=32.0 cm2), which was smaller than trees on the other two rootstocks. Trunk cross-sectional areas of OH X F 40 and OH X F 69 were 36.2 cm$^2$ and 36.1 cm$^2$, respectively. Fruiting efficiency, like yield, also was not affected by either variable (*P*=0.323 and *P*=0.538 for irrigation treatment and rootstocks, respectively).

*Bosc*. The interaction of rootstock and irrigation treatment significantly affected yield of Bosc fruit (*P*= 0.038). Yield was inconsistent among rootstocks and irrigation treatments, but most fruit were harvested from trees on OH X F 69 that were given the 50% of pan evaporation deficit (Fig. 6). Similar to that on Bartlett trees, fruit size was differentially affected by irrigation treatment and rootstock (*P*=0.001). The size of fruit from trees on OH X F 97 and OH X F 87 were greatest in the full irrigation treatment and smallest in the 25% irrigation treatment (Fig. 7). Conversely, fruit from trees on OH X F 40 and OH X F 69 were smallest in the full irrigation treatment and largest in the 25% irrigation treatment.

TCSA was significantly affected by irrigation treatment (*P*=0.041). Trees grown in the 25% irrigation treatment were significantly smaller than those in the 50% irrigation treatment (TCSA=27.8 cm$^2$ vs 31 cm$^2$, respectively), but did not differ from those in the full irrigation treatment (TCSA=29.5 cm$^2$). TCSA of trees grown under full irrigation and 50% irrigation were not different from each other. Fruiting efficiency was differentially affected by irrigation treatment and rootstock (*P*=0.025). Efficiency of OH X F 69 in the 25% irrigation treatment was more than double that of the next most efficient treatment combination, which was OH X F 69 grown in the 50% irrigation treatment (Fig. 8). Least efficient were OH X F 69, OH X F 87, and OH X F 97 grown under full irrigation and OH X F 40 grown in the 25% irrigation treatment.

### Water use by pear trees

Transpiration rates and stem water potential were measured at weekly intervals during the growing season to determine the effects of water stress on trees and to refine crop coefficients for irrigation scheduling. Examples of data from trees in the full irrigation treatments are shown in Fig. 9 and 10. No analyses of these data have been done at this time.

## ANTICIPATED BENEFITS:

This plot offers a unique laboratory for demonstrating the characteristics of OH X F rootstocks on commonly grown pear varieties under Washington conditions. The intensive monitoring of the trees in the plot under controlled irrigation regimes will allow us to study stress physiology and give us a better understanding of water use and growth parameters of European pears during the season. Refinement of crop coefficients for irrigation scheduling will facilitate development of best water and fertility management practices for pears.

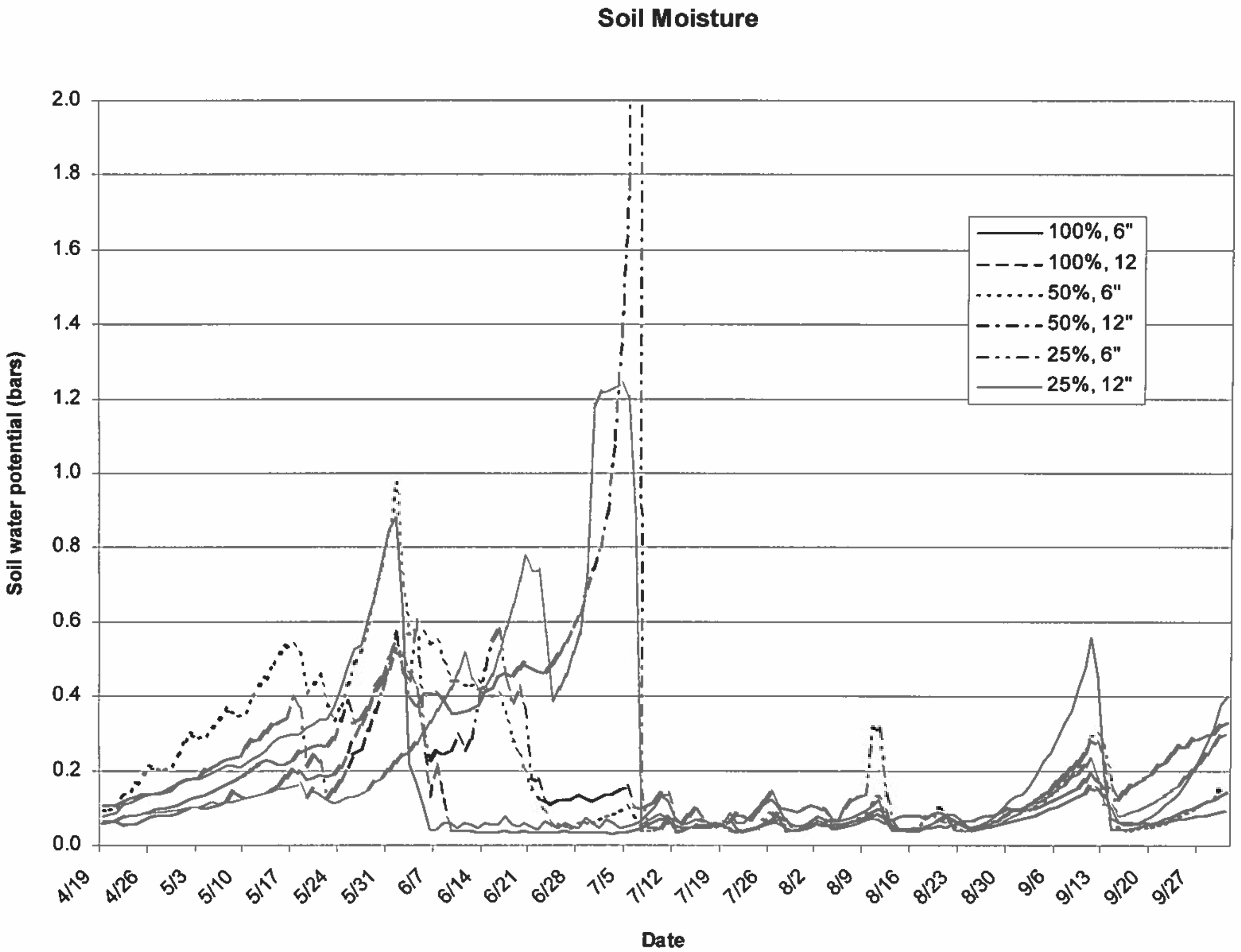

**Figure 1**. Soil water potential at 6" and 12" depths.

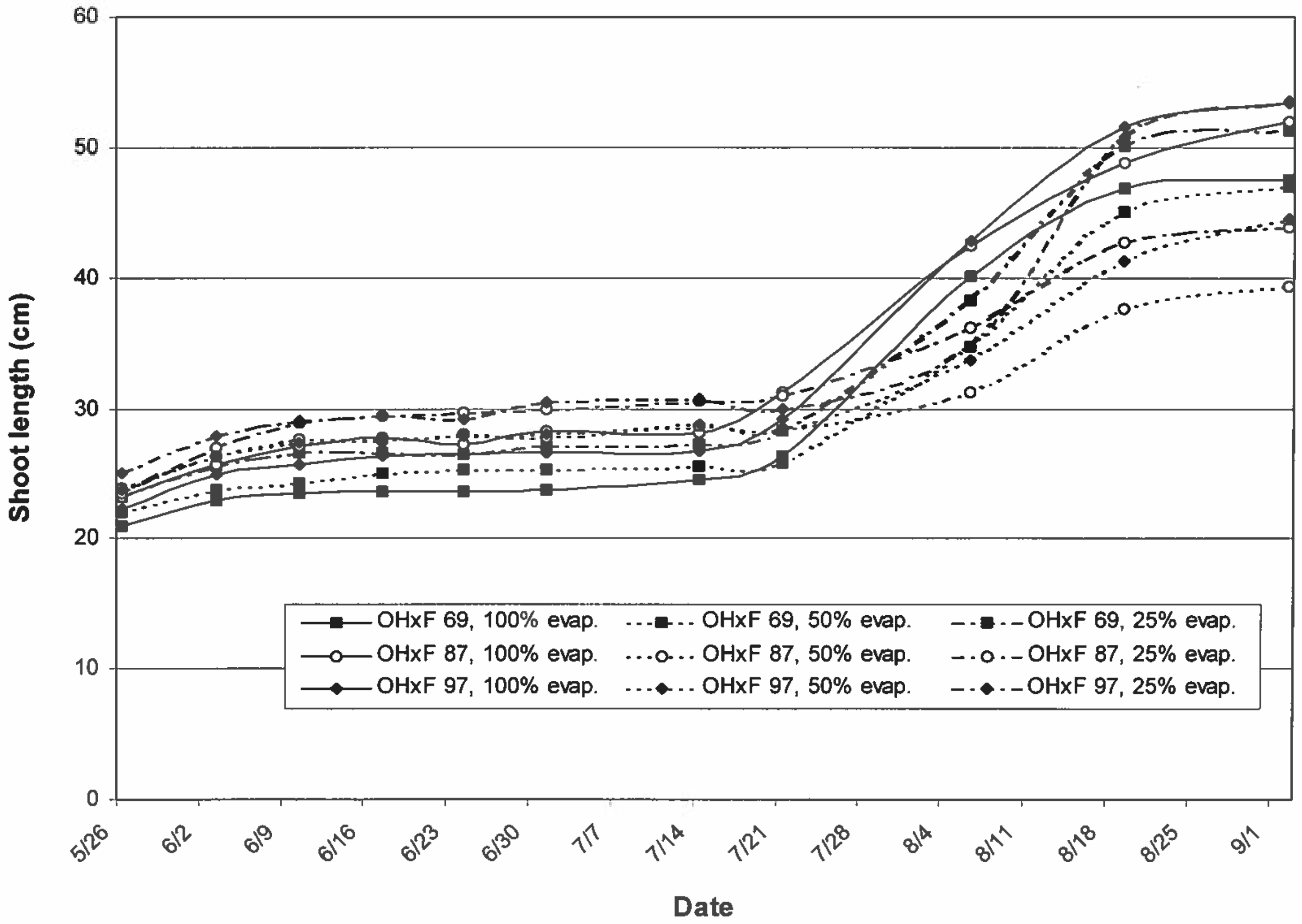

**Figure 2.** Anjou shoot growth in response to irrigation treatment and rootstock.

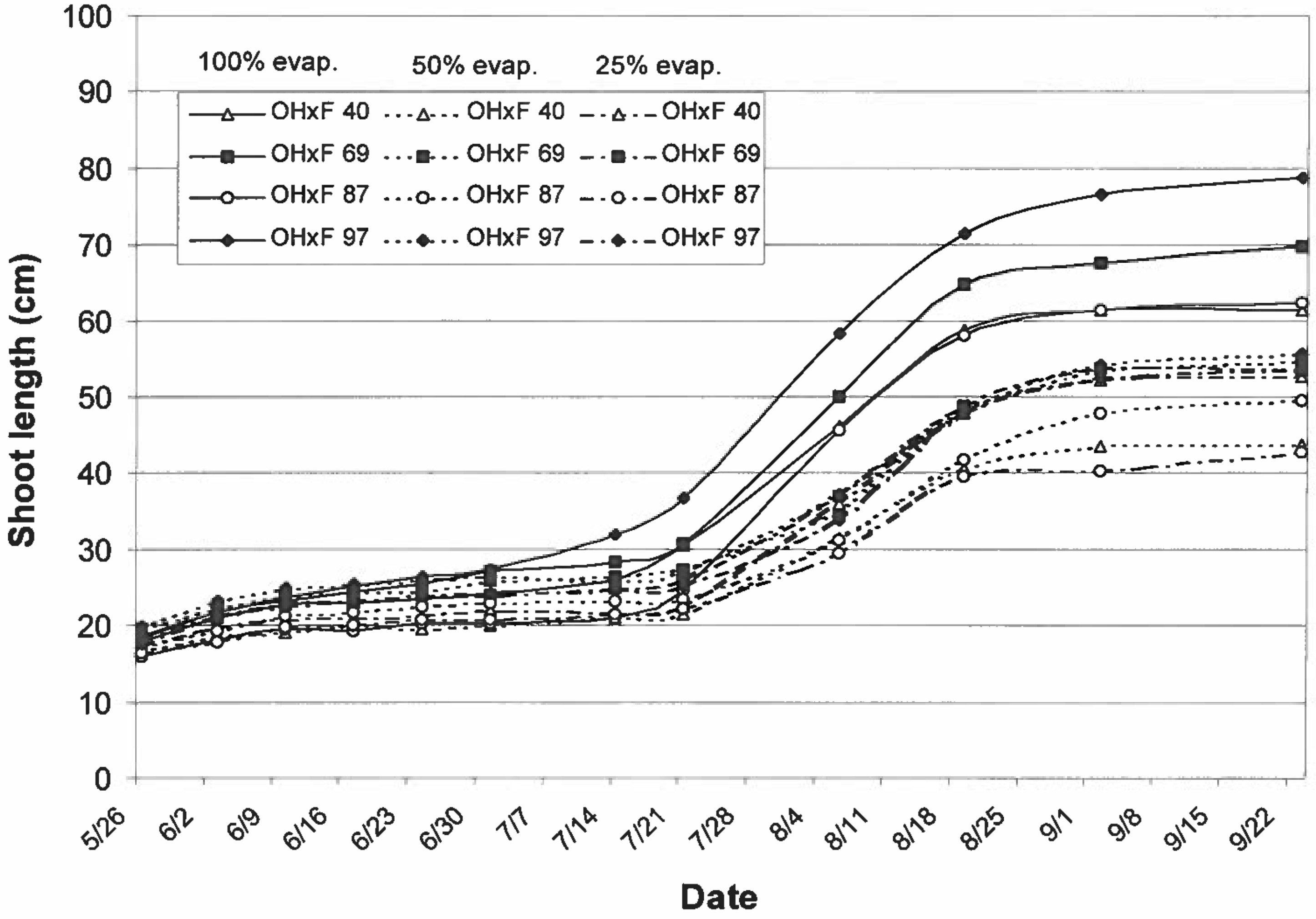

**Figure 3**. Effect of rootstock and deficit irrigation treatment on growth of shoots of Bartlett pears.

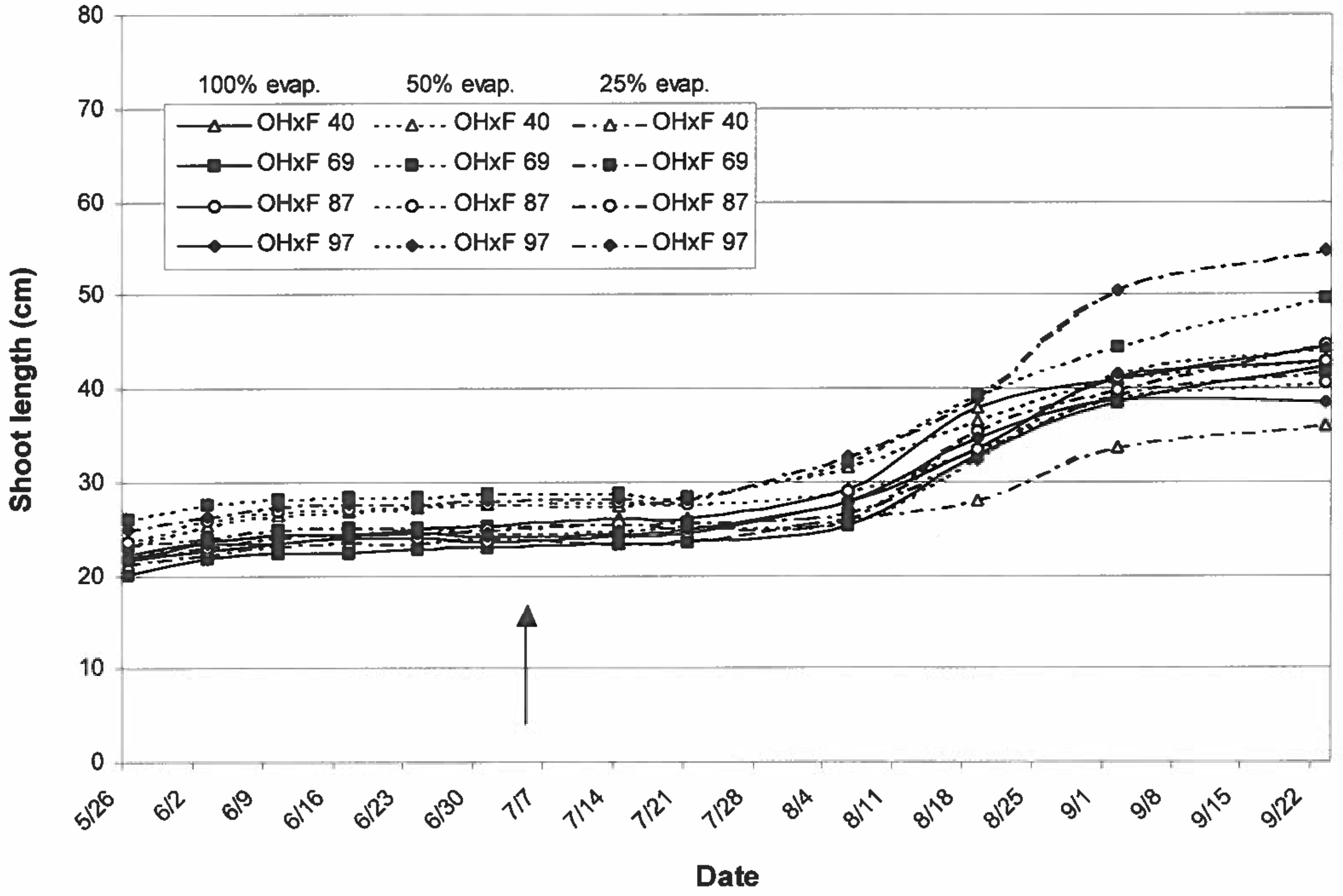

**Figure 4**. Effect of rootstock and deficit irrigation of shoot growth of Bosc pears. Arrow indicates point at which full irrigation was applied.

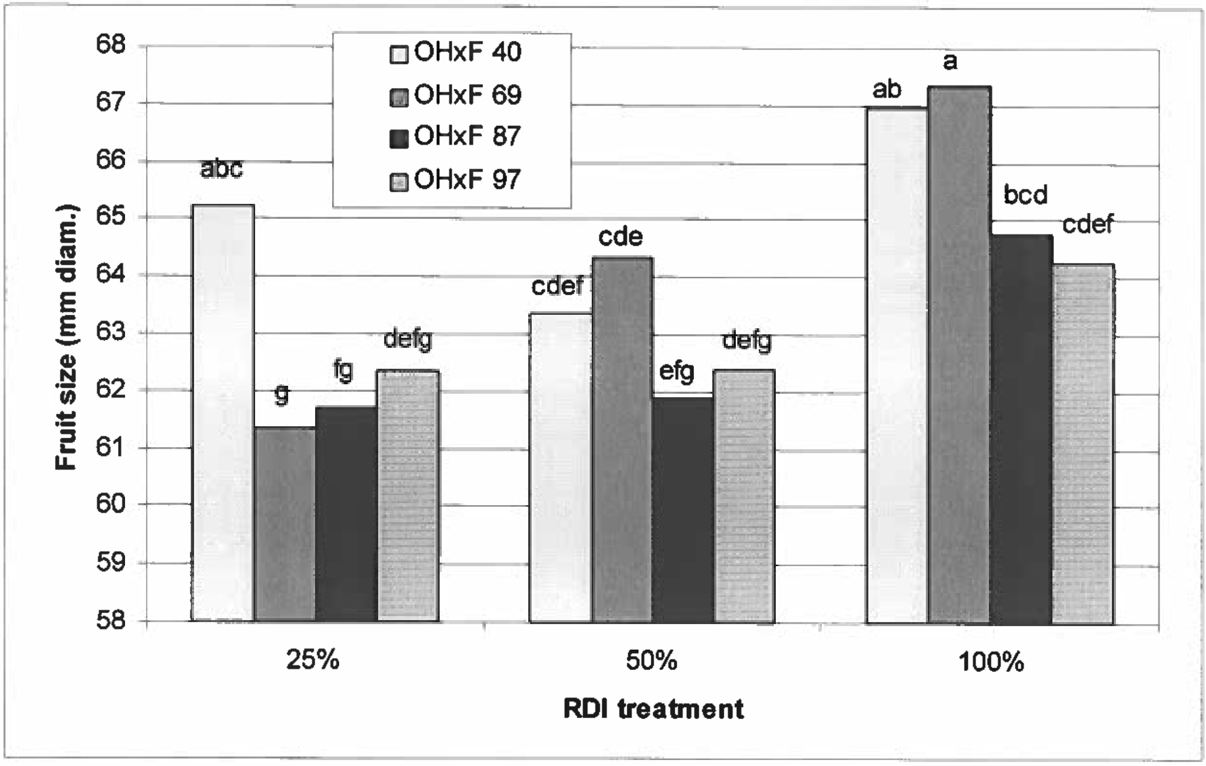

**Figure 5.** Effect of irrigation treatment and rootstock on Bartlett pear fruit size at harvest.

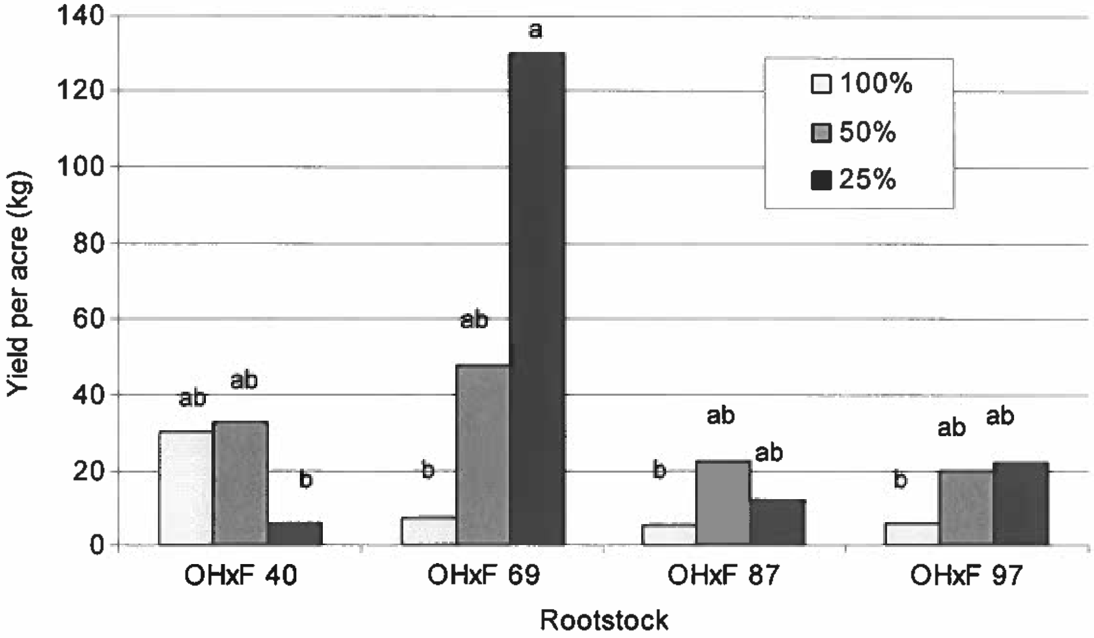

**Figure 6.** Effect of rootstock and irrigation treatment on yield of Bosc pear fruit.

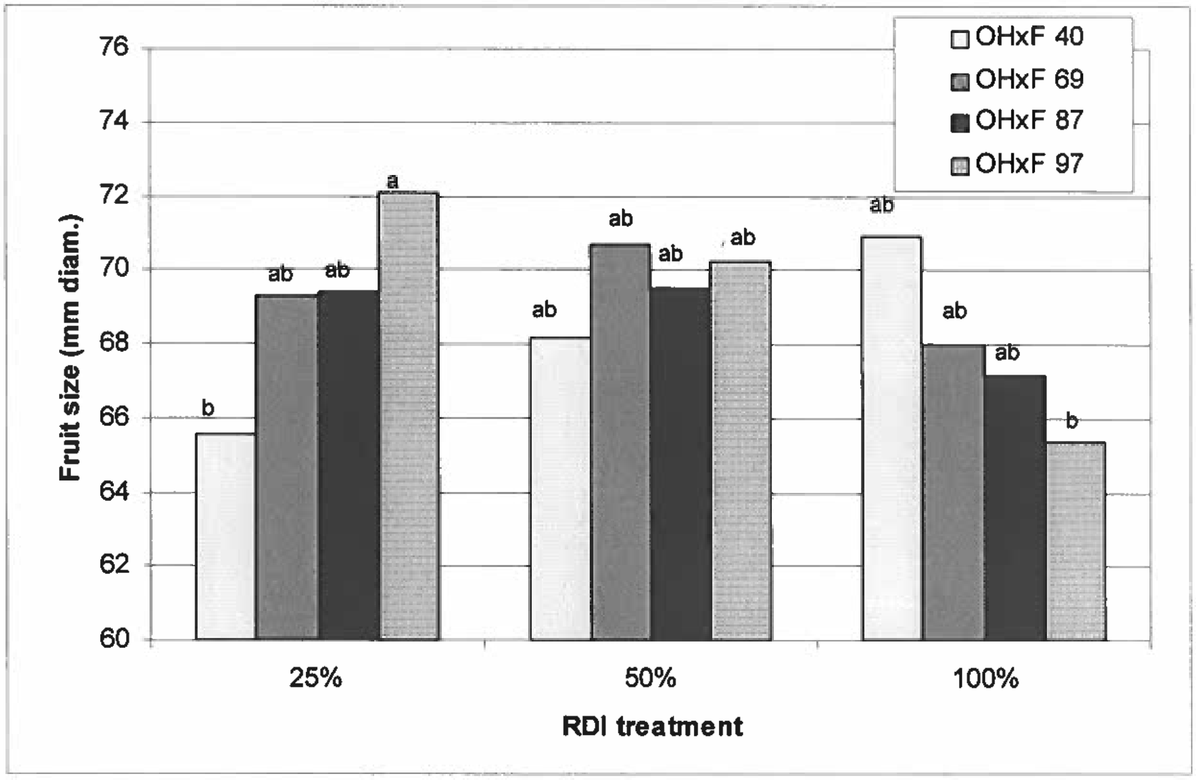

**Figure 7**. Effect of irrigation treatment and rootstock on Bosc fruit size at harvest.

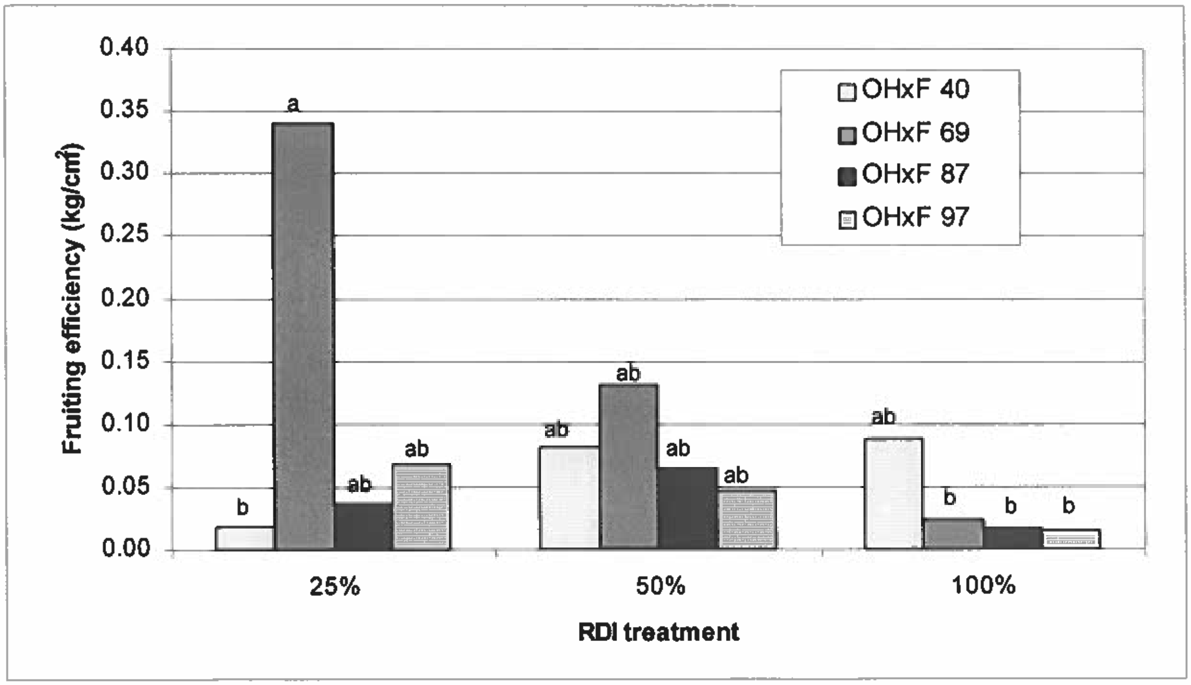

**Figure 8**. Effect of irrigation treatment and rootstock on fruiting efficiency of Bosc pears.

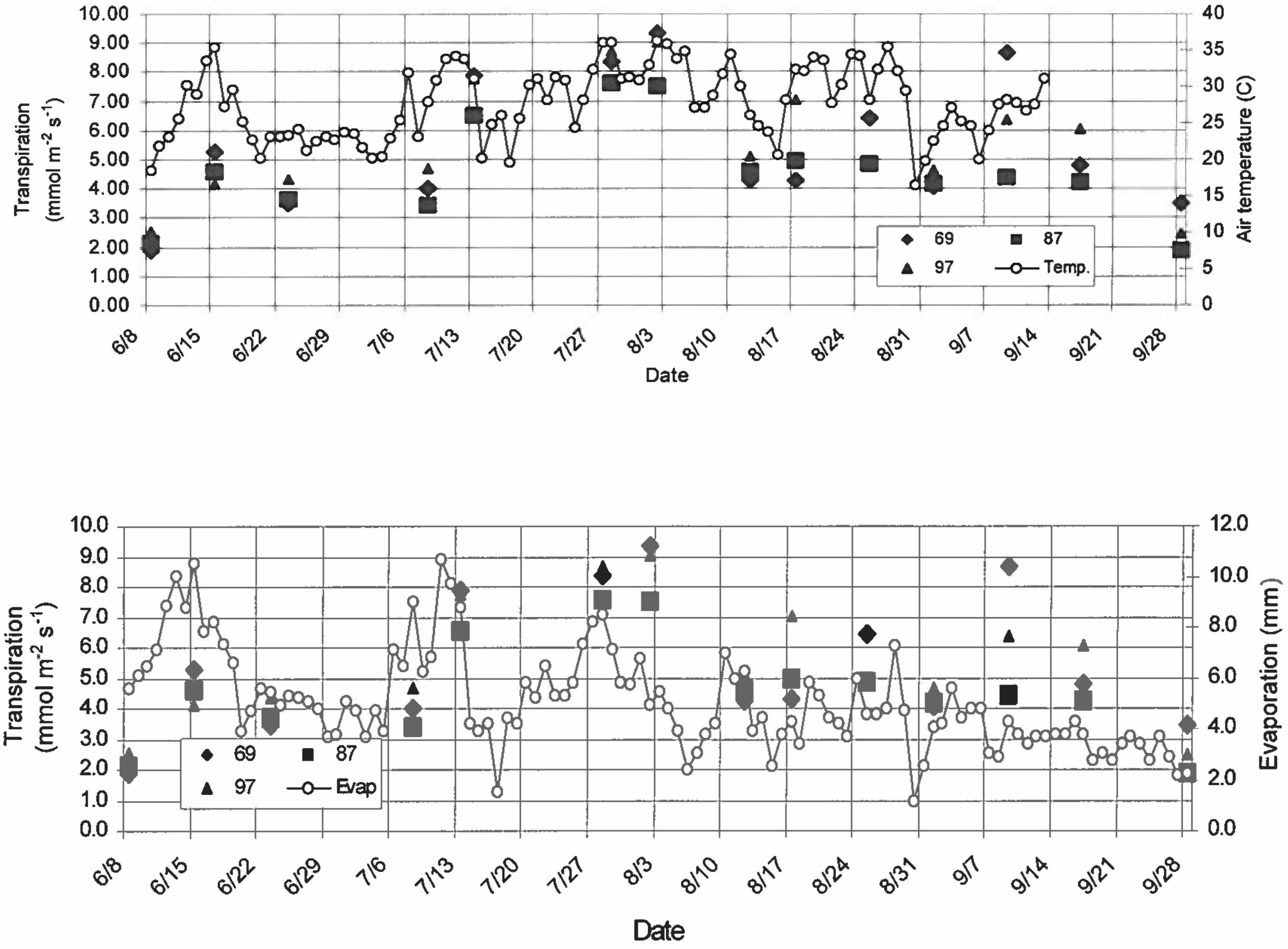

**Figure 9**. Comparison of transpiration rates of Anjou pears trees under full irrigation with air temperature (*top*) and evaporation measured with an atmometer (*bottom*).

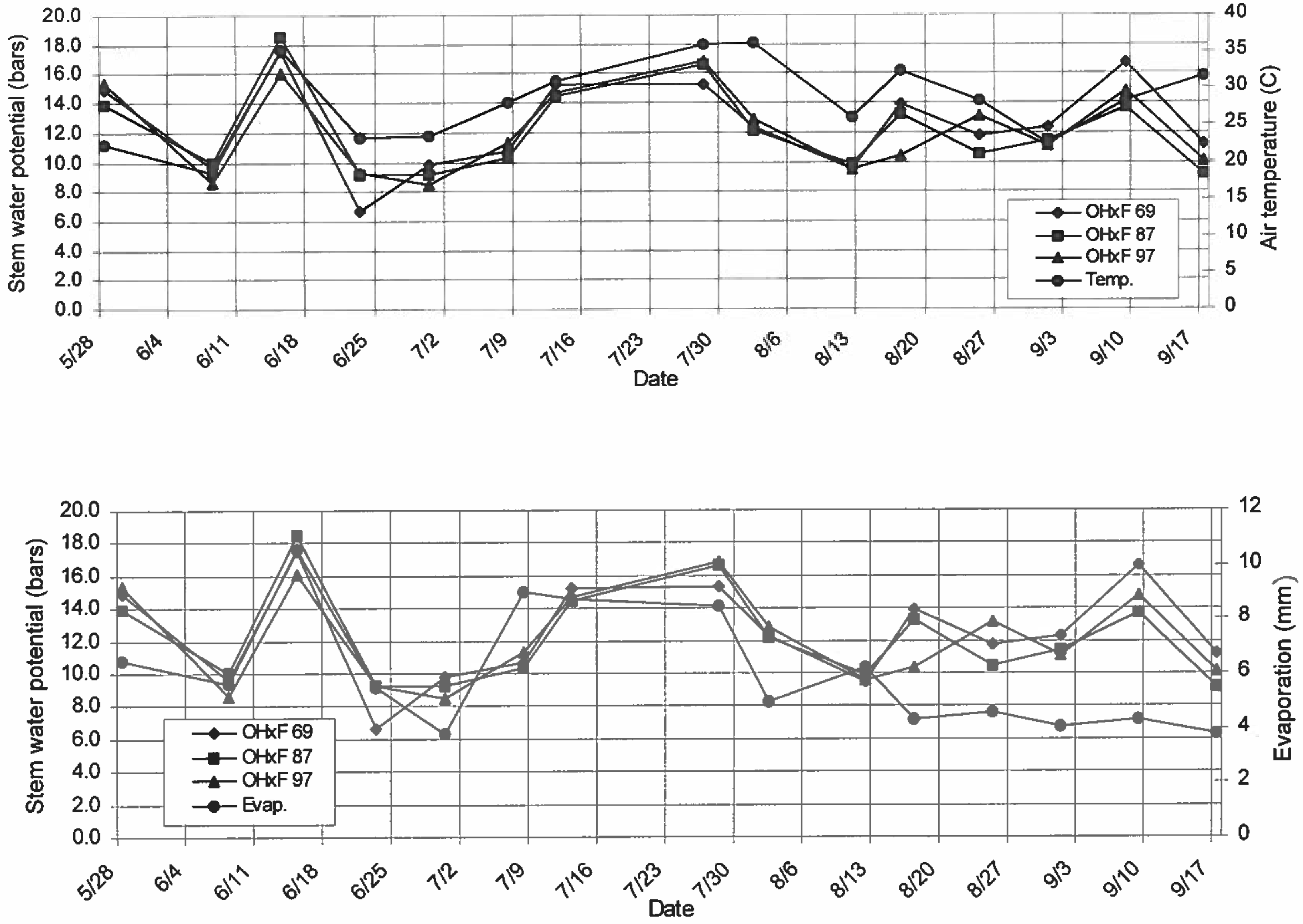

**Figure 10**. Comparison of stem water potential with air temperature (*top*) and evaporation measured with an atmometer (*bottom*).