



**SKIERNIEWICE, POLAND**

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**INFLUENCE OF IRRIGATION ON GROWTH AND YIELD OF  
PLUM TREES CV BLUEFRE GRAFTED ON MYROBALAN AND  
WANGENHEIM PRUNE**

**ABSTRACT.** The effect of drip irrigation on growth and fruiting of plum trees cv Bluefre grafted on Wangenheim Prune and Myrobalan seedlings was investigated. The study was carried during 1990-1998 in the Pomological Orchard of the Institute of Pomology and Floriculture, Skierniewice. The trees were planted in the spring 1990 at a spacing of 4.2 x 2.9 m. Influence of drip irrigation on tree growth, yield and fruit quality depended on weather conditions during different years, but generally it significantly increased the studied factors. Better effect of irrigation was observed on plums grafted on Wangenheim Prune as compared to those on Myrobalan seedlings.

**Key words:** plum, drip irrigation

**INTRODUCTION.** The climate of Poland is characterized by a high variation, especially in the total precipitation and its distribution during the season. Dry years occur periodically. High negative climatic water balance

(deficit of more than 100 mm) characterize 24% of area of Poland (Bac, 1980). Repeated negative climatic water balance during a vegetative season affects negatively growth and development of plum trees. Yield and quality of fruits are limited by the quantity of precipitation. It has been reported that drought reduces an active surface of root system and in consequence decreases water and mineral salts uptake (Evans and Proebsting, 1985; Pacholak, 1994). Treder (1996) showed that irrigation significantly increases growth and yield of apples, cherries, peaches and other fruit crops in Polish conditions. The main purpose of the experiment was to study the long-term effect of drip irrigation on growth, yield and fruit quality of plum trees grafted on two rootstocks.

**MATERIAL AND METHODS.** The trial was set up in the Pomological Orchard of the Research Institute of Pomology and Floriculture, Skierniewice. The orchard was planted in the spring 1990 with plum trees (*Prunus domestica* L. cv Bluefre) grafted on Wangenheim Prune and Myrobalan seedlings (*Prunus cerasifera*). The tree spacing was 4.2 x 2.9 m (821 trees/ha). The soil was light, medium class, sandy-loam. The experiment was set up in a factorial design 2 x 2, where trees grafted on two rootstocks were or were not drip irrigated (6 replications of one tree each). On-line pressure compensating drippers ( $4 \text{ l h}^{-1}$ ) were located at a distance of 0.35 m on opposite sides of tree trunk. Water was supplied at a rate sufficient to maintain soil water potential at the level of -0.02 MPa, controlled by tensiometers. Water quality: pH - 7.0, Ca - 60 ppm, Mg - 15 ppm. The following observations and measurements were taken:

- trunk thickness 30 cm above the grafting point (each year in autumn);
- total annual shoot growth during 1991, 1992 and 1993;
- yield and mean fruit weight.

Data were statistically elaborated with an analysis of variance. Student's "t" test was employed to calculate the significance of differences at  $P = 0.05$ . Data presented on the graph are arithmetical means  $\pm$  standard errors (SE).

Precipitation distribution and mean monthly temperatures are presented in Figure 1. It shows a great variability between years. During the course of the research there were five dry seasons: 1991, 1992, 1993, 1994, 1995 and three semi-wet: 1996, 1997, 1998. However, in each

season there were dry periods requiring irrigation. Annual supply of irrigation water is presented in Table 1.

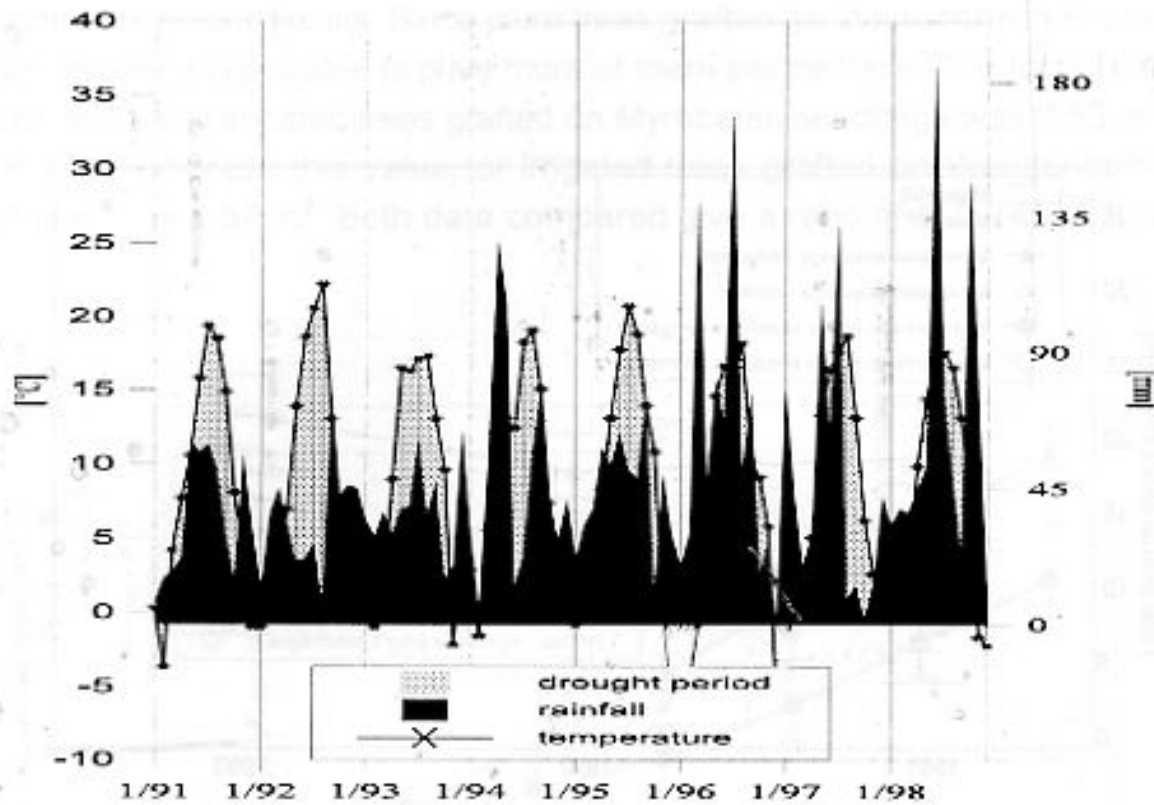


Figure 1. Climatic graph, Skierniewice 1991 - 1998

Table 1. Annual supply of irrigation water [mm/year]

1990	1991	1992	1993	1994	1995	1996	1997	1998
4	10	53	10	86	105	56	40	21

**RESULTS AND DISCUSSION.** Shoot growth was the poorest on non-irrigated trees grafted on Wangenheim Prune and the highest on irrigated trees grafted on Myrobalan seedlings (Fig. 2). Irrigation had a significantly stronger effect on shoot growth of trees grafted on Wangenheim Prune. In general, trees on Wangenheim Prune grew less vigorously than those on Myrobalan seedlings. Similar results for ten different plum

cultivars grafted on those two rootstocks were obtained by Rozpara and Grzyb (1997). According to those authors, the degree of dwarfing by Wangenheim Prune was strictly correlated with the cultivar and ranged from 34 to 60%.

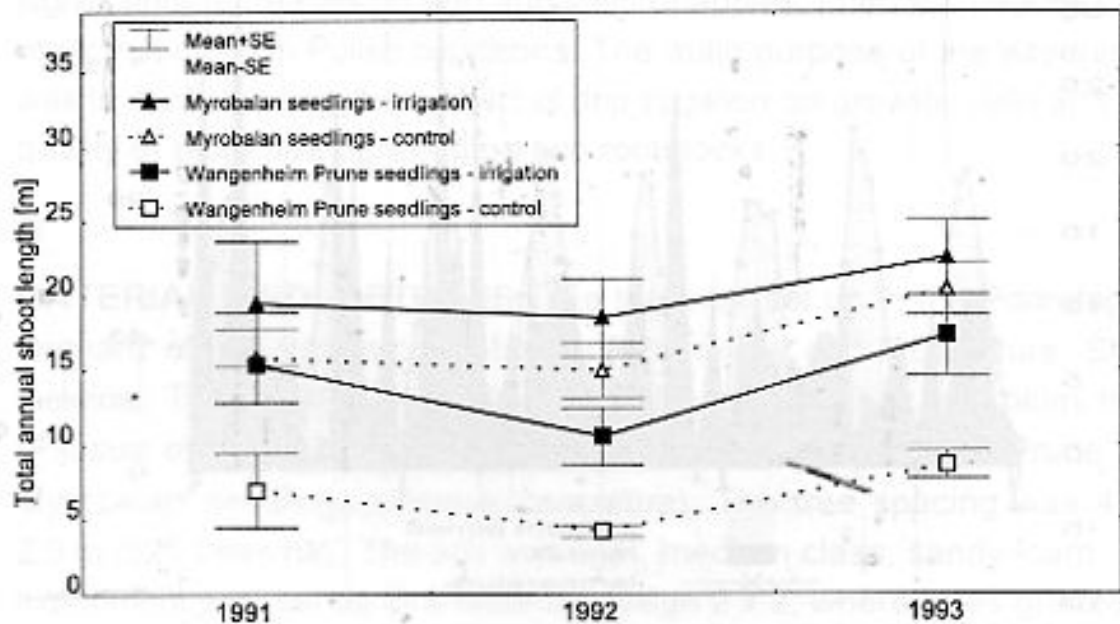


Figure 2. Influence of drip irrigation on total annual shoot growth of plum trees cv Bluefre grafted on two rootstocks

In 1993 and 1994 significant differences in the trunk cross-section area (TCA) of irrigated and control trees grafted on both Wangenheim Prune and Myrobalan seedlings were observed (Fig. 3). However, in the following years very heavy rainfall caused a rapid growth of the trees, what resulted in levelling off growth vigour of both irrigated and non-irrigated trees grafted on Myrobalan seedlings. As opposite, growth of irrigated trees grafted on Wangenheim Prune was more vigorous than growth of those non-irrigated during the entire period of the experiment. Eight years after planting (1998) control trees grafted on Wangenheim Prune had a considerable smaller TCA than those irrigated and non-irrigated grafted on Myrobalan seedlings. Treder et al. (1997) obtained similar results with plum trees cv Valor and concluded that in Polish

climatic conditions trees grafted on Wangenheim Prune are expected to be sensitive to water stress. Rozpara and Grzyb (1994) suggested that, considering a less vigorous growth, plum trees grafted on Wangenheim Prune seedlings could be suitable for intensive orchards. This was confirmed by our results. Since plum trees grafted on Wangenheim Prune are smaller it is possible to plant more of them per hectare. The total TCA per hectare of irrigated trees grafted on Myrobalan seedlings was 7.53 m<sup>2</sup> in 1998 whereas this value for irrigated trees grafted on Wangenheim Prune was 5.57 m<sup>2</sup>. Both data compared give a ratio of 1: 0.74. TCA is

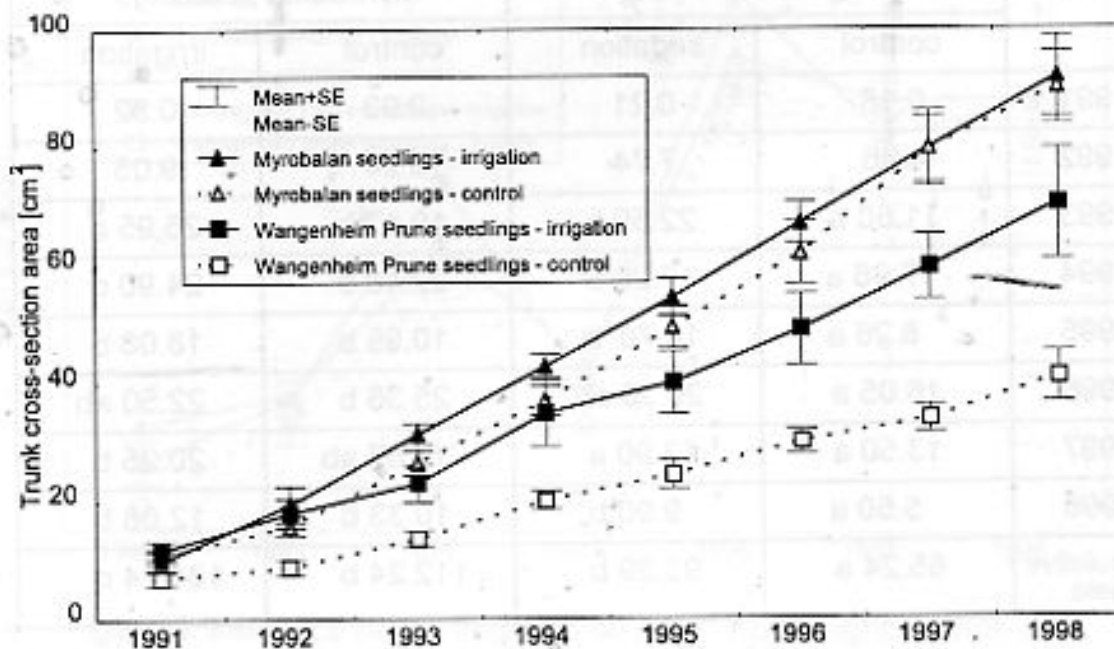


Figure 3. Influence of drip irrigation on trunk cross-section area of plum trees cv Bluefre grafted on two rootstocks

strictly related to the tree growth vigour and to the total area of its leaves, which affects productivity. Therefore, the total TCA can be used as a parameter helpful to determine the density of planting. In order to make the total TCA comparable, 821 trees of plums grafted on Myrobalan seedlings should be planted per hectare as compared with 1100 trees grafted on Wangenheim Prune.

Yields during the experiment are shown in Table 2. In the first two years neither of the investigated treatments influenced the crop. Irrigation significantly affected the yields of trees grafted on both rootstocks in

1993, 1994 and 1998. The increased yield of fruit from irrigated trees in the wet 1998 season shows that additional irrigation resulted in a larger yield even in the years when there was no water deficit. A similar phenomenon was reported by Pacholak (1994), who observed that apple trees irrigated for several years yielded better than those non-irrigated irrespective of wet or dry season.

Table 2. Influence of drip irrigation on yield of plums cv Bluefre grafted on two rootstocks

Year	Yield [kg/tree]			
	Wangenheim Prune		Myrobalan seedlings	
	control	irrigation	control	irrigation
1991	0.18	0.21	0.03	0.32
1992	4.46	7.74	6.24	9.05
1993	11.60 a	22.50 b	19.17 b	26.95 c
1994	7.98 a	17.26 b	22.48 b	24.90 c
1995	8.26 a	10.70 b	10.95 b	18.08 b
1996	16.05 a	20.30 ab	25.36 b	22.50 ab
1997	13.50 a	13.90 a	17.67 ab	20.25 b
1998	5.50 a	9.90 b	10.33 b	12.08 b
Cumulative yield	65.24 a	93.39 b	112.24 b	134.14 c

A total yield from irrigated trees was significantly higher as compared to those non-irrigated. It was also reported by Vodyanotskaya et al. (1994) and Treder et al. (1997) for plum trees in Eastern and Central Europe. Trees grafted on Myrobalan seedlings had a significantly higher cumulative yield per tree than those on Wangenheim Prune.

Productivity index (We), expressed as a yield increase in t/ha per 10 mm of applied water, for trees grafted on Wangenheim Prune and Myrobalan seedlings was 0.60 and 0.47, respectively. It means that the effectiveness of irrigation is higher for the trees grafted on Wangenheim Prune.

The average weight of fruits varied in the years of the experiment (Fig. 4). It was the lowest in the first four seasons after planting. In 1994 and

1996 the effect of irrigation on fruit weight was more pronounced for trees grafted on Wangenheim Prune than on Myrobalan seedlings. The rootstock had no effect on fruit size. This confirms results obtained by Rozpara and Grzyb (1997) in the experiment consisting of the same rootstocks (Wangenheim Prune and Myrobalan seedlings) and several plum cultivars, i.e. Dąbrowicka Prune, Čačanska Rana, Čačanska Najbolja, Čačanska Rodna, Stanley, Valor, Bluefre, Empres and Oneida.

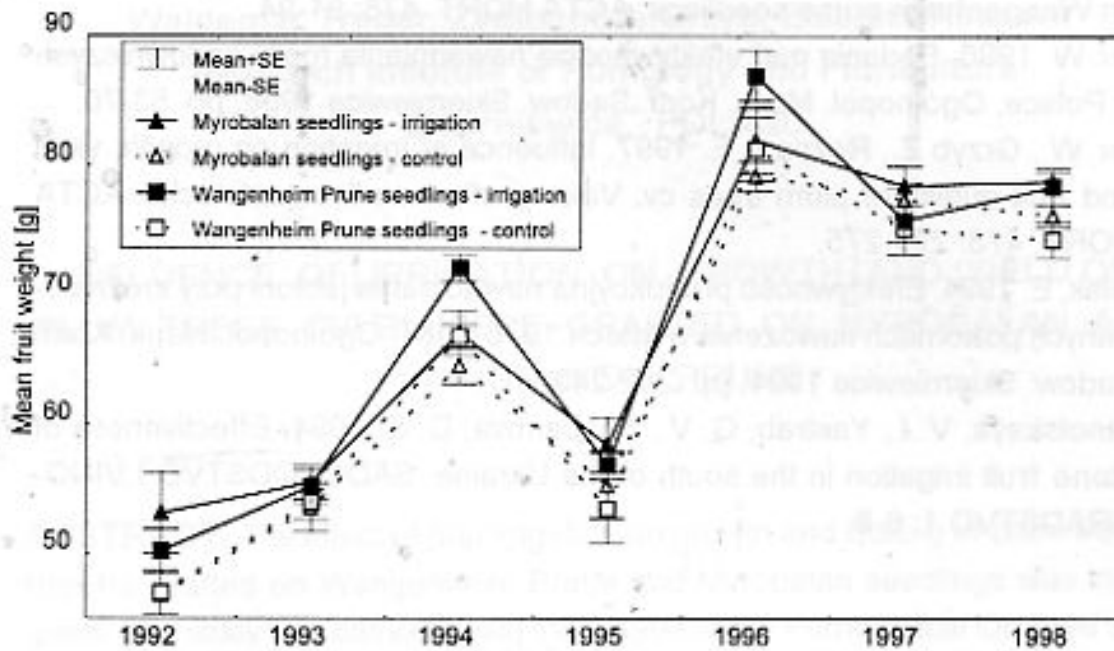


Figure 4. Influence of drip irrigation on mean fruit weight of plum cv Bluefre grafted on two rootstocks

## CONCLUSIONS

1. In Polish climatic conditions drip irrigation increased the yield of plum trees grafted on Wangenheime Prune and Myrobalan seedlings.
2. Irrigation of trees grafted on Wangenheim Prune is more effective as compared with those grafted on Myrobalan seedlings.
3. Wangenheim Prune seems to be a suitable rootstock for intensive orchards only when trees are subjected to irrigation.

## REFERENCES

- Bac S. 1980. Celowość nawodnień na tle klimatu. Mat. Konf. NOT "Problemy nawodnień użytków rolnych w Polsce". Bydgoszcz 1980, pp. 65-94.
- Evans R., Proebsting E. 1985. Response of Red Delicious apples to trickle irrigation. 3rd Intern. Drip/Trickle Irrigation Congress, Fresno 1985. Vol. 1, pp. 239-321.
- Rozpara E., Grzyb Z. 1994. Growth and cropping of twelve plum cultivars grafted on two rootstocks. ACTA HORT. 359: 229-236.
- Rozpara E., Grzyb Z. 1997. Growth and yielding of some plum cultivars grafted on Wangenheim prune seedlings. ACTA HORT. 478: 91-94.
- Treder W. 1996. Badania nad efektywnością nawadniania roślin sadowniczych w Polsce. Ogólnopol. Nauk. Konf. Sadow. Skierniewice 1996, pp. 53-70.
- Treder W., Grzyb Z., Rozpara E. 1997. Influence of irrigation on growth, yield and fruit quality of plum trees cv. Valor grafted on two rootstocks. ACTA HORT. 478: 271-275.
- Pacholak, E. 1994. Efektywność produkcyjna nawadniania jabłoni przy zróżnicowanych poziomach nawożenia w latach 1976-1987. Ogólnopol. Nauk. Konf. Sadow. Skierniewice 1994, pp. 242-243.
- Vodyanotskaya, V. I., Yastreb, G. V., Shabanova, D. S. 1994. Effectiveness of stone fruit irrigation in the south of the Ukraine. SADOVODSTVO I VINOGRADSTVO 1: 6-8.