JOURNAL
OF FRUIT
AND
ORNAMENTAL
PLANT
RESEARCH

VOL. IV
No. 3
1996

SKIERNIEWICE, POLAND

Waldemar Treder, Augustyn Mika
Research Institute of Pomology and Floriculture, Skierniewice, POLAND

THE EFFECT OF IRRIGATING APPLE TREES CV. LOBO PLANTED IN TWO SYSTEMS

ABSTRACT. Apple trees cv. Lobo grafted on M 26 were planted 3.5 x 0.3 m apart either on beds covered with polyethylene black foil or using a standard method. Trees were drip irrigated or unwatered. Unirrigated trees planted on beds showed the poorest growth and yield. Effect of irrigation was best on trees planted on beds.

Key words: irrigation, effectiveness, planting on beds

INTRODUCTION. Modern orchards in Western Europe are planted either following standard methods or on beds. In the latter system the roots of the trees are placed on a surface and covered mechanically with a layer of soil (bed). This method allows a high degree of mechanization, which increases work efficiency. According to Sako and Laurinen (1986) planting on beds increases the temperature in the vicinity of the root system, which in turn increases nutrient uptake in the spring. However, the beds elevated above the soil surface have a tendency to dry out, which causes a decrease in nutrient uptake (Blase et al., 1983).

In the climatic conditions of Poland, irrigation significantly increases growth and yield of apple trees (Treder et al., 1992/93). Its effect should be even more pronounced for trees planted on beds. The aim of this work was to compare

the effect of drip irrigation on growth and yield of apple trees planted either using a traditional method or on beds.

MATERIALS AND METHODS. The experiments were conducted in the Experimental Orchard of the Research Institute of Pomology and Floriculture in Skierniewice during 1992-1994. The orchard was planted with Lobo trees grafted on M 26 rootstock. The experiment was set in factorial design 2 x 2, where trees planted using the two methods were drip irrigated, and identically planted unirrigated trees served as a control. Systematic arrangement of the experiment included 14 replications, where one tree consisted a replication.Trees were planted in spring of 1992, spaced 3.5 x 0.3 m. Budded unbranched one year old trees of uniform growth, with trunk diameter about 7.7 mm were chosen for the experiment.

Two methods of planting were tested: standard and on beds. Planting on beds (Fig. 1) consisted of placing trees on an even soil surface and covering them with peat, then with black foil. Drip irrigation was applied to maintain soil humidity at -0.02 MPa. The control trees were unirrigated. Water was delivered through Dripline 2000 hose and emitters were placed every 0.5 m delivering 1.75 l h^{-1}. Time of water application was regulated by tensiometers placed in the soil. Trees in both planting systems received the same amount of water. Total monthly supply of water is presented in Table 1.

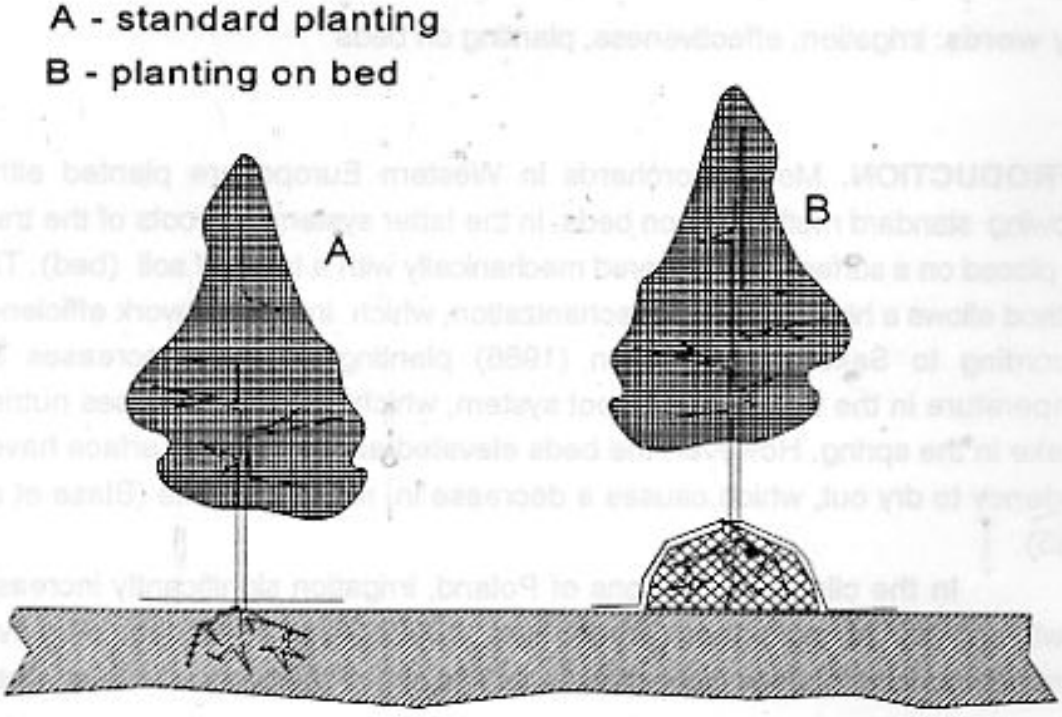

Fig. 1. Planting systems

Table 1. Total supply of water (mm)

Years	Months					
	V	VI	VII	VIII	IX	sum
1992	5.2	8.1	36.3	47.3	11.6	108.5
1993	7.7	14.6	10.0	12.4	5.6	50.3
1994	3.1	43.6	57.2	17.2		121.1

The following measurements were taken: yield, mean fruit weight and trunk thickness at 30 cm above the grafting point. Data concerning yield and trunk diameter increment were subjected to analysis of variance.

Weather conditions in the course of the experiment. Rainfall distribution and monthly temperatures are shown on climatic graph (Fig. 2). It is a graphical presentation of temperature and precipitation allowing determination of drought periods (Pacholak, 1986). During the course of the research there were potential deficiencies of rain.

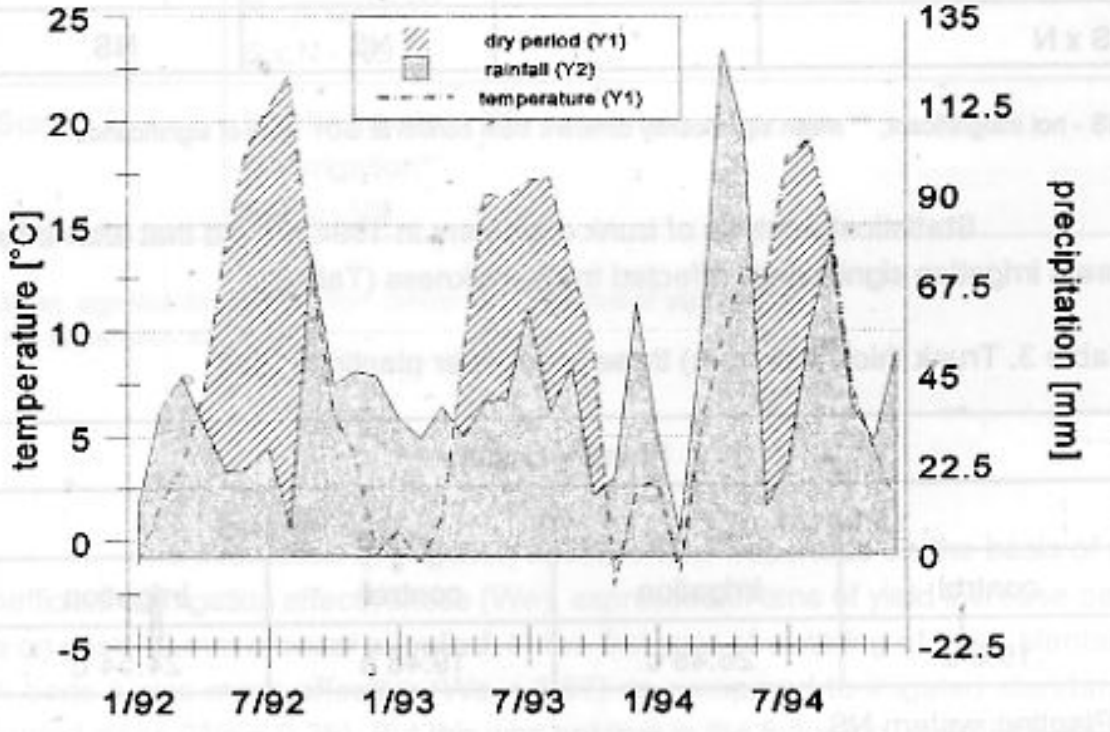

Fig. 2. Climatic graph - Skierniewice 1992-1994

RESULTS. In all three years of the experiment irrigation significantly affected tree growth expressed as the increment of trunk cross-section area (Tab.2). But the planting system itself influenced growth vigor only in the first year after planting (Tab. 2). During the first year the interaction between planting method and irrigation was observed. The greatest increment of trunks (104.24 mm²) was obtained for irrigated trees planted in a traditional fashion.

Table 2. Influence of planting system and irrigation on increment of trunk cross-section area (mm²)

Factor	Years		
	1992	1993	1994
Planting systems(S)			
On bed (S_1)	56.49	76.56	206.32
Standard (S_2)	70.42	88.85	224.75
Significance	**	NS	NS
Irrigation (N)			
Irrigation + (N_1)	89.93	100.32	280.56
Control (N_2)	36.98	65.08	150.51
Significance	**	**	**
S x N	**	NS	NS

NS - not insignificant; ** mean significantly different from control at 0.01 level of significance

Statistical analysis of trunk diameters in 1994 proved that after three years irrigation significantly affected trunk thickness (Tab. 3).

Table 3. Trunk thickness (mm) three years after planting (1994)

Planting system			
standard		on bed	
control	irrigation	control	irrigation
19.6 a	26.48 c	19.48 a	24.54 b
Planting system NS Irrigation**			

Means followed by the same letter do not differ at 5% level of significance: Duncan's multiple range t-test
** mean significantly different from control at 0.01 level of significance

Irrigation was the only factor that influenced the yield (Tab. 4). Total yield (1993-1994) from irrigated trees was significantly higher than that from the nonirrigated control. The fruit mean weight was also affected by irrigation (Tab. 5).

Table 4. Yield (kg tree^{-1})

Years	Planting system			
	standard		on bed	
	control	irrigation	control	irrigation
1993	0.56 a	0.76 ab	0.55 a	1.06 b
1994	1.56 a	2.24 b	1.54 a	2.17 ab
Sum	2.12 a	3.0 b	2.09 a	2.23 b
1993	planting system NS N - irrigation* S x N - NS			
1994	planting system NS N - irrigation** S x N - NS			
Sum	planting system NS N - irrigation** S x N - NS			

* Mean significantly different from control at 0.05 of level of significance

** For explanation see Table 3

The evaluation of irrigation effectiveness was made on the basis of a coefficient of irrigation effectiveness (We), expressed in tons of yield increase per ha on each 10 mm of water supplied. In the first year of watering of trees planted on beds it was more effective (We = 0.97) as compared to irrigated standard planted trees (We = 0.38). But this was not true in the following year. However, the coefficient of effectiveness for total yield (two years) for irrigated trees planted on beds was 0.64 and was higher than for irrigated, standard planted trees (0.49).

Table 5. Mean fruit weight in g

Years	Planting system			
	standard		on bed	
	control	irrigation	control	irrigation
1993	186 a	225 bc	198 ab	237 c
1994	126 a	164 b	126 a	169 b
1993	planting system NS N - irrigation* S x N - NS			
1994	planting system NS N - irrigation** S x N - NS			
Sum	planting system NS N - irrigation* S x N - NS			

*, ** For explanation see Table 4

DISCUSSION. There is a tendency in Holand to extend tree planting on beds. In Dutch orchards with prevailing heavy, wet fen soils, placing root systems on the earth surface could be beneficial. Finnish scientists Sako and Laurinen (1986) are also of the opinion that on the waterlogged and cold soils prevailing in Finland planting on beds can improve tree growth in conditions of short growing seasons. In the Venetto region of Italy good results are obtained with peaches planted on beds covered with foil.

The results presented were obtained on light permeable soils, so the trees planted on beds were subjected to drought, lessened however by foil cover. Thus, there was no yield increase but only a slight growth retardation in first year after planting. The beneficial effect of irrigation on apple tree growth and yield has been proven by several authors (Rzekanowski, 1988; Pacholak and Wiśniewski, 1994 ab; Treder et al., 1992/93). Watering increased the volume and quality of crop. On the other hand, apple quality was lowered after drought (Assaf et al., 1984; Pacholak, 1986; Treder et al., 1992/93). Foil cover did not ensure sufficient protection against long dry periods. Treder (1993) obtained similar results with

raspberries. It appears that foil, though it can limit water evaporation from soil, in our climatic conditions does not ensure sufficient protection against drought. The planting system did not affect growth vigour, with the exception of the first year. Treder and Mika (1996) report that apple trees grafted on M 9 and planted on beds were stunted in growth. It seems that more vigorous M 26 apple root system reached deeper soil layers not subjected to drought.

CONCLUSIONS

1. Lobo apple trees on M 26 planted on beds showed growth limitation only in the first year after planting.
2. Planting method did not affect fruit yield.
3. Drip irrigation increased yield and improved fruit quality.
4. Trees planted on beds are more exposed to drought than these planted traditionally.

REFERENCES

Assaf R., Levin I,, Bravdo B. 1984. Effect of drip irrigation on the yield and quality of Golden Delicious and Jonathan apples. J. HORT.SCI. 59(4): 493-499.

Blase W., Bringze A., Grittner I. 1983. Ergebnise und konsequenzen der Apfel-bewaserung. Gartenbau: 210-213.

Pacholak E. 1986. Wpływ nawożenia i nawadniania na wzrost i plonowanie jabłoni odmiany James Grieve. Rocznik AR w Poznaniu. Zeszyt nr 160.

Pacholak E. , Wiśniewski J. 1994a. Efektywność produkcyjna nawadniania jabłoni przy zróżnicowanych poziomach nawożenia w latach 1976-1987. Materiały XXXIII Ogólnopolskiej Naukowej Konferencji Sadowniczej. Part 2: 242-246.

Pacholak E., Wiśniewski J. 1994b. Efektywność produkcyjna nawadniania jabłoni w latach 1988-1993 po replantacji. Materiały XXXIII Ogolnopolskiej Naukowej Konferencji Sadowniczej. Part 2: 247-249.

Rzekanowski C. 1988. Wpływ nawadniania kroplowego na plonowanie trzech odmian jabłoni. Materiały II Krajowej Konferencji Naukowo-Technicznej, SGGW-AR: 142-149.

Sako J., Laurinen E. 1986. Apple trees in ridge planting. ACTA HORT. 160: 285-292.

Treder W., Mika A., Cegłowski M. 1992/93. Efekty kroplowego i podkroplowego nawadniania jabłoni. PR.INS. SAD. Seria A, 31: 33-40.

Treder W. 1993. Wpływ nawadniania i ściółkowania czarną folią na plonowanie maliny odmiany Canby. ZESZ. NAUK. INST. SADOW. KWIAC. 1: 27-32.

Treder W., Mika A. 1996. Efektywność nawadniania jabłoni odmian Szampion i Gala przy dwu sposobach sadzenia. ZESZ. PROBL. POST. NAUK ROL. 438: 183-192.