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EFFECT OF IRRIGATION AND FERTILIZATION ON THE GROWTH AND YIELDING OF APPLE-TREES CULTIVAR ŠAMPION IN A REPLANTED ORCHARD

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Abstract. Studies were carried out in an experimental orchard established on the area of Agricultural and Pomicultural Experimental Farm in Przybroda belonging to the Agricultural University in Poznań. The establishing of an orchard in the place of a previously existing one exerted an influence on the tree growth impediment and increased the number of tree losses. Poor growth decreased both the individual yield from one tree and the yielding from the area unit. Irrigation as well as fertilization had an effect on the occurrence of soil fatigue phenomenon. Increased irrigation intensity and low fertilization doses increased the results of replantation disease. The least effects of soil fatigue were found in case of no additional irrigation and an increased dose of tree fertilization. Experimental conditions did not exert any effect on fruit quality.

Key words: apple-tree, soil fatigue, tree growth, yield, fruit mass, extract, firmness

INTRODUCTION

Intensification of orchard production as well as technological changes in orchard management shorten in a significant degree the period of tree cultivation in the same place. Establishment of a new orchard in the same place of a previously existing one has become a necessity because of the investments accompanying such procedure. However, it is associated with the danger of soil fatigue being a serious agrotechnical and economical problem [Aldea 1998; Hoestra 1994; Pacholak and Zydlik 2004; Pacholak et al. 2004a, 2004b].

Fatigue of arable soils is a typical example of unfavourable changes in the natural environment evoked by the disturbed functioning of the particular elements of soil biocenosis [Barabasz and Smyk 1997; Barabasz et al. 1998].

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According to Szajdak [2003], in conditions of monoculture continued for many years, there comes to the development of many unfavourable biological, physical, chemical and bioochemical differences in the soil. The changes are observed in the decrease of fertility, biological activity and in a qualitative and quantitative degradation of organic matter in pomicultural soil use continued for many years on the same place. This problem has been named the replantation disease. This disease in fruit-tree plantations occurs most intensely when fruit trees are planted directly in the same locality or soon after the removal of the previous trees of the same or similar species grown there [Pacholak et al. 1994a; Pacholak et al. 1996a].

The objective of this work was the estimation of the effect of a continued for many years differentiated fertilization and irrigation on the growth and yielding of apple-trees Šampion cultivar in conditions of replanted orchard.

MATERIAL AND METHODS

Studies were carried out in the experimental orchard on the area of the Agricultural and Pomicultural Experimental Farm in Przybroda.

Apple-trees of Šampion cv. with pollinator Golden Delicious on rootstock P60 were planted in sprinng 1994 on grey-brown podzolic soil in a 3.5×1.5 m spacing (1900 trees/ha) on a field where in autumn 1993, the previously grown apple-trees were dug up.

Results from the first years of orchard management were presented in other papers [Pacholak et al. 1994a, 1996; Przybyła and Pacholak 2000].

Experiment carried out in the orchard included three irrigation combinations:

W_0 – control without irrigation;

W_1 – irrigation was used to keep soil moisture at the level of –0.03 MPa of water potential;

W_2 – irrigation was used to keep soil moisture at the level of –0.01 MPa of water potential.

Within each irrigation loevel, the following fertilization combinations were applied:

1. 65 kg N/ha;
2. 65 kg N, 95 kg K_2O/ha;
3. 65 kg N, 95 kg K_2O, 2000 kg Ca/ha;
4. 130 kg N, 190 kg K_2O/ha;
5. 130 kg N, 190 kg K_2O, 2000 kg Ca/ha;
6. no fertilization (until 1994: 195 kg N, 285 kg K_2O/ha was applied);
7. no fertilization + 2000 kg Ca/ha.

In the estimation from the years 2003–2006, the following measurements, observations and analyses were carried out:

Growth

Estimation was carried out on the basis of stem circumference measurement at the height of 30 cm above earth, and on this basis, the field of stem cross-section (f.s.c.s.)

was calculated. Furthermore, the percentage of tree losses in relation to the number of planted trees was calculated as well.

Yieldidng

Yield. The term of fruit harvest was determined on the basis of starch decomposition degree and fruit firmness, taking into consideration the individual yield from one tree (kg) converted into the output from 1 ha (in t), while from the field of stem cross-section and the sum of yields – the tree fertility coefficient was computed.

Fruit quality. Quality estimation was carried out directly after fruit harvest considering the following traits:

– *mass:* 20 fruits were taken from each replication and they were weighed exact to 1 g,

– *firmness of fruit*: measurement was done on 10 fruits from each replication on the basic side of fruit with its intensiveness of colour. It was done using firm ness measurement instrument „Fruit Pressure Tester, mod. 327" of Facchini Co. fixed on a stand. This testing equipment is known as Magness-Taylor tester and its mechanism consists in the punching of apple flesh to the depth of 8 mm with the help of a pin with a rounded head of 22 mm diameter. The measurement value is expressed in KG.

– *Extract content* was measured on the same fruits which were used for firmness measurement. Extract content was estimated using Abbe's refractometer. From the fruit, on its two opposite sides, flesh slices were cut and their sap was expressed on the refractometer plate. The measurement value was expressed in Brix degrees.

Results were elaborated by the analysis of variance and the significance of differences between the mean values was estimated by Duncan's test for confidence interval $\alpha = 0.05$.

Course of weather conditions and irrigation needs

Climatic conditions in the years 2002–2004 were characterized by a high variability both in the temperatures and in atmospheric precipitations, as well as in the particular years and vegetation periods. Generally, one can state that the conditions with the application of additional irrigation were very favourable for tree growth and for the development of apple trees.

Mean temperatures in the vegetation period oscillated between 15.7°C and 17.0°C, and in four of five analysed years, they were higher than the mean values for many years (tab. 1). The sum of temperatures in that period exceeded 3350°C.

The sum of atmospheric precipitations in the years 2002–2006 was characterized by a high variability from 330.7 in the year 2003 to 489.7 mm in 2005. Also the precipitation sums in the vegetation periods were differentiated ranging from 183.7 mm (2003) to 324.3 mm (2006). The analysis of the distribution of rain falls in the vegetation period (tab. 1) permits the statement that periods of water deficiency appeared rather irregularly (tab. 2). It must be stressed that in all periods of vegetation, additional irrigation was necessary in order to insure optimal conditions of tree growth and development (tab. 2).

Table 1. Characteristics of climatic conditions in Przybroda in the years 2002–2006 (Meteorological Station on the area of the Agricultural and Pomicultural Experimental Farm in Przybroda)

Tabela 1. Charakterystyka warunków klimatycznych w warunkach Przybrody w latach 2002–2006 (Stacja meteorologiczna na terenie R-SGD w Przybrodzie)

Year Rok	Months – Miesiące												Mean temperature Średnia temperatura IV–IX	Annual mean value Średnia roczna
	January styczeń	February luty	March marzec	April kwiecień	May maj	June czerwiec	July lipiec	August sierpień	Sept. wrzesień	October paźdz.	Nov. listopad	Dec. grudzien		
mean temperature – średnie temperatury, °C														
2002	0.5	3.8	4.6	18.3	17.4	18.6	21.0	22.0	14.3	7.4	3.7	-3.8	17.0	9.8
2003	-2.3	-3.3	3.3	8.9	16.2	20	20.9	20.8	15.2	5.6	5.2	1.6	17.0	9.3
2004	-3.9	1.4	4.6	10.0	13.2	16.7	18.7	21.0	14.9	10.4	3.9	1.3	15.3	9.4
2005	1.5	-2	1.4	9.6	14.3	17.5	20.4	17.6	16.7	10.5	3.1	0.2	16.1	9.2
2006	-6.6	-1.4	0.7	9.2	14.4	19.5	22.9	16.7	16.1	10.5			16.5	
Mean of many years Średnia wieloletnia 1991–2000	0.0	0.8	3.9	9.9	15.2	17.7	20.0	19.6	14.3	11.3	3.2	0.2	16.1	9.7
sum of precipitations – sumy opadów, mm														
2002	32.5	57.1	45.3	33.6	59.9	29.2	25	53.4	28.6	92	49.9	10.6	229.7	516.1
2003	48.8	6.6	11.1	24.5	14.6	24.6	85.7	14.5	19.8	27.9	20.9	31.7	183.7	330.7
2004	46	24.1	12.4	14.9	46.9	63.8	41.7	41.8	33.3	40.6	39.5	33.9	242.4	438.9
2005	22	41.6	24.7	14.2	68	11.5	96.6	52.8	52.7	5.6	12.4	87.6	295.8	489.7
2006	11	12.1	16.6	39.8	33.3	17.4	23.8	162	22.6	25.4			324.3	364
Mean of many years Średnia wieloletnia 1991–2000	24.4	29.4	43.7	29.7	47.9	60.6	82.6	58.4	39.2	29.6	33.2	39.4	318.3	518.0

Table 2. Sprinkling irrigation, water amount necessary for the maintenance of moisture at the level of –0.03 MPa (W_1) and –0.01 MPa (W_2) in the years 2003–2006

Tabela 2. Nawadnianie deszczowniane, ilość wody niezbędnej do utrzymania wilgotności na poziomie –0,03 MPa (W_1) i –0,01 MPa (W_2) w latach 2003–2006

Year Rok	Water use – Zużycie wody, mm										Sum Suma	
	V		VI		VII		VIII		IX			
	W_1	W_2	W_1	W_2	W_1	W_2	W_1	W_2	W_1	W_2	W_1	W_2
2003	-	-	-	48	16	40	32	64	-	-	48 (6)	152 (10)
2004	-	-	8	16	8	16	40	80	-	-	56 (5)	112 (5)
2005	-	-	8	16	16	32	-	-	-	-	24 (2)	48 (2)
2006	-	-	-	-	16	32	16	32	-	-	32 (2)	64 (2)
Sum Suma	0	0	16	80	56	120	88	176	0	0	mean – średnio	
											40 (4)	94 (5)

In the period of 4 years, seasonal water doses providing optimal moisture conditions ranged from 24 mm to 56 mm (W_1) and in W_2 variant, the range was 48–152 mm (tab. 2).

RESULTS

Cultivation of apple-trees for many years with the application of replantation in the first years after tree plantation [Gullino and Mezzalama 1993; Pacholak et al. 1994a; Przybyła and Pacholak 2000] as well as in actual conditions had a significant effect on the yielding of trees. Furthermore, the use of differentiated irrigation and fertilization showed that these treatments can exert an influence on the obtained production results of Šampion cv. The individual yield from one tree, next to the mentioned factors depended also on the weather conditions in the given year (tab. 3)

It must be stressed that weather conditions exerted a lesser effect on the obtained yield (tab. 3). An essential and important influence on the production results was exerted by the moisture conditions of the soil. The sum of yields for the period of 4 years showed that the highest yield was obtained from trees in natural conditions of atmospheric precipitations (tab. 2). Irrigation or rather the maintenance of moisture at the level of –0.03 MPa and –0.01 MPa contributed to a decrease of tree yield (tab. 1). Individual yield from one tree for the irrigation levels was respectively by 37% (W_1) and by 33% (W_2) lower than in case of the absence of additional irrigation (tab. 4).

The effect of fertilization on the yield depended on the conditions of soil moisture maintenance (tab. 4). In conditions of natural precipitations, the yield from one tree, depending on the applied combination, oscillated within the limits from 15.5 to 19.2 kg/tree (tab. 2); with the maintenance of moisture at the level of –0.03 MPa, the range was 4.8–14 kg/tree; while at the moisture of –0.1 MPa, it was from 8.3 to 16.1 kg/tree (tab. 4).

Table 3. Effect of fertilization and irrigation on the yield of Šampion cultivar in a replanted orchard (yield in kg/tree)

Tabela 3. Wpływ nawożenia i nawadniania na plon odmiany Šampion w sadzie replantowanym

Combination – Kombinacje		Years – Lata				Yield sum in kg/tree Suma plonu w kg/drzewo
irrigation nawadniania	fertilization nawożenia	2003	2004	2005	2006	
W_0	65 N	10.4 c*	15.6 e	16.7 g	19.3 e	62.0 e
	65 N + 95 K**	10.7 cd	17.0 f	18.2 h	19.9 e	65.6 ef
	65 N + 95 K + Ca	11.3 d	23.3 h	18.6 h	23.7 f	76.8 g
	130 N + 190 K	12.6 d	19.7 g	17.6 h	21.4 e	71.2 fg
	130 N + 190 K + Ca	12.0 d	17.6 fg	19.3 h	24.2 f	73.2 fg
	0 N + 0 K	10.9 c	22.3 h	18.9 h	23.9 f	76.0 g
	0 N + 0 K + Ca	10.7 c	19.3 f	19.7 h	20.0 e	69.6 fg
Mean – Średnio		11.2 c	19.3 b	18.4 b	21.8 b	70.6 b
W_1	65 N	6.5 ab	11.1 d	16.1 fg	21.6 e	55.2 d
	65 N + 95 K	5.3 a	6.7 b	12.0 de	16.8 cd	40.8 b
	65 N + 95 K + Ca	5.0 a	2.1 a	5.7 a	6.6 a	19.2 a
	130 N + 190 K	8.2 bc	11.0 d	14.4 e	15.3 c	48.8 c
	130 N + 190 K + Ca	7.0 b	7.9 b	13.6 e	15.9 c	44.4 bc
	0 N + 0 K	9.2 c	18.0 f	7.9 ab	20.8 e	56.0 de
	0 N + 0 K + Ca	6.7 ab	9.6 c	11.8 d	17.4 d	45.6 bc
Mean – Średnio		6.8 a	9.3 a	11.6 a	16.3 a	44.3 a
W_2	65 N	4.8 a	5.9 b	8.9 b	16.1 cd	35.6 b
	65 N + 95 K	6.3 ab	8.4 c	10.2 bc	17.5 de	42.4 b
	65 N + 95 K + Ca	7.6 b	7.3 b	7.6 ab	10.7 b	33.2 b
	130 N + 190 K	9.0 c	9.1 c	11.0 cd	23.0 f	52.0 c
	130 N + 190 K + Ca	10.1 c	12.3 de	10.8 cd	16.1 cd	49.2 c
	0 N + 0 K	12.1 d	14.4 e	15.5 fg	22.5 ef	64.4 ef
	0 N + 0 K + Ca	11.6 d	12.0 de	14.4 f	15.1 c	53.2 cd
Mean – Średnio		8.8 b	9.9 a	11.2 a	17.3 a	47.1 a

* Mean values marked with the same letters within years do not differ significantly among each others $\alpha = 0.05$. Średnie oznaczone tymi samymi literami w obrębie lat nie różnią się istotnie między sobą na poziomie prawdopodobieństwa $\alpha = 0{,}05$

** Note – Uwaga K = K_2O; Ca = CaO

The percentage of tree losses was also closely correlated with irrigation and fertilization. It was found that the lowest percentage of tree losses in 2006 was 20.21% with no additional irrigation, and as high as 42% and 50% in case of additional application of irrigation (tab. 5).

Taking into consideration the percentage of tree losses, it was found that there was a very high differentiation in the yield from 1 ha. With the absence of additional irrigation, i.e. in natural precipitation condition. 28 t/ha were obtained, while in case of the use of irrigation to maintain the moisture at the level of –0.03 MPa and –0.01 MPa, the obtained yield amounted to 11.7 and 14 t/ha, respectively.

Table 4. Effect of fertilization and irrigation on the yield of Šampion cultivar in a replanted orchard

Tabela 4. Wpływ nawożenia i nawadniania na plon odmiany Šampion w sadzie replantowanym

Combination Kombinacja		Mean yield in 2003–2006 Średni plon z lat 2003–2006				Number of fruiting trees Liczba drzew owocujących	
		per tree z drzewa		per 1 ha z hektara			
irrigation nawadniania	fertilization nawożenia	kg	%	t/ha	%	pcs szt.	%
W_0	65 N	15.5 e	100.00	23.3	100.00	1504	
	65 N + 95 K	16.4 ef	105.81	28.6	122.75	1741	
	65 N + 95 K + Ca	19.2 g	123.87	30.4	130.47	1583	
	130 N + 190 K	17.8 fg	114.84	29.6	127.04	1662	
	130 N + 190 K + Ca	18.3 fg	118.06	26.1	112.02	1425	
	0 N + 0 K	19.0 g	122.58	31.6	135.62	1662	
	0 N + 0 K + Ca	17.4 fg	112.26	26.2	112.45	1504	
Mean – Średnio		17.66 b	100.00	28.0	100.00	1583	83.81
W_1	65 N	13.8 d	89.03	16.4	70.39	1187	
	65 N + 95 K	10.2 b	65.81	8.1	34.76	792	
	65 N + 95 K + Ca	4.8 a	30.97	1.5	6.44	319	
	30 N + 190 K	12.2 c	78.71	14.5	62.23	1187	
	130 N + 190 K + Ca	11.1 bc	71.61	9.7	41.63	871	
	0 N + 0 K	14.0 de	90.32	21.1	90.55	1504	
	0 N + 0 K + Ca	11.4 bc	73.55	10.3	44.21	900	
Mean – Średnio		11.07 a	62.68	11.7	41.78	965	50.79
W_2	65 N	8.9 b	57.41	8.0	34.33	900	
	65 N + 95 K	10.6 b	68.39	10.9	46.78	1029	
	65 N + 95 K + Ca	8.3 b	53.58	9.1	39.05	1108	
	130 N + 190 K	13.0 c	83.87	13.4	57.51	1029	
	130 N + 190 K + Ca	12.3 c	79.35	11.1	47.64	900	
	0 N + 0 K	16.1 ef	103.87	24.2	103.86	1504	
	0 N + 0 K + Ca	13.3 cd	85.81	21.1	90.56	1583	
Mean – Średnio		11.78 a	66.70	14.0	50.00	1150	60.53

* Mean values marked with the same letters within years do not differ significantly among each others. Średnie oznaczone tymi samymi literami w obrębie lat nie różnią się istotnie między sobą na poziomie prawdopodobieństwa $\alpha = 0{,}05$

* See note Tab. 1. Patrz uwaga tab. 1.

The cross-section field of tree stem also depended on the applied irrigation and fertilization. Trees which in a replanted orchard grew in natural conditions of atmospheric precipitations were characterized by a more intensive growth than in case of additionally applied irrigation (tab. 5).

Calculated fertility coefficient (tab. 5) confirmed a close interdependence between the growth and yielding of trees which oscillated between 1.54 and 3.67 kg/cm^2.

Estimation of fruit quality measured by the mass, firmness and extract showed that irrigation and fertilization in a replanted orchard did not exert any significant effect on

these features (tab. 4). The mass of apples Šampion cv. ranged between 123.9 and 179.9; fruit firmness oscillated from 5.6 to 6.4 KG; while the extract obtained was within 14.3–15,3% (tab. 6).

Table 5. Effect of fertilization and irrigation on the growth, tree losses and fertility coefficient of Šampion cv, in a replanted orchard

Tabela 5. Wpływ nawożenia I nawadniania na wzrost i% wypadów odmiany Šampion w sadzie replantowanym.

Combination Kombinacja		Field of stem cross-section (f.s.c.s.) p.p.p.p.		Increase of f.s.c.s. Przyrost p.p.p.p. 2006–2003	% of tree losses % wypadów		Fertility coefficient Sum of yield / f.s.c.s. Współczynnik plenności Suma plonu/p.p.p.p. kg/cm^2
irrigation nawożenia	fertilization nawożenia	2003	2006		2003	2006	
	65 N	15.2 ab *	21.9 b	6.7 de	16.95	24.96	2.82 f
	65 N + 95 K	20.1 bc	26.4 d	6.3 de	8.33	8.33	2.48 d
	65 N + 95 K + Ca	23.7 c	33.1 f	9.4 fg	12.79	24.96	2.32 c
W_0	130 N + 190 K	21.4 bc	30.6 ef	9.2 fg	16.95	16.95	2.33 cd
	130 N + 190 K + Ca	20.6 bc	29.4 ef	8.8 f	16.95	29.12	2.49 d
	0 N + 0 K	19.9 bc	27.1 d	7.2 e	4.16	16.95	2.80 f
	0 N + 0 K + Ca	18.7 bc	24.8 c	6.1 d	12.79	20.80	2.81 f
Mean – Średnio		19.9 b	27.6 c	7.7 c	12.79	20.21	2.56 b
	65 N	15.4 ab	21.8 bc	6.4 d	12.79	41.60	2.53 d
	65 N + 95 K	8.9 a	11.1 a	2.2 a	45.76	79.04	3.67 g
	65 N + 95 K + Ca	8.3 a	9.8 a	1.5 a	83.20	83.20	1.96 b
W_1	130 N + 190 K	16.9 bc	24.1 cd	7.2 d	24.96	37.44	2.02 b
	130 N + 190 K + Ca	15.2 ab	21.6 b	6.4 d	41.60	41.60	2.05 b
	0 N + 0 K	21.5 bc	26.1 d	4.6 bc	8.33	37.44	2.14 bc
	0 N + 0 K + Ca	14.9 ab	19.8 b	4.9 bc	24.96	41.60	2.30 c
Mean – Średnio		14.4 a	19.2 a	4.8 a	33.28	50.00	2.31 ab
	65 N	9.4 a	13.3 a	3.9 b	29.12	49.92	2.68 e
	65 N + 95 K	17.1 bc	27.6 de	10.5 g	33.28	45.76	1.54 a
	65 N + 95 K + Ca	8.7 a	13.3 a	4.6 bc	37.44	45.76	2.50 d
W_2	130 N + 190 K	19.1 bc	23.0 c	3.9 b	29.12	49.92	2.26 c
	130 N + 190 K + Ca	17.6 bc	23.2 c	5.6 cd	29.12	49.92	2.12 b
	0 N + 0 K	18.2 bc	29.4 e	10.2 g	16.95	20.80	2.19 bc
	0 N + 0 K + Ca	21.4 bc	27.7 de	6.3 cd	16.95	24.96	1.92 b
Mean – Średnio		15.9 a	22.5 b	6.6 b	29.12	41.60	2.09 a

* Mean values marked with the same letters within years do not differ significantly among each others. Średnie oznaczone tymi samymi literami w obrębie lat nie różnią się istotnie między sobą na poziomie prawdopodobieństwa $\alpha = 0{,}05$

* See note Tab. 1. Patrz uwaga tab. 1.

Table 6. Effect of irrigation and fertilization on the quality of apples Šampion cultivar from a replanted orchard (means 2003–2006)

Tabela 6. Wpływ nawadniania I nawożenia na jakość jabłek odmiany Šampion z sadu replantowanego (średnie z lat 2003–2006)

Combination Kombinacja		Mass in g Masa w g	Firmness in KG Jędrność w Kg	Extrakt in % Ekstrakt w %
irrigation nawadniania	fertilization nawożenia			
W_0	65 N	158.5 c	6.5 d	14.3 a
	65 N + 95 K	139.6 ab	6.4 cd	14.9 c
	65 N + 95 K + Ca	154.2 c	6.1 b	15.0 a
	130 N + 190 K	164.7 cd	6.0 b	15.0 a
	130 N + 190 K + Ca	160.2 c	5.8 ab	14.9 c
	0 N + 0 K	155.4 c	6.3 cd	14.4 a
	0 N + 0 K + Ca	149.7 b	6.1 b	15.3 c
W_1	65 N	153.3 bc	6.0 b	14.6 b
	65 N + 95 K	159.9 c	5.7 a	15.0 c
	65 N + 95 K + Ca	163.1 cd	6.1 b	14.9 c
	130 N + 190 K	151.4 b	5.8 ab	14.2 a
	130 N + 190 K + Ca	149.5 b	6.2 bc	14.9 c
	0 N + 0 K	149.3 b	6.0 b	14.6 bc
	0 N + 0 K + Ca	155.3 c	5.8 ab	14.5 ab
W_2	65 N	123.9 a	6.3 c	14.4 a
	65 N + 95 K	168.7 d	5.6 a	14.3 a
	65 N + 95 K + Ca	139.2 ab	5.9 ab	14.5 ab
	130 N + 190 K	179.9 d	5.6 a	14.6 b
	130 N + 190 K + Ca	153.4 c	5.9 ab	14.5 ab
	0 N + 0 K	146.4 b	6.3 c	14.7 b
	0 N + 0 K + Ca	134.1 a	5.8 ab	14.5 ab

* Mean values marked with the same letters do not differ significantly between each others at probability level of $\alpha = 0.05$. Średnie oznaczone tymi samymi literami w obrębie lat nie różnią się istotnie między sobą na poziomie prawdopodobieństwa $\alpha = 0{,}05$

DISCUSSION

Replantation of apple-trees was carried out after 18 years of the same species cultivation. The newly planted trees of Šampion cultivar showed a distinctly poor growth and a high percentage of lost trees. Similar phenomena after replantation were observed also by other researchers, like Hoestra [1994], Utkhede and Smith [1994]. Szczygieł [1997], Pacholak et al. [1996a, 1996b]. It is a common opinion that soil fatigue is the reason of poor growth and fruiting. Many years of studies have revealed that the causative factors contributing to soil fatigue include such biotic factors as bacteria, fungi, actinomycetes and nematodes [Pacholak and Zydlik 2004; Pacholak et al. 2004b; Pacholak et al. 2006b; Politycka et al. 2001; Rutkowski et al. 2006; Zydlik and Pacholak 2003; Zydlik et al. 2006], as well as abiotic factors such as: phytotoxic substances, mineral components and enzymes [Pacholak and Zydlik 2003; Politycka et al. 2001; Styła 2006].

In our experiment with differentiated conditions of fertilization and soil moisture maintenance, it was found that these factors also contributed to soil fatigue. Our studies have shown an interesting observation that with increased intensity of irrigation, i.e. with increased soil moisture and decreased fertilization dose, the soil fatigue phenomena on trees were intensified. On the other hand, in conditions of natural atmospheric precipitations, soil fatigue phenomena on trees were significantly less frequent and the differences in fertilization doses were significantly lower. Similar observations were found in the studies by Gullino and Mezzalama [1993] and by Pacholak et al. [1996b]. On the other hand, Szczygieł [1997] argued that intensive irrigation helps in the prevention of replantation disease.

CONCLUSIONS

1. Establishment of a new orchard after the liquidation of a previous one existing in the same place (replantation) has a significant effect on growth impediment and loss of trees.

2. Poor growth and numerous tree losses decreased both the individual yield from one tree and the total yield from the area unit.

3. Increased intensity of irrigation and the application of low fertilization doses increased the effects of soil fatigue.

4. In natural conditions of atmospheric precipitations, the phenomena of soil fatigue appeared in the lowest degree.

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WPŁYW NAWADNIANIA I NAWOŻENIA NA WZROST I PLONOWANIE JABŁONI ODMIANY ŠAMPION W SADZIE REPLANTOWANYM

Streszczenie. Badania przeprowadzono w latach 2003–2006 w sadzie doświadczalnym założonym na terenie Rolniczo-Sadowniczego Gospodarstwa Doświadczalnego w Przybrodzie należącego do Akademii Rolniczej w Poznaniu. Zakładanie sadu po sadzie miało istotny wpływ na zahamowanie wzrostu i zwiększało ilość wypadów. Osłabienie wzrostu obniżało plon zarówno jednostkowy z drzewa jak i wydajność z jednostki powierzchni. Zarówno nawadnianie, jak i nawożenie miało wpływ na występowanie zjawiska zmęczenia gleby. Wzrost intensywności nawadniania i niskie dawki nawożenia zwiększały skutki choroby replantacyjnej. Najmniejsze skutki zmęczenia gleby stwierdzono przy braku nawadniani, a zwiększonym nawożeniu drzew. Warunki prowadzenia doświadczenia nie wpływały na jakość owoców.

Słowa kluczowe: jabłoń, zmęczenie gleby, wzrost drzew, plon, masa, ekstrakt, jędrność

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