

## EFFECT OF ROOTSTOCKS ON THE GROWTH AND YIELDING OF SHARKA-RESISTANT 'JOJO' PLUM TREES UNDER ORGANIC ORCHARD CONDITIONS

### Summary

The experiment was established in the spring of 2005 at the Experimental Ecological Orchard in Nowy Dwór-Parcela (central Poland). The aim was to assess tree growth vigour and yielding as well as fruit quality of the cultivar 'Jojo' grafted onto Myrobalan and 'Wangenheim Prune' seedlings. The trees were maintained in accordance with the principles of organic fruit-growing. The trees grafted onto Myrobalan seedlings grew much more vigorously than those on 'Wangenheim Prune' seedlings. On both rootstocks, the trees of the cultivar 'Jojo' came into fruiting in the second year after planting. In the first years of fruiting, the fruit yields produced by the trees grafted on Myrobalan and 'Wangenheim Prune' seedlings did not differ significantly. A significant effect of the rootstock on the yielding of trees was found in the years 2013-2016, i.e. from the ninth year after planting. Higher yields were obtained from the 'Jojo' trees grafted onto Myrobalan seedlings. There was no significant effect of the rootstock on fruit weight in any year of the study. Under the organic orchard conditions, some of the fruits were affected by the plum fruit moth (*Laspeyresia funebrana*) and by the brown rot of stone fruits (*Monilinia laxa*, *Monilinia fructigena*). The type of rootstock was not found to have an effect on the degree of fruit infestation by pests or infection with diseases.

**Key words:** plum, rootstock, plum pox virus, organic fruit production, fruit quality

## WPŁYW PODKŁADEK NA WZROST I PLONOWANIE ODPORNEJ NA SZARKE ŚLIWY 'JOJO', W WARUNKACH SADU EKOLOGICZNEGO

### Streszczenie

Doświadczenie założono wiosną 2005 roku w Ekologicznym Sadzie Doświadczalnym w Nowym Dworze – Parceli (centralna Polska). Oceniano siłę wzrostu i plonowanie drzew oraz jakość owoców odmiany 'Jojo' szczepionych na siewkach ałyczy i 'Węgierki Wangenheima'. Drzewa prowadzono zgodnie z zasadami sadownictwa ekologicznego. Drzewa szczepione na siewkach ałyczy rosły wyraźnie silniej niż na siewkach 'Węgierki Wangenheima'. Na obydwu podkładkach, drzewa odmiany 'Jojo' weszły w okres owocowania w drugim roku po posadzeniu. W pierwszych latach owocowania plony zbierane z drzew szczepionych na siewkach ałyczy i 'Węgierki Wangenheima' nie różniły się istotnie. Istotny wpływ podkładki na plonowanie drzew stwierdzono w latach 2013-2016, a więc od dziewiątego roku po posadzeniu. Lepiej plonowały drzewa odmiany 'Jojo' szczepione na siewkach ałyczy. Nie stwierdzono istotnego wpływu podkładki na masę owocu w żadnym roku badań. W warunkach sadu ekologicznego część owoców była porażona przez owocówkę śliwkóweczkę (*Laspeyresia funebrana*) i przez brunatną zgniliznę drzew pestkowych (*Monilinia laxa*, *Monilinia fructigena*). Nie stwierdzono wpływu podkładki na stopień porażenia owoców przez szkodniki i choroby.

**Słowa kluczowe:** śliwa, podkładka, szarka, ekologiczna produkcja owoców, jakość owoców

### 1. Introduction

Plum trees are successfully grown in commercial orchards managed by the integrated method. Growing them in organic orchards, however, causes many difficulties [1, 2, 4, 8, 9, 11, 14]. A serious problem is connected with diseases and pests that damage the fruit, reducing its quality. A special threat to plum trees is posed by Sharka – a viral disease spread from diseased trees onto healthy ones by aphids. In some years, they colonize plum trees in very large numbers, and to control them under organic orchard conditions is difficult. The preparations used, such as Biocozos, are not fully effective. The problem with Sharka can be avoided by choosing resistant cultivars for cultivation. Such a cultivar, known in Poland for many years, is the cultivar 'Jojo' [5, 6, 7, 10].

In fruit-growing practice, two rootstocks are commonly used for plum trees – the Myrobalan seedling and the 'Wangenheim Prune' seedling [3, 13, 14, 15, 16]. As shown by re-

search to date, the 'Wangenheim Prune' is more useful for integrated commercial orchards. The trees grafted onto it grow less vigorously and begin to bear fruit earlier in comparison with trees grafted onto Myrobalan seedlings. The literature on the usefulness of rootstocks for plum trees grown in organic orchards is markedly less abundant. Based on the preliminary results, Grzyb and Rozpara [4] found that the rootstock did not significantly affect the yield of fruit, but the fruits harvested from trees on low-vigour rootstocks had a smaller mass than those from trees on Myrobalan seedlings.

The work presented here is an assessment of the frost resistance, susceptibility to disease, growth vigour and yielding of trees, and the quality of fruit of the Sharka-resistant plum cultivar 'Jojo' grafted onto two rootstocks, under organic orchard conditions.

### 2. Materials and methods

The experiment was established in the spring of 2005 at the Experimental Ecological Orchard in Nowy Dwór-Parcela near

Skierniewice, on a sandy-loam podzolic soil, underlaid by a clay subsoil, of quality class IVb of rye-potato complex. The average organic matter content was 1.3-1.4%. One-year-old trees of the cultivar 'Jojo' grafted onto Myrobalan (*Prunus cerasifera* var. *divaricata*) and 'Wangenheim Prune' seedlings were planted in a random block design, at a spacing of 4.5×3.5 m, in four replications, with five trees per plot.

Myrobalan seedling – quite resistant to diseases and pests. Trees grafted onto it grow vigorously, come later into fruiting, and in the first years after planting yield less than those on low-vigour rootstocks.

'Wangenheim Prune' seedling – quite resistant to diseases. Trees grafted onto it come early into fruiting and are productive. The fruits are of good quality and usually ripen a few days earlier than those on Myrobalan seedlings.

For the first two years, the soil in the orchard was kept in mechanical fallow. From the third year, mechanical fallow was kept in the rows of trees, and self-seeded grass was allowed to grow in the inter-rows. The tree crowns were trained in a spindle form. Every year, light sanitary and rejuvenation pruning was carried out. From 2007, the trees were irrigated with a drip system. The programme of protection of plum trees against diseases included 2-3 treatments each year with a copper preparation (Miedzian 50 WG in a dose of 3 kg/ha (the first treatment in the stage of leaf bud swelling) and in a dose 1,5 kg/ha (in the stage of flowering or fruit development). The programme of protection against pests included one treatment with Treol 770 EC or Promanal 60 EC against the red spider mite (*Panonychus ulmi*) and the brown scale (*Parthenolecanium corni*). Aphids were controlled using from one to several treatments, depending on the severity of the pest, with a mixture of Bioczoz and horticultural soap. In the years 2009-2012, treatments with SpinTor 240 SC bacterial preparation were performed 2-3 times against the plum fruit moth (*Laspeyresia funebrana*).

The experiment assessed tree growth vigour and yielding, and fruit quality. The thickness of the trunk was measured every year in autumn, in a permanently marked place, at a height of 30 cm above the soil surface. In the first two years after planting, the diameter of the trunk was measured, and from the third year – its circumference. On this basis, the cross-sectional area of the trunk was calculated. After the 'Jojo' plum trees had come into fruiting, fruit yields were measured annually, separately for each tree. The date of fruit ripening was recorded. Mean fruit weight was determined on the basis of a sample of 400 fruits taken at random from each replication (4 × 100 fruits). Similar samples (4 × 100 fruits) were taken to assess fruit infestation by the plum fruit moth (*Laspeyresia funebrana*) and infection with the brown rot of stone fruits.

The obtained results were statistically analyzed using analysis of variance in Statistica 13. To assess the differences between means, the Duncan test was used at a significance level of 0.05.

### 3. Results

#### 3.1. Health condition of trees

During the twelve years of observations (2005-2016) conducted at the Experimental Ecological Orchard, no frost damage to the root system of 'Jojo' plum trees or their aboveground parts was found. Symptoms of the shot-hole disease of stone-fruit trees were observed on the trees every

year. The disease developed most intensely during warm and rainy summers. There was no effect of the rootstock on the degree of tree infection. Despite the presence of trees of other cultivars infected with Sharka and numerous areas with high concentrations of aphids in the orchard, the 'Jojo' trees and fruits remained healthy throughout the entire period of the study.

#### 3.2. Growth and yielding of trees

The trunk cross-sectional area (TCSA) and yielding of the 'Jojo' plum trees grafted onto two rootstocks are presented in Table 1. The rootstock was found to have a significant effect on the growth of trees of the cultivar 'Jojo'. The trees grafted on 'Wangenheim Prune' seedlings grew by 30% less vigorously than the trees grafted on Myrobalan seedlings. Regardless of the rootstock, the first, very few, fruits from the 'Jojo' plum trees were harvested in the second year after planting. Late spring frosts contributed to the lack of a fruit crop in 2007. Higher yields were obtained in the fourth year after planting. In the first years of fruiting (2008-2012), the yields from the trees grafted onto Myrobalan and 'Wangenheim Prune' seedlings did not differ significantly. A significant effect of the rootstock on the yielding of trees was found in the years 2013-2016, i.e. from the ninth year after planting. The 'Jojo' trees grafted onto Myrobalan seedlings yielded better, as they produced 30-45% more fruit than the trees on 'Wangenheim Prune' seedlings.

The productivity index expressed as yield (kg) per 1 cm<sup>2</sup> of trunk cross-sectional area did not differ significantly for the two rootstocks used.

#### 3.3. Fruit ripening time and quality

Fruits from the trees grafted onto 'Wangenheim Prune' seedlings were harvested 2-5 days earlier than those from the trees on Myrobalan seedlings. The fruits gained more weight in the years 2008-2011, when fruit setting was poorer and yields were lower. There was no significant effect of the rootstock on mean fruit weight in any year of the study (Table 2).

During harvesting, it was found that some fruits showed evidence of damage caused by the plum fruit moth. The degree of the damage depended on the year of the study. In the years 2009-2012, fruit infection by the plum fruit moth was low, which could be attributed to the use of the preparation SpinTor 240 SC. The percentage of damaged fruit increased significantly in the years 2013-2016, when the preparation was not used. Since 2013, SpinTor 240 SC has not been authorized for use on fruit crops. The highest percentage of fruit damaged by the plum fruit moth was recorded in 2016. There was no significant effect of the rootstock on the degree of fruit infestation (Table 3).

Weather conditions have an effect on the extent of infection with the brown rot of stone fruits. The most extensive rotting of fruit due to infection with the brown rot of stone fruits was observed in 2016 (Table 4). The development of infection was promoted by relatively low temperatures and abundant rainfall during fruit ripening. Attempts were made to control the disease by spraying with copper preparations registered for use in organic farming, but they proved to be insufficiently effective.

Table 1. Effect of rootstock on the growth and yielding of 'Jojo' plum trees in an ecological orchard

Tab. 1. Wpływ podkładki na wzrost i owocowanie drzew odmiany 'Jojo' w warunkach sadu ekologicznego

Rootstock	TCSA [cm <sup>2</sup> ]	Yield [kg/tree]						Total fruit yield [kg/tree]	Productivity index [kg/cm <sup>2</sup> ]
		2008-11	2012	2013	2014	2015	2016		
Myrobalan plum	183,8 a	32,1 a	37,9 a	23,5 a	37,6 a	34,5 a	23,6 a	189,2 a	1,039 a
Wangenheim Prune	128,7 b	30 a	33,8 a	12,6 b	21,5 b	24,3 b	12,7 b	134,9 b	1,063 a

\* TCSA – trunk cross-sectional area

Source: own study / Źródło: opracowanie własne

Table 2. Effect of rootstock on the fruit weight of 'Jojo' cultivar in an ecological orchard

Tab. 2. Wpływ podkładki na masę owoców odmiany 'Jojo' w warunkach sadu ekologicznego

Rootstock	Mean fruit weight [g]						
	2008-11	2012	2013	2014	2015	2016	Average
Myrobalan plum	55,1 a	38,1 a	26,9 a	39,3 a	38,4 a	32,9 a	42,6 a
Wangenheim Prune	54,7 a	36,7 a	28,1 a	45,5 a	37,4 a	36,6 a	43,5 a

Source: own study / Źródło: opracowanie własne

Table 3. Effect of rootstock on the degree of infestation of 'Jojo' cultivar by larvae of the plum moth in an ecological orchard

Tab. 3. Wpływ podkładki na stopień porażenia owoców odmiany 'Jojo' przez owocówkę śliwkoweczkę w warunkach sadu ekologicznego

Rootstock	Number of fruits with plum moth larvae [%]						
	2008	Average 2009-12*	2013	2014	2015	2016	Average 2013-2016
Myrobalan plum	4,5 a	1,3 a	14,8 a	20,3 a	13,0 a	26,0 a	18,5 a
Wangenheim prune	6,5 a	0,8 a	18,0 a	18,8 a	12,8 a	26,3 a	18,9 a

\* after treatments with SpinTor 240 SC against the plum moth

Source: own study / Źródło: opracowanie własne

Table 4. Effect of rootstock on the degree of infestation of 'Jojo' cultivar by brown rot disease in an ecological orchard

Tab. 4. Wpływ podkładki na stopień porażenia owoców odmiany 'Jojo' przez brunatną zgniliznę drzew pestkowych w warunkach sadu ekologicznego

Rootstock	Number of fruits infected by brown rot disease [%]									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
Myrobalan plum	14,8 a	9,3 a	18,0 a	4,5 a	22,5 a	8,5 a	21,5 a	3,3 a	29,5 a	14,6 a
Wangenheim Prune	12,5 a	7,0 a	15,5 a	2,0 a	21,3 a	8,0 a	23,8 a	2,0 a	32,3 a	13,8 a

Source: own study / Źródło: opracowanie własne

#### 4. Discussion

Sharka is the most serious disease that makes the cultivation of plum trees difficult. It causes high economic losses [7, 17]. Many problems can be avoided by choosing a resistant cultivar. This is important for all types of orchards, and in particular for organic orchards because of the limited possibilities of protecting trees against aphids, which are vectors of the virus. The first cultivar resistant to Sharka called 'Jojo' showed great suitability for organic fruit-growing. Despite the presence of trees affected by Sharka and numerous aphid-infested areas in the orchard, the 'Jojo' plum trees and fruits remained healthy over the entire duration of the experiment. This confirms the information [5, 6, 7, 10] about the resistance of this cultivar to Sharka.

Apart from the cultivar, the rootstock is an important factor determining the economic profitability of plum cultivation. There are many publications on the usefulness of rootstocks for plum trees grown in traditional commercial orchards [12, 13, 14, 16]. However, there are no similar publications reporting on research conducted in organic orchards. In Poland, plum trees are grown mainly on Myrobalan and 'Wangenheim Prune' seedlings, and these root-

stocks were chosen for research under organic orchard conditions. Greater usefulness for organic fruit-growing was shown by the Myrobalan seedling because of the better yielding of trees. This was due to the limited possibilities of protection and fertilization of trees in the organic orchard, which had been reported by Grzyb and Rozpara [4]. Trees grafted onto Myrobalan seedlings grow more vigorously and have lower requirements than trees on 'Wangenheim Prune' seedlings [18]. In traditional commercial orchards, however, the 'Wangenheim Prune' works better because it increases the trees productivity in comparison to Myrobalan seedling and allows to intensify plum production [3, 12, 13, 15, 16].

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