

# THE INFLUENCE OF TWO TRAINING SYSTEMS ON GROWTH AND CROPPING OF THREE PEAR CULTIVARS

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## A B S T R A C T

The influence of two training systems on growth, cropping and fruit quality of three pear cultivars was estimated in the experiment conducted during 2001-2005 at the Fruit Experimental Station near Wrocław, South-Western Poland. The experiment was carried out on 'Dicolor' 'Erika' and 'Radana' trees on Quince S<sub>1</sub> rootstock planted in a randomized split-plot design in 4 replications with 7-8 trees per a plot. The trees were trained in two systems: Drilling form and V-Güttingen and were spaced in rows at 1.7 m and 1.2 m, respectively, whereas a distance between the rows was 3.5 m. Results showed that pear trees trained as a V-Güttingen gave higher yield per hectare. Tree form had no influence on fruit quality. Trees in V-Güttingen system had thinner trunks than in Drilling. Significantly higher cumulative yield was obtained for 'Erika'. The smallest fruits had 'Dicolor'.

**Key words:** pear, Quince S<sub>1</sub>, Drilling, V-Güttingen, yield, growth, quality

## INTRODUCTION

Pear production in Poland reaches 5% of apple production and consumption per capita is only 1.5 kg yearly (Błaszczuk, 2005). However, increasing consumer's interest in this fruit is the motivation to enhance the production and use new cultivars by

orchardists (Kruczyńska, 2006), especially for fruits with attractive taste or interesting look, e.g. with red blush like 'Dicolor' (Kurlus and Łysiak, 1999).

Planting and training systems were examined in economic and ecological terms for high quality production. Many such experiments were carried out with apple trees.

Drilling (triplet) trees have three main branches; therefore vegetative growth is partitioned into three elements of equal strength (Widmer and Krebs, 1997), whereas V-system trees have one branch. Drilling is a new training system and was developed in Güttingen experimental farm belonging to the Swiss Federal Research Station (FAW). There are three branch elements instead of four as with the Mikado system and therefore it is suitable for cultivars with less vigorous growth (Widmer and Krebs, 1997). The pattern of light intensity in open canopies, such as V- Güttingen, Mikado and Solen, promotes high fruit quality (Buler and Mika, 2004). According to Widmer and Krebs (1997), an important advantage of these novel systems is lower investment cost of establishing orchards compared with the currently used spindle single-row system, but Meland and Hovland (1997) and Vercammen (2002) claim that planting and cultivating practice during the first three years of growth in V-system are associated with higher cost, as compared with traditional training system.

The open-tree form like Drilling allows optimal light interception and generates good fruit quality (Widmer and Krebs, 2001). Mikado and triple systems develop the light interception advantages of the V-systems further, while reducing planting costs (Widmer, 2005).

The aim of our experiment was to compare cropping, fruit quality and vegetative growth of three pear cultivars trained as a V-Güttingen

and Drilling during first five years after planting.

## MATERIAL AND METHODS

The experiment was conducted at the Fruit Experimental Station in Samotwór near Wrocław during 2001-2005. The research was carried out on 'Dicolor' 'Erika' and 'Radana' trees on Quince S<sub>1</sub> rootstock planted in a randomized split-plot design in 4 replications with 7 trees per a plot. The trees were trained in two systems and were spaced in rows at 1.7 m (Drilling form – 3 leaders, 1681 trees·ha<sup>-1</sup>) and 1.2 m (V-Güttingen – 1 leader, 2381 trees·ha<sup>-1</sup>), whereas a distance between the rows was 3.5 m. In this way, the number of leaders per hectare in Drilling form (5043) was more than twice higher in comparison with V-Güttingen (2381). Two-year-old trees were planted as non-feathered (laterals had to be removed because they grew too low) and therefore they were cut down at a height of 60 cm above the budding place. For that reason their yielding was delayed by one growing season. Trees were not irrigated and fruitlets were not thinned. Trees were pruned only during summer period. Plant protection was carried out according to the current recommendations of the Orchard Protection Programme.

In 2002-2005, records of yield and fruit quality were taken. The results were statistically elaborated by an analysis of variance. The significance of differences between means was evaluated by Duncan's multiple range t-test at  $p = 0.05$ .

## RESULTS AND DISCUSSION

Trees in the experiment had the same growth vigour. There were no significant differences between training systems in number and total length of annual shoots (Tab. 1). Sosna (2004) observed more intensive vegetative growth of 'Elstar' and 'Jonagold' apple trees training in V-Güttingen than in Drilling on apples. However, similar influence of Mikado and spindle system on growth in first years was obtained in experiments performed by Buler and Mika (2004) on apple trees.

Cultivar had no influence on total length of annual shoots per a tree. Number of shoots was significantly higher in 'Erika' (77) than in 'Carola' and 'Dicolor' (52 and 41, respectively). Interaction of these factors (cultivar and training system) shows important differences in number of shoots. 'Dicolor' with both training systems and 'Carola' in drilling system were assigned to the group with low number of shoots. Interaction had important influence of total length of shoots, too. The highest total length of shoots had 'Erika' in both systems and 'Dicolor' in Drilling. 'Carola' and 'Dicolor' in V-system had significantly shorter total length of shoots.

There were no differences between trees in double-factors combination for TCSA and crop efficiency index (Tab. 2). Similar results were obtained by Sosna (2006) on 'Conference' and 'Komisówka'. In this trial there was no influence of canopy training system on vegetative growth of pear

trees. There was also no significant difference in CEC index between cultivars.

Important differences were observed in TCSA, where 'Carola' had the smallest one (18.8 cm<sup>2</sup>) as compared with 'Dicolor' (23.8 cm<sup>2</sup>) and 'Erika' (24.8 cm<sup>2</sup>). TCSA values are substantially higher than these obtained by Błaszczuk (2005) in experiment on trees in the same age bracket. Influence of training system was distinct on TCSA – trees trained in V-Güttingen system had thinner trunks (21.0 cm<sup>2</sup>) than these trained in Drilling system (23.9 cm<sup>2</sup>). Differences in TCSA and cumulative yield are reflected in various CEC index. For trees trained in V-system it averaged 0.98 whereas for these trained in Drilling system it was only 0.76.

Cumulative yield for first five years averaged 18 kg per tree in Drilling system and 20.5 kg in V-system (Tab. 3) and this difference is not significant. Opposite results observed Widmer et al. (2005) on apple 'Golden Delicious', where yields per tree were highest in the triple system. There are no significant differences in yield per a tree, but per hectare trees in V-Güttingen system produced 48.8 tons while these trained in Drilling only 30.4 tons. Level of yielding of V-system was lower also in experiment conducted by Iglesias et al. (2004) with 'Conference' pear trees. Similar effect obtained Mass and Steeg (2001) in Netherlands, where V-system with single branched trees was characterised by the highest production in the first three years after planting.

Table 1. Annual shoot's number and length of 'Carola', 'Dicolor' and 'Erika' pear depending on tree form

Treatment		Total number of shoots per tree 2001-2003	Total length of shoots per tree [cm] 2001-2003
Carola	Drilling	42.8 a*	1042 a
	V-Güttingen	61.0 b	1368 ab
Dicolor	Drilling	43.6 a	1740 c
	V-Güttingen	37.4 a	1307 ab
Erika	Drilling	76.6 c	1757 c
	V-Güttingen	77.4 c	1610 bc
Means for cultivar			
Carola		51.9 a	1205 a
Dicolor		40.5 a	1524 a
Erika		77.0 b	1684 a
Means for training system			
Drilling		54.3 a	1513 a
V-Güttingen		58.6 a	1428 a

\*Means followed by the same letter do not differ at  $p = 0.05$  according to Duncan's multiple range t-test

Table 2. Trunk cross-sectional area (TCSA) and crop efficiency index (CEC) of 'Carola', 'Erika' and 'Dicolor' pear depending on tree form

Treatment		TCSA [cm <sup>2</sup> ] autumn 2005	CEC [kg cm <sup>-2</sup> ] 2001-2005
Carola	Drilling	19.4 a*	0.64 a
	V-Güttingen	18.2 a	1.01 a
Dicolor	Drilling	24.8 a	0.81 a
	V-Güttingen	22.7 a	0.74 a
Erika	Drilling	27.3 a	0.82 a
	V-Güttingen	22.4 a	1.19 a
Means for cultivar			
Carola		18.8 a	0.83 a
Dicolor		23.8 b	0.78 a
Erika		24.8 b	1.01 a
Means for training system			
Drilling		23.9 b	0.76 a
V-Güttingen		21.0 a	0.98 b

\*Explanations, see Table 1

Table 3. Yielding and mean fruit weight of 'Carola', 'Dicolor' and 'Erika' pear depending on tree form

Treatment		Cumulative yield 2002-2005		Mean fruit weight 2004-2005 [g]
		[kg tree <sup>-1</sup> ]	[t ha <sup>-1</sup> ]	
Carola	Drilling	12.6 a*	21.2 a	261 a
	V-Güttingen	18.3 a	43.6 a	221 a
Dicolor	Drilling	20.0 a	33.6 a	198 a
	V-Güttingen	16.5 a	39.3 a	189 a
Erika	Drilling	21.6 a	36.3 a	254 a
	V-Güttingen	26.7 a	63.6 a	254 a
Means for cultivar				
Carola		15.5 a	32.4 a	241 b
Dicolor		18.2 a	36.5 a	193 a
Erika		24.2 b	50.0 b	254 b
Means for training system				
Drilling		18.1 a	30.4 a	238 a
V-Güttingen		20.5 a	48.8 b	221 a

\*Explanations, see Table 1

Yielding of the cultivars examined was differentiated: 'Erika' gave 24.2 kg fruit per a tree (50.0 t·ha<sup>-1</sup>) and it was higher than fruit yield from 'Carola' (15.5 kg·tree<sup>-1</sup>, 32.4 t·ha<sup>-1</sup>) and 'Dicolor' (18.2 kg·tree<sup>-1</sup>, 36.5 t·ha<sup>-1</sup>). 'Erika' was recognized also as a highly productive cultivar by another researchers (Blazek et al., 2003; Błaszczyk, 2005).

There was no significant influence of a training system on fruit quality. Mean fruit weight was comparable in both the training systems and in all the combinations. Similar results were obtained by Iglesias et al. (2004) in a trial with 'Conference'. Good fruit quality from open tree form was obtained by Widmer and Krebs (2001) on 'Royal Gala' and 'Golden Delicious' apple trees and by Sosna (2004) on 'Elstar' and 'Jonagold'.

'Erika' and 'Carola' fruit had similar weight (254 and 241 g), which

were significantly heavier than fruit of 'Dicolor' (193 g). It is in agreement with general opinion that 'Erika' and 'Carola' are characterised as large-size fruit cultivars, whereas 'Dicolor' is assigned to the group of cultivars with medium-size fruit (Kurlus and Łysiak, 1999; Paprstein and Bouma, 2000; Błaszczyk, 2005).

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## PLYW DWÓCH FORM KORON ROZPINANYCH NA WZROST I OWOCOWANIE KILKU ODMIAN GRUSZY

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### S T R E S Z C Z E N I E

Doświadczenie prowadzono w latach 2001-2005 w Stacji Doświadczalnej Uniwersytetu Przyrodniczego w Samotworze koło Wrocławia. Posadzono dwuletnie drzewka gruszy odmian 'Carola', 'Dicolor' i 'Erika' na podkładce pigwa S<sub>1</sub>. Grusze prowadzono w koronie wrzecionowej jednoprzewodnikowej, posadzonej w systemie V w rozstawie 3,5 x 1,2 m (2381 drzew ha<sup>-1</sup>) oraz w formie korony trzyprzewodnikowej – Drilling, w rozstawie 3,5 x 1,7 m (1681 drzew ha<sup>-1</sup>). Doświadczenie założono metodą podbłoków, w czterech powtórzeniach, po 7 drzew na każdym poletku doświadczalnym. Za pierwszy czynnik uznano formę prowadzenia korony, za drugi odmianę. Dwuletnie drzewka miały nieliczne, zbyt nisko położone odgałęzienia boczne, więc po posadzeniu były one usunięte. Dla porównania średnich zastosowano test t-Duncana, przyjmując poziom istotności 5%. Celem badań była ocena wpływu formy korony na wzrost i owocowanie drzew kilku odmian gruszy.

Forma korony nie miała istotnego wpływu na wysokość plonu z drzewa oraz średnią masę owoców w pierwszych latach po posadzeniu. Jednak w przeliczeniu na jednostkę powierzchni, istotnie wyższe plony zebrano z drzew prowadzonych w systemie V-Güttingen. Drzewa prowadzone w koronie Drilling charakteryzowały się większym polem przekroju poprzecznego pnia. Z uwagi na słabszy wzrost wegetatywny, drzewa prowadzone na jeden przewodnik uzyskały wyższy współczynnik plenności.

Do piątego roku po posadzeniu najobficiej plonowały drzewa odmiany 'Erika' (24,2 kg), dając istotnie wyższy plon z drzewa w porównaniu z odmianami 'Carola' i 'Dicolor' (odpowiednio 15,5 oraz 18,2 kg). Duże owoce miały odmiany 'Erika' i 'Carola' (odpowiednio 254 i 241 g). Ich masa różniła się istotnie od owoców 'Dicolor' (193 g). Odmiany różniły się siłą wzrostu drzew mierzoną polem przekroju poprzecznego pnia. Słabszym wzrostem charakteryzowała się odmiana 'Carola'. Z uwagi na wyższy współczynnik plenności, przy porównywalnym plonowaniu z drzewa i jakości owoców w pierwszych latach po posadzeniu, za bardziej korzystne uznać należy prowadzenie drzew gruszy w systemie V-Güttingen.

**Słowa kluczowe:** grusza, pigwa S<sub>1</sub>, Drilling, V-Güttingen, plon, wzrost, jakość