

## TRAINING SYSTEM AND FRUIT QUALITY IN THE APPLE CULTIVAR 'JONAGOLD'

Maria Licznar-Małańczuk

Agricultural University, Department of Horticulture  
Rozbrat 7, 50-334 Wrocław, POLAND  
e-mail: liczmal@ozi.ar.wroc.pl

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### A B S T R A C T

The relationship between fruit quality and planting and training systems was studied in 'Jonagold' apples in the first ten years of cropping under the climatic conditions of Lower Silesia. One-year-old 'Jonagold' apple trees grafted on M.9 rootstock were planted at densities from 3 333 to 13 223 trees per hectare in single-row, double-row, triple-row, or V planting systems. Trees were trained as typical spindles, slender spindles or super-spindles. Fruit quality was lower in all double-row and triple row systems. Fruit quality was higher with the V system and single-row spindles or super-spindles systems. However, the proportion of oversize fruit was high in single-row systems. The best planting and training system was the spindle single-row system with 3 333 trees per hectare.

**Key words:** apple, quality, training system, size, weight, blush

### INTRODUCTION

Fruit quality is a combination of appearance, flavour, texture and nutritional value. It is affected by pre-harvest factors such as climatic conditions and cultural methods (Kader, 2000). The proper choice of cultivar, rootstock, spacing and training system are necessary to ensure a well illuminated canopy. Proper management of the trees during their first few years in the orchard ensures better fruit quality (Mika, 1997). During the first four years of cropping in multi-row systems with 2 500 to 3 700 apple trees per hectare, the proportion of blush on the skin area was reduced even though the fruit size was not reduced (Rüger, 1989). In single-row and V systems, doubling the density from 3 000 to 6 000 spindle apple trees per hectare

slightly decreased mean fruit weight and diameter up to the seventh year of cropping (Widmer and Krebs, 2000 and 2001). However, in orchards with 10 000 trees per hectare, fruit were smaller, colour development was incomplete, and yield was too small for profitable production (Widmer and Lemmenmeier, 1999). In a super spindle system, fruit colour was inferior during the first eight years of cropping (Mantinger and Vigl, 1999).

The aim of this study was to determine the relationship between fruit quality and planting and training systems in 'Jonagold' apples in the first ten years of cropping under the climatic conditions of Lower Silesia.

## MATERIAL AND METHODS

The experiment was carried out at the Fruit Experimental Station in Samotwór near Wrocław, Poland, on a medium silty loam class III b soil. In the spring of 1992, one-year-old 'Jonagold' apple trees grafted on M.9 rootstock were planted at densities from 3 333 to 13 223 trees per hectare in a single-row, double-row, triple-row, or V planting system. Trees were trained as typical spindles, slender spindles or super-spindles (Tab. 1). Minimum pruning and horizontal bending of limbs were performed in the first two years after planting. Starting in 1994, trees were pruned every year after blooming, except in 1999. Starting in 1996, the trees were also pruned in summer. Herbicide fallow was maintained in the tree rows and sward in the alleyways. Plant protection was carried out in accordance with the current recommendations of the Orchard Protection Program.

Table 1. Details of the planting and training systems used for 'Jonagold' apples

No	Number of trees per hectare	Spacing [m]	Planting system	Training system
1.	3 333	3.00 x 1.00	single-row	Spindle
2.	5 333	3.00 + 0.75 x 1.00	double-row	
3.	6 667	3.00 + 2 x (0.75) x 1.00	triple-row	
4.	5 333	3.75 x 0.50	single-row	V-system
5.	5 333	3.50 + 0.25 x 1.00	double-row	
6.	7 407	2.25 x 0.60	single-row	super-spindle
7.	13 223	2.25 + 0.50 x 0.55	double-row	

The experiment was carried out in a randomized block design with eight replicates. Each plot consisted of four to ten trees depending on planting density. Yield and fruit quality were recorded for each plot during the first ten

years of cropping (1993 to 2002). Quality of fruit based on weight of 20 fruit from each plot were estimated. Samples of about 35 kg per two replications were categorized on the basis of fruit diameter and proportion of blushing.

Data were statistically elaborated and verified by Student's multiple-range t-test at  $P=0.05$ .

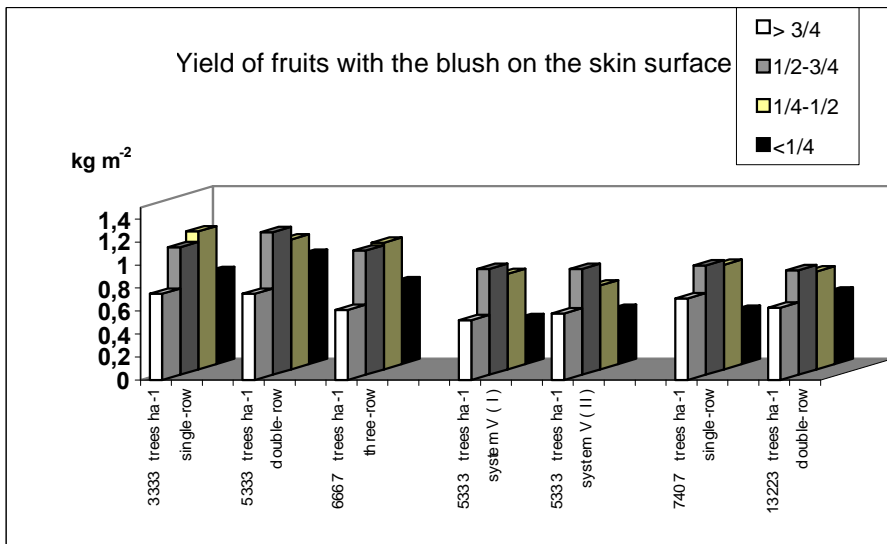
## RESULTS AND DISCUSSION

During the first ten years of cropping, planting density was the main factor determining yield. Mean yield per tree was highest at a planting density of 3 333 trees per hectare (Tab. 2). Mean fruit weight was about the same in the single- and multi-row spindle systems (198-200 g). Fruit weight was higher with the V system and with the super-spindle single-row system. Fruit weight was significant lower only at a planting density of 13 223 trees per hectare (192 g). This agrees well with earlier studies (Widmer and Lemmenmeier, 1999).

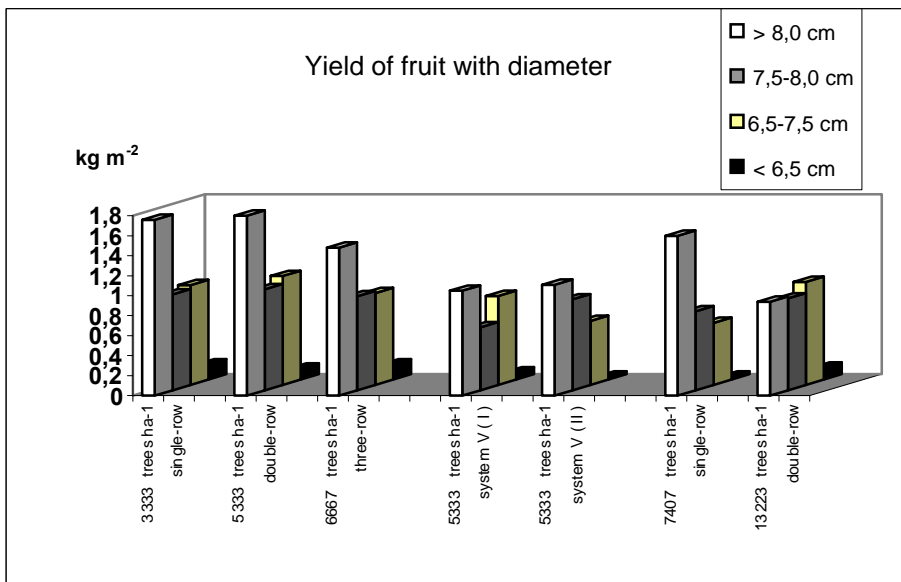
Fruit quality was lower in all double-row and triple row systems (Fig. 1). The proportion of apples with insufficient blushing was higher. The mean yield of fruit with less than one quarter blushing per square meter was highest in the double-row system with 5 333 trees per hectare ( $0.95 \text{ kg m}^2$ ). This agrees well with an earlier study on multiple-row systems during the first years of cropping (Gruca, 1998; Rüger, 1989). Fruit quality was higher with the V system and single-row systems with spindles or super-spindles. However, at a planting density of 3 333 trees per hectare, the proportion of apples with insufficient blushing was also higher ( $0.80 \text{ kg m}^2$ ).

Table 2. Mean annual yield and weight of fruit in relation to apple-tree planting and training system in 'Jonagold'cv. (1993-2002)

Number of trees per hectare and planting system	Mean yield		Weight of fruit [g]		
	kg tree <sup>-1</sup>	kg m <sup>-2</sup>	the lowest	mean	the highest
3 333 – single-row	11.61	3.87	152	198	231
5 333 – double-row	7.62	4.07	151	198	236
6 667 – three-row	5.24	3.49	166	200	226
5 333 – single-row V system	4.95	2.64	169	211	245
5 333 – double-row V system	5.06	2.70	165	202	229
7 407 – single-row	4.10	3.04	176	208	238
13 223 – double-row	2.39	3.16	141	192	229
LSD $\alpha=0.05$	1.40	0.72	-	10	-



**Figure 1.** Mean quantity of fruit with different blush colour in relation to apple-tree planting and training system in ‘Jonagold’ (1993-2002)



**Figure 2.** Mean quantity of fruit with different size in relation to apple-tree planting and training system in ‘Jonagold’ (1993-2002)

Fruit diameter depended on the planting system used (Fig. 2). Fruit diameter was low at a planting density of 13 223 trees per hectare, which agrees well with earlier studies (Widmer and Lemmenmeier, 1999). The proportion of oversize fruit over 8.0 cm in diameter was high in the spindle and super-spindle single-row systems and also the spindle multi-row system. The lowest proportion of oversize fruit was observed with both V systems. The quantity of fruit with less than 6.5 cm in diameter smallest with the V systems. However, when fruit diameter, blushing and yield are all taken into account, the best planting and training system was the spindle single-row system with 3 333 trees per hectare, which agrees well with earlier recommendations (Mantinger and Vigl, 1999).

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## SYSTEM PROWADZENIA DRZEW A JAKOŚĆ OWOCÓW ODMIANY 'JOANGOLD'

Maria Licznar-Małańczuk

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

W okresie pierwszych 10 lat owocowania (1993-2002) oceniano wpływ systemu sadzenia i prowadzenia jabłoni na jakość owoców. Jednoroczne okulanty odmiany 'Jonagold'/M.9 posadzono wiosną 1992. Oceniano kilka systemów prowadzenia drzew przy zagęszczeniu od 3 333 do 13 223 drzew na ha, które posadzono w systemach jedno-, wielorzędowych lub systemie V. Korony drzew były formowane na typowe wrzeciono, wąskie wrzeciono lub superwrzeciono.

We wszystkich systemach wielorzędowych uzyskano słabszą jakość owoców. Jednorzędowy wrzecionowy i superwrzecionowy system prowadzenia jabłoni, a także system V uznano za dobry sposób uzyskania dobrej jakości jabłek. Jednak plon uzyskany w systemach jednorzędowych, charakteryzował się znacznym udziałem owoców bardzo dużych, o średnicy powyżej 8,0 cm. Uwzględniając obok jakości uzyskanych owoców również wysokość plonu, za najlepsze rozwiązanie uznano, jednorzędowy system wrzecionowy z liczbą 3 333 drzew na ha.

**Słowa kluczowe:** jabłoń, jakość, system prowadzenia, wielkość, masa, wybarwienie