PROTECTION OF GENETIC RESOURCES OF POMOLOGICAL PLANTS AND SELECTION OF GENITORS WITH TRAITS VALUABLE FOR SUSTAINABLE FRUIT PRODUCTION

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THE EFFECT OF DIFFERENT TYPES OF MULCHING ON YIELD, SIZE, COLOR AND STORABILITY OF 'JONAGORED' APPLES

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A B S T R A C T

In the spring of 2000, two-year-old 'Jonagored' apple trees on M.9 rootstock were planted 0.5 x 3.5 meters apart (5714 trees per hectare). The trees were subjected to three different methods of soil management: 1) Herbicide fallow; 2) Mulching with pine bark; and 3) Mulching with non-woven polypropylene.

Trees mulched with pine bark and non-woven polypropylene had higher yields than trees treated with herbicide. Trees mulched with pine bark had a significantly higher cumulative yield than those mulched with non-woven polypropylene. Trees mulched with pine bark bore the largest apples. Fruit color was not affected by which method of soil management was used. In 2001 and 2003, apples from trees mulched with pine bark and non-woven polypropylene had higher calcium concentrations and lower potassium/calcium ratios. In 2003, apples from trees mulched with pine bark were firmer at harvest time than apples from trees treated with herbicide or mulched with non-woven polypropylene. In 2001, apples from trees treated with herbicide lost a higher percentage of fruit weight during storage than trees mulched with pine bark. The percentage of apples with bitter pit varied widely from year to year, and did not seem to be affected by which method of soil management was used.

Key words: soil mulching, apple, yield, fruit quality, K, Ca

INTRODUCTION

In-row mulching improves fruit quality (Stanek and Navotna, 1985; Engel, 1985; Niggli et al., 1988). Mulching with organic material increases mean fruit weight (Mantinger and Gasser, 1996; Rubauskis et al., 2002). Mulching with organic matter also increases the percentage of fruits larger

than seven centimeters in diameter (Engel et al., 2001). Mulching also indirectly helps preserve fruit quality during storage. Mulching with sawdust promotes root development and increases the concentrations of calcium, potassium and magnesium in the upper layer of the soil column (Lang et al., 2001). Mulching with sawdust also increases the concentrations of calcium and potassium in the tree leaves, and reduced the occurrence physiological disorders in apple fruits (Lang et al., 2001).

MATERIAL AND METHODS

The experiment was carried out from 2000 to 2003. In the spring of 2000, two-year-old 'Jonagored' apple trees on M.9 rootstock were planted 0.5 x 3.5 meters apart (5714 trees per hectare). The trees were subjected to three different methods of soil management: 1) Herbicide fallow, 2) Mulching with pine bark, and 3) Mulching with black non-woven polypropylene (Wigofil).

In 2001, at the end of May and at the beginning of July, Roundup 360 SL (5 l ha^{-1}) and Chwastox extra 300 SL (2 l ha^{-1}) were applied to control weeds. In 2001-2003, Casaron GR (dichlobenil, 70 kg ha^{-1}) was applied to maintain the herbicide fallow.

Immediately after harvest, fruit size and blushing were determined visually. Potassium, magnesium and calcium concentrations were determined by atomic absorption spectrophotometry (AAS) and phosphorus concentration was measured by inductively coupled plasma atomic emission spectrometry (ICP-AES).

Flesh firmness and soluble solids content were determined both immediately after harvest and after storage. Fruit firmness was measured with an INCO penetrometer with a probe eleven millimeters in diameter. Each fruit was tested twice, once on the blushed side, and once on the opposite side. Soluble solids content was measured with a refractometer. After 150 days of cold storage, weight loss and the percentage of apples with symptoms of bitter pit were recorded.

Data were elaborated by analysis of variance. Before analysis, data recorded as percentages (weight loss, bitter pit) were transformed using the Bliss function: $y = \arcsin \sqrt{x}$. The significance of differences between means was evaluated using Duncan's multiple range t-test at $P = 0.05$.

RESULTS

Trees mulched with pine bark and non-woven polypropylene had higher yields than trees treated with herbicide. Trees mulched with pine bark had higher yields during the first two years of the study, and a higher three-year cumulative yield than trees mulched with non-woven polypropylene (Tab. 1).

Table 1. Yield of 'Jonagored' and soil management from 2001 to 2003

Treatment	Yield [kg tree^{-1}]			Cumulative yield 2001-2003	Productivity index [kg cm^{-2}]
	2001	2002	2003		
Herbicide fallow	3.7 a*	5.9 a	7.2 a	16.7 a	2.8 a
Pine bark	6.3 b	8.2 c	8.2 b	22.7 c	3.5 c
Non-woven polypropylene	4.1 a	6.9 b	8.6 b	19.6 b	3.1 b

*Means followed by the same letter do not differ significantly at P = 0.05 according to Duncan's t-test

Trees mulched with pine bark bore the largest apples, and bore the highest percentage of fruits larger than 7.5 centimeters in diameter (Fig. 1).

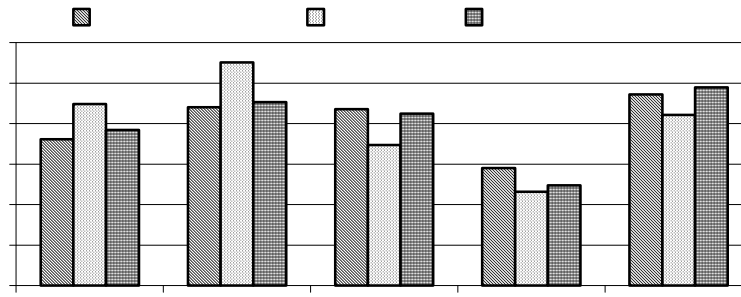

Figure 1. Percentage of fruit sorted by size class and soil management (mean of 2001 to 2003)

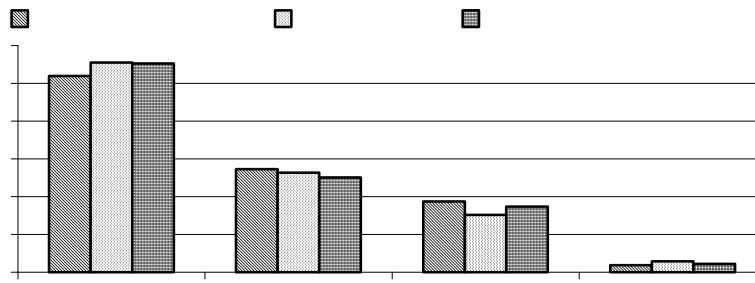

Figure 2. Percentage of fruit sorted by degree of blushing and soil management (mean of 2001 to 2003)

Fruit color was very good, and the percentage of fruit surface covered with blush did not seem to be affected by which method of soil management was used (Fig. 2).

The post-harvest mineral content of the apples was affected by which method of soil management was used (Tab. 2). In 2001 and 2003, apples from trees mulched with pine bark and non-woven polypropylene had higher calcium concentrations and lower potassium/calcium ratios. In 2003, apples from the trees treated with herbicide had a higher potassium concentration than apples from trees mulched with pine bark or non-woven polypropylene.

Table 2. Concentrations of phosphorus, potassium, magnesium and calcium in 'Jonagored' apples and soil management from 2001 to 2003

Treatment	Phosphorus [g kg^{-1} dry matter]	Potassium [g kg^{-1} dry matter]	Magnesium [g kg^{-1} dry matter]	Calcium [g kg^{-1} dry matter]	Potassium/ calcium ratio
2001					
Herbicide fallow	0.47 a*	3.89 a	0.26 b	0.16 a	26.4 b
Pine bark	0.46 a	3.83 a	0.23 a	0.27 c	14.6 a
Non-woven polypropylene	0.53 b	3.95 a	0.25 b	0.22 b	19.1 a
2002					
Herbicide fallow	0.30 a	6.99 a	0.25 a	0.18 a	39.8 a
Pine bark	0.29 a	6.99 a	0.25 a	0.16 a	39.9 a
Non-woven polypropylene	0.28 a	7.11 a	0.27 a	0.18 a	38.9 a
2003					
Herbicide fallow	0.25 a	9.26 c	0.45 b	0.20 a	46.4 c
Pine bark	0.22 a	8.66 b	0.45 b	0.22 b	39.4 b
Non-woven polypropylene	0.28 a	7.98 a	0.40 a	0.23 b	35.2 a

*For explanation, see Table 1

The method of soil management used did not seem to affect soluble solids content either after harvest or after storage (Tab. 3).

The effect of soil management on fruit firmness was not clear-cut. Only in 2003 were apples from trees mulched with pine bark firmer immediately after harvest than apples from trees treated with herbicide or mulched with non-woven polypropylene.

In 2001, apples from trees treated with herbicide lost a greater percentage of their weight during storage than apples from trees mulched with pine bark or non-woven polypropylene (Tab. 3).

Table 3. The influence of soil management in the rows of trees on some features of 'Jonagored' apples, after harvest [A] and after storage [B]

Treatment	Firmness [kG]		Soluble solids [%]		Weight loss [%]	Apples with bitter pit [%]
	after harvest	after storage	after harvest	after storage		
2001						
Herbicide fallow	7.9 a*	3.9 a	12.1 a	11.5 a	2.9 b	5.5 b
Pine bark	7.4 a	3.9 a	11.8 a	11.2 a	1.1 a	2.0 a
Non-woven polypropylene	7.4 a	3.8 a	12.0 a	10.9 a	1.6 ab	5.0 b
2002						
Herbicide fallow	6.5 a	3.9 a	9.5 a	8.7 a	3.7 a	2.2 b
Pine bark	6.4 a	3.8 a	10.1 a	8.9 a	3.0 a	3.6 b
Non-woven polypropylene	6.4 a	4.2 a	9.8 a	9.0 a	2.9 a	0.7 a
2003						
Herbicide fallow	7.4 a	5.1 a	13.8 a	12.9 a	3.3 a	1.1 a
Pine bark	8.1 b	4.9 a	14.1 a	12.4 a	2.9 a	0.3 a
Non-woven polypropylene	7.7 ab	4.7 a	13.2 a	12.7 a	2.9 a	0.7 a

*For explanation, see Table 1

The percentage of apples with bitter pit varied widely from year to year, and did not seem to be affected by which method of soil management was used (Tab. 3).

DISCUSSION

In-row mulching improved yield, which agrees with the findings of Engel et al. (2001). Numerous studies have shown that mulching increases fruit size (Mantinger and Gasser, 1996; Szewczuk and Sosna, 2001; Rubauskis et al., 2002). In this study, mulching with pine bark and non-woven polypropylene improved both yield and fruit size. Fruit color and soluble solids content were not affected by which method of soil management was used. Even though mulching increased fruit sized, it also increased calcium concentration and reduced the potassium/calcium ratio. Tomala's (1995) found that the potassium/calcium ratio had a greater influence on fruit storability than potassium content. The effect of soil management on fruit firmness was not clear-cut. The low fruit potassium content recorded in 2003 can be attributed to the decline in soil potassium levels which occurs after a few years of mulching (Szewczuk, 2001).

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WPŁYW RÓŻNYCH SPOSOBÓW ŚCIÓŁKOWANIA DRZEW JABŁONI NA PLON, WIELKOŚĆ, WYBARWIENIE I ZDOLNOŚĆ PRZECHOWALNICZĄ OWOCÓW ODMIANY ‘JONAGORED’

Adam Szewczuk i Ewelina Gudarowska

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

Wiosną 2000 roku dwuletnie rozgałęzione drzewka odmiany ‘Jonagored’ posadzono na podkładce M.9 w rozstawie 3,5 x 0,5 m (5714 drzew/ha). Zastosowano trzy sposoby utrzymania gleby w rzędach drzew: 1) ugór herbicydowy, 2) ściółkę z kory sosnowej, 3) ściółkę z włókniny. W latach 2001-2003 najwyższy plon zebrano z drzew ściółkowanych korą sosnową, a najniższy z drzew rosnących w pasie herbicydowym. Ściółkowanie korą sosnową poprawiło wielkość owoców. Nie stwierdzono dużych różnic w pokryciu owoców rumieńcem w zależności od sposobu utrzymania gleby w rzędach drzew. Ściółkowanie gleby korą sosnową lub włókniną wpłynęło na większą zawartość wapnia w owocach w latach 2001 i 2003, a także obniżenie stosunku potasu do wapnia. W 2001 roku owoce odmiany ‘Jonagored’ pochodzące z drzew rosnących w ugorze herbicydowym miały większe ubytki masy w okresie przechowywania niż owoce z drzew ściółkowanych korą. W 2003 roku owoce z drzew ściółkowanych korą wykazywały wyższą jędrność w momencie zbioru. Występowanie objawów gorzkiej plamistości podskórnej było zróżnicowane w poszczególnych latach badań i nie wynikało z sposobu uprawy gleby w rzędach drzew.

Słowa kluczowe: uprawa gleby w rzędach drzew, jabłoń, plon, jakość owoców, K, Ca