

EFFECTS OF MULCHING IN A NECTARINE ORCHARD IN SUSTAINABLE FRUIT PRODUCTION

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A B S T R A C T

The experiment was conducted in the years 1996-2004 in the Experimental Station, located near Wrocław. The trees of nectarine 'Redgold' on seedling *Prunus mandshurica* were planted in the spring of 1996, at the spacing of 6 x 2.4 m (694 trees per ha). The trees in the rows were subject to the three following kinds of soil management: 1) herbicide fallow; 2) mulching with pine bark; and 3) mulching with black polypropylene fabric.

Mulching with pine bark did not have the influence on the cropping of nectarine trees during the 8 years of yielding. Using of plastic much improved the cropping of the trees in the first two years of yielding. The total yield for 8 years was higher in the case of the trees mulched with polypropylene fabric, but no significant differences were noted. The tree vigour, expressed by trunk cross – sectional area, was more intensive in the case of the trees mulched with pine bark. The polypropylene fabric did not have the influence on the growth of nectarine trees. The calculated costs of soil tillage were the lowest for herbicide fallow, but taking into account sustainable fruit production, mulching with polypropylene fabric is the most advisable method to control weeds in a nectarine orchard because of the lowest application of active substances per 1 ha.

Key words: nectarine, mulching, pine bark, polypropylene fabric, herbicide fallow

INTRODUCTION

Traditional fruit production demands using a lot of herbicides. That is why growers in many countries are replacing conventional methods with Integrated Fruit Production methods (Suckling et al., 1999).

One promising integrated soil management technique is mulching. Mulches reduce herbicide use and improve growth and yield in many different fruit trees (Engel et al., 2001; Kawecki et al., 1999; Szewczuk and Maszczyk,

2000). For example, organic and plastic mulches improve yield in peaches (Szewczuk, 2001).

Organic mulches should be reapplied every three years. With organic mulches, herbicides are still needed to control overgrowth by perennial weeds.

Weed control is more cost effective when herbicides are used together with mulches than when herbicides are used alone, because the herbicides can be applied locally (Reganold et al., 2001). Using herbicides together with mulches is more effective in controlling weeds than using herbicides alone (Rifai et al., 2002). Plastic mulches effectively control weeds. Unfortunately, however, they are expensive to use (Himmelsbach, 1992; Stojanowska, 1998).

MATERIAL AND METHODS

The experiment was carried out from 1996 to 2004 at the Experimental Station near Wrocław, Poland. In the spring of 1996, nectarine trees of the cultivar 'Redgold' grafted on *Prunus mandshurica* seedling rootstock were planted 6 x 2.4 meters apart (694 trees per hectare). Trees were formed and trained as vase-shaped canopies. After the trees were planted, grass was sown between the rows.

Trees rows were subjected to three soil management techniques:

- 1) herbicide fallow;
- 2) mulching with pine bark; and
- 3) mulching with black polypropylene fabric.

The herbicide fallow was two meters wide. The herbicides used were glifosat and MCPA. Herbicides were also applied in a 20 cm strip between the grass and the mulches.

Mulches were applied in a 1.6 meter wide strip. The pine bark mulch was reapplied every three years. With the pine bark mulch, herbicides were applied locally to control overgrowth by perennial weeds. Only the polypropylene fabric mulch effectively reduced weed growth over the course of the experiment.

Trees were protected against *Myzus persicae*, *Leucostoma persooni* and *Taphina deformans*.

The experiment was carried out in a randomized block design with four replicates of three trees per plot. Each year, yield, trunk cross-sectional area and mean fruit weight were recorded for each tree.

Data were statistically elaborated using analysis of variance, followed by means separation using LSD_{0.05}.

The costs of soil management were estimated on the basis of the costs of associate with weed control and labor. It is difficult to determine a reliable price for pine bark because it is an industrial by-product. Therefore, the costs of mulching with pine bark were calculated both with and without the cost of the pine bark included. The costs of mulching included additional costs

...mulching in a nectarine orchard in sustainable fruit...

associated with weed control, pruning and harvesting. The following prices were used in calculating costs:

- Manual labor: 5.50 PLN per hour;
- Machinery: 45.00 PLN per hour;
- Fruit price from 1997 to 2004: 1.44 to 2.60 PLN per kilogram;
- Pine bark: 34.00 PLN per cubic meter;
- Black polypropylene fabric: 1.37 PLN per square meter; and
- Herbicide: 24.00 PLN per liter.

RESULTS

Mulching with pine bark did not improve either annual yield or eight-year cumulative yield (Tab. 1 and 2).

Table 1. Soil management technique and yield in 'Redgold' nectarine trees from 1997 to 2000

Treatment	Yield [kilograms per tree]			
	1997	1998	1999	2000
Herbicide fallow	0.7 b*	10.0 a	30.7 a	39.3 a
Pine bark	0.4 a	9.5 a	30.5 a	33.7 a
Polypropylene fabric	0.9 c	14.4 b	32.9 a	38.0 a

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

Table 2. Soil management technique and yield in 'Redgold' nectarine trees from 2001 to 2004

Treatment	Yield [kilograms per tree]				Cumulative yield 1997-2004
	2001	2002	2003	2004	
Herbicide fallow	30.9 a*	20.9 a	51.7 a	34.7 a	218.9 a
Pine bark	32.3 a	21.0 a	48.7 a	41.3 a	217.4 a
Polypropylene fabric	34.1 a	25.4 a	49.8 a	39.3 a	234.9 a

*For explanation, see Table 1

Mulching with polypropylene fabric significantly improved yield in the first two years of bearing. Trees mulched with polypropylene fabric also had a higher eight-year cumulative yield, although the difference was not statistically significant (Tab. 2). Trees had a higher trunk cross-sectional when mulched with pine bark, but not with polypropylene fabric (Tab. 3).

Mulching had no effect on mean fruit weight (Tab. 3).

With pine bark, herbicides still had to be applied locally to reduce overgrowth by perennial weeds. However, the amount of herbicide that had to be applied was only 45% of what was applied to the herbicide fallow (Tab. 4).

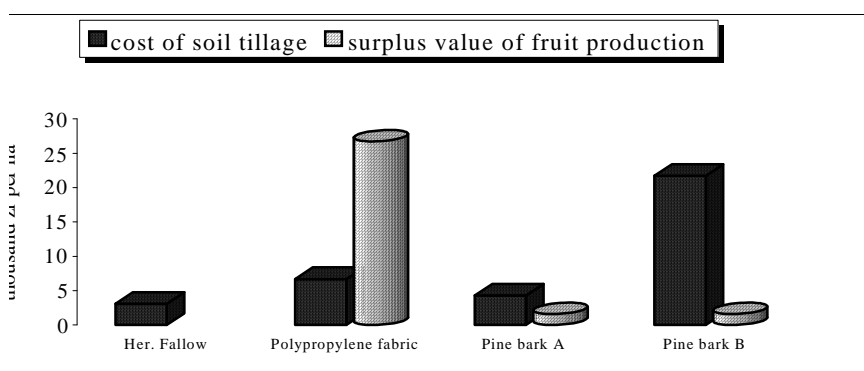
Table 3. Soil management technique, trunk cross-sectional (TCSA) and mean fruit weight in 'Redgold' nectarine trees

Treatment	Increase in TCSA 1996-2004 [cm ²]	Mean weight of fruit 1997-2004 [g]
Herbicide fallow	77.1 a*	85.5 a
Pine bark	100.3 b	93.4 a
Polypropylene fabric	88.0 ab	87.9 a

*For explanation, see Table 1

Table 4. Soil management technique and mean annual herbicide use in 'Redgold' nectarine trees age from 1997 to 2004

Treatment	Herbicide used [kilograms of biologically active ingredient per hectare]			
	glifosat	MCPA	total	%
Herbicide fallow	1.80	0.90	2.70	100
Pine bark	0.81	0.41	1.22	45
Polypropylene fabric	0.36	0.18	0.54	20



Pine bark A: Soil management costs not including the cost of the pine bark

Pine bark B: Soil management costs including the cost of the pine bark

Figure 1. Soil management costs and income from additional fruit production in nectarine trees in the first eight years of bearing

With polypropylene fabric, herbicides were also applied in a strip between the grass and the mulch. The amount of herbicide that had to be applied was only 20% of what was applied to the herbicide fallow.

Soil management costs were lowest for herbicide fallow (Fig. 1). However, the value of the additional fruit from the trees mulched with polypropylene fabric more than covered the costs associated with mulching. With pine bark, the value of fruit produced was higher than with herbicide fallow in spite of the lower yields. This was because fruit prices changed from year to year.

DISCUSSION

The choice of soil management technique affected yield in nectarine trees. Polypropylene fabric improved yield in the first two years of bearing, which agrees well with previous studies (Devyatov and Statskevich, 1997; Stojanowska, 1994). Pine bark did not improve yield, which does not agree with other studies (Bielińska, 2001, Engel et al., 2001; Kawecki et al., 1999; Szwedo and Maszczyk, 2000. Yield depends on the kind of mulch used (Link, 1997). Trees mulched with pine bark grew more vigorously, which agrees well with previous studies (Engel et al., 2001; Kawecki et al., 1999).

Herbicide fallow was the least expensive soil management technique, which agrees well with previous reports that herbicide fallow is less expensive than mulching because of the costs associated with purchasing, applying and maintaining the mulches (Himmelsbach et al., 1995). On the other hand, the value of the additional fruit from trees which have been mulched can offset the costs associated with mulching.

The choice of soil management technique depends on the grower's financial resources (Lipecki, 1998). Mulching can reduce the amount of money spent on herbicides. In this study, the costs associated with herbicide use were 55 to 80% lower with mulching than without mulching. Previous studies also found that using herbicides together with mulches is more cost effective than using herbicides alone (Reganold et al., 2001; Rifai et al., 2002).

Mulching with pine bark reduced herbicide use, increased soil management costs, and did not improve yield. Mulching with polypropylene fabric also reduced herbicide use and increased soil management costs, but significantly improved yield to the point that it more than paid for itself. Mulching with polypropylene fabric is therefore a cost effective method to control weeds in nectarine trees in sustainable fruit production.

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ŚCIÓLKOWANIE GLEBY W SADZIE NEKTARYNOWYM W WARUNKACH ZRÓWNOWAŻONEJ PRODUKCJI OWOCÓW

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

Doświadczenie prowadzono w latach 1996-2004 w Stacji Doświadczalnej AR we Wrocławiu. Drzewa nektaryny odmiany 'Redgold' na podkładce 'Siewka Mandzurska' posadzono wiosną 1996 roku w rozstawie 6 x 2,4 m (694 drzew na ha). Zastosowano trzy sposoby uprawy gleby w rzędach drzew: ugor herbicydowy, ściółkę z kory sosnowej i ściółkę z czarnej tkaniny polipropylenowej. Przez 8 lat doświadczenia ściółka z kory sosnowej zastosowana w rzędach drzew nie wpłynęła na poprawę plonowania nektaryny, nie stwierdzono również dużych różnic w plonowaniu drzew w poszczególnych latach badań. Ściółkowanie gleby tkaniną polipropylenową istotnie poprawiło plonowanie drzew w pierwszych dwóch latach owocowania. Zaobserwowano również tendencję do poprawy plonowania za okres 8 lat, jednak ta różnica nie była udowodniona statystycznie. Ściółkowanie gleby korą sosnową przyczyniło się do silniejszego wzrostu drzew mierzonego polem przekroju poprzecznego pnia. Stosowanie ściółki syntetycznej nie miało wpływu na wzrost drzew nektaryny. Wyliczone koszty stosowania poszczególnych sposobów utrzymania gleby są najniższe w przypadku ugoru herbicydowego, biorąc jednak pod uwagę kryterium zużycia środków chemicznych, można polecać do nasadzeń stosujących zasady IPO ściółkę z tkaniny polipropylenowej.

Słowa kluczowe: nektaryna, ściółki, kora sosnowa, tkanina polipropylenowa, ugor herbicydowy