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MULCHING SYSTEMS AND WEED CONTROL IN JAPANESE QUINCE (*Chaenomeles japonica* LDL.) PLANTATIONS

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ABSTRACT

In orchards of Japanese quince, weed control is difficult because of the dwarf and spreading habit. of the plant. The dwarf Japanese quince is a poor competitor. Weed control may therefore have a major impact on the profitability of organic cultivation of this crop. Therefore, various methods of weed control were studied and the efficiencies of these methods (fabric, plastic, woven plastic, wood chips, herbicides and weeding by machine or by hand) were compared. Synthetic mulches controlled weeds the best, improved plant growth and yield, and prevented the fruit from getting contaminated by soil. Wood chips resulted in nitrogen deficiency. Herbicides improved the growth of young plants.

Key words: *Chaenomeles japonica*, organic mulches, synthetic mulches, yield, fruit quality, weed control

INTRODUCTION

Japanese quince (*Chaenomeles japonica*) has been cultivated as a minor fruit crop in Latvia and Lithuania for more than thirty years. The fruit has a characteristic high acidity and robust aroma, and has been used in various products, including syrup, liqueur and marmalade (Rumpunen et al., 1998). Based on trials in the Baltic countries, Japanese quince promises to be a fruit

crop suited to the climate of northern Europe (Rumpunen, 2002).Japanese quince is environmentally friendly crop, which can be grown without chemical control of pests and diseases (Kviklys et al., 2003). One of the main tasks in plantation management is weed control. In commercial orchards of Japanese quince, weeds are controlled primarily by machine or by hand. An orchard of Japanese quince is expected to produce for at least fifteen years, though yield is drastically reduced when perennial weeds grow in the rows. Controlling weeds by machine or by hand is not sufficient in the long term, because Japanese quince is a poor competitor.

Weed management systems based on organic mulches have been developed for many fruit and berry crops (Engel et al., 2001; Laugale et al., 2002; Rubauskis et al., 2002). Unfortunately, organic mulches alone cannot efficiently control perennial weeds. It is also important to prevent weeds from becoming established in new orchards. Weed management systems based on synthetic mulches (fabric, plastic and woven plastic) have therefore generated more interest and are now commonly employed in the cultivation of many horticultural crops (Dale, 2000; Forsella et al., 2003; Starast et al., 2002; Weber, 2003).

The objectives of the present investigation were to study and develop methods of weed control in orchards of Japanese quince, and to study the influence of different mulches on yield and fruit quality.

MATERIAL AND METHODS

Field management trials were carried out at three sites: Dobele, Latvia; Babtai, Lithuania and Balsgård, Sweden. Four genotypes of Japanese quince (C9, C23, C25 and C26) with contrasting plant habit were micropropagated and grown for one season in 13 cm pots before being set the field, which occurred in the autumn of 1999 in Lithuania and Sweden, and in the spring 2000 in Latvia. Plants were set 1 m apart in rows 3.5 m apart, in a randomized block trial (4 cultivars x 5 plants x 5 treatments x 3 blocks).

Weeds were controlled by: A) black fabric (all sites), B) black plastic (all sites), C) black woven plastic (Sweden), D) wood chips (Latvia and Lithuania), E) herbicides (Latvia and Lithuania) and F) mechanical or manual removal (all sites). The herbicides used were Goltix (3 l/ha), Betanal Progress AM (2 l/ha), Lontrel 300 (0.3 l/ha) in Lithuania and glyphosate (3 l/ha) in Latvia. Herbicides were applied as needed depending on weed growth. Synthetic mulches were applied before planting; holes for the plants were cut by hand with a knife. Wood chips were applied after planting in a 10 cm thick layer.

The following data were recorded: plant height, plant width, total shoot length, yield per plant, number of fruit per plant, average fruit weight, full flowering date and fruit maturity, which was evaluated at the same picking

time; yellow fruits with brown seeds were given 5 fruit maturity pants and green fruits with white seeds, one point. In Sweden in 2003, fruits were scored according to weight of healthy fruits, weight of diseased fruits, total fruit weight, percentage of diseased fruits, and the presence of fruit spots. Results were statistically evaluated using Anova analysis of variance. Differences between treatments were evaluated using Duncan's multiple range t-test at P = 0.05. For analysis of variance of flowering date, the number of days from Jan 1 were used.

RESULTS

Plant survival

Planting in autumn resulted in significant plant death in Lithuania. Fields treated with synthetic mulches suffered the greatest losses. In the Swedish trial, which was also planted in the autumn, only 3% of the plants were lost. In Latvia, spring planting also resulted in a loss of 4% of the plants. No plants were lost during the second winter at any of the sites.

Flowering and ripening

Flowering and ripening were evaluated only in Lithuania. Flowering time did not significantly differ with respect to which treatment was employed. However, genotype C26 flowered very late and very uneveny.

Black plastic and black fabric resulted in earlier ripening (Tab. 1), whereas wood chip and herbicides resulted in delayed ripening.

Table 1. Effect of soil management on plant phenology, Lithuania

Treatment	Full flowering date	Maturity, points
Black fabric	May 12th a*	4.4 a*
Black plastic	May 9th a	4.6 a
Wood chips	May 9th a	4.1 b
Herbicides	May 9th a	4.1 b
Mechanical weeding	May 11th a	4.3 ab

*Means within columns marked with the same letter do not differ significantly at P = 0.05

Plant development

Herbicides reduced plant growth and height in both Lithuania and Latvia during the first season (Tab. 2). Wood chips also resulted plant height in Lithuania during the first season, and in Latvia during the second season.

There were no significant differences in plant height in Sweden during either season, or in Lithuania during the second season.

Herbicides reduced total shoot length during the first season, but not during the second season. Wood chips reduced total shoot length, whereas synthetic mulches increased it.

Table 2. Effect of soil management on plant height [cm]

Treatment	2001			2002		
	Latvia	Lithu-ania	Sweden	Latvia	Lithu-ania	Sweden
Black fabric	40.4 a*	27.3 ab	29.1 a	53 a	54 a	54 a
Black plastic	35.9 ab	27.8 a	30.3 a	49 a	49 a	55 a
Woven plastic	–	–	26.6 a	–	–	53 a
Wood chips	37.7 a	23.6 c	–	44 b	50 a	–
Herbicides	31.9 c	25.3 bc	–	50 a	49 a	–
Mechanical weeding	37.0 a	28.3 a	30.1 a	54 a	52 a	56 a

*For explanations, see Table 1; – not tested

Yield

During the first season, the number of fruits on the young plants was very low; it is impossible to draw any reliable conclusion about the effects of the various treatments on yield. Synthetic mulches promoted strong growth during the first season, which resulted in high yields during the second season (Tab. 3). In Latvia and Lithuania, black fabric resulted in the highest yield, followed by plastic and wood chips. Herbicides resulted in the lowest yields, though not significantly lower than wood chips or mechanical weeding. There are no significant differences between treatments in Sweden, except that black plastic resulted in the highest average yield in the first season.

Table 3. Effect of soil management on average yield (kg/plant) in young and full bearing plantation

Treatment	Average 2001-2002			2003		
	Latvia	Lithu-ania	Sweden	Latvia	Lithu-ania	Sweden
Black fabric	0.72 a	0.43 a	0.57 a	3.95 a	1.82 c	0.90 b
Black plastic	0.62 ab	0.34 b	0.85 a	3.83 a	3.15 a	2.10 a
Woven plastic	–	–	0.63 a	–	–	1.90 a
Wood chips	0.55 b	0.31 bc	–	2.45 b	2.01 bc	–
Herbicides	0.43 bc	0.24 c	–	1.75 c	2.35 b	–
Mechanica weeding	0.45 b	0.28 bc	0.77 a	2.69 b	1.95 c	1.80 a

*For explanations, see Table 1 and 2

The effects of different treatments was clearer in the third season, when fruit production was higher. Black plastic resulted in the highest yields at all sites. Black fabric also increased yield in Latvia, but decreased yields in Lithuania and Sweden. There were no significant difference between wood chips and mechanical weeding in Latvia and Lithuania, though both those treatments resulted in lower yield than synthetic ground covers, as was also noted in Sweden.

In Sweden, black plastic resulted in lower total yields as well as in lower yields of healthy fruits.

Weed control

Black fabric, black plastic and wood chips efficiently controlled weeds during the first season. Weeds grew only in the planting holes in the synthetic mulches, and had to be removed only once. In contrast, mechanical weeding was needed four times in Lithuania and Sweden, and three times in Latvia. Herbicides were applied twice. Herbicides could be used until the end of August; during fruit ripening, weeds were mechanically removed.

During the second season, black plastic was the best mulch. Weeds grew only in the planting holes, and could easily be removed by hand. With black fabric, weeds grew not only in the planting holes, but on and through the mulch as well. At the beginning of the second season, weeds started to germinate in the wood chips; weeds were removed by hand twice. With herbicides, two sprayings and one mechanical weeding was sufficient in controlling weeds. With mechanical weeding alone, four weedings were necessary.

In the third season, there was no significant difference between black fabric and mechanical weeding; weeding was needed four times in either case. Black plastic proved again to the best mulch.

DISCUSSION

Young plants of Japanese quince are more sensitive to winter frost. In Lithuania, up to 33% of the plants treated with black fabric and black plastic were lost, probably as a result of frost damages. With synthetic mulches, snow blows away from the rows, possibly reducing protection from the cold. Plastic mulches performed similarly with other horticultural crops in northern climates (Starast et al., 2002). It may be difficult for Japanese quince plants to become established; they should be planted in the spring in cold climate, especially if synthetic mulches are used.

Many investigations have noted that black plastic hastens ripening of fruits and vegetables (Greer and Dole, 2003; Rulevich et al., 2003). Japanese quince fruits ripened earlier with black plastic or fabric than with wood chips or herbicides. Black mulches probably accumulate heat, which promotes ripening. Since quinces start to flower very early, the mulches used did not

significantly affect flowering time. Plants which flower later like strawberries, respond positively to black plastic mulch (Plekhanova and Petrova, 2002).

Wood chips resulted in reduced height and total shoot length in Japanese quince, as has been noted with strawberries and highbush blueberries (Kęsik and Maskalaniec, 2003; Starast et al., 2002), though conflicting results were noted by other investigations (Engel et al., 2001; Rubauskis et al., 2002). The growth of Japanese quince was probably caused by nitrogen deficiency; when nitrogen was applied at a 40% higher rate during the second season in Lithuania, the differences in growth of plants treated with the different methods were smaller.

Although herbicides did not cause any visually detectable damage, they seen to have a negative effect on young Japanese quince plants, and should be applied sparingly until the plants become established.

Synthetic mulches increased total shoot length in comparison to mechanical weeding, herbicides and wood chips.

Better plant development resulted in higher crop. Mulching increased yields though there were differences between genotypes. All mulches, improved yields more than herbicides and mechanical weeding. Mulches probably improved yields by reducing competition with weeds, for nutrients, increased heat accumulation (Ibarra et al., 2001), improved water balance (Greer and Dole, 2003), and increasing the concentration of nutrients higher up the soil column (Lang et al., 2001).

During the third season, black fabric resulted in lower yields in Lithuania and Sweden, probably because it was not UV-stable and broke down during the second season, allowing grass to invade the rows. For this some reason black fabric also reduced the yield of health fruits in Sweden. Black plastic had the opposite effect. Plastic mulches have proven superior in controlling diseases and improving fruit quality in other crops (Diaz-Perez et al., 2003; Prokkola et al., 2003; Laugale et al., 2002).

During the first season, all mulched provided the best weed control. During the second year, weeds began to grow on and through the black fabric. Black fabric proved not to last long, and should be further improved or exchanged for longer protection. Weeds also started to germinate in the wood chips. Even though weeds were twice removed by hand, a new layer of wood chips had to be applied to maintain weed control. At all sits, black plastic proved to be the best method of weed control.

CONCLUSIONS

1. Weed control by various mulches improves growth and development of Japanese quince plants and increases yield.
2. Black plastic mulches result in earlier fruit ripening.

3. Synthetic mulches control weeds efficiently, but a long lasting material should be selected.
4. Organic mulches should be renewed annually for a lasting effect.

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ŚCIÓŁKOWNIE I ZWALCZANIE CHWASTÓW NA PLANTACJACH PIGWOWCA JAPOŃSKIEGO (*Chaenomeles japonica* LDL.)

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STRESZCZENIE

Słaby wzrost i rozłożysty pokrój krzewów jest powodem trudności z kontrolowaniem zachwaszczenia na plantacjach pigwowca japońskiego (*Chaenomeles japonica*). Niewyrośnięte jeszcze krzewy bardzo często przegrywają konkurencję z chwastami. Odchwaszczanie jest podstawowym zabiegiem agrotechnicznym mającym bardzo duży wpływ na opłacalność produkcji na plantacjach pigwowca prowadzonych metodami organicznymi. Dlatego też celem przeprowadzonych badań była ocena efektywności kilku metod kontrolowania zachwaszczenia (czarna włóknina, czarna folia, rozdrobnione gałęzie, odchwaszczanie mechaniczne oraz zastosowanie herbicydów). Ściółki syntetyczne najlepiej ograniczały zachwaszczenie, wpływały także pozytywnie na wzrost i plonowanie krzewów, a dodatkowo zabezpieczały owoce przed ubrudzeniem ziemią. Na poletkach, na których zastosowano rozdrobnione gałęzie zaobserwowano niedobory azotu. Stosowanie herbicydów wyraźnie poprawiało wzrost młodych krzewów.

Słowa kluczowe: *Chaenomeles japonica*, ściółki organiczne, ściółki syntetyczne, plon, jakość owoców, zwalczanie chwastów