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# EFFECT OF BLACK SYNTHETIC MULCHES ON THE FRUIT QUALITY AND SELECTED COMPONENTS OF NUTRITIVE VALUE OF MELON

Edyta Kosterna, Anna Zaniewicz-Bajkowska, Robert Rosa, Jolanta Franczuk, Izolda Borysiak-Marciniak, Krystyna Chromińska
University of Podlasie in Siedlce

**Abstract**. The use of synthetic materials for mulching is a very common practice for vegetable crops. Soil mulching influences the microclimate around plants and soil environmental conditions. Mulching with black materials is particularly recommended for thermophilic species, especially those requiring high soil temperature. An experimet was established to evaluate an effect of soil mulching with synthetic materials (black polyethylene film, black polypropylene nonwoven 50 g·m, black fabric 94 $g \cdot m^{-2}$) on the fruit quality and nutritive value of two melon cultivars ('Seledyn', 'Yupi') cultivated in the field under the climatic conditions of central-eastern Poland. The greatest numbers of fruit per 1 $m^2$ and marketable fruit were harvested in the year 2007 which was most favourable for melon growing compared with the remaining study years. The number of the fruits which were either unripe or showed symptoms of decay did not differ significantly in individual study years. 'Yupi' was characterised by a significantly higher total number of fruit and number of marketable fruit than 'Seledyn'. 'Yupi' fruits were less affected by decay than 'Seledyn' which, however, produced significant less unripe fruit. 'Yupi' fruits had significantly more dry matter, total sugars, monosaccharides and vitamin C as compared to 'Seledyn'. In both the cultivars examined, higher nutrient contents were determined in the fruit grown using black film mulching.

**Key words**: black polyethylene film, black polypropylene nonwoven, *Cucumis melo* L., fabric, soil mulching, quality

Corresponding author – Adres do korespondencji: Edyta Kosterna, Anna Zaniewicz-Bajkowska, Robert Rosa, Jolanta Franczuk, Izolda Borysiak-Marciniak, Krystyna Chromińska Department of Vegetable Crops, University of Podlasie, Prusa 14 St., 08-110 Siedlce, e-mail: warzywa@ap.siedlce.pl

## INTRODUCTION

Soil mulching with plastic mulches influences the microclimate around plants and soil environment conditions [Buczkowska 1999, Brault et al. 2002, LeClaire 2002, White 2003, Dyduch and Najda 2004, Jenni et al. 2004, Locher et al. 2005, Jenni et al. 2006, Moreno and Moreno 2008, Ban et al. 2009]. Mulching with black materials is particularly recommended for thermophilic species, especially those requiring high soil temperature. Melon, representing this group, is the most thermophilic species cultivated in Poland [Romić et al. 2003, Negreiros et al. 2005, McCann et al. 2007].

Weather conditions in the central-eastern part of Poland are more favourable for melon cultivation than in other parts of the country. It is due to the continental climate whose greater effect is associated with higher temperatures and lower precipitation over the summer period. Such conditions are suitable for the cultivation of melon which, although tolerant of water shortages in the growing period, needs the temperatures of at least 16°C.

Research on field-grown melon in Poland is scarce and as a result many points of agrotechnology of the species require extensive studies and more detailed description.

The objective of the present work was to determine an effect of soil mulching with black film, black nonwoven and fabric on the fruit quality and selected components of nutritive value of two melon cultivars grown under the weather conditions of central-eastern Poland.

## MATERIALS AND METHODS

A field experiment was carried out in 2006–2008 at the University of Podlasie investigative object located in Siedlce which has long been uses for horticultural purposes. The experiment was conducted on anthropogenic soil with hortisol properties. In the autumn of the year preceding melon growing, farmyard manure was applied at a rate of 40 $t \cdot ha^{-1}$. In the spring soil analysis was conducted prior to experiment set-up to determine the soil content of organic carbon and plant-available macroelements. The soil contained an average of 2.1 to 2.4% organic carbon (C-org.) (tab. 1). The contents of plant-available elements were referred to the respective optimal contents for cucumber which were also assumed to be optimal for melon. Plant-available nutrient contents were below the optimum values for melon so the decision was made to apply Azofoska at a rate of 1 kg per 10 $m^{-2}$ of cultivated area prior to planting transplants.

The experiment was set up a completely randomised design with four replications. To investigate the effect of soil mulching with synthetic materials (black polyethylene film, black polypropylene nonwoven 50 $g \cdot m^{-2}$, fabric 94 $g \cdot m^{-2}$) on the fruit quality and nutritive value of two melon cultivars (‘Seledyn’, ‘Yupi’).

Melon seedlings were grown in a non-heated greenhouse. The seeds were sown in the third decade of April to the peat-cellulose pots with a diameter of 8 cm. The seedlings were produced using peat substrate.

One week before seedlings were planted, experimental units were covered with black film, black polypropylene nonwoven or fabric. To stimulate production of side

vines before planting of seedlings in the ground, their vine tops were removed above the third true leaf. The transplants were moved permanently outdoors and planted in the first 10-days of June and covered with white polypropylene agrotextile which was removed at the beginning of flowering. Melon seedlings were planted at 80 × 100 cm spacing, at 10 plants on each plot.

Table 1. Characteristic of soil conditions before experiment placing (available food components contents)

Tabela 1. Charakterystyka warunków glebowych przed założeniem doświadczenia (zawartość łatwo przyswajalnych składników pokarmowych)

| Years – Lata | pH | C-org.% | $N\text{-}NO_3$ | $N\text{-}NH_4$ | P | K | Ca | Mg |
|---|---|---|---|---|---|---|---|---|
| | | | $mg \cdot dm^{-3}$ air dry mass – powietrznie suchej masy | | | | | |
| 2006 | 6.4 | 2.2 | 33.3 | 64.0 | 51.2 | 151.0 | 2388.5 | 81.9 |
| 2007 | 6.7 | 2.4 | 43.5 | 56.3 | 43.5 | 186.9 | 2222,1 | 61.4 |
| 2008 | 7.0 | 2.1 | 25.6 | 56.3 | 66.6 | 156.2 | 2483.2 | 66.6 |
| Mean – Średnio | 6.7 | 2.2 | 34.1 | 58.9 | 53.8 | 164.7 | 2364.6 | 70.0 |
| Optimum limit Wartości optymalne [Sady 2000] | 6.0–7.2 | - | 55-80 | | 60–80 | 175–250 | 1000–1500 | 60–80 |

Field operations included weed control and split application of two rates of nitrogen and potassium fertilizers.

As plants grew, excessive buds were removed leaving five largest buds on the plant. Moreover, fruit-bearing vines were shortened leaving two leaves located close to the bud. In addition, non-fruit-bearing vines were removed.

Fruit harvest was performed once a week as fruit ripened. During the harvest there was determined the number of fruit per 1 $m^2$ according to the following categories: total fruit number, marketable fruit number and number of fruit showing symptoms of decay and unripe fruit.

Marketable fruits harvested at the third date were sampled to perform chemical analyses in order to determine the following contents: dry matter – using the oven-drying gravimetric method, total sugars and monosaccharides – using the Luff Schoorl method, and vitamin C – using the Pijanowski method.

The results of the experiment were analysed statistically by means of the analysis of variance. The significance of differences was verified using Tukey test at the significance level of $\alpha = 0.05$.

The mean air temperature in the growing period of melon (June–September) in the study years ranged from 16.4°C in 2008 to 17.8°C in 2006 and was higher than the long-term mean (1951–1980) (tab. 2). The least favourable for melon growth and performance was the year 2006 which was characterized by varied air temperature and very irregular rainfall distribution. High temperatures and drought in July hindered the growts and flowering of plants. Heavy rainfall in August accompanied by the temperature lower then the long-term mean delayed fruit ripening, development of fungus dis-

eases (*Botrytis cinerea* Pers.) and fruit decay. Unfavourable conditions in 2006 decreased the total and marketable fruit number produced per 1 $m^2$. The most favourable

Table 2. Mean air temperature and precipitation sums in the vegetation period of melon
Tabela 2. Średnie temperatury powietrza i sumy opadów atmosferycznych w okresie wegetacji melona

| Years – Lata | Temperature – Temperatura (°C) | | | | | Precipitation – Opady (mm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | June czerwiec | July lipiec | August sierpień | September wrzesień | mean średnio | June czerwiec | July lipiec | August sierpień | September wrzesień | mean średnio |
| 2006 | 16.6 | 21.8 | 17.7 | 15.1 | 17.8 | 25.7 | 8.6 | 255.5 | 28.3 | 318.1 |
| 2007 | 18.2 | 18.5 | 18.6 | 13.1 | 17.1 | 59.9 | 70.2 | 31.1 | 67.6 | 228.8 |
| 2008 | 17.0 | 18.1 | 18.4 | 12.2 | 16.4 | 56.7 | 108.8 | 85.1 | 46.4 | 297.0 |
| Mean – Średnia 1951–1980 | 16.6 | 17.7 | 18.9 | 12.7 | 16.5 | 75.0 | 80.0 | 68.0 | 47.3 | 270.3 |

weather conditions for melon yields were in 2007 when uniform and high temperature was accompanied moderate rainfalls in June and July in the growing period of melon, and low rainfall during fruit ripening in August.

## RESULTS AND DISCUSSION

The total number of fruit and number of marketable fruit harvested in 2007 amounted to 3.58 and 2.53 fruit·$m^{-2}$, respectively, and was by 0.60 and 0.68 fruit·$m^{-2}$ higher than in 2008 and by 1.32 and 1.43 fruit·$m^{-2}$ higher than in 2006, the year being the least favourable for melon cultivation. The differences in the total number of fruit and number of marketable fruit harvested in the consecutive study years were statistically significant. The number of the fruits which were either unripe or showed symptoms of decay did not differ significantly in individual study years (tab. 3).

Table 3. Differentiation the number of melon fruit in the consecutive study years
Tabela 3. Zróżnicowanie liczby owoców melona w poszczególnych latach badań

| Years – Lata | Number of fruit, fruit·$m^{-2}$ – Liczba owoców, szt.·$m^{-2}$ | | | |
|---|---|---|---|---|
| | total wszystkie | marketable handlowe | showing symptoms of decay z objawami gnicia | unripe niedojrzałe |
| 2006 | 2.26 | 1.10 | 0.31 | 0.83 |
| 2007 | 3.58 | 2.53 | 0.35 | 0.71 |
| 2008 | 2.98 | 1.85 | 0.65 | 0.71 |
| Mean – Średnio | 2.94 | 1.83 | 0.36 | 0.75 |
| $LSD_{0.05}$ – $NIR_{0,05}$ | 0.19 | 0.36 | n.s – n.i. | n.s – n.i. |

Of the total number of fruit, marketable fruit constituted 62.3%, fruit with symptoms of decay 12.2% and fruit which did not ripe till the end of the growing period 25.5% (tab. 4). 'Yupi' produced significantly more total and marketable fruit than 'Seledyn'. Also, the number of marketable fruit produced by 'Yupi' was by 0.5 greater than by 'Seledyn'. What is more, 'Yupi' fruits showed less symptoms of decay than 'Seledyn'. Although the number of unripe 'Yupi' fruit was significantly higher than 'Seledyn', the percentages of unripe fruit in the total number of fruit for both the cultivars were on a similar level and amounted to 22.7% for 'Seledyn' and 27.8% for 'Yupi'.

The number of marketable fruit significantly depended on the interaction between the cultivar and the kind of cover (tab. 4). The number of marketable fruit was most favourably influenced by the cultivation including an application of black film. A similar number of fruit was harvested from plants cultivated on the fabric-mulched soil and in the control. A significantly lower number of fruit was produced by plants cultivated on the black polypropylene nonwoven -mulched soil. Black polypropylene nonwoven was found to be the best cover in the cultivation of 'Yupi', as the number of 'Yupi' fruit per 1 $m^2$ was significantly higher than in the black film-mulched treatments. 'Yupi' cultivated on the fabric-mulched soil and in the control produced a similar number of fruit compared with the plants cultivated on the black film-mulched soil. In their studies Ban et al. [2009] found a significant effect of the kind of mulch on the number of melon fruit per 1 ha and per 1 plant. The favourable effect of mulches was confirmed in the studies on the number of melon fruit [Romić et al. 2003], pepper [Hutton and Handley 2007] and tomato [Abdul-Baki and Spence 1992, Moreno and Moreno 2008]. In the studies by Najda and Dyduch [2005] soil mulching with black polyethylene film and black polypropylene nonwoven significantly influenced the investigated characteristics of celery. The authors found that the mulches applied in the experiment increased the number of petioles in a rosette and the average length of petioles, compared with the control without mulch. The authors reported that better results were obtained after black film mulching compared with nonwoven. Rekowska [1998] examined soil mulching in garlic cultivation and reported a significant increase (of 16.2%) of marketable garlic yield as compared to cultivation without mulch. Moreover, soil mulching with black film increased the diameter and mass of garlic cloves.

'Yupi' was characterized by significantly higher contents of dry matter, total sugars, monosaccharides and vitamin C than 'Seledyn' (tab. 5). Black film mulch had the most favourable influence on the dry matter and monosaccharides contents of 'Seledyn'. Significantly less dry matter was found in the fruit harvested from treatments mulched with nonwoven and fabric, and in the control whereas significantly less monosaccharides were determined in the non-mulched control. The kind of cover had no significant influence on the dry matter content in 'Yupi' fruit.

In 'Yupi' cultivation, black film mulching had the most favourable influence on fruit contents of total sugars and monosaccharides whereas an application of nonwoven mulch had the best effect on total sugar content. A significantly lower total sugar content was determined in 'Yupi' fruit in the control without mulching and in the plots where fabric mulch was applied. The content of monosaccharides was significantly lower in the nonwoven-mulched treatments. Higher vitamin C contents in the fruit of

Table 4. The effect of kind of synthetic mulch on the quality of melon fruit (mean for years 2006–2008)
Tabela 4. Wpływ rodzaju ściółki syntetycznej na jakość owoców melona (średnia z lat 2006–2008)

| Kind of mulch<br>Rodzaj ściółki | Number of fruit (fruit·m$^{-2}$) – Liczba owoców (szt·m$^{-2}$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | total<br>łącznie | | | marketable<br>handlowe | | | showing symptoms of decay<br>z objawami gnicia | | | unripe<br>niedojrzałe | | |
| | Seledyn | Yupi | mean<br>średnio | Seledyn | Yupi | mean<br>średnio | Seledyn | Yupi | mean<br>średnio | Seledyn | Yupi | mean<br>średnio |
| Control – Kontrola | 2.75 | 3.22 | 2.99 | 1.58 | 1.94 | 1.76 | 0.50 | 0.31 | 0.40 | 0.67 | 0.97 | 0.82 |
| Black polyethylene film<br>Folia polietylenowa | 2.83 | 3.03 | 2.93 | 1.83 | 1.89 | 1.86 | 0.50 | 0.31 | 0.40 | 0.50 | 0.83 | 0.67 |
| Black polypropylene nonwoven<br>Włóknina polipropylenowa | 2.52 | 3.47 | 3.00 | 1.39 | 2.36 | 1.88 | 0.44 | 0.25 | 0.35 | 0.69 | 0.86 | 0.78 |
| Black fabric<br>Tkanina polipropylenowa | 2.45 | 3.25 | 2.85 | 1.50 | 2.14 | 1.82 | 0.42 | 0.17 | 0.29 | 0.53 | 0.94 | 0.74 |
| Mean – Średnio | 2.64 | 3.24 | 2.94 | 1.58 | 2.08 | 1.83 | 0.47 | 0.26 | 0.36 | 0.60 | 0.90 | 0.75 |
| $LSD_{0.05}$for – $NIR_{0,05}$ dla:<br>cultivar – odmiany,<br>kind of cover – rodzaju ściółki,<br>for interaction – dla współdziałania:<br>cultivar – odmiana × kind of cover – rodzaj ściółki | | 0.12<br>n.s – n.i.<br><br>n.s – n.i. | | | 0.24<br>n.s – n.i.<br><br>0.44 | | | 0.13<br>n.s – n.i.<br><br>n.s – n.i. | | | 0.15<br>n.s – n.i.<br><br>n.s – n.i. | |

Table 5. The effect of kind of synthetic mulch on the selected components of nutritive value of melon (mean for years 2006–2008)
Tabela 5. Wpływ rodzaju ściółki syntetycznej na wybrane elementy wartości odżywczej melona (średnia z lat 2006–2008)

| Kind of mulch<br>Rodzaj ściółki | Dry matter, %<br>Sucha masa | | | Total sugar, % f.m.<br>Cukry ogółem, % św.m. | | | Monosaccharides, % f.m.<br>Cukry redukujące, % św.m. | | | Vitamin C, $mg \cdot 100g^{-1}$ f.m.<br>Witamina C, $mg \cdot 100g^{-1}$ św.m. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seledyn | Yupi | mean<br>średnio | Seledyn | Yupi | mean<br>średnio | Seledyn | Yupi | mean<br>średnio | Seledyn | Yupi | mean<br>średnio |
| Control – Kontrola | 4.05 | 5.56 | 4.75 | 2.46 | 3.85 | 3.15 | 0.65 | 0.80 | 0.72 | 16.20 | 18.68 | 17.44 |
| Black polyethylene film<br>Folia polietylenowa | 4.80 | 5.55 | 5.18 | 2.64 | 4.69 | 3.66 | 0.76 | 1.00 | 0.88 | 17.20 | 18.81 | 18.01 |
| Black polypropylene nonwoven<br>Włóknina polipropylenowa | 4.03 | 5.18 | 4.61 | 2.42 | 4.35 | 3.38 | 0.70 | 0.84 | 0.77 | 16.06 | 18.22 | 17.14 |
| Black fabric<br>Tkanina polipropylenowa | 4.13 | 5.44 | 4.79 | 2.34 | 3.89 | 3.12 | 0.69 | 0.83 | 0.76 | 16.93 | 18.33 | 17.63 |
| Mean – Średnio | 4.25 | 5.41 | 4.83 | 2.47 | 4.19 | 3.33 | 0.70 | 0.86 | 0.78 | 16.60 | 18.51 | 17.55 |
| $LSD_{0.05}$for – $NIR_{0,05}$ dla:<br>cultivar – odmiany,<br>kind of cover – rodzaju ściółki,<br>for interaction – dla współdziałania:<br>cultivar – odmiana × kind of cover –<br>rodzaj ściółki | | 0.16<br>0.52<br><br>0.52 | | | 0.29<br>0.23<br><br>0.37 | | | 0.04<br>0.06<br><br>0.11 | | | 0.23<br>0.77<br><br>n.s – n.i. | |

both cultivars were determined when black film mulching was applied, as compared to polypropylene nonwoven. The difference amounted to 0.87 mg·100 $g^{-1}$ f. m.

In the studies by Wierzbicka [1999], soil mulching with black film increased dry matter and vitamin C contents in the lettuce head but only in the year with a warmer growing season, compared with non-mulched soil. On the contrary, research by Dyduch and Najda [2005] revealed that soil mulching reduced dry matter and L-ascorbic acid contents in both petioles and leaves as well as the whole leaves of celery. Studies by Słociak and Kołota [2003] showed that soil mulching with white film reduced dry matter and vitamin C contents as well as total sugar and monosaccharide contents in the courgette fruit. Siwek [2002] investigated the effect of soil mulching on nutrient contents in cucumber and celery and found that plants growing on mulches contained lower quantities of some active substances because of higher content of water in the soil.

## CONCLUSIONS

1. The greatest numbers of fruit per 1 $m^2$ and marketable fruit were harvested in the year 2007 which was most favourable for melon growing compared with the remaining study years.

2. 'Yupi' was characterised by a significantly higher total number of fruit and number of marketable fruit than 'Seledyn'. 'Yupi' fruits were less affected by decay than 'Seledyn' which, however, produced significant less unripe fruit.

3. 'Yupi' fruits had significantly more dry matter, total sugars, monosaccharides and vitamin C.

4. In both the cultivars examined, higher nutrient contents were determined in the fruit grown using black film mulching.

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## WPŁYW CZARNYCH ŚCIÓŁEK SYNTETYCZNYCH NA JAKOŚĆ OWOCÓW I WYBRANE ELEMENTY WARTOŚCI ODŻYWCZEJ MELONA

**Streszczenie**. Stosowanie materiałów syntetycznych do mulczowania gleby jest często praktykowane w uprawie warzyw. Ściółkowanie gleby wpływa na mikroklimat wokół roślin oraz warunki środowiska glebowego. Ściółkowanie czarnymi materiałami zalecane jest szczególnie dla gatunków ciepłolubnych, a zwłaszcza tych, które wymagają wysokiej temperatury gleby. W doświadczeniu badano wpływ ściółkowania gleby materiałami syntetycznymi (czarna folia polietylenowa, czarna włóknina polipropylenowa 50 $g \cdot m^{-2}$, czarna tkanina polipropylenowa 94 $g \cdot m^{-2}$) na jakość oraz wartość odżywczą owoców dwóch odmian melona (‘Seledyn’, ‘Yupi’) uprawianego w gruncie w warunkach klimatycznych

środkowowschodniej Polski. Najwięcej owoców z 1 $m^2$ oraz owoców handlowych zebrano w najbardziej sprzyjającym uprawie melona roku 2007 w porównaniu z pozostałymi latami badań. Liczba owoców niedojrzałych i wykazujących objawy gnicia w poszczególnych latach badań nie różniła się istotnie. Odmiana 'Yupi' charakteryzowała się istotnie większą łączną liczbą owoców i liczbą owoców handlowych niż odmiana 'Seledyn'. Owoce odmiany 'Yupi ' były też mniej podatne na gnicie. Istotnie mniej owoców niedojrzałych dała odmiana 'Seledyn'. Istotnie więcej suchej masy, cukrów ogółem i redukujących oraz witaminy C stwierdzono w owocach odmiany 'Yupi' w porównaniu z odmianą 'Seledyn'. W przypadku obu badanych odmian większą zawartością składników odżywczych charakteryzowały się owoce z obiektów ściółkowanych folią polietylenową.

**Słowa kluczowe**: *Cucumis melo* L., czarna folia, czarna włóknina, jakość, tkanina polipropylenowa, ściółkowanie gleby

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