Acta Agrobotanica

DOI: 10.5586/aa.1699

Publication history
Received: 2016-04-01
Accepted: 2017-01-04
Published: 2017-06-01

Handling editor
Danuta Kozak, Faculty of Horticulture and Landscape Architecture, University of Life Sciences in Lublin, Poland

Authors' contributions
AZB, MP: designing the research; MP: field work; JF, RR, EKK, AZB: data analyses, writing the manuscript

Funding
The research was supported by the Polish Ministry of Science and Higher Education as part of the statutory activities of the Siedlce University of Natural Sciences and Humanities.

Competing interests
No competing interests have been declared.

Citation
Franczuk J, Rosa R, Kosterna-Kelle E, Zaniewicz-Bajkowska A, Panasz M. The effect of transplanting date and covering on the growth and development of melon (*Cucumis melo* L.). Acta Agrobot. 2017;70(2):1699. https://doi.org/10.5586/aa.1699

ORIGINAL RESEARCH PAPER

The effect of transplanting date and covering on the growth and development of melon (*Cucumis melo* L.)

Jolanta Franczuk, Robert Rosa*, Edyta Kosterna-Kelle, Anna Zaniewicz-Bajkowska, Marzena Panasz

Faculty of Agriculture, Siedlce University of Natural Sciences and Humanities, Bolesława Prusa 14, 08-110 Siedlce, Poland

* Corresponding author. Email: robert.rosa@uph.edu.pl

Abstract

The effect of different transplanting dates (May 15, May 25, and June 4) and date of polypropylene fiber removal (4 and 8 weeks after transplanting, and control without covering) on the growth, development, and yield of melon (*Cucumis melo* L.) were investigated. The experiment was carried out during 2008–2010 in eastern Poland (51°53′23.64″ N, 22°27′47.96″ E). Plants planted on May 15 were longer by 22% and 56%, weighed more by 39% and 76%, and their leaf area index (LAI) was higher by 24% and 117% compared to plants planted on May 24 and June 4, respectively. However, delayed planting reduced the period of growth and development by 7 and 17 days, respectively. When the covering application period was extended from 4 to 8 weeks, stem length increased by an average of 23% and LAI by 38%, but harvest was delayed by 6 days. The respective yields of melon fruits planted on May 15, May 25, and June 4 amounted to 5.09, 4.73, and 3.99 kg m^{-2}. The covering of plants planted at each date contributed to an increase in yield and in the share of marketable fruit yield in the total yield. However, the length of the cover application period did not affect yield levels.

Keywords

Cucumis melo; transplanting date; growth attributes; polypropylene fiber; yields

Introduction

Melon (*Cucumis melo* L.) is cultivated in Poland by amateurs only. However, due to its nutritional benefits, medicinal properties, and flavor-related attributes, the cultivation of this plant should be popularized and considered for commercial production. Also, the melon's biological value is much higher compared with its close relative, the cucumber [1].

Ideal growing conditions for melons, in which the plant growth stages progress best, include an air temperature of over 20°C. When temperature drops below 15°C, the growth of melon plants is inhibited. Melons are also very prone to air and soil temperature fluctuations, which cause physiological disturbances. To avoid damage caused to thermophilic vegetables by low air and soil temperatures (April, May), it is recommended to delay the transplanting date. However, there is an economic incentive to start cultivation earlier so as to accelerate the harvest, or to extend the growing season by transplanting seedlings in less favorable thermal conditions. Whereas the sowing date affects seedling quality, the transplanting date influences the growth of plants after seedlings have been transplanted [2–4].

In addition, the water needs of melon are high, particularly during the period of intense vegetative growth and fruit formation [5].

The growth and development of thermophilic vegetable species in the field is improved when plants have been covered with polypropylene fiber [6–8]. Covers reduce evaporation and decrease heat losses at night. In the study by Kosterna [9], soil temperature increased by 1.3–1.7°C as a result of covering. A soil temperature increase due to cover application was observed in the last week of May. Moreno et al. [10] reported that the soil temperature at a depth of 5 cm was on average by 5°C higher under a nonwoven polypropylene sheet. In the study by Hamouz et al. [11], plant covering with polypropylene fiber contributed to a 1.8°C increase in soil temperature and a 2.0°C increase in air temperature, on average. Plants grown under polypropylene fiber are more uniform, taller, and their mass of aboveground parts is higher compared with cultivation without covers [12–14]. Earlier plant development under covers contributes to greater solar radiation interception and the enlargement of the assimilation leaf area, which has the greatest impact on plant productivity [9,15–16].

The study aimed to determine the effect of an earlier date of transplanting melon seedlings and different dates of polypropylene fiber removal on the growth and development of plants and fruit yields.

Material and methods

Experimental site

The experiment was carried out during 2008–2010 in eastern Poland (51°53′23.64″ N, 22°27′47.96″ E). According to the international system of FAO classification, the soil was classified as Podzols [17]. The soil was characterized by a humus level of 37–43 cm, the average organic carbon content amounted to 2.1%, and the value of pH determined in H_2O was 5.8. The total contents of macroelements in mg dm^{-3} were as follows: 14 mg NH_4–N; 20 mg NO_3–N; 19 mg P_2O_5; 145 mg K_2O; 797 mg Ca; 76 mg Mg.

Experimental design

The experiment was arranged as a split-block design with four replicates. The effect of transplanting date of cv. 'Malaga F1' melon seedlings (June 4 – the conventionally recommended transplanting date in Central Europe, May 25 – 10 days earlier, May 15 – 20 days earlier compared with the recommended date) and date of polypropylene fiber removal (4 and 8 weeks after transplanting and control without covering) on the selected attributes of plant growth and development was investigated.

Field work and measurements

The field for melon cultivation was prepared following conventional cultivation recommendations. Pre-winter ploughing was performed in fall and followed by leveling in spring. Mineral fertilizers were applied at the following rates: 75 N, 140 P, and 160 K kg ha^{-1}, in the form of, respectively, urea, granular superphosphate and potassium sulfate. Next, they were mixed with the soil and the soil surface was smoothed using combined soil preparation equipment. Melon seedlings were grown in a non-heated greenhouse. Seeds were sown 4 weeks before the transplanting date, i.e., April 17, April 27, and May 7. Before the transplanting of seedlings in the field, they were hardened off and their vine tops were removed, so that each plant had three or four leaves, to stimulate the plants to produce side shoots on which flowers are formed. The seedlings were transplanted at a spacing of 80 × 100 cm, 16 plants per plot. Measurements were taken from four plants. The plot area for harvest was 12 m^2.

Plant growth was determined before transplanting and 8 weeks after transplanting. The following measurements were taken: stem length (cm), weight of aboveground plant parts (g), number of leaves per plant, assimilation leaf area (cm^2). Assimilation leaf area was determined by the gravimetric method. The plant growth data was used to calculate leaf area index (LAI) and leaf area ratio (LAR). Also, total fruit yield (kg m^{-2}), fruit weight (kg), and number of days from planting to first harvest were determined in each plot. In addition, the share of marketable yield in the total yield (%) was calculated. Fruit harvest was performed once a week as fruit ripened.

Statistical analysis

The results were statistically analyzed by ANOVA. The significance of differences was determined by Tukey's test at the significance level of α = 0.05. All the calculations were performed using STATISTICA, version 12.0, and MS Excel.

Meteorological conditions

Weather conditions varied during the study period and were not always favorable for plant growth (Fig. 1). In June 2008 and 2010, thermal conditions just after transplanting were more favorable than in 2009. Throughout all the study years, July and August were warmer compared with the long-term mean for these months. The most favorable thermal conditions in July and August were in 2010. The year 2009 was most unfavorable in terms of the amount of precipitation. Also, low temperatures in June were accompanied by very high precipitation. Moreover, high temperatures and drought in July exacerbated the situation. Unstable weather conditions in 2009 contributed to much poorer growth of seedlings.

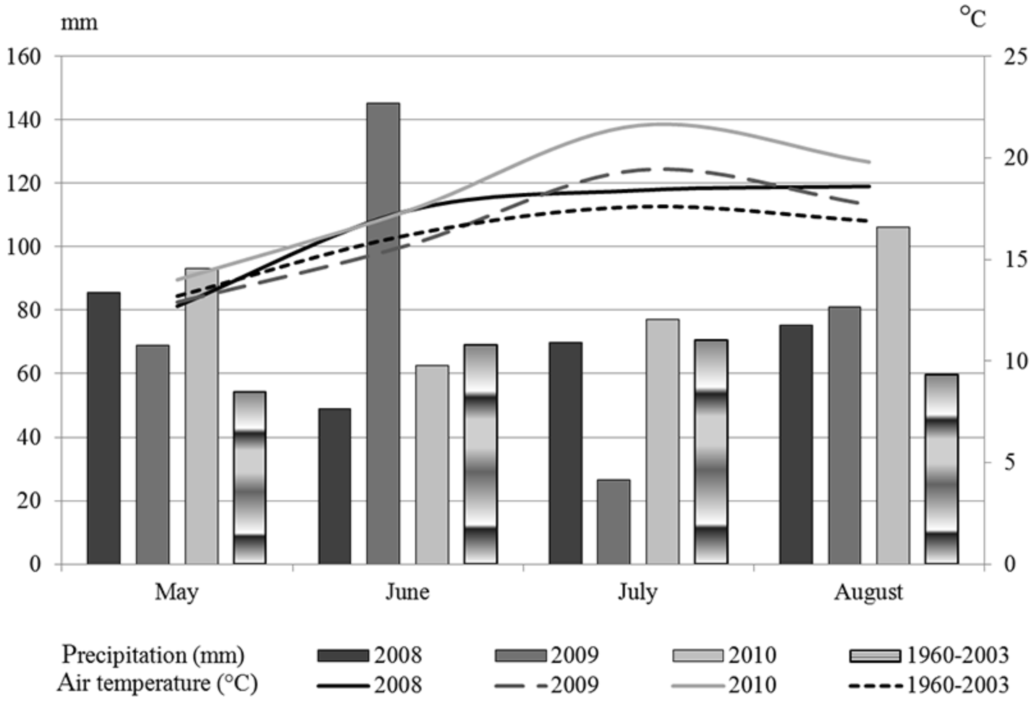

Fig. 1 Weather conditions during the growing season of melon (*C. melo*).

Results

Seedlings prepared for transplanting on June 4 were significantly longer and heavier, and had a higher assimilation leaf area and LAR than those transplanted on May 15 and May 25, although in each case the time from sowing the seeds to the measurement was 28 days (Tab. 1).

Air temperature and precipitation in 2009 fluctuated substantially (dry and hot July, wet and colder August). As a result, melon plants weighed less but their stems were longer than in 2008 when both rainfall and temperatures were more uniform during the

Tab. 1 Plant growth attributes before transplanting of melon (*Cucumis melo*) (averages for 2008–2010).

Transplanting date	Stem length (cm)	Plant weight (g)	Assimilation leaf area (cm^2)	LAR ($cm^2\ g^{-1}$)
May 15	5.90 ^{a}	2.90 ^{a}	11.50 ^{a}	3.90 ^{a}
May 25	6.40 ^{a}	3.00 ^{a}	12.10 ^{a}	4.00 ^{a}
June 4	9.20 ^{b}	4.00 ^{b}	20.00 ^{b}	4.90 ^{b}
F-value	3.38	52.09	35.22	9.03
p	0.03	<0.001	<0.001	0.005
Mean	7.20	3.30	14.50	4.30

Values followed by the same letters are not significantly different at $p \leq 0.05$. LAR – leaf area ratio.

Tab. 2 Plant growth attributes of melon 8 weeks after transplanting of melon (*C. melo*).

Years	Stem length (cm)	Plant weight (g)	LAI	LAR ($cm^2\ g^{-1}$)
2008	32.30 ^{a}	102.20 ^{b}	1.27 ^{a}	17.10 ^{b}
2009	36.90 ^{b}	82.80 ^{a}	1.21 ^{a}	14.60 ^{b}
2010	47.90 ^{c}	153.50 ^{c}	1.76 ^{b}	7.90 ^{a}
F-value	79.45	105.58	10.11	26.21
p	<0.001	<0.001	0.006	0.002

Values followed by the same letters are not significantly different at $p \leq 0.05$. LAI – leaf area index; LAR – leaf area ratio.

growing season. The most favorable weather conditions for melon crops were in 2010 when the highest average air temperatures were recorded. Stem length, plant weight and LAI were significantly higher but LAR was significantly lower compared with the remaining study years (Tab. 2).

Eight weeks after transplanting, the stem elongated more than five times and the weight of plants increased more than 30 times compared with their length and weight prior to transplanting. Stem length, plant mass, and LAI markedly declined whether the transplanting date was delayed by 10 or 20 days (Tab. 3).

Irrespective of the transplanting date, plants covered with polypropylene fiber had significantly longer stems, weighed more and their LAI was higher compared with non-covered plants. At each transplanting date, plants with significantly longer stems grew in the plots where covering had been applied for 8 rather than 4 weeks. Plants transplanted on June 4 and May 25 covered for 8 weeks had a significantly higher weight (by 25%) and LAI (by 7%), respectively. Regardless of the transplanting date, non-covered plants had significantly higher LAR index values than those covered for either 4 or 8 weeks post-planting (Tab. 3).

In the conditions of eastern Poland, delayed melon transplanting significantly reduced fruit yield and weight (Fig. 2). The yield of melons transplanted on May 25 and June 4 decreased by 7.6% and 29.5%, while the weight of fruits by 4.7% and 6.2%, respectively, compared to the first date (May 15). Irrespective of the transplanting date, covering with polypropylene fiber contributed to a significant increase in melon yield compared with lack of cover. At the consecutive transplanting dates, the increase due to covering amounted to 200%, 160%, and 125%, respectively. The length of covering time did not affect the yield level. The fruit weight of melon plants planted on May 15 and May 25 increased significantly as a result of plant covering. The increase amounted to 17% and 15.5%, respectively, compared with the non-covered control.

The highest (84%) and the lowest (76%) share of marketable yield in the total yield was recorded for plants planted on June 4 and May 15, respectively (Fig. 2). Covering

Tab. 3 Plant growth attributes of melon 8 weeks after transplanting of melon (*C. melo*) (averages for 2008–2010).

Covering	Transplanting date							
	May 15	May 25	June 4	Mean	May 15	May 25	June 4	Mean
	Stem length (cm)				Plant weight (g)			
No covering	19.00* [a]	17.20 [a]	17.00 [a]	17.70 [a]	64.90 [a]	43.60 [a]	26.40 [a]	45.00 [a]
Covered for 4 weeks after planting	59.70 [b]	43.60 [b]	30.50 [b]	44.60 [b]	193.60 [b]	138.90 [b]	100.50 [b]	144.20 [b]
Covered for 8 weeks after planting	64.20 [c]	55.80 [c]	44.00 [c]	54.70 [b]	185.80 [b]	136.10 [b]	125.90 [c]	149.30 [b]
F-value	45.72			42.80	10.97			157.22
p	<0.001			<0.001	0.004			<0.001
Mean	47.60** [C]	38.90 [B]	30.50 [A]	39.00	148.10 [C]	106.20 [B]	84.30 [A]	112.80
F-value	91.18				83.49			
p	<0.001				<0.001			
	LAI				LAR ($cm^2 g^{-1}$)			
No covering	0.80 [a]	0.68 [a]	0.53 [a]	0.67 [a]	15.30 [b]	23.50 [b]	22.70 [b]	20.50 [b]
Covered for 4 weeks after planting	2.29 [b]	1.39 [b]	0.81 [ab]	1.50 [b]	10.50 [a]	8.60 [a]	7.30 [a]	8.80 [a]
Covered for 8 weeks after planting	2.53 [b]	2.45 [c]	1.23 [b]	2.07 [c]	10.80 [a]	12.00 [a]	7.80 [a]	10.20 [a]
F-value	10.03			35.71	7.81			58.81
p	0.004			<0.001	0.006			<0.001
Mean	1.87 [C]	1.51 [B]	0.86 [A]	1.41	12.20 [A]	14.70 [A]	12.60 [A]	13.20
F-value	29.01				5.71			
p	<0.001				>0.05			

* Values within columns followed by the same lowercase letters are not significantly different at $p \leq 0.05$. ** Values within rows followed by the same uppercase letters are not significantly different at $p \leq 0.05$. LAI – leaf area index; LAR – leaf area ratio.

increased the share of marketable yield in the total yield at each transplanting date. However, when the transplanting date was delayed, the effect of covering on the share of marketable yield decreased gradually.

When the transplanting date was delayed by 10 and 20 days, a respective 8- and 17-day decrease in the number of days from transplanting to the beginning of fruit harvest was observed. At all the transplanting dates, covering reduced the transplanting-to-harvest time compared with no covering. After 4 and 8 weeks of covering, this period was shorter by 14 and 8 days, respectively (Fig. 2).

The study results revealed correlations between plant growth attributes and the beginning of harvest as well as yield and the average fruit weight. Irrespective of the transplanting date, the number of days from transplanting to the beginning of harvest was negatively correlated with stem length and plant weight (Tab. 4).

The total yield was significantly positively correlated with stem length, plant weight, and LAI, but significantly negatively associated with LAR for all the transplanting dates.

For transplanting on May 15 and May 25, the average fruit weight was significantly positively correlated with stem length and plant weight, whereas for the June 4, such a relationship was not found. However, the average fruit weight was significantly negatively correlated with LAI for all the transplanting dates.

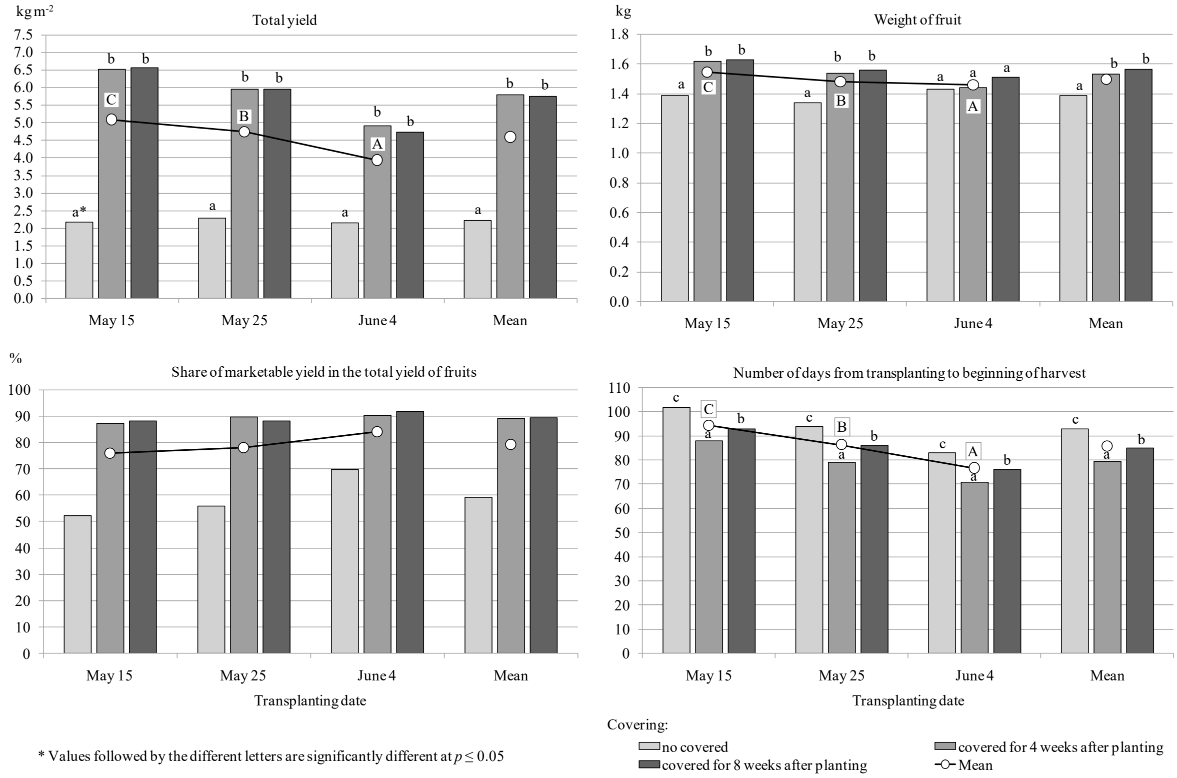

Fig. 2 The effect of the investigated factors on the yields, length of period from transplanting to beginning of harvest and weight of melon fruits (*C. melo*) (averages for 2008–2010).

Tab. 4 The correlation coefficients between growth attributes and selected parameters of melon yield.

Investigated parameters (N = 12)	Number of days to harvest			Total yield			Mean fruit weight		
	Transplanting date								
	May 15	May 25	June 4	May 15	May 25	June 4	May 15	May 25	June 4
Stem length	−0.543*	−0.422*	−0.477*	0.885*	0.785*	0.588*	0.586*	0.447*	0.180
Plant weight	−0.362	−0.421*	−0.501*	0.778*	0.564*	0.721*	0.502*	0.367*	0.165
LAI	−0.393	−0.267	−0.300	0.732*	0.620*	0.346	−0.805*	−0.583*	−0.675*
LAR	0.446*	0.402	0.545*	−0.613*	−0.523*	−0.641*	0.481*	0.285	−0.129
	Date of polypropylene fiber removal								
	NC	C4	C8	NC	C4	C8	NC	C4	C8
Stem length	0.591*	0.734*	0.322	−0.284	0.593*	0.642*	0.013	0.351	0.315
Plant weight	0.117	0.686*	0.597*	0.554*	0.565*	0.757*	0.256	0.291	0.308
LAI	0.401	0.790*	0.439	−0.645*	0.491*	0.743*	−0.531*	0.340	0.160
LAR	−0.113	−0.050	−0.083	−0.719*	−0.241	0.166	−0.431	0.061	−0.145

LAI – leaf idea index; LAR – leaf area ratio; NC – no covering; C4 – covered for 4 weeks after planting; C8 – covered for 8 weeks after planting. * Significant at α = 0.01.

Stem length was the only trait significantly positively correlated with the number of days from transplanting to harvest when covering with polypropylene fiber had not been applied. For the 4-week covering treatment, such a relation was found between stem length, plant weight, and LAI, whereas for 8-week covering between plant weight and the time from transplanting to beginning of harvest.

When no covering had been used, plant weight was significantly positively correlated with total fruit yield. For the 4- and 8-week cover application times, such a correlation was determined between stem length, plant weight as well as LAI and total fruit yield. The average fruit weight of covered plants, irrespective of the length of covering, was not significantly positively correlated with stem length, plant weight, or LAI.

Discussion

The study results showed a significant effect of weather conditions on the growth and development of melon plants. A marked influence of weather conditions prevailing in eastern Poland on tomato and potato development and yield was also reported by Wadas et al. [14] and Kosterna [18].

Seedlings transplanted at the second and third date were characterized by poorer growth. Application of covers influenced melon growth. According to Ibarra et al. [12], polypropylene fiber contributes to an increase in temperature around plants because it prevents some of the heat emitted by both soil and plants from escaping. Higher soil and air temperatures under covers provide better conditions for plants immediately after transplanting and allow them to produce a higher mass of aboveground parts [11,14,19]. More favorable conditions under covers increased the leaf area index (LAI) which describes the growth of the plants. In her study, Kosterna [9] demonstrated that the LAI value of plants cultivated under polypropylene fiber was almost 1.5 as high as the index calculated for non-covered plants. A higher assimilation leaf area and LAI value were reported by Gimenez et al. [13] who cultivated cabbage, beet, spinach, and lettuce under covers. According to these authors, LAI has been traditionally considered an appropriate index to characterize the interception of radiation in many crops. The larger LAI and, consequently, greater relative interception of incoming photoactive radiation as well as the higher soil temperature appear to have more than compensated for the reduction of photoactive radiation caused by the covers. Extension of the covering period from 4 to 8 weeks had a more favorable effect on the growth attributes of melon plants. An increase in melon stem length as a result of covering was also confirmed in the study by Ibarra-Jiménez et al. [20]. In turn, Wadas et al. [14] reported an increase in the height, weight, and LAI of potatoes which had been covered for 3 weeks compared with a 2-week covering period. Both the transplanting date and cover application did not affect the LAR value. Plants cultivated without covers had the highest LAR values, the finding also confirmed by Wadas et al. [14].

In the present study, delaying the transplanting date contributed to a decline in fruit yield, but the yield was significantly higher due to application of covers. Previous studies by Kosterna et al. [21] and Majkowska-Gadomska [8] showed that flat covers used under moderate climate conditions helped to obtain satisfactory yields of ripe melon fruits even when the summer months were characterized by lower air temperatures. Also, Benincasa et al. [22] found in their study, conducted in central Italy, a 12% increase in melon yield as a result of covering. However, Gordon et al. [23], who carried out their study in a subtropical humid climate, reported a 30% decline in pumpkin yield due to cover application compared with cultivation without covering. Under hot climatic conditions, row covers and floating covers have been used to a limited extent to protect plants from insect attack. However, it often resulted in yield reductions of muskmelon and other cucurbits [24,25]. Melon is a plant pollinated by insects only. When the period of keeping melon plants under cover is extended, fruit yields may decline because pollinating insects have more difficulty gaining access to the flowers [26]. In the present study, the length of plant covering period did not affect yield levels, which is consistent with the findings by Santos et al. [27] who reported that the length of melon plant covering period (18, 21, 24, 27, and 30 days) did not significantly influence fruit yields. In turn, Ibarra-Jiménez et al. [20] showed a significant increase in melon fruit yield following an extension of the cover application time. The marketable yield increased by 18% after 24 days and by 81% after 41 days of covering compared with non-covered control. In the current study, covering increased the average weight of melon fruit and the share of marketable yield in the total fruit yield. On the contrary, Santos et al. [27] did not find an increase in fruit weight as a result of covering.

Both delaying the transplanting date and application of covers reduced the transplanting-to-harvest period. It is consistent with the report by Ibarra-Jiménez et al. [20], in which an extension of the time when plants were kept under covers contributed to a proportional reduction in the length of melon growing season by 4 days after 24 days and by 6 days after 41 days of covering. In the work by Ibarra et al. [12], fruit harvest from plants grown under covers was conducted 24 days earlier than from the control. Thus, increases in air and soil temperatures under plastic mulch and row covers were probably responsible for the reduction in the time to anthesis and harvest, by increasing the rate of plant development. The effectiveness of covering depends largely on the growing conditions. In the colder climate, the length of the growing season as a result of covering is reduced more than in the warmer climate.

In the present study, a significant relationship was found between growth attributes, harvest earliness, and yield. An increase in yield associated with an increasing length of melon stems was also noted by Ibarra-Jiménez et al. [20].

The earlier seedlings were transplanted, the more fruit weight depended on plant size. However, irrespective of transplanting dates, the average fruit weight was significantly negatively correlated with LAI, which confirms the fact that the more nutrients the plant allocated for the development of assimilation leaf area, the less remain to be used for the development and growth of generative organs. In the cultivation of plants whose generative organs are the yield harvested by growers, it is preferable to take care of the balance between vegetative growth and generative development. Application of covers may disturb the balance as they modify the microclimate around the plants (less light, higher humidity and temperature) and thus create better conditions for vegetative growth.

The strongest positive correlations between stem length, plant weight, LAI value, and harvest earliness were found for melons covered for 4 weeks, and between stem length, plant weight, LAI value, and yield level for plants covered for 4 and 8 weeks. These associations indicate that fruit production by covered plants began later, but the total fruit yield was higher. Covered plants had better growth conditions and, therefore, intensively produced vegetative mass and bloomed later but more profusely. According to many authors, a higher assimilation leaf area and LAI value can cause an increase in yield and improve its quality [13,28,29]. Gordon et al. [23] covered pumpkin plants and achieved a significant increase in plant height, although no increase in fruit yield was observed. All of the above-mentioned studies were carried out under conditions of subtropical humid climate.

Conclusions

The best growth attributes were found for seedlings transplanted at the last date. After 8 weeks of growing, plants transplanted at the earliest date were longer by 22% and 56%, heavier by 39% and 76%, and their LAI values were higher by 24% and 117% compared with 10- and 20-day delays. Delaying the transplanting date reduced the length of the growing period by 7 and 17 days, respectively.

Irrespective of the transplanting date, extension of covering period from 4 to 8 weeks increased stem length by 23% and LAI by 38% on average, but delayed harvest by an average of 6 days.

An earlier transplanting date contributed to higher yields of melon but with lower shares of marketable fruits. The respective total yields of melons transplanted on May 15, May 25, and June 4 averaged 5.09, 4.73, and 3.99 kg m^{-2}.

Covering of plants transplanted at each of the above dates resulted in the following respective yield increases: 200%, 160%, and 125%. Also, it increased the share of marketable fruit yield in the total yield by, respectively, 68%, 59%, and 30%. However, the length of cover application time did not affect the yield level.

Total yield was significantly positively correlated with stem length, plant weight, and LAI, but significantly negatively associated with LAR. The weight of non-covered plants, and the stem length, plant weight, and LAI of plants covered for 4 and 8 weeks were significantly positively correlated with the total yield of melon fruits.

References

1. Al-Sayed HMA, Ahmed AR. Utilization of watermelon rinds and sharlyn melon peels as a natural source of dietary fiber and antioxidants in cake. Ann Agric Sci. 2013;58(1):83–95. https://doi.org/10.1016/j.aoas.2013.01.012
2. Gajc-Wolska J, Kowalczyk K, Nowecka M, Mazur K, Metera A. Effect of organic-mineral fertilizers on the yield and quality of endive (*Cichorium endivia* L.). Acta Scientiarum Polonorum. Hortorum Cultus. 2012;11(3):189–200.
3. Kalisz A, Kostrzewa J. Growth modelling of Chinese cabbage (*Brassica rapa* var. *Chinensis*) seedlings and evaluation of the relationships between plant features before planting out to the field and during harvest. Acta Agrophysica. 2012;19(2):329–242.
4. Kalisz A, Sękara A, Kostrzewa J. Effect of growing date and cultivar on the morphological parameters and yield of *Brassica rapa* var. *japonica*. Acta Scientiarum Polonorum. Hortorum Cultus. 2012;11(3):131–143.
5. Sensoy S, Ertek A, Gedik I, Kucukyumuk C. Irrigation frequency and amount affect yield and quality of fieldgrown melon (*Cucumis melo* L.). Agric Water Manag. 2007;88:269–274. https://doi.org/10.1016/j.agwat.2006.10.015
6. Lamont W J. Plastic mulches for the production of vegetable crops. Horttechnology. 1993;3(1):35–39.
7. Jifon JL, Lester GE. Foliar fertilization of muskmelon: effects of potassium source on market quality and phytochemical content of field-grown fruit. In: Proceedings of the 2007 Fluid Forum; 2007 Feb 18–20; Scottsdale, AZ, United States; 2017. p. 154–161.
8. Majkowska-Gadomska J. Mineral content of melon fruit (*Cucumis melo* L.). J Elem. 2009;14(4):717–727. https://doi.org/10.5601/jelem.2009.14.4.717-727
9. Kosterna E. The effect of covering and mulching on the soil temperature, growth and yield of tomato. Folia Horticulturae. 2014;26(2):91–101. https://doi.org/10.2478/fhort-2014-0009
10. Moreno DA, Víllora G, Hernández J, Castilla N, Monreal LR. Yield and chemical composition of Chinese cabbage in relation to thermal regime as influenced by row covers. J Am Soc Hortic Sci. 2002;127(3):343–348.
11. Hamouz K, Lachman J, Dvořák P, Trnková E. Influence of non-woven fleece on the yield formation of early potatoes. Plant Soil Environ. 2006;52(7):289–294.
12. Ibarra L, Flores J, Díaz-Pérez JC. Growth and yield of musk melon in response to plastic mulch and row covers. Sci Hortic (Amsterdam). 2001;87:139–145. https://doi.org/10.1016/s0304-4238(00)00172-2
13. Gimenez C, Otto RF, Castilla N. Productivity of leaf and root vegetable crops under direct cover. Sci Hortic (Amsterdam). 2002;94(1–2):1–11. https://doi.org/10.1016/s0304-4238(01)00356-9
14. Wadas W, Kosterna E, Kurowska A. Effect of perforated foil and polypropylene fibre covers on growth of early potato cultivars. Plant Soil Environ. 2009;55(1):33–41.
15. Soltani N, Anderson La Mar J, Hamson AR. Growth analysis of watermelon plants grown with mulches and row covers. J Am Soc Hortic Sci. 1995;120(6):1001–1009.
16. Kołodziejczyk M. Effect of the degree and timing of the simulated reduction of plants assimilation area on the yielding of potato. Fragmenta Agronomica. 2012;29(3):81–87.
17. IUSS Working Group WRB. World reference base for soil resources 2014: international soil classification system for naming soils and creating legends for soil maps. Rome: FAO; 2015. (World Soil Resource Reports; vol 106).
18. Kosterna E. The effect of soil mulching with straw on the yield and selected components of nutritive value in broccoli and tomatoes. Folia Horticulturae. 2014b;26(1):31–42. https://doi.org/10.2478/fhort-2014-0003

19. Kosterna E. The yield and quality of broccoli grown under flat covers with soil mulching. Plant Soil Environ. 2014;60(5):228–233.
20. Ibarra-Jiménez L, Flores-Velásquez J, Quezada MR. Relationship between growth and yield of muskmelon (*Cucumis melo* L.) and time under floating row covers. Rev Chapingo Ser Hortic. 2001;7(1):95–109.
21. Kosterna E, Zaniewicz-Bajkowska A, Franczuk J, Rosa R. Effect of foliar feeding on the field level and quality of six large-fruit melon (*Cucumis melo* L.) cultivars. Acta Scientiarum Polonorum. Hortorum Cultus. 2009;8(3):13–24.
22. Benincasa P, Massoli A, Polegri L, Concezzi L, Onofri A, Tei F. Optimising the use of plastic protective covers in field grown melon on a farm scale. Italian Journal of Agronomy. 2014;9:556. https://doi.org/10.4081/ija.2014.556
23. Gordon GG, Wheeler GF, Stewart TR, Brown JE, Vinson E, Woods FM. Plastic mulches and row covers on growth and production of summer squash. International Journal of Vegetable Science. 2008;14(4):322–338. https://doi.org/10.1080/19315260802215830
24. Ramírez VJ. Cubiertas flotantes para desarrollar cultivos hortícolas y controlar virosis. Culiacán Rosales: Universidad Autónoma de Sinaloa; 1994. (Cuadernos Agropecuarios, Serie Agricultura; vol 1).
25. Ibarra L, Flores J. Acolchado plástico, cubiertas flotantes, y desarrollo y rendimiento de sandía y calabacita. Agrociencia. 1997;31:9–14.
26. Rodrigo Gómez S, Ornosa C, Selfa J, Guara M, Polidori C. Small sweat bees (Hymenoptera: Halictidae) as potential major pollinators of melon (*Cucumis melo*) in the Mediterranean. Entomol Sci. 2016;19(1):55–66. https://doi.org/10.1111/ens.12168
27. dos Santos FGB, de Negreiros MZ, de Medeiros JF, de Sousa Nunes GH, de Medeiros DC, Grangeiro LC. Produção e qualidade de melão Cantaloupe em cultivo protegido temporariamente com agrotêxtil em Mossoró, Rio Grande do Norte. Revista Ceres. 2015;62(1):93–100. https://doi.org/10.1590/0034-737x201562010012
28. Zrůst J, Hlušek J, Juzl M, Přichystalowá V. Relationship between some chosen growth characteristics and yield of very early potato varieties. Rostlinna Vyroba. 1999;45(11):503–509.
29. Liu T, Song F, Liu S, Zhu X. Light interception and radiation use efficiency response to narrow-wide row planting patterns in maize. Aust J Crop Sci. 2012;6(3):506–513.

Wpływ terminu sadzenia rozsady i osłaniania na wzrost i rozwój melona (*Cucumis melo* L.).

Streszczenie

Celem badań była ocena zróżnicowanego terminu sadzenia rozsady (15 i 25 maja oraz 4 czerwca) oraz terminu zdjęcia osłony (4 i 8 tygodni po posadzeniu rozsady, kontrolna bez osłaniania) na wzrost, rozwój i plonowanie melona (*Cucumis melo* L.). Eksperyment polowy przeprowadzono w latach 2008–2010 w środkowo-wschodniej Polsce (51°53′23.64″ N, 22°27′47.96″ E). Rośliny posadzone 15 maja charakteryzowały się większą o 22% i 56% długością łodyg, o 39% i 76% masą oraz o 24% i 117% większym LAI w porównaniu z posadzonymi 24 maja i 4 czerwca. Jednak późniejsze sadzenie roślin powodowało skracanie okresu wegetacji odpowiednio o 7 i 17 dni. Wydłużanie okresu osłaniania roślin z 4 do 8 tygodni powodowało wzrost długości łodyg średnio o 23%, wskaźnika LAI o 38%, ale opóźniało zbiór średnio o 6 dni. Plon owoców melona posadzonego 15 maja wyniósł średnio 5.09 kg m^2, posadzonego 25 maja 4.73 kg m^2, a 4 czerwca 3.99 kg m^2. Osłanianie roślin sadzonych w każdym terminie powodowało wzrost plonu oraz zwiększało udział plonu handlowego owoców w plonie ogółem. Jednak długość okresu osłaniania nie różnicowało wielkości plonów.