EFFECTS OF ORCHARD MULCHING WITH REFLECTIVE MULCH ON APPLE TREE CANOPY IRRADIATION AND FRUIT QUALITY

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A B S T R A C T

Effects of reflective mulch spread under apple trees on irradiation within tree canopy and fruit quality of ‘Pinova’, ‘Jonagold’ and ‘Jonagored’ cvs was studied during three growing seasons.

The results showed that in ‘Pinova’ trees irradiation within a canopy was reduced by leaf shading to 26% at 0.5 m, 31% at 1.0 m, 42% at 1.5 m and 48% at 2.0 m above the ground as compared to solar irradiation above the tree. Reflective mulch increased reflected light intensity 8 times at 0.5 m, 4 times at 1.0 m, 2 times at 1.5 m and by 10% at 2.0 m when compared to bare soil. Reflective mulch improved red color of ‘Pinova’ apples in the bottom zone of tree canopy only. There was no effect of reflective mulch on quantity of apples and mean fruit weight.

In ‘Jonagold’ trees light intensity was reduced by leaf shading to 18% at 0.75 m, 24% at 1.5 m, and 36% at 2.25 m as compared to that above the tree canopy. Reflective mulching increased reflective light 7 times at 0.75 m, 2 times at 1.5 m and by 10% at 2.25 m above the ground. In the bottom zone, up to 75 cm from the ground, there were 2 times more well colored fruit (with red blush on surface over 50%) on trees mulched than on the control. Mulching had no influence on quantity of apples and mean fruit weight. The biggest leaf area was found at the horizontal layer between 1.5 and 2.0 m. Leaf area index assessed per canopy cast to the ground was 0.45.

Irradiation within ‘Jonagored’ apple canopy, fruit and leaf distribution was similar to these in ‘Pinova’. In the season 2004, reflective mulching improved significantly red blush on ‘Jonagored’ apples, and in the next season there was no effect because on mulched and control trees all apples had 100% of red skin. There was no significant influence of mulching in June on fruit bud setting, fruit set, mean fruit weight and fruit firmness.

Key words: apple tree, reflective mulching, orchard micro-climate, irradiation, fruit quality

INTRODUCTION

Light intensity within apple tree canopy shows a great variation. The outer parts of the tree usually receive sufficient irradiation but the inner parts are inadequately irradiated (Jackson, 1970). In the main outer fruiting zone irradiation ranges from 30 to 80% of that measured above the tree canopy. Light intensity in the lower part of the tree is usually below 30% and in some parts only about 10% (Jackson, 1970; Jacyna, 1978).

Low light intensity in the shaded parts of the tree reduces leaf photosynthesis rate and have a direct effect on fruit bud formation, fruit setting and fruit development (Heinicke, 1966; Mika and Antoszewski, 1972). Insufficient irradiation reduces drasticcally apple colorouring. Jackson (1968) found that under condition of East England apples of high commercial quality were not obtained on parts of trees receiving less than 50% of total solar radiation. The variation of light intensity within a tree canopy leads to a considerable variability in fruit size, color and their storage quality (Jackson et al., 1971).

In commercial fruit culture different treatments are applied to improve light penetration into the tree canopy such as growing dwarf trees, training and pruning. In spite of these efforts it is almost impossible to obtain adequate irradiation of lowest branches of the tree.

Using highly reflective materials under trees in order to improve the light climate within the orchard was considered long time ago by Stanhill (1978), but not practiced in Europe. Some experiments were done in Israel by Moreshet et al. (1975) and by Mika (1980) in Poland with promising results. In Norway, Vangdal et al. (2004) obtained significant improvement of ‘Aroma’ apple color, size and TSS content with reflective mulch spread with 3.0 m width sheet in alleyways from July to October. Mulching with reflective material spread under tree canopies 3 weeks before apple harvest is commonly practiced in Japanese orchards to improve fruit color. Reflective sheets are rolled out along tree rows 2-3 weeks before harvest and reeled back afterward to be saved for the next season (Fukuda, 1994).

The aim of this work was to determine the effect of reflective mulch on apple coloring in climatic condition of Poland.

MATERIAL AND METHODS

Canopies of five-year-old ‘Pinova’ apple trees, grafted on M.9 rootstock, trained as slender spindle and spaced at 3.5 x 1.4 m (2040 trees/ha) in N-S oriented rows, were subdivided in the spring of 2003 by bamboo canes into 0.5 x 0.5 x 0.5 m cubes (in total about 60 per tree). In each cube, the number of fruit at harvest (on 3-rd

October) and fruit quality (size, mean fruit weight, color, firmness, TSS content) were determined as well as the leaf area in autumn after fruit picking by means of an 'AMS Delta-T Devices' apparatus. The levels of sunlight irradiation were measured four times during vegetative season in five horizontal zones, on sunny days only, at midday hours, with a 'Sun Scan Probe' portable solarimeter (Delta-T Devices Ltd., Burwell, England); 64 readings were obtained from each measurement. The results of the measurements in W m^{-2} were converted to the percentage of light reaching inside the canopy in relation to the irradiation above the canopy. The measurements were made at four trees of similar vigor and canopy size, and growing side by side in the same row. These trees were treated as replications. During the peak of vegetation, apple trees were slightly over 2.5 m high, had canopies 1.5 m wide at the base and branches touching the ground.

Intercepted radiation was measured on the plot described above with 12 tube solarimeters (Delta-T, Burwell, UK), 1 meter in length, from June to October at 10 minute intervals. The tubes were mounted horizontally, 10 cm above ground, across tree line from one alley centre to another in three parallel lines treated as replications. The obtained data were stored in Data Logger DL2e (producer as above).

To increase canopy irradiation the soil under adjacent 4 trees in the row was mulched at the end of May with reflective sheets consisted of polypropylene textile covered with aluminum foil. The sheets were 0.7 m wide and were spread on both sides of tree trunks along the tree row. Trees grown on bare soil maintained by herbicides served as control. On mulched trees the same measurements were done as on control ones. Light reflected by the mulch and by the ground was measured by the portable solarimeter described above.

In the same season, experiments were conducted on 5-year-old 'Jonagold' apple trees grafted on P 22 rootstock, trained as slender spindle and spaced at 3.5 x 1.0 m (2857 trees/ha). In this case, all the records were taken in 3 horizontal layers: 0 to 0.75 m, 0.75 to 1.50 m, and 1.50 to 2.25 m formed by positioned bamboo canes. Trees were 3.0 m high with canopies 2.0 m wide at the base, forming a continuous hedgerow. In this experiment, reflective mulch was spread on the ground 34 days before harvest and removed at harvest time (12 October).

The experiment was repeated in years 2004 and 2005 on 6 and 7-year- old 'Jonagored' trees grafted on M.9, trained as slender spindle and spaced at 3.5 x 1.4 m (2040 trees/ha).

The biometric measurements were worked out by analysis of variance. The significance of differences between means were assessed using Duncan's multiple range t-test at $p<0.05$.

RESULTS

Light intensity measured after blooming on 'Pinova' trees, at the end of May, revealed significant differences in irradiation between bottom and top parts of the tree canopy. Bottom part received less than half of incident sunlight when compared to the top (Fig. 1). Light levels at the bottom part did not change much during the summer whereas at the top part irradiation decreased as season progressed. Significant changes in irradiation were found between May and late August measurements; thus only these records are presented in Figure 1. Reflective mulch spread on the ground had no effect on incident light. Some differences observed between mulched and control trees in the spring resulted probably from different canopy density at the tree top. On the contrary, reflected light intensity in the lowest part of tree canopy was 8 times higher as compared to the control, 4 times higher in the second canopy layer and 2 times higher in the third layer above the ground. There was no difference in reflected irradiation between mulching and control treatment in canopy layers situated 1.5 m above the ground (Fig. 1). Intensity of reflected light (max. 129 W m^{-2}) was low when compared with intensity of incident light above tree canopy, which was approximately 1600 W m^{-2} at noon in a sunny day. Light measurements at a ground level with tube solarimeters showed around 70% interception of the light reaching the orchard.

The greatest leaf area was found in canopy layers situated at a height 0.5-1.5 m above the ground (Tab. 1). Fruits were distributed more evenly in layers situated at a height from 0.5 to 2.5 m. At the bottom part of the tree canopy there was roughly 1.5 dm^2 of leaf area per one apple fruit, and at the medium part over 2.0 dm^2. Total leaf area per a tree was 5.7 m^2, and leaf area index (LAI) calculated per canopy cast (2.8 m^2) was 2.

Mean fruit weight and percentage of apple surface with red blush increased from the bottom to the top of tree canopy. In two top layers mean fruit weight on the control trees was significantly higher than on the mulched ones. Unexpectedly, there was no effect of mulching on mean fruit weight, firmness and TSS content in the bottom layers of the canopy, up to 1 m above the ground, where reflected light was most intensive. Fruit firmness and TSS content was significantly higher at the top of tree canopy than at the bottom. Fruit red blush was signify-cantly increased by mulching only in the lowest canopy layer. Again, there was no differences in fruit coloring in canopy top between mulched and control trees (Tab. 1).

The results obtained from the all measuring cubes enabled to analyze also effects of vertical layers on the measured parameters. However, the results seen in vertical sections were less clear than in horizontal layers and most of the differences were not significant.

The results of the second experi-ment with reflective mulching of 'Jonagold' trees are presented in Figure 2 and Table 2. All data were collected from 3 horizontal layers of the tree canopy. Light intensity within

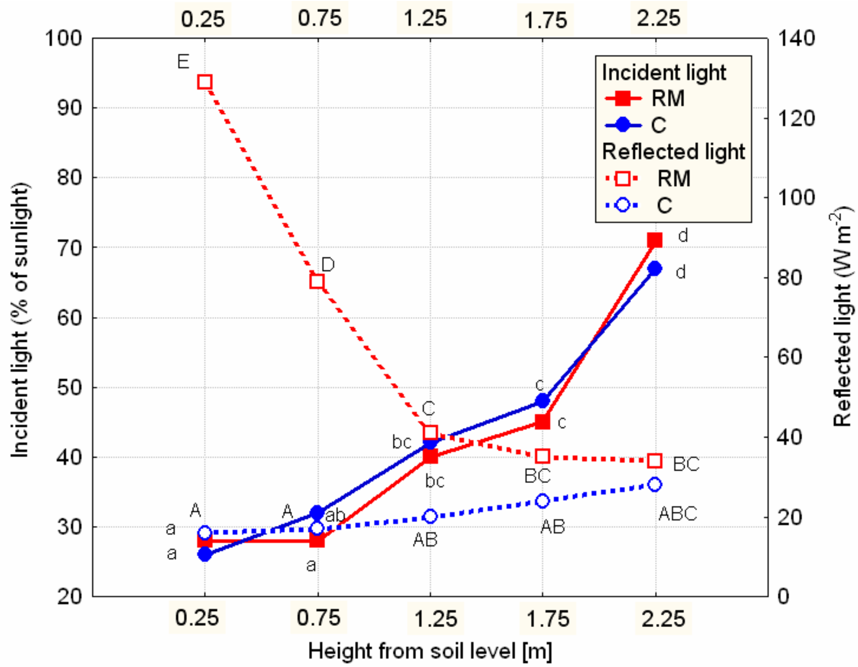

Figure 1. Levels of incident light within 'Pinova' apple tree canopy (2003) expressed as % of sunlight above the tree, and of reflected light in W m^2; RM – reflective mulch; C – control

Table 1. Leaf and fruit distribution and fruit quality in 0.5 m thick horizontal layers within 'Pinova' apple tree canopy, in 2003. Fruit and leaf density expressed per measuring cube (0.5 x 0.5 x 0.5 m). (RM – reflective mulch, C – control)

Parameter		Horizontal layers in m above ground				
		0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5
Leaf area per cube [dm^2]	RM	6.7 a*	30.0 c	23.5 abc	15.1 abc	17.0 abc
	C	9.5 a	30.2 c	28.6 c	16.2 abc	13.0 ab
Fruit per cube [No]	RM	5.0 a	14.2 bc	9.5 ab	10.2 ab	18.0 c
	C	4.9 a	11.9 abc	13.6 b	7.7 ab	10.4 ab
Mean fruit weight in a cube [g]	RM	98 a	99 a	100 a	110 ab	123 cd
	C	105 ab	106 ab	113b c	124 cd	127 d
Red blush on apple in a cube [%]	RM	45 b	52 b	70 bc	79 cd	95 e
	C	33 a	50 b	62 b	81 cd	90 de
Fruit firmness in a cube [kG]	RM	6.9 a	6.9 a	6.8 a	7.1 ab	7.4 b
	C	6.8 a	6.9 a	6.8 a	7.1 ab	7.3 b
Fruit TSS content in a cube [%]	RM	12.4 ab	12.0a	12.6 bc	12.8 bc	13.3 c
	C	11.7 a	11.9 a	12.2 ab	12.9 c	12.9 c

*The mean with the same letter don't differ significantly at $p<0.05$ according to Duncan's multiple range t-test

The mean light interception: RM – 68.6% C – 73.7%

The mean yield kg/tree: RM – 22.1 kg C – 24.4 kg

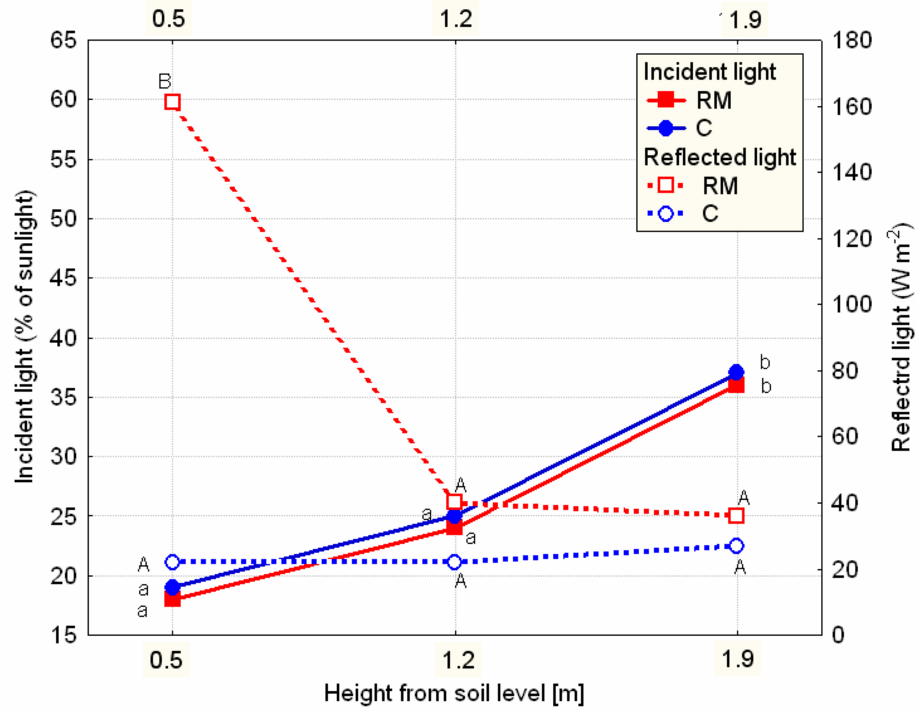

Figure 2. Levels of incident light within 'Jonagold' apple tree canopy (2003) expressed as % of sunlight above the tree, and of reflected light in W m^{-2}; RM – reflective mulch; C – control

Table 2. Fruit distribution and quality in 0.75 m thick horizontal layers within 'Jonagold' apple tree canopy, in 2004. (RM – reflective mulch, C – control)

Parameter		Horizontal layers in m above ground		
		0-0.75	0.75-1.50	1,50-2.25
Fruit in layer [No]	RM	67 a*	92 ab	55 a
	C	50 a	75 a	60 a
Mean fruit weight [g]	RM	180 a	183 a	196 a
	C	175 a	187 a	196 a
Red blush on apple surface [%]	RM	70 bc	57 ab	70 bc
	C	49 a	65 bc	79 c
Apples with red blush over ½ of skin surface [%]	RM	34 b	34 b	50 c
	C	17 a	38 b	47c
Fruit firmness [kG]	RM	6.6 a	6.8 a	6.8 a
	C	6.5 a	6.8 a	6.6 a
Fruit TSS content [%]	RM	12.1 a	12.5 b	13.2 c
	C	12.0 a	12.7 bc	13.3 c

*See Table 1
The mean light interception: RM – 76.0% C – 78.0%

'Jonagold' tree canopy was much lower than in 'Pinova' (Fig. 2). After blooming, light intensity in the bottom part of the canopy was about 25%, and in upper part approximately 50% of that above the tree. At the end of August irradiation decreased to 19% and 36% in bottom and upper parts of the canopy, respectively. Mulching increased 7 times reflected light level at 0.75 m above the ground and 2 times at 2.0 m. Most of fruits were situated in the middle part of tree canopy, but there were also nume-rous apples in the bottom part that could take advantage of reflected irradiation. In fact, fruit skin surface covered with red blush was increased by 20 and share of apples having half surface covered with red blush was doubled. Significant differences in apple blushing were found between horizontal layers of tree canopy, while fruit weight and firmness were comparable. Apples from the middle and the top parts had higher TSS content than these from the bottom part (Tab. 2).

The trial with 'Jonagored' apple trees performed in 2004 delivered similar results like experiments with 'Jonagold' done in 2003. Incident light intensity measured in August was very low at the bottom part of the tree canopy and at a satisfactory level at the top (Fig. 3). Mulching with reflective mulch had no effect on canopy irradiation by incident light. On the contrary, reflected light intensity was increased by mulching 13 times in the lowest part of tree canopy, 7 times in the second layer and 3 times in the third layer as compared to the bare ground. The relation of leaf area to fruit number in the medium and the top parts of 'Jonagored' tree was much higher than on 'Pinova', which caused that light levels at the canopy base was low. Reflective mulch had no significant effect on mean fruit weight, firmness and TSS content but improved significantly red blush on apples from bottom and middle layers of tree canopy (Tab. 3).

In the season 2004, 'Jonagored' trees were exposed to reflective mulch from the first days of June to fruit harvesting in October. It was expected that reflected light would increase flower bud and fruit setting in the next season due to a better irradiation. However, records done in 2005 did not show any significant differences in flower and fruit numbers between mulched and control trees. The results of reflective mulching of 'Jonagored' trees in 2005 are similar to those obtained in 2004 except of red fruit blush. Incident light intensity within tree canopy in 2005 was lower than in 2004, but the pattern of distribution from the tree top to its base was comparable in both seasons (Fig. 4). Intensity of light reflected by mulching was 11 times higher in the first canopy layer, 8 times in the second layer and 3 times in the third layer as compared to the light reflected by bare ground. Fruit distribution in 2005 showed the same pattern as in 2004. There were no significant differences in mean fruit weight and firmness between mulched

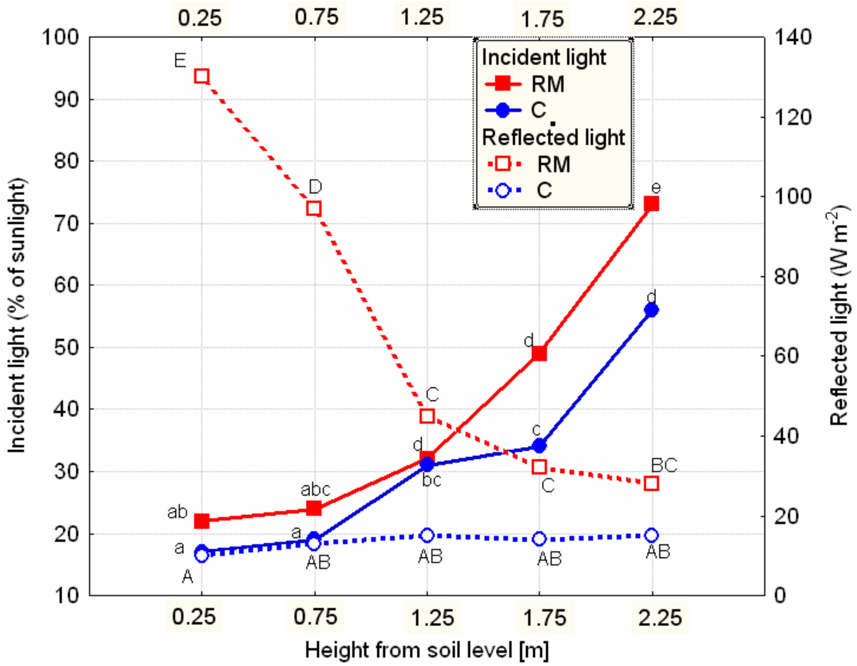

Figure 3. Levels of incident light within 'Jonagored' apple tree canopy (2004) expressed as % of sunlight above the tree, and of reflected light in W m^{-2}; RM – reflective mulch; C – control

T a b l e 3. Leaf and fruit distribution and fruit quality in 0.5 m thick horizontal layers within 'Jonagored' apple tree canopy, in 2004. Fruit and leaf density expressed per measuring cube (0.5 x 0.5 x 0.5 m). (RM – reflective mulch, C – control)

Parameter		Horizontal layers in m above ground				
		0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5
Leaf area per cube [dm^2]	RM	10.1 ab*	26.2 cd	19.2 abc	18.3 abc	30.4 cd
	C	7.3 a	27.3 cd	25.6 cd	21.7 bc	38.9 d
Fruit per cube [No]	RM	2.5 ab	5.7 bc	7.3 c	6.4 c	6.7 c
	C	1.4 a	4.6 abc	5.7b c	6.2 c	6.3 c
Mean fruit weight [g]	RM	245 bc	241 ab	246 bc	252 bc	278 bc
	C	209 a	249 bc	274 bc	282 c	318 d
Red blush on apple [%]	RM	94 cd	93 cd	91 cd	93 cd	99 d
	C	50 a	70 b	86 c	91 cd	97 cd
Fruit firmness [kG]	RM	7.0 ab	7.0 ab	6.9 ab	7.0 ab	6.9 ab
	C	7.2 b	7.0 ab	7.1 ab	6.9 ab	6.9 a
Fruit TSS content [%]	RM	13.0 ab	12.8 ab	12.7 ab	12.8 ab	13.2 b
	C	12.2a	12.4 ab	12.6 ab	12.7 ab	13.0 ab

*See Table 1
The mean light interception: RM – 77.0% C – 82.2%
The mean yield kg/tree: RM – 40.5 kg C – 42.6 kg

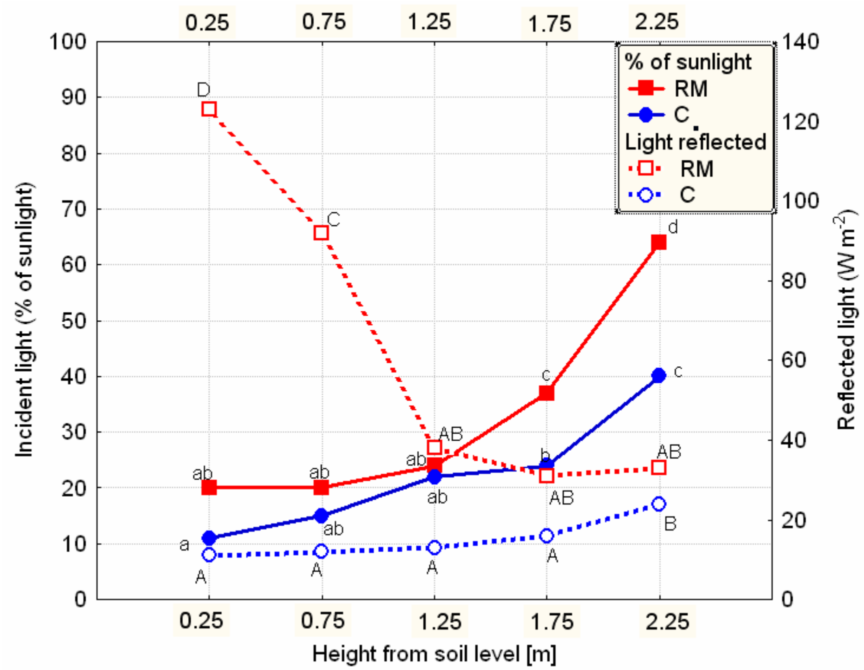

Figure 4. Levels of incident light within 'Jonagored' apple tree canopy (2005) expressed as % of sunlight above the tree, and of reflected light in W m^{-2}; RM – reflective mulch; C – control

Table 4. Fruit distribution and quality in 0.5 m thick horizontal layers within 'Jonagored' apple tree canopy, in 2005. Fruit expressed per measuring cube (0.5 x 0.5 x 0.5 m). (RM – reflective mulch, C – control)

Parameter		Horizontal layers in m above ground				
		0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5
Fruit per cube [No]	RM	2.6 a*	4.9 b	4.5 b	5.8 b	13.3 d
	C	2.4 a	3.6 b	5.3 b	5.4 b	8.2 c
Mean fruit weight [g]	RM	173 a	179 a	194 a	194 a	194 a
	C	163 a	179 a	188 a	194 a	202 a
Red blush on apple [%]	RM	100 a	100 a	99 a	100 a	100 a
	C	95	97 a	99 a	100a	100a
Fruit firmness [kG]	RM	8.0 ab	7.8 ab	7.6 a	7.7 a	7.8 ab
	C	7.8 ab	7.5 a	7.7 a	7.9 ab	8.3 b
Fruit TSS [%]	RM	15.1 cd	15.0 cd	14.9 bcd	15.4 d	15.5 d
	C	13.9 a	13.8 a	14.1 ab	14.4 abc	14.8 bcd

*See Table 1
The mean light interception: RM – 77.4%   C – 88.2%
The mean yield kg/tree: RM – 29.3 kg   C – 34.8 kg

and control trees. All the fruit from mulched and control trees were fully dark red and that was the most striking effect of the trial (Tab. 4).

DISCUSSION

The light measurements within canopy of 'Pinova' apple trees shoved that irradiation decrease from the top of the tree downwards, similarly like in earlier studies of Cain (1971), Jackson and Palmer (1971), Mika et al. (2002). It is worth to underline that very early in the growing season, within 20 days after blooming, the intensity of incident light reaching canopy base was 3 times lesser than that reaching canopy top. Later in the season light intensity at the tree upper parts decreased because of new shoot growth, while the changes at the canopy base were minimal. Reduction of irradiation during the growing season in the canopy top was more evident than in the other studies (Mika et al., 2002). There was no significant light reduction as measured from tree periphery towards tree centre, probably because of overlapping branches of adjacent trees. Leaf and fruit distribution in the tree canopy was advantageous because the largest leaf area was situated lower in tree canopy than the largest fruit number. For this reason large quantity of apples received adequate irradiation. Mika et al. (2002) found that in some cases the greatest leaf area is above the main fruiting zone of tree. The results obtained in our study revealed that canopies of 'Pinova' trees were well penetrated by light. Leaf area index (LAI) in densely planted apple orchard with trees on M.9 usually averages 3 (Jackson et al., 1971). In this study LAI was only 2. On contrary to that, light interception was similar to that in intensive apple orchard (Jackson and Palmer, 1971). There were suitable conditions, especially on the canopy zone from 1 m upwards, for developing red fruit colour. The apples were rather small, but it is well known that large 'Pinova' fruit can be obtained only with hard thinning, which was not done in this trial. It was expected that fruit color in the lowest canopy zone should be improved by reflective mulch, as it was demonstrated previously by Moreshet et al. (1975) and Mika (1980). However, in this trial the main role in color developing played fruit positioning in tree canopy, while mulching increased red blush of apples in the lowest zone of tree canopy by 12% only. Such result does not justify commercial use of reflecting mulch, especially since the other quality indices were not improved. One can presume that apples of 'Pinova' cv. are less sensitive to reflected light irradiation than 'McIntosh'-type cultivars, as was reported by Mika (1980).

Much better response to ref-lective mulch was found in 'Jonagold' trees treated in the same year as 'Pinova'. Mulching increased reflected light intensity 8 times at the tree base and doubled red skin blush on apples in the lowest layer of the tree canopy. These results were nearly as good as those obtained previously by Mika (1980). Irradiation of 'Jonagold' tree canopies was much lower than of 'Pinova' because they were higher and closer spaced in a row forming a hedgerow system. This was also visible in light interception, reaching nearly 80% in this cultivar. This is by 10% higher than recorded in other trials (Robinson, 2004) indicating intensive shading within tree communities. Fruit posi-tioning in the canopy was critical for fruit coloration also in this cultivar. Reflecting mulch increased reflective light intensity 8 times in the lowest part of tree canopy, but its effect on improvement of apple color was minimal because only 1/3 of apple crop was located in the zone where reflective light was active.

Mulching of 'Jonagored' trees for two years showed that reflective mulch may give various results in apple coloration depending on growing season. All 'Jonagored' strains require sunny, dry weather and cold nights to get red skin blush. Wet autumn with warm nights, like in 2004 season, was not favorable for red blush development and reflective mulch proved to be effective. As it was mentioned above, the energy value of reflected light is much lower than that of the direct sunlight and probably doesn't play significant role in photosynthesis. For this reason, reflecting mulching applied as early as June and kept during the whole season had no effect on fruit bud formation, fruit setting, mean fruit weight, firmness and TSS content. This shows that application of reflective mulch early in the growing season is unfonded. Instead, it and shall be applied 2-3 weeks before apple harvest, as it is done in Japan.

CONCLUSIONS

1. Reflective mulch spread under apple tree canopies increase reflected light intensity within tree base, but not in the tree top.
2. Reflective mulch can improve apple red blush but the result depends on cultivar and on the growing season.
3. Energy of reflected light is a low and it has no significant effect on fruit bud and fruit setting nor on mean fruit weight, firmness and TSS content.
4. Further trials are required to evaluate economical effect of mulching in various apple cultivars.

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WPŁYW ŚCIÓŁKOWANIA FOLIĄ ODBLASKOWĄ NA NASŁONECZNIENIE KORON I JAKOŚĆ JABŁEK

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

Korony pięcioletnich jabłoni odmiany 'Pinova' szczepionych na podkładce M.9 rosnących w rozstawie 3,5 x 1,4 m prowadzonych w formie wysmukłego wrzeciona, podzielono wiosną 2003 roku tyczkami na sześciany o bokach 0,5 x 0,5 x 0,5 m, formując 60 sześcianów pomiarowych na jednym drzewie. W każdym sześcianie określano liczbę owoców, jakość jabłek i powierzchnię liści jesienią. Latem 2003 roku czterokrotnie mierzono nasłonecznienie na pięciu poziomach korony. Wyniki nasłonecznienia przeliczono na procent światła docierającego do korony w stosunku do światła nad koroną przyjętego za 100%. Dla zwiększenia nasłonecznienia koron glebę pod drzewami od końca maja ściółkowano folią odblaskową. Dwa płaty folii szerokości 0,7 m rozkładano z dwóch stron pni wzdłuż rzędu drzew. Kontrolę stanowiły drzewa z ugorem herbicydowym pod koronami bez chwastów. Takie samo doświadczenie prowadzono na pięcioletnich jabłoniach odmiany ‘Jonagold’ szczepionych na podkładce P 22, rosnących w rozstawie 3,5 x 1,0 m i prowadzonych w formie wysmukłego wrzeciona. W tym doświadczeniu wszystkie pomiary wykonywano na trzech poziomach: 0-0,75 m, 0,75-1,50 m i 1,50-2,25 m. Doświadczenie z odmianą ‘Pinova’ powtórzono w latach 2004 i 2005 na odmianie ‘Jonagored’ szczepionej na podkładce M.9, posadzonej w takiej samej rozstawie i formowanej tak samo jak odmiana ‘Pinova’.

Nasłonecznienie koron odmiany ‘Pinova’ było zmniejszone w stosunku do nasłonecznienia nad koronami do 26% w warstwie do wysokości 0,5 m od ziemi, 31% do 1,0 m, 42% do 1,5 m, 48% do 2,0 m w porównaniu z nasłonecznieniem nad koroną drzew. Folia odblaskowa zwiększyła 8-krotnie ilość światła odbitego na wysokości 0,5 m od ziemi, 4-krotnie na wysokości 1,0 m, 2-krotnie na wysokości 1,5 m w porównaniu z glebą nieokrytą folią. Folia odblaskowa polepszyła wybarwienie jabłek odmiany ‘Pinova’ tylko w dolnej strefie korony drzewa. W strefie tej nie było wpływu folii odblaskowej na liczbę jabłek i ich średni ciężar oraz refrakcję.

Nasłonecznienie drzew odmiany ‘Jonagold’ było zmniejszone w obrębie korony do 18% w warstwie do wysokości 0,75 m od ziemi, 24% do 1,5 m i 36% do wysokości 2,25 m w porównaniu z nasłonecznieniem nad koroną drzew. Folia odblaskowa zwiększyła 7-krotnie ilość światła odbitego na wysokości 0,75 m od ziemi, 2-krotnie na wysokości 1,5 m oraz o 10% na wysokości 2,25 m. W dolnej strefie korony, do wysokości 0,75 m od ziemi, z drzew ściółkowanych zebrano 2 razy więcej lepiej wybarwionych owoców (wybarwienie na powierzchni powyżej 50%) niż z drzew kontrolnych. Ściółkowanie nie miało wpływu na wielkość plonu i ich średni ciężar. Największa powierzchnia liściowa znajdowała się w warstwie korony między 1,5 a 2,0 m. Nasłonecznienie w obrębie koron drzew odmiany ‘Jonagored’, owocowanie i dystrybucja światła były podobne do wyników z odmianą ‘Pinova’. W 2004 roku folia odblaskowa istotnie poprawiała wybarwienie jabłek odmiany ‘Jonagored’, natomiast w następnym sezonie nie odnotowano żadnego wpływu, ponieważ wszystkie jabłka były w 100% wybarwione, zarówno te zebrane z drzew, pod którymi była folia odblaskowa, jak i z drzew kontrolnych. Nie odnotowano istotnego wpływu ściółkowania folią odblaskową na tworzenie się pąków kwiatowych, zawiązywanie owoców, średni ciężar owoców i jędrność.

Słowa kluczowe: jabłoń, ściółkowanie gleby, mikroklimat sadu, nasłonecznienie, jakość owoców