

Research Report

Responses to Reflective Cloth in Hawkes Bay Apple Orchards

May 2014

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Summary

Replicated orchard trials to measure apple fruit colouration and maturity responses to reflective cloth were carried out in Hawkes Bay orchards during season 2014.

In the first group of trials with four apple varieties, Colour-It brand cloth was compared with an untreated control for intervals varying from 11-30 days. Fruit colouration measured at the start of harvest was significantly increased in all varieties. The proportion of the crop below 40% colouration was significantly reduced and the proportion above 70% was significantly increased by the cloth treatments as follows:

VARIETY	TREATMENT DURATION	CONTROL	CLOTH	COLOUR INCREASE	CHANGE IN % OF CROP IN THE FOLLOWING COLOUR BANDS WITH COLOUR-IT	
<i>All standard clones</i>	<i>Number of days cloth was under trees before assessment and start of harvest</i>	<i>Treatment means</i>	<i>Treatment means</i>	<i>Average difference in apple % colour coverage assessed before harvest</i>	<i>Less than 40%</i>	<i>70% or more</i>
Royal Gala	23	48%	57%	+9%	-10%	+18%
Jazz	11	35%	56%	+21%	-33%	+30%
Fuji	30	39%	50%	+10%	-19%	+16%
Pink Lady	11	39%	44%	+5%	-9%	+8%

Fruit internal quality was unaffected by the reflective cloth treatment.

In a second group of trials, Colour-It and Extenday branded cloths were compared with an untreated control with two late season apple varieties. No significant response to either cloth treatment was measured with either variety although the duration of cloth treatment was short (5-8 days) and sunshine radiation was variable.

Fruit colouration response to Colour-It reflective cloth appears to be influenced by a number of inter-related factors including variety, treatment duration, sunshine energy and tree canopy volume.

Trial results suggest that for Hawkes Bay conditions and blocks of larger trees (>18,000 cu m/ha), a cloth treatment duration of three weeks is required to achieve a desirable response for most varieties. For more responsive varieties such as Jazz (and probably blush types like Pacific Queen and Rose) a duration of 10-14 days may be sufficient, especially with smaller dwarf canopies.

Introduction

Two groups of orchard trials to measure apple fruit colouration response to reflective cloth were carried out in Hawkes Bay orchards during season 2014 as follows:

Group 1 – comparing Colour-It brand cloth with an untreated control repeated with four apple varieties.

Group 2 – comparing Colour-It and Extenday branded cloths with an untreated control repeated with two apple varieties.

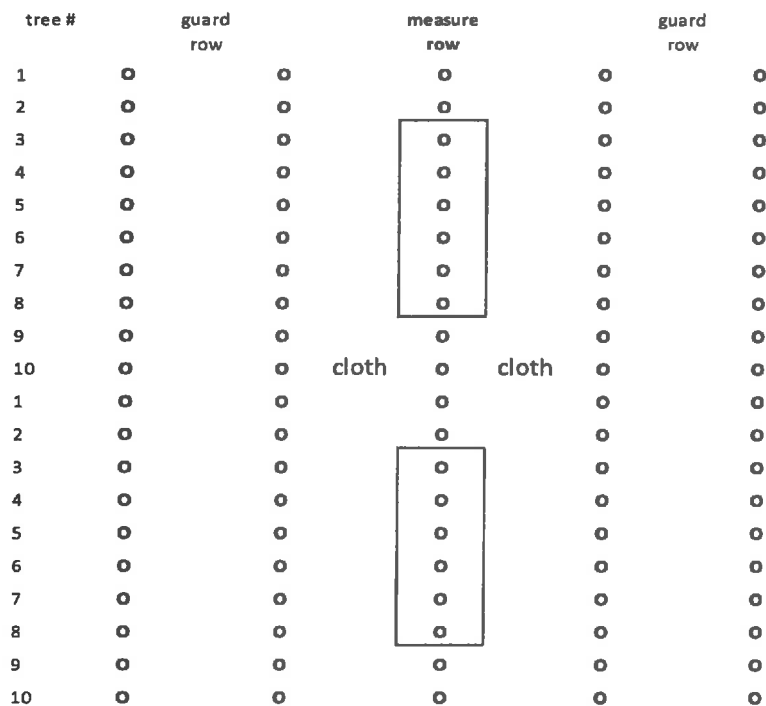
Trial objectives were to measure:

- Any change in fruit colour coverage
- Any difference in internal fruit attributes

Methods

Group 1 trials

Cloth was cut into 25m sections and each replicate was arranged as follows:



Each variety plot was replicated at least 3 times and 4 times if allowed by longer row length. The cloth was laid down 2-4 weeks before expected harvest depending on variety and available time.

Fruit was assessed on-tree once, immediately before harvest, by visually determining the percentage export acceptable colour (or blush) coverage to the nearest 10% percentile. The cloth was then moved to the next maturing variety.

Fruit colour assessments comprised 30-50 fruit accessible from the ground on each side of 6 trees per replicate and treatment. Total number of fruit assessed ranged between 1,440 and 1,800 per treatment. Individual fruit data from each tree was averaged so the analysis file format was : treatment / replicate / tree.

A maturity sample (20 fruit per treatment and replicate) was taken immediately before harvest to measure starch pattern index (SPI), flesh firmness (FF) and soluble solids (Brix).

Statistical analysis was carried out using the ANOVA test in Mintab.

Tree canopy volume was measured to estimate cubic metres of canopy for each variety. Radiation data (W / m-2) was kindly supplied by HortPlus from the Havelock North weather station.

Standard variety strains were used for each variety. Block and treatment details were:

Variety	Rootstock	Row width	Canopy Volume (cu m/ha)	Date cloth laid	Assessment Date	Cloth Duration (days)
Royal Gala	MM106	4.2	19,905	15-Jan	7-Feb	23
Jazz	M9	3.7	13,622	20-Feb	3-Mar	11
Fuji	MM106	4.0	24,000	3-Mar	2-Apr	30
Pink Lady	MM106	4.0	18,500	4-Apr	15-Apr	11

Group 2 trials

The Group 2 trials were started later in the season on Fuji and Pink Lady varieties. New Extenday cloth was supplied by the grower and arranged in 2 x 50m sections so this trial was assessed as 2 replicates. The reflective cloths were laid and shifted by the grower resulting in treatment duration being shorter than in the Group 1 trials.

Assessment methods were otherwise identical with Group 1 except that maturity tests were not carried out for the Group 2 trials.

Results

Group 1 – comparing Colour-It brand cloth with an untreated control

The percentage coverage of fruit colour was significantly increased by the cloth treatment for all varieties with differences significant at the 99% Confidence Interval for all varieties.

The proportion of the crop at the start of harvest with less than 40% blush coverage was decreased by the cloth treatment and the proportion of the crop with more than 70% blush coverage was increased by the cloth treatment.

VARIETY	TREATMENT DURATION	CONTROL	CLOTH	COLOUR INCREASE	CHANGE IN % OF CROP IN THE FOLLOWING COLOUR BANDS WITH COLOUR-IT	
					Less than 40%	70% or more
<i>All standard clones</i>	<i>Number of days cloth was under trees before assessment and start of harvest</i>	<i>Treatment means</i>	<i>Treatment means</i>	<i>Average difference in apple % colour coverage assessed before harvest</i>		
Royal Gala	23	48%	57%	+9%	-10%	+18%
Jazz	11	35%	56%	+21%	-33%	+30%
Fuji	30	39%	50%	+10%	-19%	+16%
Pink Lady	11	39%	44%	+5%	-9%	+8%

Further detailed results on individual varieties follows:

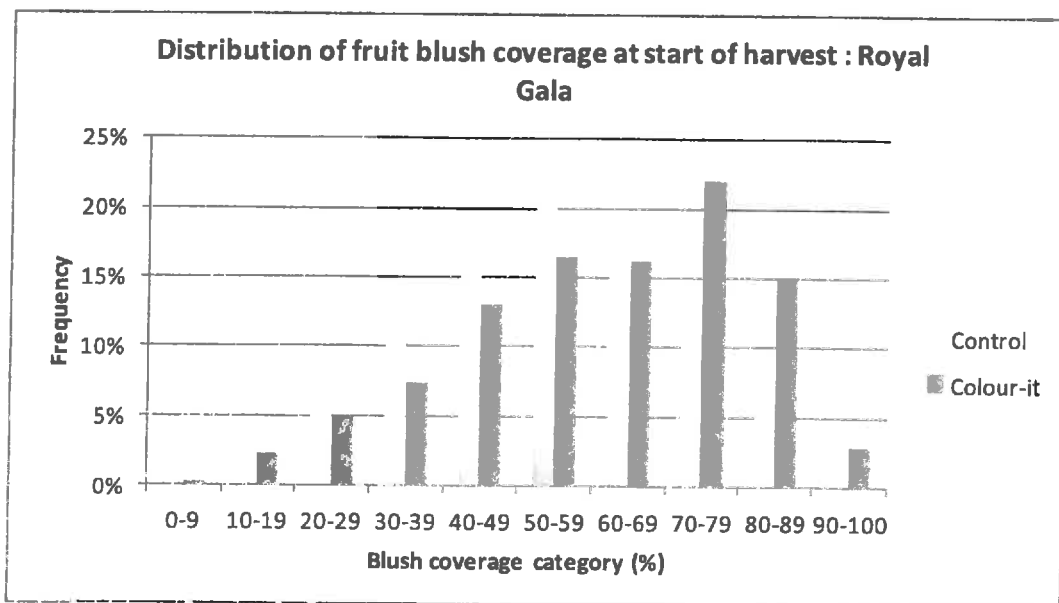
Royal Gala

Overall average increase in blush percentage in the Colour-It cloth treatment was 9% and was highly statistically significant ($p < 0.001$).

The reflective cloth reduced the proportion of the crop with less colouration and increased the proportion with more. At the commencement of harvest, there was 10% less fruit in the treated area with less than 40% colouration and 18% with more than 70% colouration. This data is shown in the table 1 and the following graph.

Table 1. Royal Gala response to Colour-It reflective cloth

Blush Category	Control	Colour-it	Accumulated proportion below and above specified colour bands	Control	Colour-it	Difference from Control
0-9	1%	0%				
10-19	4%	2%				
20-29	8%	5%				
30-39	12%	7%	<40%	25%	15%	-10%
40-49	18%	13%				
50-59	20%	16%				
60-69	16%	16%				
70-79	15%	22%	70%+	22%	40%	18%
80-89	6%	15%				
90-100	0%	3%				



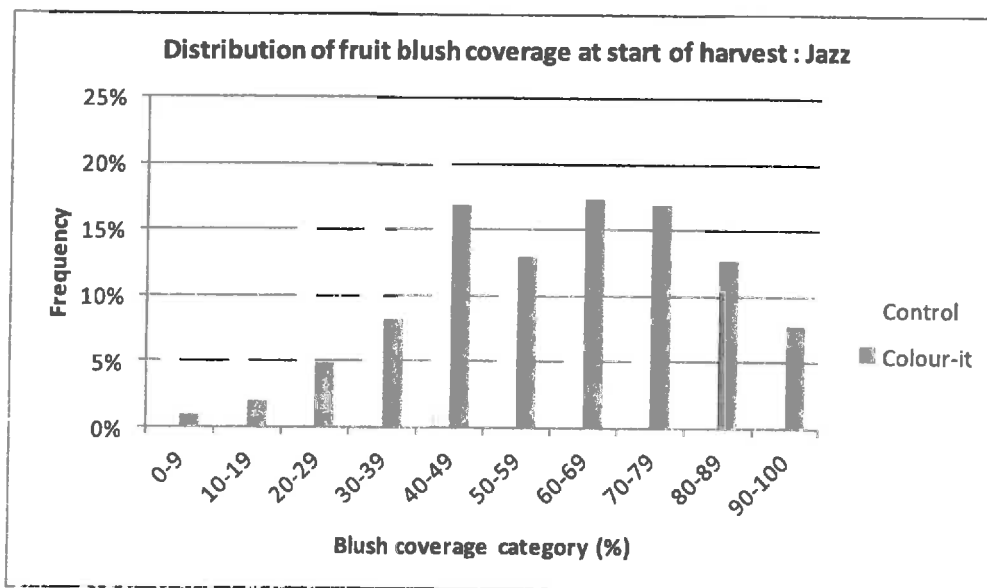
Jazz

Overall average increase in blush percentage in the Colour-it cloth treatment was 21% and was highly statistically significant ($p=0.000$).

The reflective cloth reduced the proportion of the crop with less colouration and increased the proportion with more. At the commencement of harvest, there was 33% less fruit in the treated area with less than 40% colouration and 30% with more than 70% colouration. This data is shown in the table 2 and the following graph.

Table 2. Jazz response to Colour-It reflective cloth

Blush Category	Control	Colour-it	Accumulated proportion below and above specified colour bands	Control	Colour-it	Difference from Control
0-9	6%	1%				
10-19	9%	2%				
20-29	16%	5%				
30-39	18%	8%	<40%	49%	16%	-33%
40-49	22%	17%				
50-59	14%	13%				
60-69	7%	17%				
70-79	5%	17%	70%+	7%	37%	30%
80-89	2%	13%				
90-100	0%	8%				



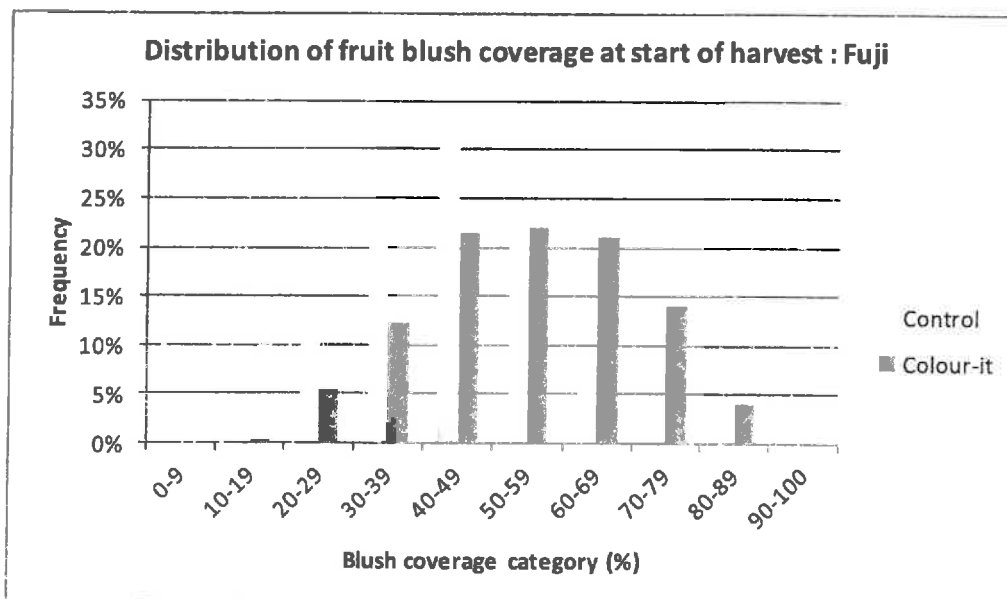
Fuji

Overall average increase in blush percentage in the Colour-it cloth treatment was 10% and was highly statistically significant ($p=0.000$).

The reflective cloth reduced the proportion of the crop with less colouration and increased the proportion with more. At the commencement of harvest, there was 19% less fruit in the treated area with less than 40% colouration and 16% with more than 70% colouration. This data is shown in the table 3 and the following graph.

Table 3. Fuji response to Colour-It reflective cloth

Blush Category	Control	Colour-it	Accumulated proportion below and above specified colour bands	Control	Colour-it	Difference from Control
0-9	0%	0%				
10-19	1%	0%				
20-29	11%	5%				
30-39	25%	12%	<40%	37%	18%	-19%
40-49	32%	21%				
50-59	20%	22%				
60-69	9%	21%				
70-79	2%	14%	70%+	2%	18%	16%
80-89	0%	4%				
90-100	0%	0%				



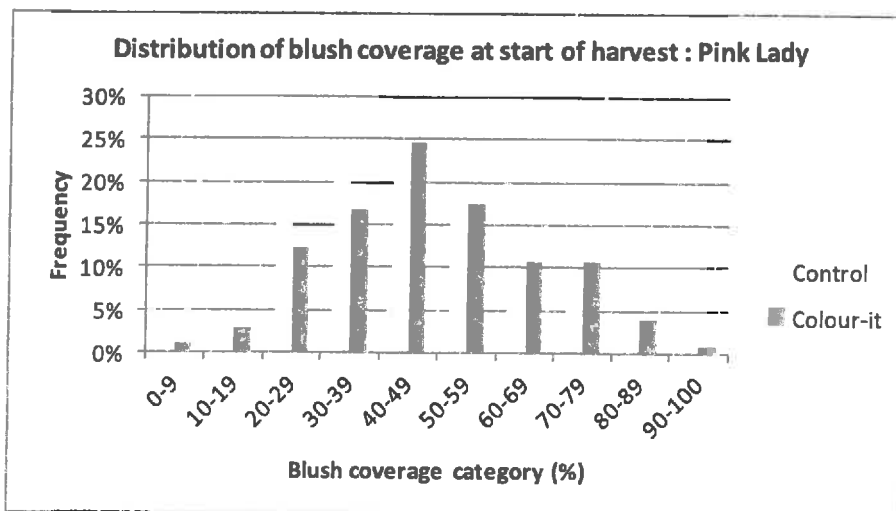
Pink Lady

Overall average increase in blush percentage in the Colour-it cloth treatment was 5% and was highly statistically significant ($p=0.000$).

The reflective cloth reduced the proportion of the crop with less colouration and increased the proportion with more. At the commencement of harvest, there was 10% less fruit in the treated area with less than 40% colouration and 18% with more than 70% colouration. This data is shown in the table 1 and the following graph.

Table 4. Pink Lady response to Colour-it reflective cloth

Blush Category	Control	Colour-it	Accumulated proportion below and above specified colour bands	Control	Colour-it	Difference from Control
0-9	2%	1%				
10-19	3%	3%				
20-29	15%	12%				
30-39	20%	17%	<40%	42%	32%	-9%
40-49	24%	24%				
50-59	17%	17%				
60-69	10%	11%				
70-79	6%	11%	70%+	7%	15%	8%
80-89	2%	4%				
90-100	0%	1%				
	100%	100%				



Effect on internal fruit quality

There was no effect on internal fruit condition for any variety.

Treatment	Soluble Solids (%)	Background Colour	Firmness (kg-f)	Starch Pattern
Control	11.6	3.9	8.2	4.6
Colour-it	11.3	4.1	8.3	4.0
<i>P value</i>	<i>0.48</i>	<i>0.57</i>	<i>0.79</i>	<i>0.47</i>
Significance	NS	NS	NS	NS

Factors influencing fruit colouration effects

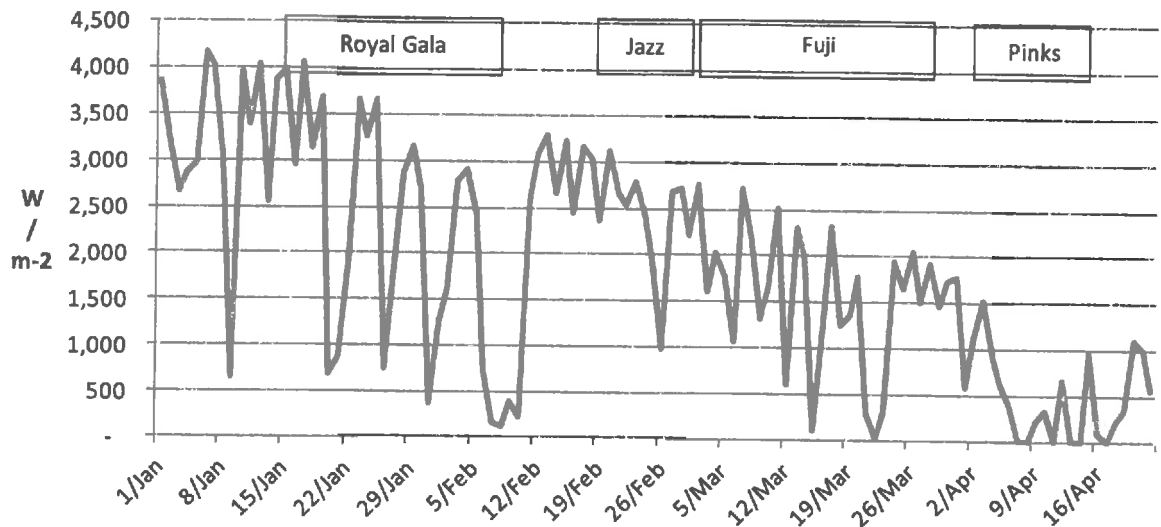
The extent of fruit colouration from the cloth treatment appeared to be influenced by a number of factors including variety, treatment duration, incoming sunshine radiation and tree size.

Variety	Rootstock	Overall Colour Increase (%)	Cloth Duration (days)	Sunshine' radiation (W/m-2)	Potential mean daily 'sunshine' energy (W/m-2)	Canopy Volume (cu m/ha)
Royal Gala	MM106	+9%	23	55,361	2,407	19,905
Jazz	M9	+21%	11	28,420	2,584	13,622
Fuji	MM106	+10%	30	46,238	1,541	24,000
Pink Lady	MM106	+5%	11	4,184	380	18,500

The following graph shows daily radiation over the latter part of the apple growing season. 200 W/m-2 has been subtracted from each hourly total to screen out cloudy periods and estimate actual sunshine energy. Hourly totals are summed to give daily totals. The variety boxes indicate the timing and duration of the cloth treatment to show prevailing conditions during each variety trial.

Daily radiation at Havelock North, Jan-Apr, 2014.

Hourly totals less 200 W/m² to estimate sunshine energy



Group 2 – comparing Colour-It and Extenday branded cloths with an untreated control

Cloth was laid for 8 days in a block of standard Fuji. The MM106 trees were large and block canopy volume was high at 25,000 cubic metres per hectare. The treatment duration for the Pink Lady was even shorter at 5 days. The intensive M9 planting had a fully grown canopy which was quite large at 19,500 cubic metres per hectare.

Variety	Rootstock	Row width	Canopy Volume (cu m/ha)	Date cloth laid	Assessment Date	Cloth Duration (days)
Fuji (2)	MM106	4.5	25,056	13-Mar	21-Mar	8
Pink Lady (2)	M9	3.5	19,543	28-Mar	2-Apr	5

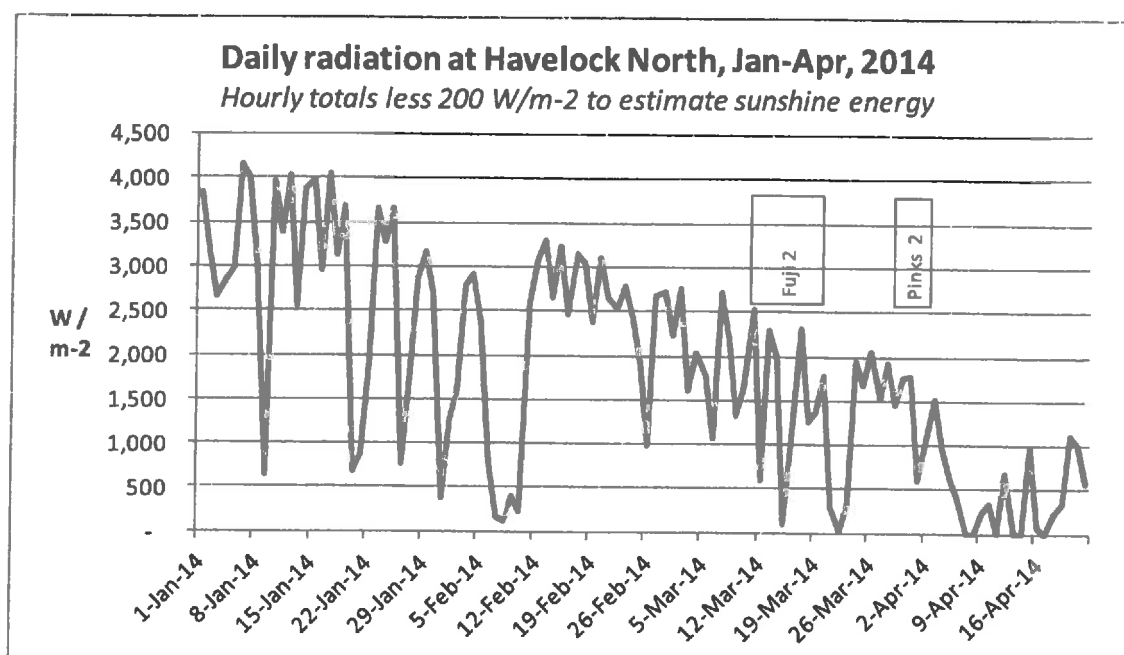
There was no significant difference in fruit blush coverage between any of the treatments for either variety.

Treatment	Average fruit blush coverage (%)	
	Fuji	Pink Lady
Extenday	38	33
Colour-It	35	31
Control	33	30
Significance (p value)	0.05	0.2

There was a trend for fruit colour from the both reflective cloths to exceed the control but differences were small and either not statistically significant (Pink Lady) or at the margin of significance (Fuji).

Sunshine radiation over the treatment interval was typical for the latter part of the harvest season and missed some cloudy days between and after their use.

Variety	Rootstock	Overall Colour Increase	Cloth Duration (days)	Sunshine' radiation (W/m-2)	Potential mean daily 'sunshine' energy (W/m-2)
Fuji (2)	MM106	-	8	12,653	1,582
Pink Lady (2)	M9	-	5	8,604	1,721



Discussion

The fruit colour response to the reflective cloth appears to be influenced by a number of inter-related factors:

- Variety – some respond better than others,
- Treatment duration – its likely there is a minimum time required to get a response. And, at the other end of the scale, an unnecessarily long interval may result in little additional benefit as well as the opportunity cost of missing gain in other varieties,
- Sunshine energy – the seasonal pattern of declining radiation energy with the onset of autumn suggests that longer intervals for later season varieties would be required to intercept equivalent energy to early varieties. And the

amount of sunshine energy intercepted and reflected by the cloth is related to the duration of treatment, the prevailing weather conditions and resulting number of sunshine hours during treatment,

- Canopy volume – the larger the canopy, the greater the proportion of incoming radiation intercepted by the canopy and the less available to be reflected back onto the fruit.

These factors for each trial block are summarised below:

Variety	Cloth Duration (days)	Sunshine radiation energy (W/m-2)	Canopy Volume (cu m/ha)	Average Colour Increase (%)
Jazz	11	28,420	13,622	21%
Fuji	30	46,238	24,000	10%
Royal Gala	23	55,361	19,905	9%
Pink Lady	11	4,184	18,500	5%
Fuji (2)	8	12,653	25,056	NS
Pink Lady (2)	5	8,604	19,543	NS

The greatest fruit colour response occurred with Jazz where good levels of radiation occurred over a moderate duration onto a smaller canopy size block. Longer treatment duration and more sunshine radiation occurred with Royal Gala but resulted in less colour increase than Jazz. This suggests that Jazz is a more responsive variety than Royal Gala.

Despite longer treatment duration with the Fuji block, less sunshine energy was intercepted largely due to normal seasonal decline. A similar colour response was achieved to Royal Gala and Fuji. The responses to the other later season varieties show the limitations of shorter duration treatment especially when combined with larger trees and lower sunshine radiation.

These results suggest that a treatment duration of three weeks is required to achieve a desirable response for most varieties – at least for Hawkes Bay conditions and for blocks of larger trees (>18,000 cu m). For more responsive varieties such as Jazz (and probably blush types like Pacific Queen and Rose) a duration of 10-14 days may be optimal, especially with smaller dwarf canopies.

Finally, while these trials did not attempt to quantify the colour increases achieved after the start of harvest ie between select picks. There is a trade-off between keeping cloth in a block longer, during harvest and shifting it to the next maturing variety. Deciding when to shift the cloth from one variety to the next requires an assessment of the relative gain achieved with improving colour to a diminishing volume of fruit in the current block verses the benefit to the whole crop of the next variety.