Early Almond Orchard Establishment with Complete Trace Plus (CTP)

1. Introduction

Orchard establishment is important in early production and plant growth can be stimulated in several ways. Addition of chelation agents is one of methods, which facilitates plants to absorb non-soluble nutrients. Thereby, plants can absorb especially micro nutrients which are important for productivity of the plants.

There are few studies on effect of chelate agents on young plant growth. In this study, effects of CTP® will be examined and plant growth parameters will be accessed.

2. Project aim

To evaluate the growth of young almond plants treated with CTP® in order to establish the orchard with minimum lag period.

2.1. Project objectives

To assess the physiological parameters of CTP® treated and control young almond plants:

(a) Evaluation of plant height.

(b) Evaluation of plant diameter.

3. Material and Methods

3.1. Trial method

The growth of three almond varieties were assessed by using CTP® application in 2016/2017 in, Darlington point, NSW. CTP® was applied as spray application after 4 months of planting and growth was evaluated of 45 plants of three varieties from CTP® treated and control areas separately. The three replicates were used in the trial and plant height and trunk diameter at 50 cm from the ground were measured. Measuring was conducted just before the application and after application at monthly intervals till 4 months. Finally, the growth parameters were assessed statistically to find out the physiological growth differences of CTP® treated young plants and control young plants.

Variety	Application rate
1. Wood colony	5L/ha – (with 1730 water/ha)
2. Montery	5L/ha – (with 1730 water/ha)
3. Nonpareil	5L/ha – (with 1730 water/ha)

Table 1

Treated varieties and spray application rates.

3.2. Trial site and layout

Figure 1 CTP® treated (a) and control (b) young almond plants in Darlington Point, NSW.

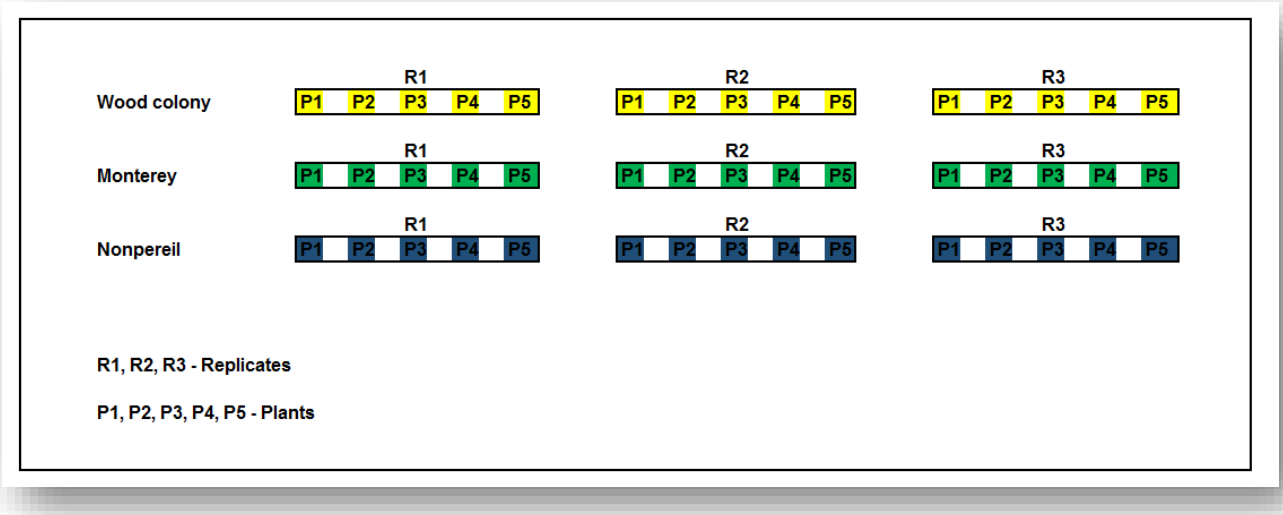

Figure 2 Trial layout of CTP® treated area in Darlington Point, NSW. The control area layout was the same as treated area.

3.3 Statistical analysis

The height and diameter data were analysed by using “R” in 2-factorial ANOVA and statistical significance was denoted by using lower alphabetical letters.

4. Analysis

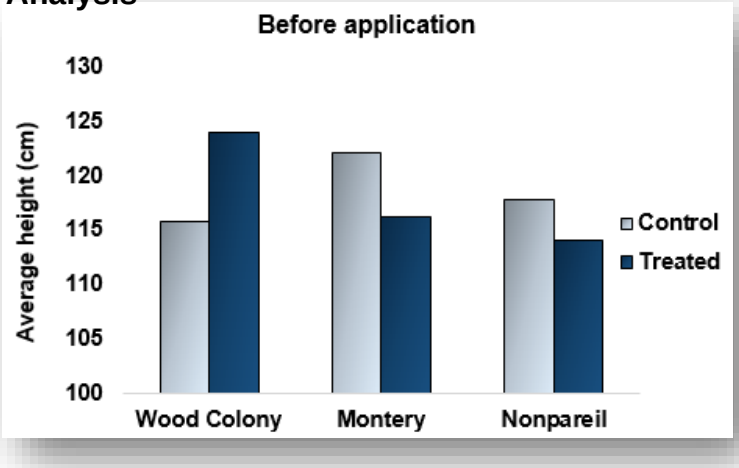

Figure 3 Average height of control and CTP® treated plants of three varieties before application of CTP®.

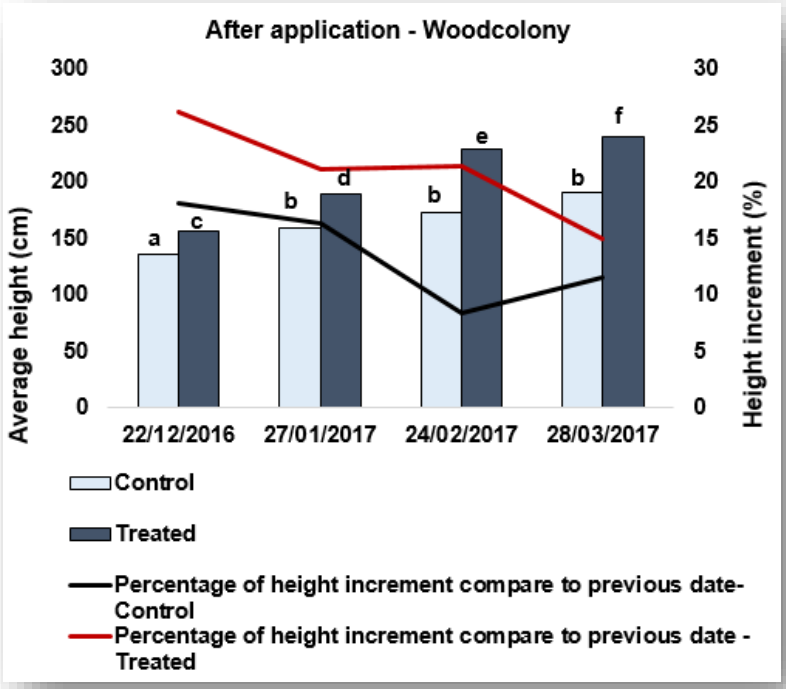

Figure 4 Average height and height increment percentages of control and CTP® treated Wood colony plants during trial period.

After CTP application, the average height of treated Wood colony plants increased between 5% – 26% while control Wood colony plants height increased between 8% – 18% during the sampling period. The height increment of control plants was significant ($P < 0.05$) at 22/12/2016 compare to previous data point while increments of height were not significant ($P \leq 0.05$) for the rest of the trial period. However, the height increments of CTP treated plants were significant ($P < 0.001$) compare to previous sampling points after application at every sampling points till end of the trial.

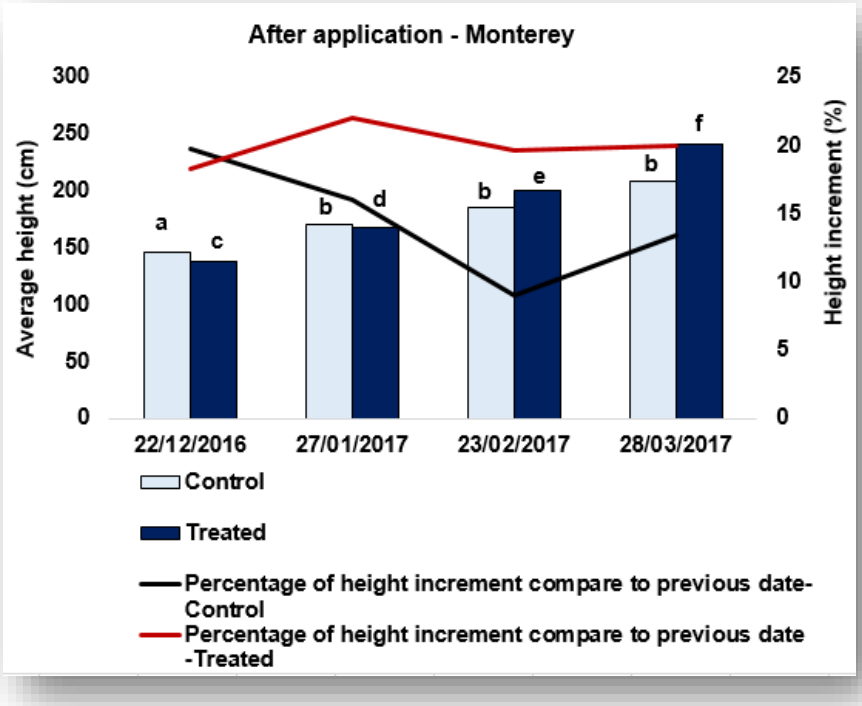

Figure 5 Average height and height increment percentages of control and CTP® treated Monterey plants during trial period.

After CTP application, Monteray treated plant height increased between 18% – 22% whereas control plant height increased between 9% – 20%. Further, the height increment of control plants was significant (P < 0.001) at 22/12/2016 compare to previous sampling dates while increments of height were not significant (P ≤0.05) when assesse monthly intervals for next three months. Further, the height increments of CTP treated plants were significant (P <0.001) at 22/12/2016, 27/01/2017, 23/02/2017 and 28/03/2017 compare to previous data point.

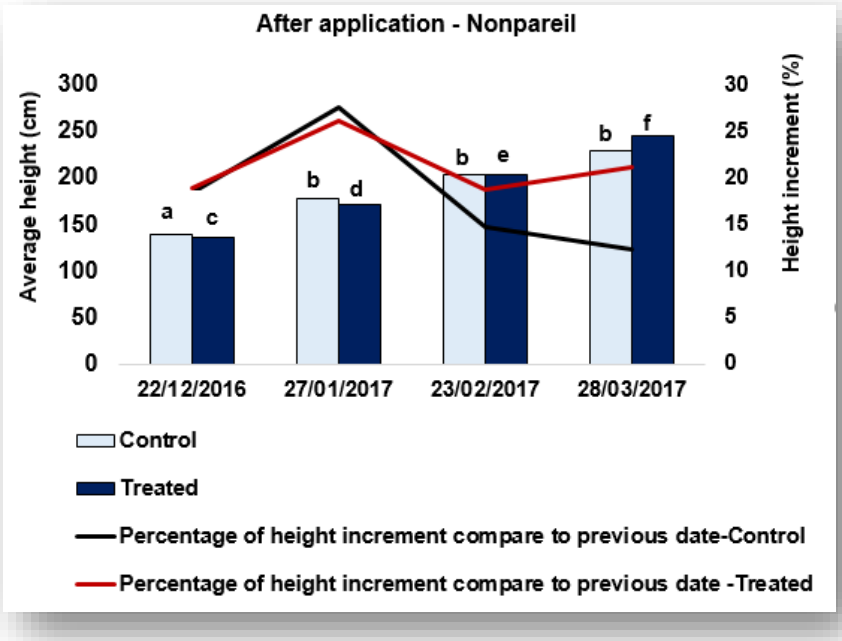

Figure 6 Average height and height increment percentages of control and CTP® treated Nonpareil plants during trial period.

After CTP application, the height of Nonpareil treated plants increased between 19% – 26% and the height of control plant increased between 12% – 28% during the sampling period. The increment of height of control plants was significant (P < 0.001) at 22/12/2016 compare to previous sampling date while the height increments of treated plants were significant (P < 0.001) compare to previous data points from 22/12/2016 to 28/03/2017 (Figure 6).

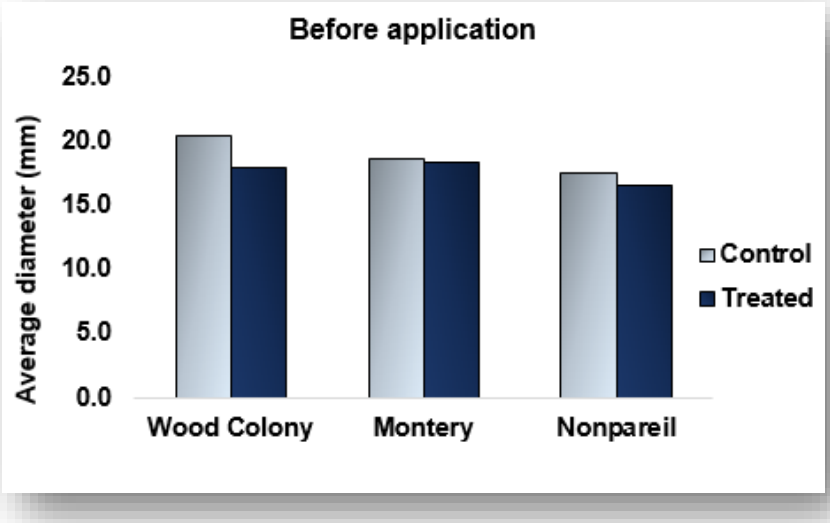

Figure 7 Average diameter of control and CTP® treated plants of three varieties before application of CTP®.

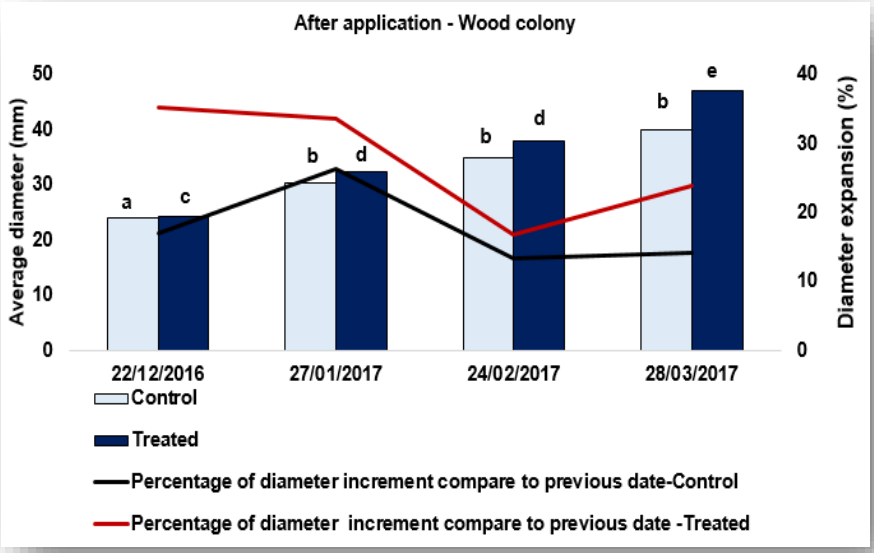

Figure 8 Average diameter and diameter increment percentages of control and CTP® treated Wood colony plants during trial period.

After CTP application, the average diameter of treated Wood colony expanded between 17% – 35% while average diameter of control plants expanded 13% – 26%. The diameter increment of control plants was significant ($P < 0.05$) at 22/12/2016 compare to previous data point while the diameter increments at 27/01/2017, 24/02/2017 and 28/03/2017 were not significant. Further, the diameter increments of treated Wood colony plants were significant ($P < 0.001$) at 22/12/2016 and 28/03/2017 whereas the height increment of treated Wood colony were not significant at 27/01/2017 and 24/02/2017 compare to previous data points.

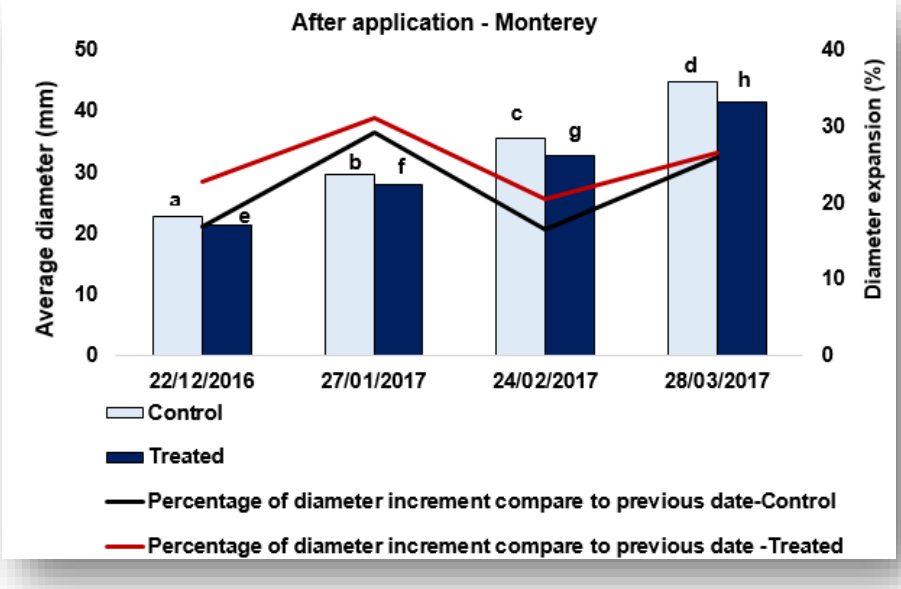

Figure 9 Average diameter and diameter increment percentages of control and CTP® treated Monterey plants during trial period.

After application, treated Monteray average diameter expanded between 17% – 31% and control average diameter increased between 20% – 29%. The increment of diameter of control plants was significant ($P < 0.05$) from 22/12/2016 to 28/03/2017 (Figure 9). Similarly, the expansion of diameter of treated plants were significant ($P < 0.001$) for above mentioned period.

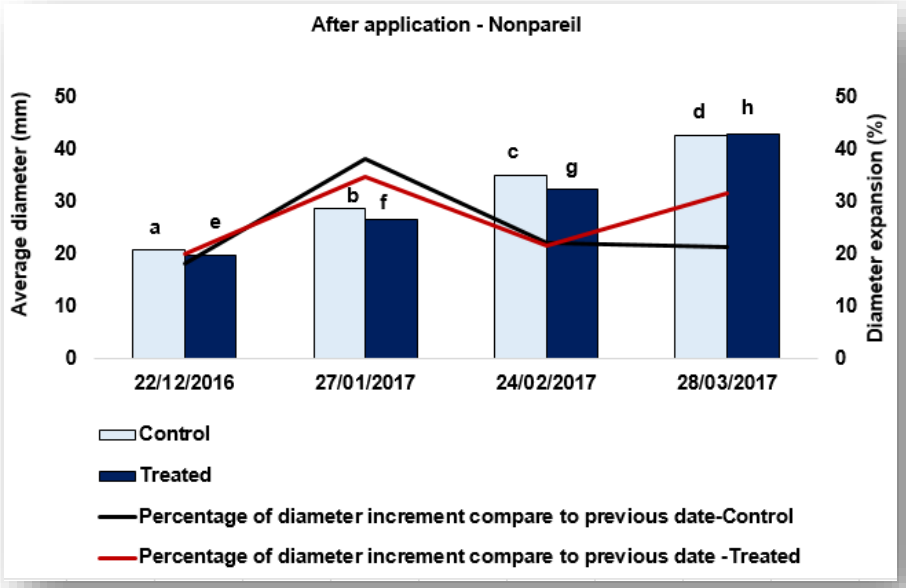

Figure 10 Average diameter and diameter increment percentages of control and CTP® treated Nonpareil plants during trial period.

Treated Nonpareil average diameter expanded between 20% – 35% while control plant diameter increased between 18% – 38% during the sampling period. The increment of diameter of control plants were significant ($P < 0.05$) during the trial period likewise the increment of CTP treated plants were significant ($P < 0.001$) from 22/12/2016 to 28/03/2017 period.

5. Canopy growth

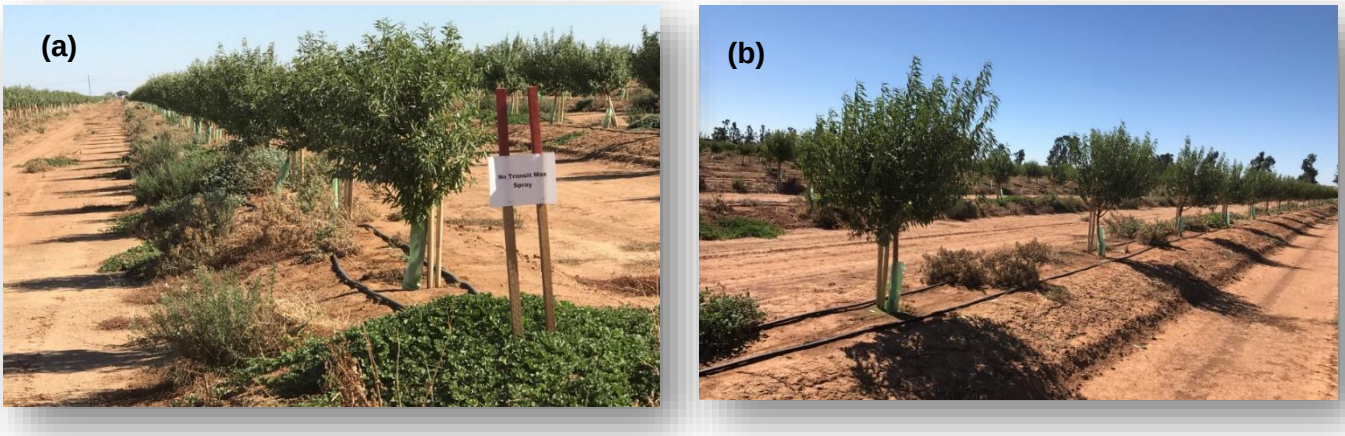

Figure 11 Control (a) and CTP® treated (b) almond plants of the Spray trial, 8 months after planting.

Figure 11 (b) shows dense canopy with more lateral branches with vigorous growth. CTP® stimulates the canopy growth which will facilitate higher photosynthesis and higher plant growth resulted early production.

6. Root growth

Figure 12 Roots (marked in the red circles) of control (a) and CTP® treated (b) almond plants of the trial, 8 months after planting.

CTP® treated plants has larger root system compare to control plants at 8 months after planting (Figure 12 a & b) which facilitates efficient water and nutrients absorption. As a result, the growth of treated plants will be higher and the lagging period for the production will be lesser compare to control.

7. Nutrient content in leaves

Table 2: Availability of nutrients of TM® treated leaves compare to control.

Nutrient	Efficiency enhancement
Nitrate N	248%
Potassium	49%
Sulphur	5%
Boron	11%
Iron	28%
Manganese	16%

Nitrogen (N) which is important for vegetative growth and chlorophyll formation was significantly higher in the CTP® treated plant leaves compare to control. Further, Potassium (K) which is effect on the growth and vigour of young plants was considerably higher in treated leaves.

Similarly, micro nutrients: Boron (B), Iron (Fe) and Manganese (Mn) which are immobile elements were relatively higher in CTP® treated leaves. Hence, this is evident for better chelation agent which carries mobile and immobile elements to inside the plants.

8.Conclusion

Young Wood colony, Monterey and Nonpareil height and diameter were significantly increased after application of CTP® from 22/12/2016 to 28/03/2017. Nevertheless, growth increment of control plants was significant only for around 6 months after planting especially height of the plants. In addition, CTP® facilitates strong root system of the plants which important for replanted young plants to establish in the new site with efficient nutrient uptake. Similarly, vigorous canopy growth by well grown lateral branches was characteristic in treated plants. N, K and immobile micro nutrients were higher in the treated leaves which stimulate the vegetative growth of young almond plants compare to control plants.

Consequently, CTP® treated Wood colony, Monterey and Nonpareil establish well in the new orchard and come to the early production. Thereby, industry can generate income with minimum lag period compare to control plants.

Appendix

1. Wood colony height after application:

(a) 22/12/2016 and 27/01/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-27.167	-4.957	1.833	5.603	17.333

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	146.307	2.589	56.51	< 2e-16 ***
TC1	23.360	3.662	6.38	6.63e-07 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 100.5608)

Null deviance: 6908.4 on 29 degrees of freedom

Residual deviance: 2815.7 on 28 degrees of freedom

AIC: 227.39

Number of Fisher Scoring iterations: 2

(b) 27/01/2017 and 24/02/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-27.167	-4.083	1.167	5.292	17.333

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	169.667	2.686	63.161	< 2e-16 ***
TC2	25.167	3.799	6.625	3.47e-16***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 108.2381)

Null deviance: 7780.9 on 29 degrees of freedom

Residual deviance: 3030.7 on 28 degrees of freedom

AIC: 229.6

Number of Fisher Scoring iterations: 2

(c) 24/02/2017 and 28/03/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-26.600	-10.300	-2.067	12.150	27.467

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	200.600	4.020	49.901	< 2e-16	***
TC3	39.933	5.685	7.024	1.22e-07	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 242.4048)

Null deviance: 18747.4 on 29 degrees of freedom
Residual deviance: 6787.3 on 28 degrees of freedom
AIC: 253.78

Number of Fisher Scoring iterations: 2

2. Monterey height after application:
(a) 22/12/2016 and 27/01/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-23.720	-6.470	3.103	9.515	15.427

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	136.720	3.223	42.422	< 2e-16	***
TC1	32.353	4.558	7.098	1.01e-07	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 155.8026)

Null deviance: 12213.0 on 29 degrees of freedom
Residual deviance: 4362.5 on 28 degrees of freedom
AIC: 240.52

Number of Fisher Scoring iterations: 2

(b) 27/01/2017 and 24/02/2017

Min	1Q	Median	3Q	Max
-23.073	-9.277	1.927	11.087	19.473

Deviance Residuals:

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	169.073	3.330	50.779	< 2e-16	***
TC2	23.453	4.709	4.981	2.92e-05	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 166.2914)

Null deviance: 8781.6 on 29 degrees of freedom
Residual deviance: 4656.2 on 28 degrees of freedom
AIC: 242.48

Number of Fisher Scoring iterations: 2

(c) 24/02/2017 and 28/03/2017
Deviance Residuals:

Min	1Q	Median	3Q	Max
-22.2	-9.2	-1.2	11.3	25.8

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	192.527	3.371	57.114	< 2e-16	***
TC3	38.673	4.767	8.112	7.84e-09	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 170.4446)

Null deviance: 15989.6 on 29 degrees of freedom
Residual deviance: 4772.4 on 28 degrees of freedom
AIC: 243.22

Number of Fisher Scoring iterations: 2

2. Nonpareil height after application:
(a) 22/12/2016 and 27/01/2017
Deviance Residuals:

Min	1Q	Median	3Q	Max
-15.227	-3.720	-1.227	3.680	21.273

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	139.600	2.025	68.955	< 2e-16	***
TC1	28.627	2.863	9.998	9.66e-11	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 61.48033)

Null deviance: 7867.6 on 29 degrees of freedom
Residual deviance: 1721.4 on 28 degrees of freedom
AIC: 212.63

Number of Fisher Scoring iterations: 2

(b) 27/01/2017 and 24/02/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-15.227	-6.283	-1.880	6.773	24.467

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	168.227	2.502	67.232	< 2e-16	***
TC2	26.307	3.539	7.434	4.27e-08	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 93.91367)

Null deviance: 7819.9 on 29 degrees of freedom
Residual deviance: 2629.6 on 28 degrees of freedom
AIC: 225.34

Number of Fisher Scoring iterations: 2

(c) 24/02/2017 and 28/03/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-26.2000	-8.2000	0.7667	6.5500	24.8000

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	171.200	3.039	56.331	< 2e-16	***
TC3	22.067	4.298	5.134	1.92e-05	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 138.5476)

Null deviance: 7531.4 on 29 degrees of freedom
Residual deviance: 3879.3 on 28 degrees of freedom
AIC: 237

Number of Fisher Scoring iterations: 2

4. Wood colony diameter after application

(a) 22/12/2016 and 27/01/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-14.700	-4.545	1.920	5.795	12.300

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	156.580	2.156	72.63	< 2e-16	***

TC1 33.120 3.049 10.86 1.5e-11 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 69.723)

Null deviance: 10179.3 on 29 degrees of freedom
Residual deviance: 1952.2 on 28 degrees of freedom
AIC: 216.4

Number of Fisher Scoring iterations: 2

(b) 27/01/2017 and 24/02/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-22.50	-6.05	1.40	8.30	16.50

Coefficients:

Estimate Std. Error t value Pr(>|t|)
(Intercept) 189.700 2.502 75.809 < 2e-16 ***
TC2 19.800 3.539 5.595 5.47

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 93.925)

Null deviance: 5570.2 on 29 degrees of freedom
Residual deviance: 2629.9 on 28 degrees of freedom
AIC: 225.34

Number of Fisher Scoring iterations: 2

(c) 24/02/2017 and 28/03/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-24.733	-6.308	1.000	7.575	16.500

Coefficients:

Estimate Std. Error t value Pr(>|t|)
(Intercept) 209.500 2.743 76.372 < 2e-16 ***
TC3 31.233 3.879 8.051 9.11e-09 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 112.8726)

Null deviance: 10476.8 on 29 degrees of freedom
Residual deviance: 3160.4 on 28 degrees of freedom
AIC: 230.85
Number of Fisher Scoring iterations: 2

5. Monterey diameter after application:
(a) 22/12/2016 and 27/01/2017
Deviance Residuals:

Min	1Q	Median	3Q	Max
-26.12	-7.40	-0.76	10.60	21.88

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	137.400	3.033	45.305	< 2e-16	***
TC1	30.220	4.289	7.046	1.15e-07	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 137.9687)

Null deviance: 10712.5 on 29 degrees of freedom
Residual deviance: 3863.1 on 28 degrees of freedom
AIC: 236.88

Number of Fisher Scoring iterations: 2

(b) 27/01/2017 and 24/02/2017
Deviance Residuals:

Min	1Q	Median	3Q	Max
-26.60	-9.48	0.39	11.63	21.88

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	167.620	3.594	46.641	< 2e-16	***
TC2	32.980	5.082	6.489	4.96e-07	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 193.7366)

Null deviance: 13582.2 on 29 degrees of freedom
Residual deviance: 5424.6 on 28 degrees of freedom
AIC: 247.06

Number of Fisher Scoring iterations: 2

(c) 24/02/2017 and 28/03/2017
Deviance Residuals:

Min	1Q	Median	3Q	Max
-26.600	-10.300	-2.067	12.150	27.467

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)

(Intercept) 200.600 4.020 49.901 < 2e-16 ***
TC3 39.933 5.685 7.024 1.22e-07 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 242.4048)

Null deviance: 18747.4 on 29 degrees of freedom
Residual deviance: 6787.3 on 28 degrees of freedom
AIC: 253.78

Number of Fisher Scoring iterations: 2

6. Nonpareil diameter after application:
(a) 22/12/2016 and 27/01/2017
Deviance Residuals:

Min	1Q	Median	3Q	Max
-26.2000	-8.2000	0.7667	6.5500	24.8000

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) 171.200 3.039 56.331 < 2e-16 ***
TC1 22.067 4.298 5.134 1.92e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 138.5476)

Null deviance: 7531.4 on 29 degrees of freedom
Residual deviance: 3879.3 on 28 degrees of freedom
AIC: 237

Number of Fisher Scoring iterations: 2

(b) 27/01/2017 and 24/02/2017
Deviance Residuals:

Min	1Q	Median	3Q	Max
-33.833	-11.692	0.233	8.433	49.667

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) 193.267 4.362 44.306 < 2e-16 ***
TC2 53.067 6.169 8.602 2.39e-09 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 285.4202)

Null deviance: 29112.3 on 29 degrees of freedom
Residual deviance: 7991.8 on 28 degrees of freedom

AIC: 258.69

Number of Fisher Scoring iterations: 2

(c) 24/02/2017 and 28/03/2017

Deviance Residuals:

Min	1Q	Median	3Q	Max
-26.200	-5.153	1.300	4.687	24.800

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	135.653	2.708	50.092	< 2e-16	***
TC3	35.547	3.830	9.282	4.86e-10	***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 110.0049)

Null deviance: 12556.9 on 29 degrees of freedom
Residual deviance: 3080.1 on 28 degrees of freedom
AIC: 230.08

Number of Fisher Scoring iterations: 2