# Proj

Mānuka background(cultural,uses,industry)

Experimental Cross Design

Two east cape parents, F1 cross siblings

**F1 Layout**   Map indicates the layout of the F1 generation resulting from a cross between EC201 and EC103 parents. Column 1 is approximately lengthways facing north.

**Height Diagram**   Diagram indicates the areas of leaf collection regarding height. Each Tree generally had 10 leaves collected (some trees have been sampled more than once), leaves were selected from low, mid and high points of the tree. The first leaf sampled from each tree was measured twice for replication comparison.

**Import and Arrange Data**   Dualex was used to measure transmittance through all samples included in this dataset, more information on how this works can be found in Clara Rey Caramés, 2015.

"Full.xlsx

- Surface content of chlorophyll in $g/cm^2$ (Chl)

- Epidermal Flavoid content in absorbance units(Au); Flavonol(Flav) and Anthocyanin(Anth)

- Nitrogen Balance Index status is calculated using Chlorophyll and Flavonol values automatically (NBI)

It also contains information about the block position, the leaf height information, and presense or absence of flowering

Sheet "Dup" contains only the replicated samples

**Checking Data Quality from Replicate Leaf Measures.**   Replicates exist in two groups; first leaf measurement (Y1), and the second leaf measurement (Y2). The second measurement was taken after removing the leaf following the first reading, to help establish the presence of any leaf positional bias.

**Replicate Plots and Data Overview**

```
##   Rep.   AnthMean     AnthSD  ChlMean    ChlSD FlavMean     FlavSD
## 1   Y1 0.09830189 0.04539806 34.93672 14.55641 1.979969 0.2863768
## 2   Y2 0.09768153 0.04439018 36.59920 14.51963 1.954280 0.2796720
```
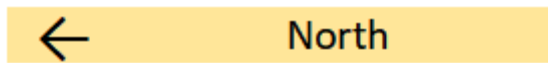
| Row | Column 1 | Column 2 | Column 3 | Column 4 |
|---|---|---|---|---|
| 50 | IN4DF | IN4F4 | IN4GN | IN4GP |
| 49 | IN4DE | IN4F3 | IN4GM | IN4GS |
| 48 | IN4DD | IN4F2 | IN4GL | |
| 47 | IN4DC | IN4F1 | IN4GK | IN4GV |
| 46 | IN4DA | IN4F0 | IN4GJ | IN4GW |
| 45 | IN4D9 | IN4EZ | IN4GH | IN4GX |
| 44 | IN4DB | IN4EY | IN4GG | |
| 43 | IN4D7 | IN4EX | IN4GF | |
| 42 | IN4D6 | IN4EW | IN4GE | |
| 41 | IN4D5 | IN4EV | IN4GD | IN4H1 |
| 40 | IN4D4 | IN4ET | IN4GC | |
| 39 | IN4D3 | IN4ES | IN4GB | |
| 38 | IN4D2 | IN4ER | IN4GA | |
| 37 | IN4D0 | IN4EP | IN4G9 | |
| 36 | IN4CY | IN4EN | IN4G8 | |
| 35 | IN4CX | IN4EM | IN4G7 | IN4H7 |
| 34 | IN4CW | IN4EL | IN4G6 | IN4H8 |
| 33 | IN4CV | IN4EK | IN4G5 | |
| 32 | IN4CT | IN4EJ | IN4G4 | IN4HA |
| 31 | IN4CS | IN4EH | IN4G3 | |
| 30 | IN4CR | IN4EG | IN4G2 | |
| 29 | IN4CP | IN4EF | IN4G1 | |
| 28 | IN4CN | IN4EE | IN4G0 | |
| 27 | IN4CM | IN4ED | IN4FZ | |
| 26 | IN4CL | IN4EC | IN4FY | |
| 25 | IN4CK | IN4EB | IN4FX | |
| 24 | IN4CJ | IN4EA | IN4FW | |
| 23 | IN4CH | IN4E9 | IN4FV | IN4HK |
| 22 | IN4CG | IN4E8 | IN4FT | |
| 21 | IN4CE | IN4E6 | IN4FS | |
| 20 | IN4CD | IN4E4 | IN4FR | |
| 19 | IN4CC | IN4E3 | IN4FP | |
| 18 | IN4CB | IN4E2 | IN4FN | |
| 17 | | IN4E1 | IN4FM | |
| 16 | IN4C9 | IN4E0 | IN4FL | |
| 15 | IN4C8 | IN4DZ | IN4FK | |
| 14 | IN4C7 | IN4DY | IN4FJ | |
| 13 | IN4C6 | IN4DX | IN4FH | |
| 12 | IN4C5 | IN4DW | IN4FG | |
| 11 | IN4C4 | IN4DV | IN4FF | |
| 10 | IN4C3 | IN4DT | IN4FE | |
| 9 | IN4C2 | IN4DFS | IN4FD | |
| 8 | IN4C1 | IN4DR | IN4FC | |
| 7 | IN4C0 | IN4DP | IN4FB | |
| 6 | IN4BZ | IN4DM | IN4FA | |
| 5 | IN4BY | IN4DL | IN4F9 | |
| 4 | IN4BX | IN4DK | IN4F8 | |
| 3 | IN4BW | IN4DJ | IN4F7 | |
| 2 | IN4BV | IN4DH | IN4F6 | |
| 1 | IN4BT | IN4DG | IN4F5 | |

Figure 1: "Map of F1 Trees"
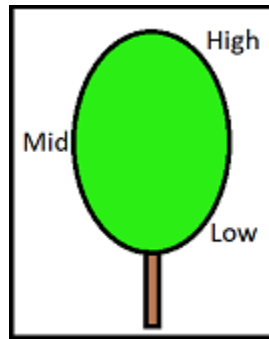
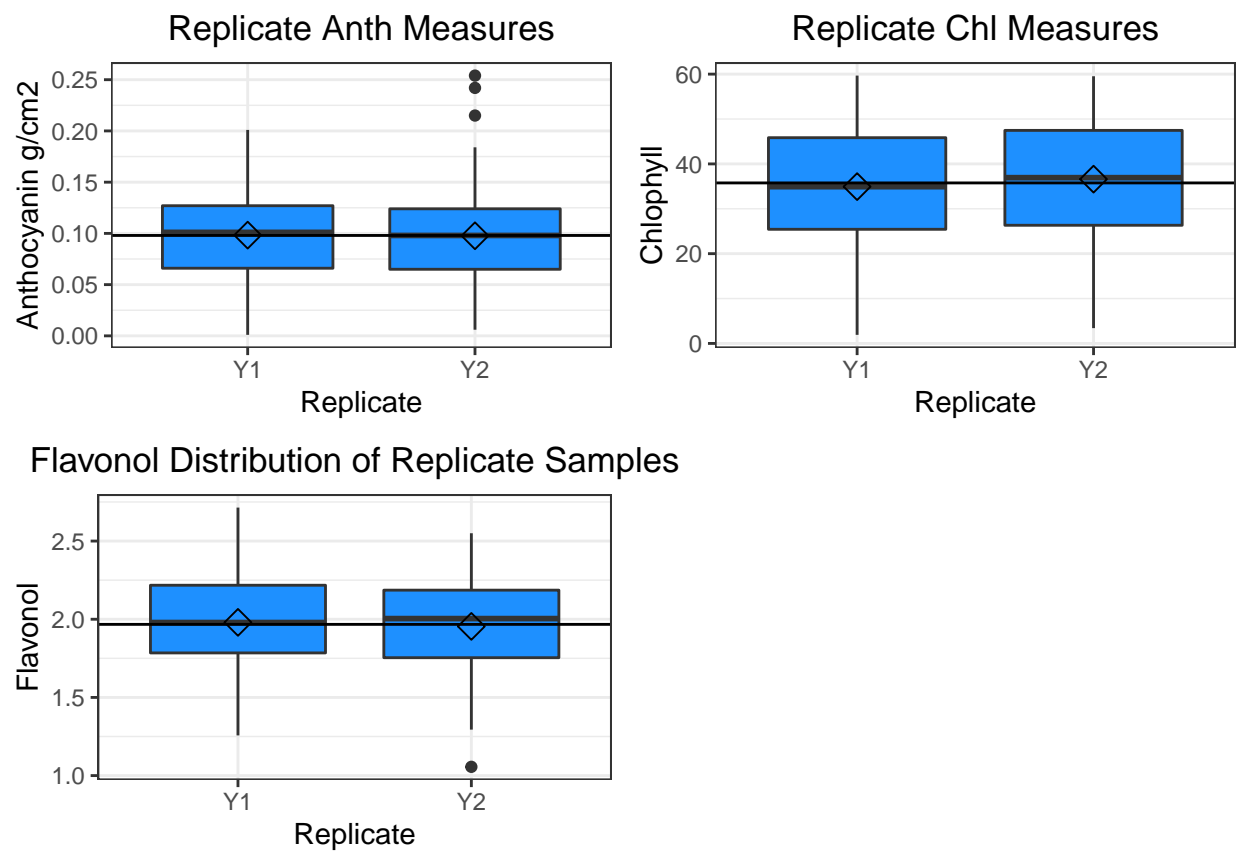Figure 2: "Diagram of leaf collection levels"



Figure 3: Plots of replicate measure disitributions, medians (lines), means (empty diamonds)

**Replicate ANOVAs**

```
## Analysis of Variance Table
##
## Response: Dup$Anth
##             Df  Sum Sq   Mean Sq F value Pr(>F)
## Dup$Rep.     1 0.00003 0.0000304  0.0151 0.9023
## Residuals 314 0.63303 0.0020160

## Analysis of Variance Table
##
## Response: Dup$Chl
##             Df Sum Sq Mean Sq F value Pr(>F)
## Dup$Rep.     1    218  218.33   1.033 0.3102
## Residuals 314  66366  211.36

## Analysis of Variance Table
##
## Response: Dup$Flav
##             Df  Sum Sq  Mean Sq F value Pr(>F)
## Dup$Rep.     1  0.0521 0.052129  0.6506 0.4205
## Residuals 314 25.1596 0.080126
```

Replicate measures and plots appear to correspond well - indicative that the measurements from the dualex are reliable. Might pay to remove the outliers.
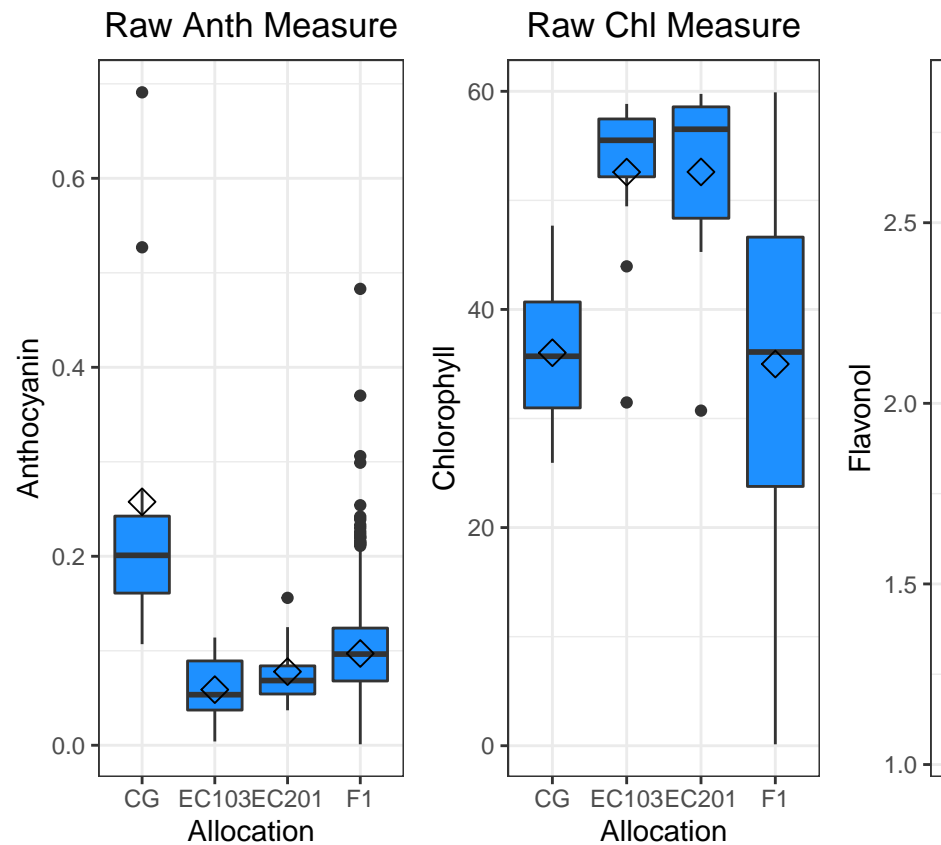


**Plots of leaf chemicals across groups**

**Data Summary**

```
##   Allocation    AnthMean     AnthSD  ChlMean      ChlSD FlavMean     FlavSD
## 1         CG 0.25763636 0.18306079 36.02836   7.090510 2.169455  0.2021457
## 2      EC103 0.05883333 0.03576650 52.59242   7.889391 1.599833  0.2334250
## 3      EC201 0.07790000 0.03665288 52.60670   9.291990 1.710800  0.2217590
## 4         F1 0.09711830 0.04437066 34.99601  15.144271 1.967003  0.2479930
```

Anthocyanin Crimson Glory(CG) outgroup apparent, F1 population more similar to parental trees.

Chlorophyll F1 very diverse, overlaps with both parent trees and outgroup, more similar median and distrubtion to outgroup.

Flavonol F1 overlaps with parents and outgroup, slightly more similar to parental trees.
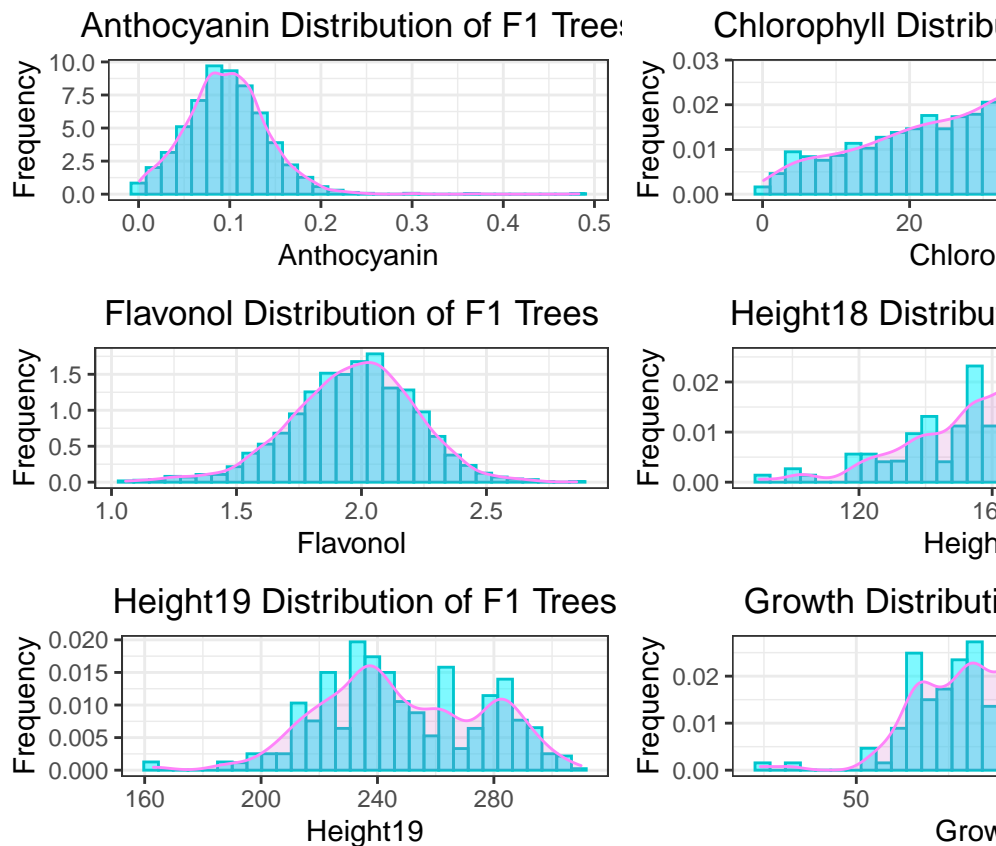


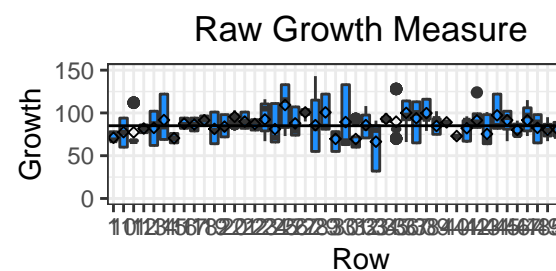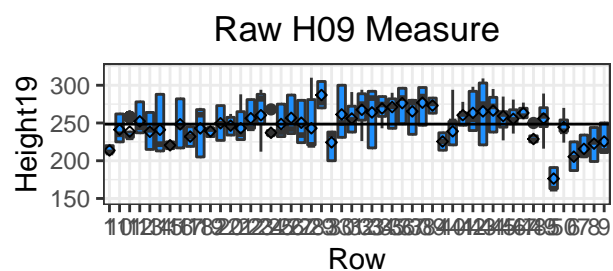**Plots of unadjusted F1 chemical**

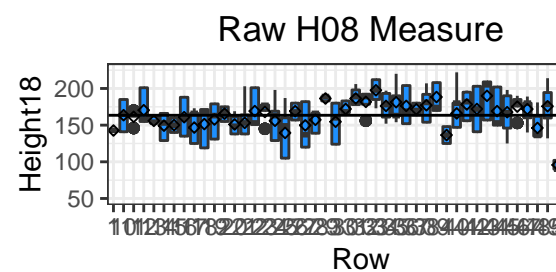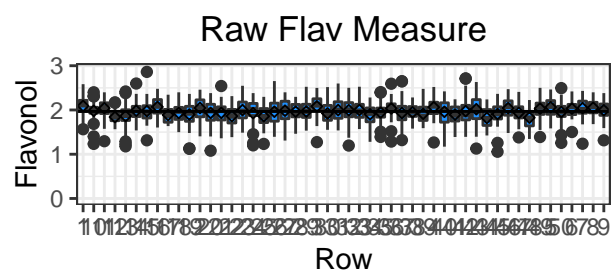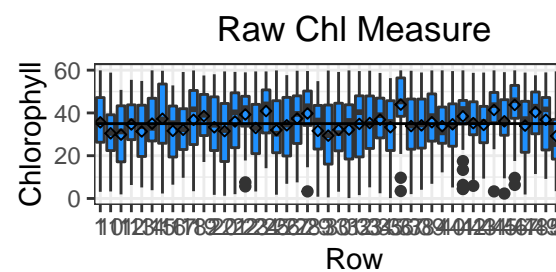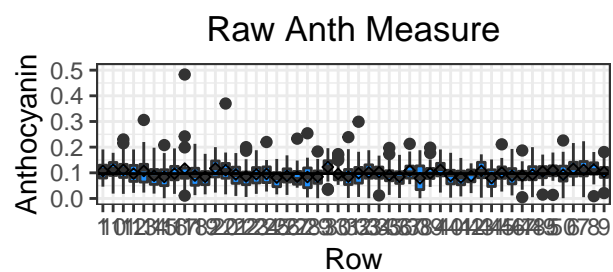Anothcyanin left bias, long tail

Chlorophyll right bias, truncated

Flavonol typical bell curve with slightly long tails both directions

Height 2018 lumpy normal disitribution

Height 2019 appears to be two overlapping distribitiuons, maybe 3

Growth maybe 3 overlapping populations

Row Comparisons

Raw Anth Measure

Raw Chl Measure

Raw Flav Measure

Raw H08 Measure

Raw H09 Measure

Raw Growth Measure
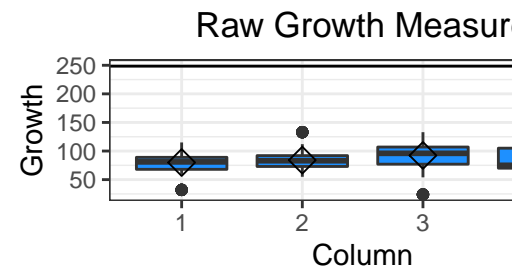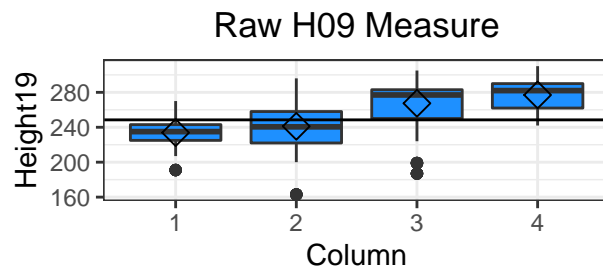
**Column Comparisons**

Row v Column Heatmaps

Raw Anth Measure

Raw Chl Measure

Raw Flav Measure
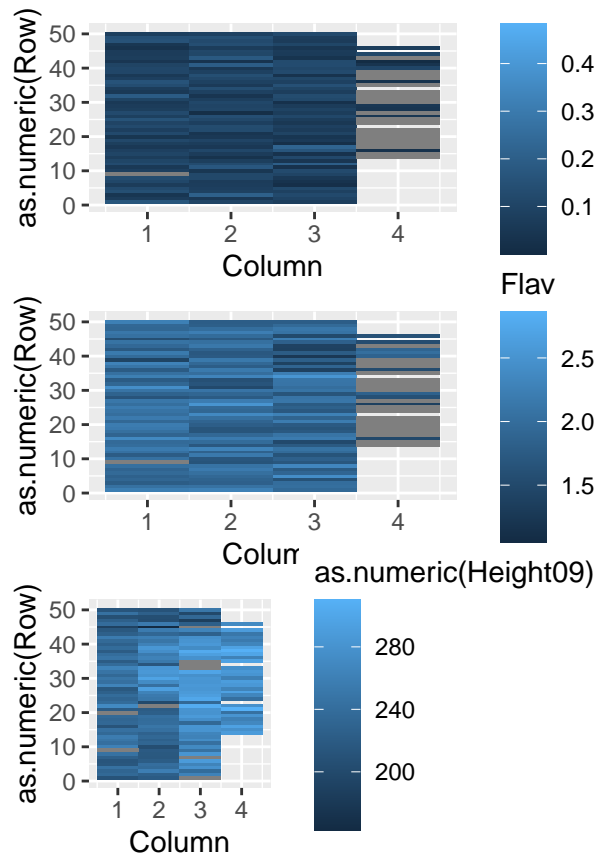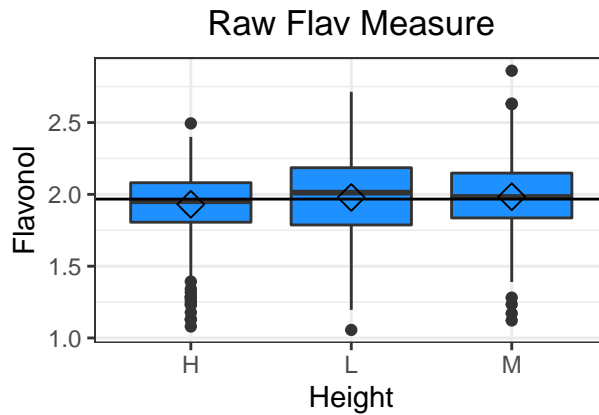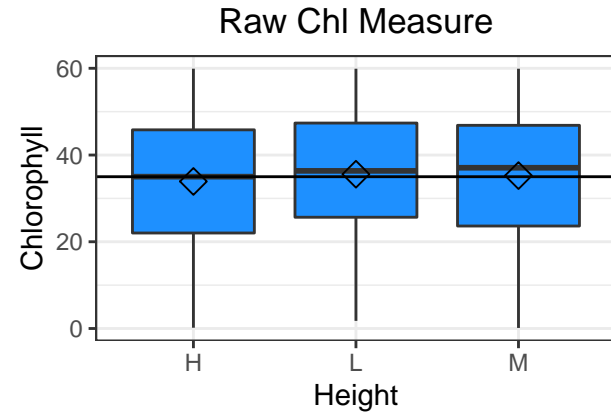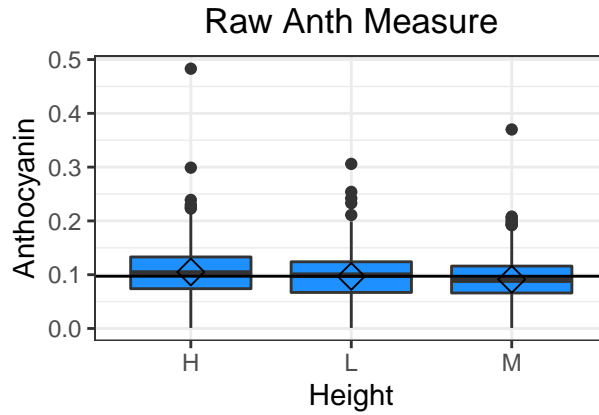
**Height Plots**
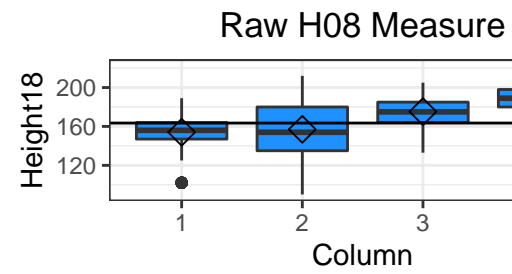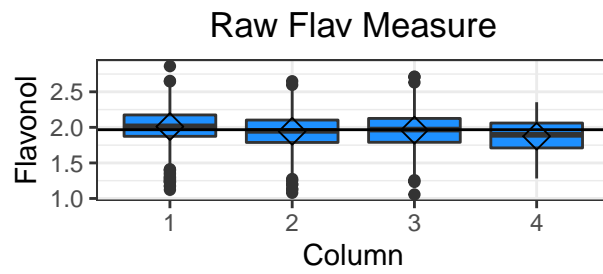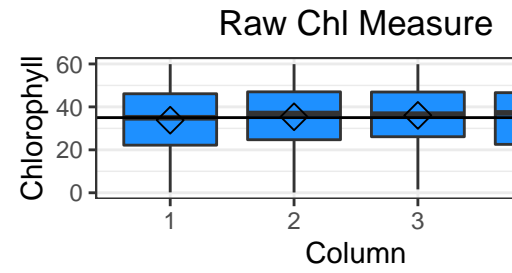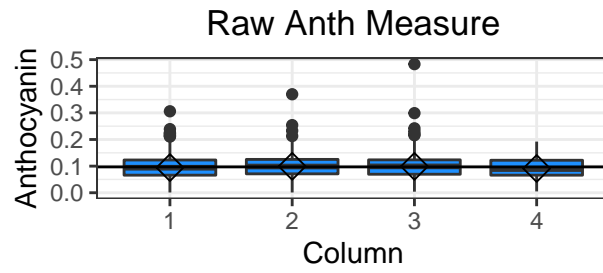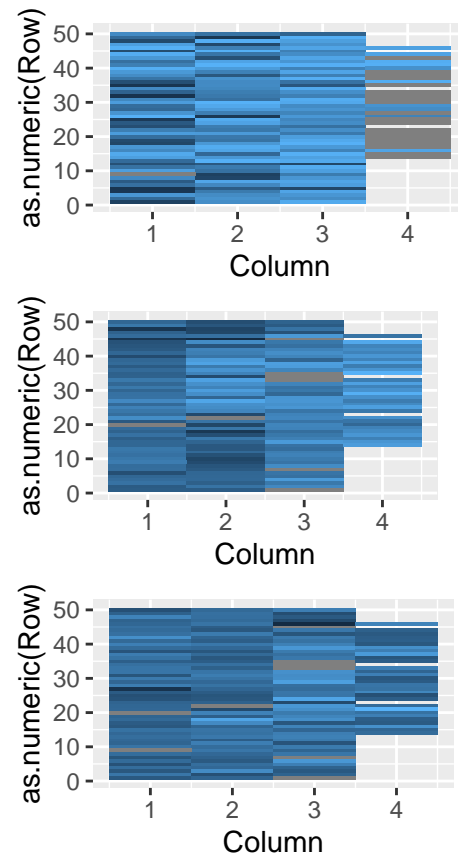
**ANOVAs comparing Height, Row and Columns for each chemical**

```
## Analysis of Variance Table
##
## Response: F1$Anth
##              Df Sum Sq   Mean Sq F value    Pr(>F)
## F1$Row       49 0.2346 0.0047878  2.5717 2.467e-08 ***
## F1$Column     1 0.0020 0.0019565  1.0509    0.3054
## F1$Height     2 0.0520 0.0260053 13.9687 9.587e-07 ***
## Residuals  1739 3.2375 0.0018617
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


## Analysis of Variance Table
##
## Response: F1$Chl
##              Df Sum Sq Mean Sq F value    Pr(>F)
## F1$Row       49  21394  436.61  1.9560 0.0001012 ***
## F1$Column     1    470  469.95  2.1054 0.1469578
## F1$Height     2    737  368.69  1.6517 0.1920166
## Residuals  1739 388163  223.21
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


## Analysis of Variance Table
```

```
## 
## Response: F1$Flav
##            Df Sum Sq Mean Sq F value    Pr(>F)
## F1$Row     49  8.215 0.16765  2.9272 1.204e-10 ***
## F1$Column   1  1.379 1.37854 24.0698 1.016e-06 ***
## F1$Height   2  0.957 0.47848  8.3545 0.0002449 ***
## Residuals 1739 99.597 0.05727
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


## Analysis of Variance Table
## 
## Response: F1$Height08
##            Df Sum Sq Mean Sq F value    Pr(>F)
## F1$Row     49 493101   10063  42.056 < 2.2e-16 ***
## F1$Column   1 154439  154439 645.422 < 2.2e-16 ***
## Residuals 1673 400321     239
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


## Analysis of Variance Table
## 
## Response: as.numeric(F1$Height09)
##            Df Sum Sq Mean Sq  F value    Pr(>F)
## F1$Row     49 626751   12791   51.649 < 2.2e-16 ***
## F1$Column   1 275536  275536 1112.606 < 2.2e-16 ***
## Residuals 1672 414069     248
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


## Analysis of Variance Table
## 
## Response: as.numeric(F1$Growth)
##            Df Sum Sq Mean Sq F value    Pr(>F)
## F1$Row     49 145650  2972.5  12.725 < 2.2e-16 ***
## F1$Column   1  17049 17049.2  72.985 < 2.2e-16 ***
## Residuals 1672 390575   233.6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Anthocyanin Significant Row and Height effects

Chlorophyll Significant Row effect

Flavonol Significant row,column and height effects

Height 2018 Very Significant effect of row and column

Height 2019 Very Significant effect of row and column

Growth difference (Height 2019- Height 2018) Very Significant effect of row and column - need to double check might be from later in analysis

**Adjusting Row, Column and Height measures**

```
##       Height Column Row Tree.ID Allocation Rep. measure Flower Flower.Level
## 490       H      3   9   IN4FM         F1    N        11      N             0
## 1307      M      2  13   IN4E4         F1    N         7      N             0
##          Chl Flav  Anth   NBI Height08 Height09 Growth AnthRowMeans ChlRowMeans
## 490   59.122 1.640 0.483 36.05      166      245     79    0.1163182    32.12650
## 1307  18.511 1.401 0.370 13.21      138      234     96    0.1105227    31.51561
##      FlavRowMeans H18RowMeans H19RowMeans AnthColMeans ChlColMeans FlavColMeans
## 490      1.886773    146.6957       232.0   0.09897588    36.04402     1.960649
## 1307     1.933068    151.0000       246.5   0.09924281    35.39257     1.944405
##      H18ColMeans H19ColMeans AnthHeightMeans ChlHeightMeans FlavHeightMeans
## 490     175.1734    267.4482      0.10500200       33.90735        1.930788
## 1307    157.0018    241.0717      0.09133645       35.25540        1.983505
##         AdjAnth
## 490   0.4559164
## 1307  0.3623774


## Analysis of Variance Table
##
## Response: F1$AdjAnth
##              Df  Sum Sq    Mean Sq F value Pr(>F)
## F1$Row        1 0.00026 0.00025836  0.1518 0.6969
## F1$Colum      1 0.00118 0.00118033  0.6934 0.4051
## F1$Height     2 0.00018 0.00008970  0.0527 0.9487
## Residuals 1785 3.03861 0.00170230


## Analysis of Variance Table
##
## Response: F1$AdjChl
##              Df Sum Sq Mean Sq F value Pr(>F)
## F1$Row        1      1    0.89  0.0041 0.9489
## F1$Column     1     72   72.41  0.3349 0.5628
## F1$Height     2    789  394.51  1.8249 0.1615
## Residuals 1785 385885  216.18


## Analysis of Variance Table
##
## Response: F1$AdjFlav
##              Df Sum Sq  Mean Sq F value Pr(>F)
## F1$Row        1  0.019 0.018555  0.3357 0.5624
## F1$Column     1  0.007 0.007400  0.1339 0.7145
## F1$Height     2  0.001 0.000454  0.0082 0.9918
## Residuals 1785 98.652 0.055267


## Analysis of Variance Table
##
## Response: F1$AdjH18
##              Df Sum Sq Mean Sq F value    Pr(>F)
## F1$Row        1   2625  2625.3  11.005 0.0009277 ***
## F1$Column     1   6285  6285.4  26.347 3.176e-07 ***
## Residuals 1719 410084   238.6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## Analysis of Variance Table
##
## Response: F1$AdjH19
##              Df Sum Sq Mean Sq F value     Pr(>F)
## F1$Row        1   3064  3063.9  12.788 0.0003586 ***
## F1$Column     1  14757 14756.5  61.589 7.385e-15 ***
## Residuals 1718 411630   239.6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


## Analysis of Variance Table
##
## Response: as.numeric(F1$Growth)
##              Df Sum Sq Mean Sq F value   Pr(>F)
## F1$Row        1     26   26.07  0.1178 0.731482
## F1$Column     1   1852 1851.64  8.3672 0.003869 **
## Residuals 1718 380187  221.30
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Adjust height row and column effects

```
## Analysis of Variance Table
##
## Response: F1$AdjH182
##              Df Sum Sq Mean Sq F value Pr(>F)
## F1$Row        1    174 173.971  0.7742 0.3790
## F1$Column     1      7   6.782  0.0302 0.8621
## Residuals 1718 386029 224.697


## Analysis of Variance Table
##
## Response: F1$AdjH192
##              Df Sum Sq Mean Sq F value     Pr(>F)
## F1$Row        1    423  423.06  1.8915 0.1692147
## F1$Column     1   3107 3107.07 13.8915 0.0001999 ***
## Residuals 1718 384260  223.67
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


## Analysis of Variance Table
##
## Response: as.numeric(F1$Growth)
##              Df  Sum Sq Mean Sq F value     Pr(>F)
## F1$Row        1   54.44   54.44  39.712 3.731e-10 ***
## F1$Column     1 2823.51 2823.51 2059.493 < 2.2e-16 ***
## Residuals 1718 2355.33    1.37
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


## Analysis of Variance Table
##
```

```
## Response: F1$AdjH193
##             Df Sum Sq Mean Sq F value Pr(>F)
## F1$Row       1     63  63.269  0.2839 0.5942
## F1$Column    1    210 209.574  0.9403 0.3323
## Residuals 1718 382892 222.871


## Analysis of Variance Table
##
## Response: as.numeric(F1$Growth)
##             Df  Sum Sq Mean Sq  F value     Pr(>F)
## F1$Row       1   54.44   54.44   39.712  3.731e-10 ***
## F1$Column    1 2823.51 2823.51 2059.493  < 2.2e-16 ***
## Residuals 1718 2355.33    1.37
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

### Anthocyanin Distribution of F1 Trees

### Chlorophyll Distribution of F1 Trees

### Flavonol Distribution of F1 Trees

### Height18 Distribution of F1 Trees

### Height19 Distribution of F1 Trees

### Growth Distribution of F1 Trees

## Adj Anth Measure

Anthocyanin

Row

## Raw Anth Measure

Anthocyanin

Row

## Adj Chl Measure

Chlorophyll

Row

## Raw Chl Measure

Chlorophyll

Row

## Adj Flav Measure

Flavonol

Row

## Raw Flav Measure

Flavonol

Row

Adj H18 Measure

Raw H08 Measure

Adj H19 Measure

Raw H09 Measure

Adj Growth Measure

Raw Growth Measure

15