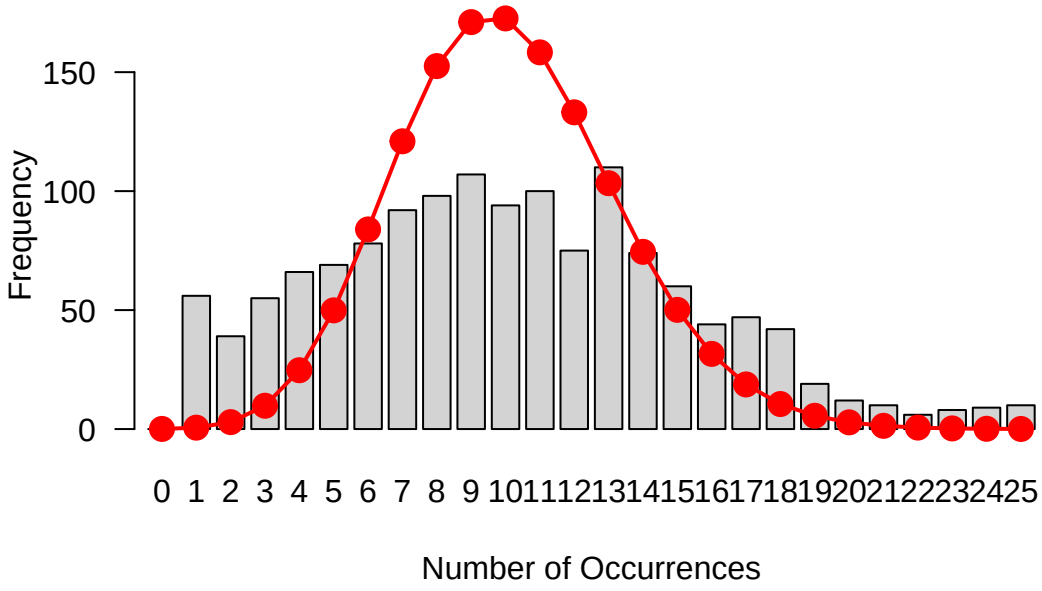
Discovering Associations

Monika Helak

Checking the distribution of the Vase Days of the count data. It looks like there is a larger degree of overdispersion than the poisson model currently accounts for.

```
gf <- goodfit(d$tot.vase.days, "poisson")
plot(gf, type="standing", scale="raw")
```



Gaussian outcome data. We received data from 180 flowers. This was distributed as 12 flowers for each compound for each of the 15 compounds. In each of those groups, there were 6 flowers per species and 6 grown in each garden. There were also 18 different subplots. The number of subplots is greater than the number of number of flowers per group.

For each of the 18 flowers, we have measurements of the width of the flower over the course of 21 days. All measurements for all flowers were taken by a single rater.

Below I transform the data so that there is a row for each measurement of each flower on each day resulting in 3780 rows.

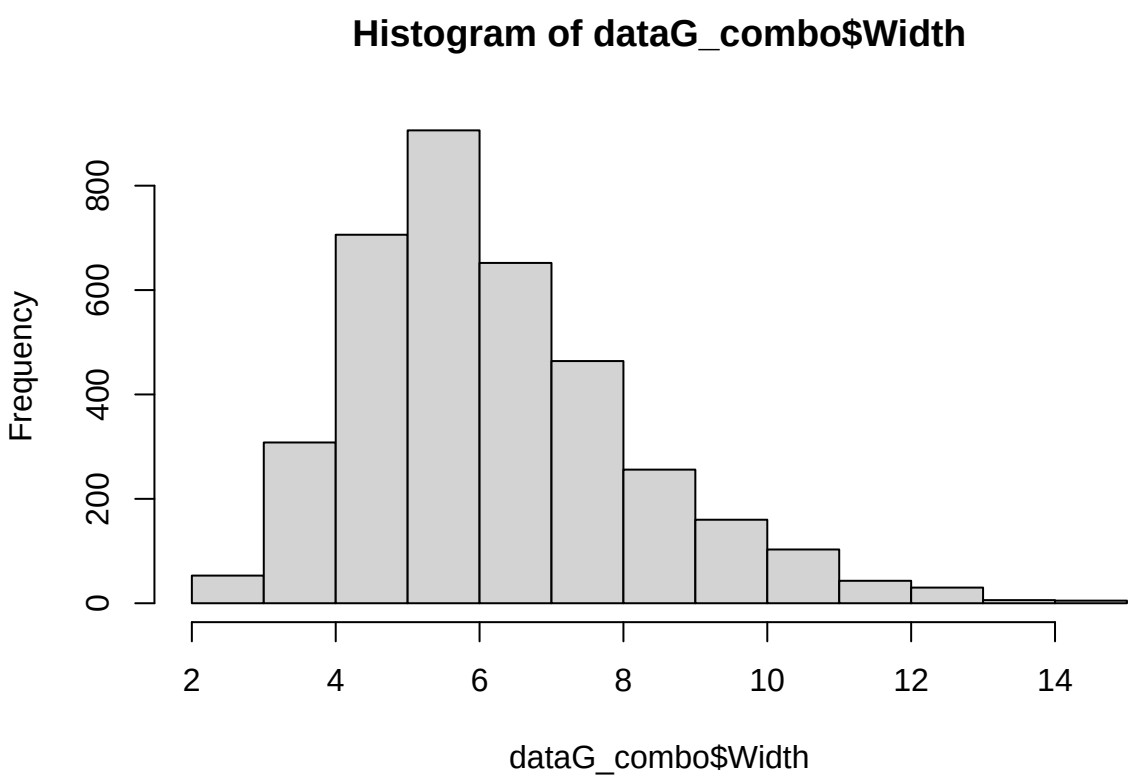
```
g$Flower_index<-factor(g$Flower_index)

colnames(g)<-c("Flower_index",0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,"Compound","Rater","
```

```
dataG_long <- gather(g, Days, Width, "0":"20", factor_key=TRUE)


dataG_long$Garden<-as.factor(dataG_long$Garden)
dataG_long$Type<-as.factor(dataG_long$Type)
dataG_long$Compound<-as.factor(dataG_long$Compound)
dataG_long$Subplot<-as.factor(dataG_long$Subplot)
dataG_long$Rater<-as.factor(dataG_long$Rater)
dataG_long$Days<-as.numeric(dataG_long$Days)

head(dataG_long)
```

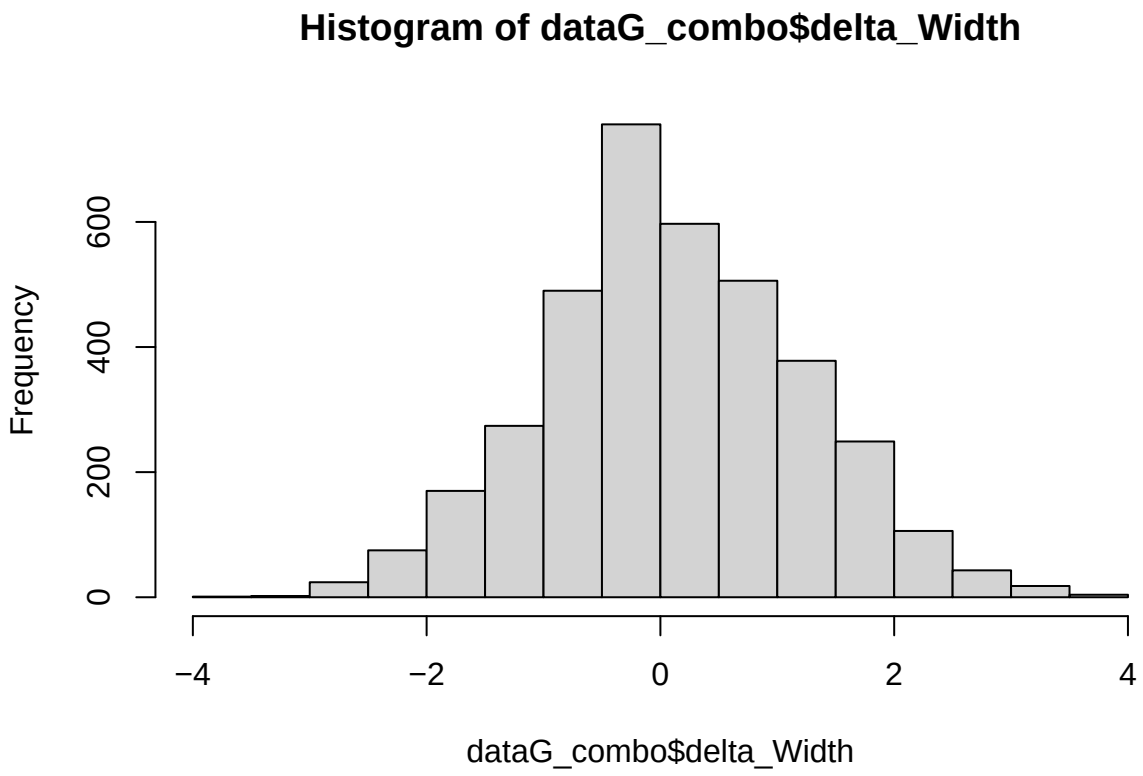
```
##   Flower_index Compound Rater Type Garden Subplot Days Width
## 1        18075        1     1    1      1       1    1   2.9
## 2        18767        1     1    1      1       2    1   2.6
## 3        18028        1     1    1      1       3    1   5.2
## 4        18326        1     1    1      2       4    1   6.5
## 5        18017        1     1    1      2       5    1   4.2
## 6        18718        1     1    1      2       6    1   5.7
```

I also added a column showing the change in the width of the flower so that we can see the change in width per day. It is worth noting that the width of the flower does not uniformly increase, instead it does fluctuate from day to day, decreasing occasionally. Also, there are quite a few missing measurements, we probably should have accounted for this in our sample size calculation?

```
hist(dataG_combo$Width)
```

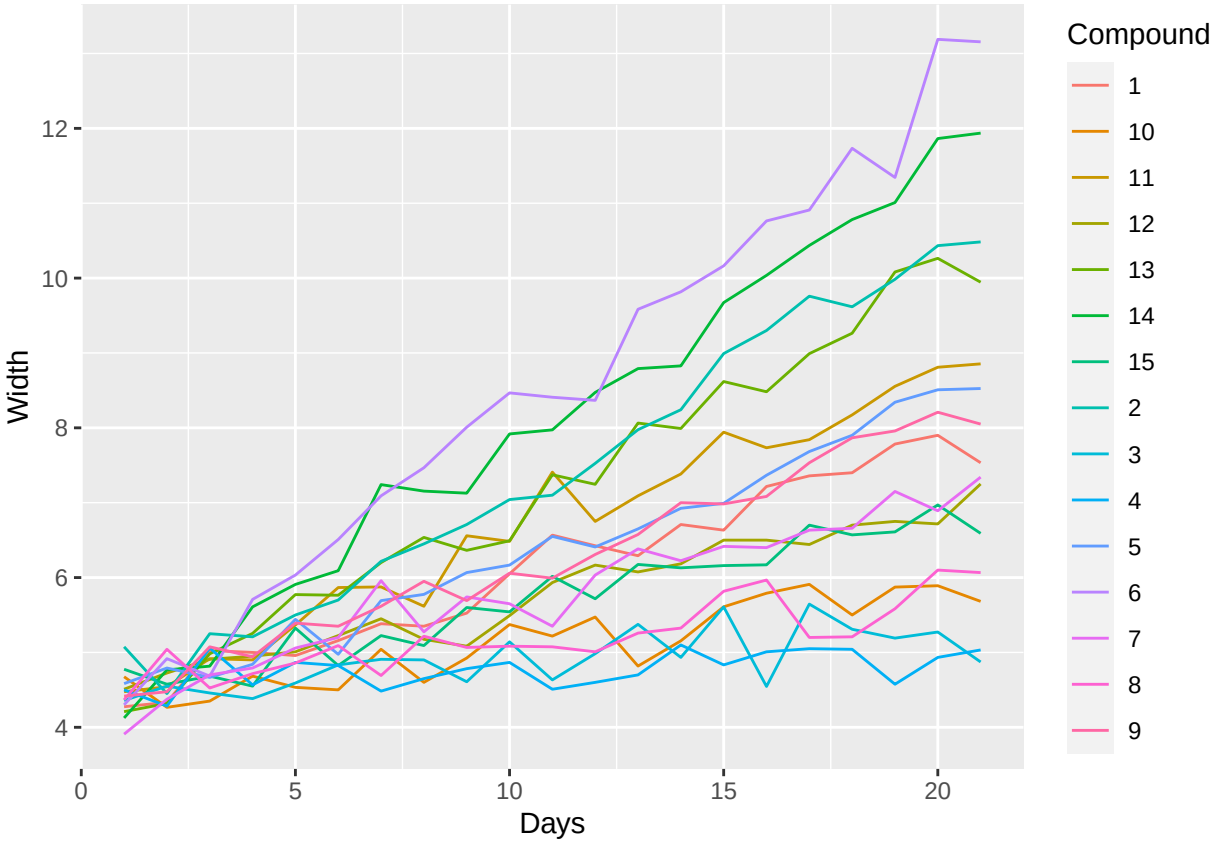



```
hist(dataG_combo$delta_Width)
```



Below I plotted the mean width of the flower by day by compound on a given day.

```
data_cc <- aggregate(Width ~ Compound + Days, data = dataG_combo, FUN = mean)

plot <- ggplot(data = data_cc)+
    geom_line(aes(x = Days, y = Width, color = Compound))

plot
```

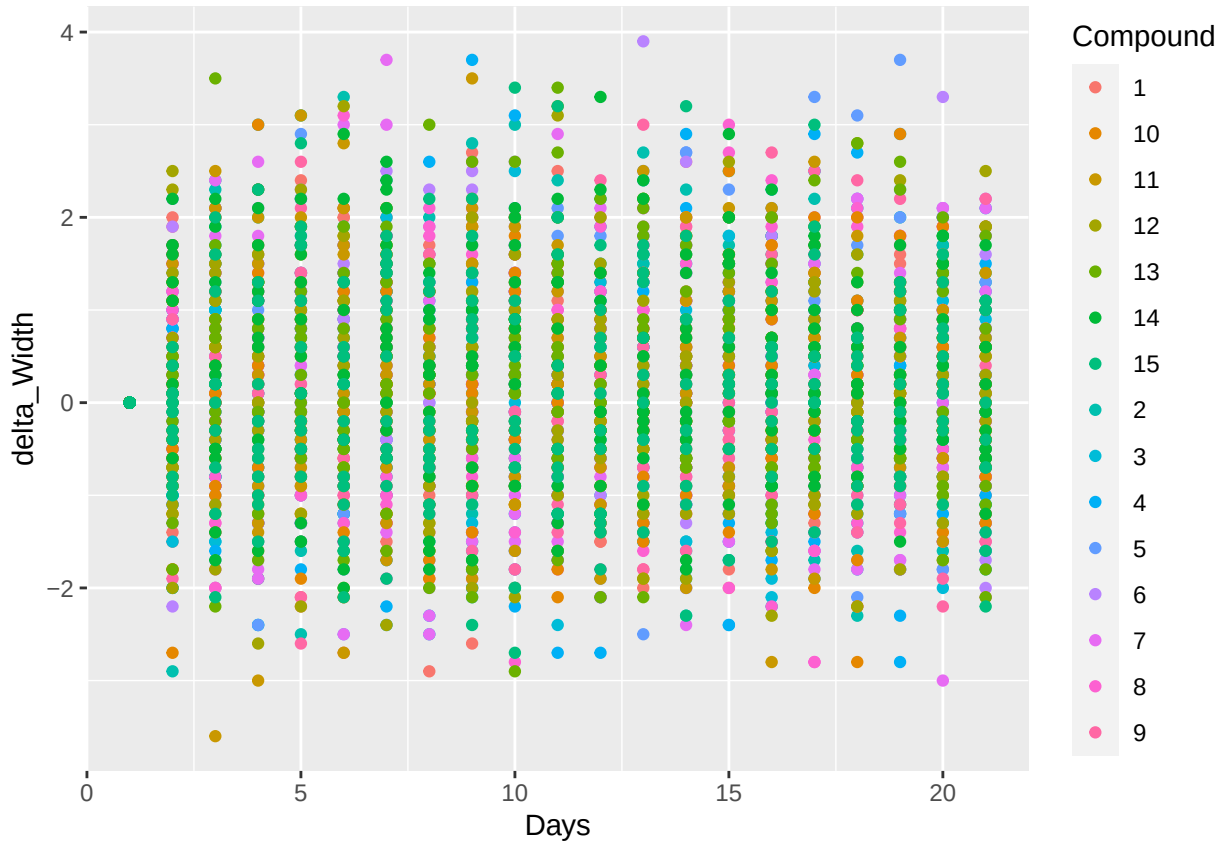


The takeaway from this graph is that for each graph, the change in the Width of the flower is not the same for each of the Compounds. Does this mean we have an interaction between Compound and Days?

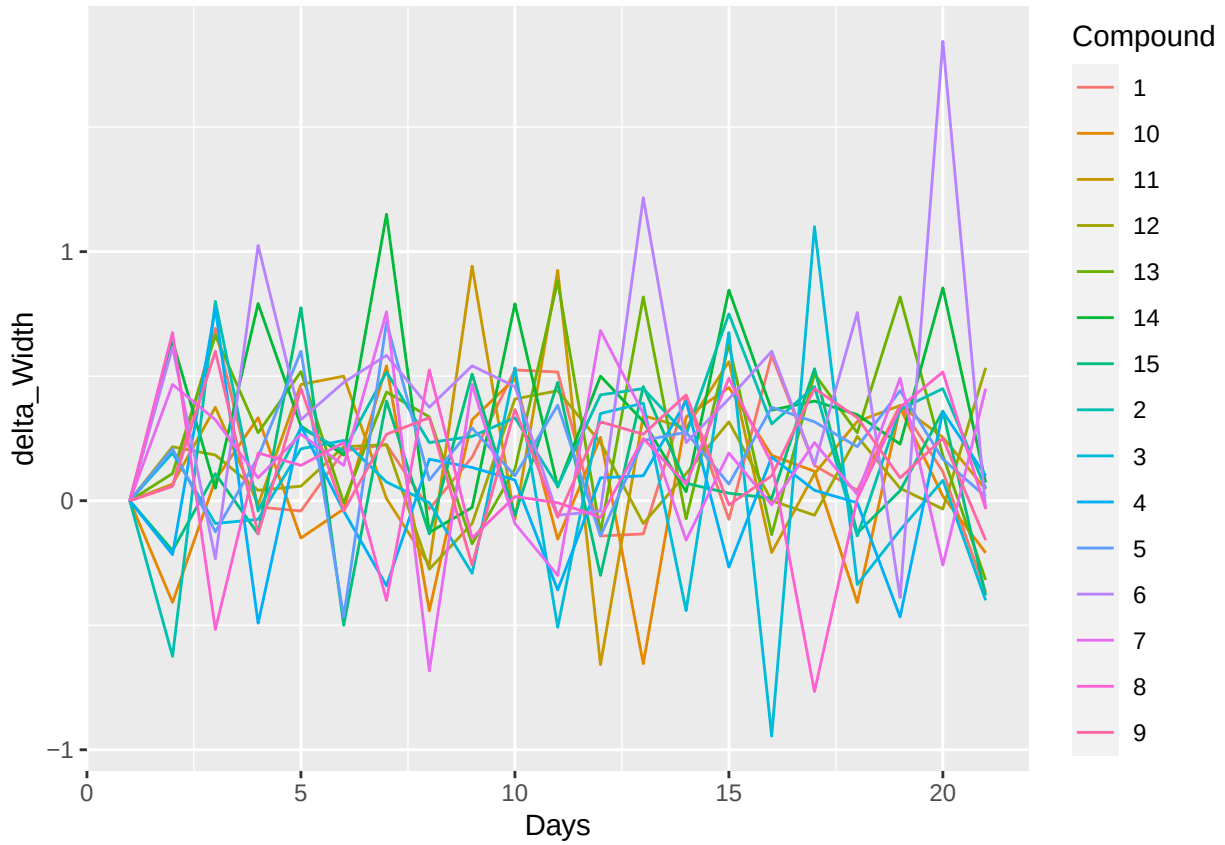
The same but for change in width of the flower does not reveal much.

```
ggplot(data = dataG_combo) +
geom_point(aes(x = Days, y = delta_Width, color = Compound))
```

```
## Warning: Removed 87 rows containing missing values (geom_point).
```




```
data_ccc<- aggregate(delta_Width ~ Compound + Days, data = dataG_combo, FUN = mean)

plot <- ggplot(data = data_ccc)+
    geom_line(aes(x = Days, y = delta_Width, color = Compound))

plot
```



I fit a linear model to the gaussian outcome data where Compound, Type, Garden and Days are included as fixed effects, a compound and days interaction is included and subplot is included as a random effect. Rater is not included because we only have one rater.

```
#g1 <- glm(Width ~ Compound + Type + Garden + Days + Compound*Days + (1 | Subplot), data=dataG_long)
g1 <- nlme::lme(Width ~ Compound + Type + Garden + Days + Compound*Days, data=dataG_long, random = ~1|S
```

Probably not right, this output is too long.

```
summary(g1)
```

```
## Linear mixed-effects model fit by REML
##   Data: dataG_long
##        AIC     BIC    logLik
##   9464.192 9675.17 -4698.096
##
## Random effects:
##  Formula: ~1 | Subplot
##         (Intercept)  Residual
## StdDev:   0.2147339 0.8412646
##
## Fixed effects:  Width ~ Compound + Type + Garden + Days + Compound * Days
##                     Value  Std.Error   DF    t-value p-value
## (Intercept)      3.969331 0.13302202 3644  29.839655  0.0000
## Compound2       -0.100474 0.15653306 3644  -0.641872  0.5210
## Compound3        0.321280 0.15691330 3644   2.047502  0.0407
```

```
## Compound4        0.412698 0.15541094 3644   2.655530  0.0080
## Compound5       -0.004800 0.15653306 3644  -0.030662  0.9755
## Compound6       -0.188846 0.15787471 3644  -1.196178  0.2317
## Compound7        0.076151 0.15541094 3644   0.489996  0.6242
## Compound8        0.336232 0.15653306 3644   2.147994  0.0318
## Compound9        0.146492 0.15652591 3644   0.935896  0.3494
## Compound10       0.112509 0.15594674 3644   0.721458  0.4707
## Compound11       0.090789 0.15694308 3644   0.578483  0.5630
## Compound12       0.325024 0.15652591 3644   2.076485  0.0379
## Compound13      -0.158397 0.15899538 3644  -0.996234  0.3192
## Compound14      -0.221169 0.15728712 3644  -1.406150  0.1598
## Compound15       0.308169 0.15743402 3644   1.957452  0.0504
## Type2           -0.342166 0.02772810 3644 -12.340032  0.0000
## Garden2          0.659915 0.10495367   16   6.287675  0.0000
## Days             0.180812 0.00875179 3644  20.659978  0.0000
## Compound2:Days   0.130487 0.01237689 3644  10.542792  0.0000
## Compound3:Days  -0.132748 0.01250639 3644 -10.614429  0.0000
## Compound4:Days  -0.161364 0.01237689 3644 -13.037491  0.0000
## Compound5:Days   0.025866 0.01237689 3644   2.089846  0.0367
## Compound6:Days   0.245544 0.01276142 3644  19.241101  0.0000
## Compound7:Days  -0.036071 0.01237689 3644  -2.914417  0.0036
## Compound8:Days  -0.115887 0.01237689 3644  -9.363210  0.0000
## Compound9:Days   0.008312 0.01237689 3644   0.671549  0.5019
## Compound10:Days -0.101137 0.01252099 3644  -8.077434  0.0000
## Compound11:Days  0.044514 0.01248175 3644   3.566288  0.0004
## Compound12:Days -0.054600 0.01237689 3644  -4.411411  0.0000
## Compound13:Days  0.118964 0.01265506 3644   9.400508  0.0000
## Compound14:Days  0.203195 0.01252409 3644  16.224369  0.0000
## Compound15:Days -0.060596 0.01267839 3644  -4.779511  0.0000
##  Correlation:
##                 (Intr) Cmpnd2 Cmpnd3 Cmpnd4 Cmpnd5 Cmpnd6 Cmpnd7 Cmpnd8 Cmpnd9
## Compound2       -0.588
## Compound3       -0.587  0.498
## Compound4       -0.584  0.496  0.495
## Compound5       -0.588  0.507  0.498  0.496
## Compound6       -0.584  0.496  0.501  0.492  0.496
## Compound7       -0.584  0.496  0.495  0.500  0.496  0.492
## Compound8       -0.588  0.507  0.498  0.496  0.507  0.496  0.496
## Compound9       -0.588  0.500  0.506  0.496  0.500  0.503  0.496  0.500
## Compound10      -0.582  0.495  0.494  0.498  0.495  0.491  0.498  0.495  0.495
## Compound11      -0.587  0.506  0.497  0.495  0.506  0.495  0.495  0.506  0.499
## Compound12      -0.588  0.500  0.506  0.496  0.500  0.503  0.496  0.500  0.507
## Compound13      -0.571  0.485  0.485  0.489  0.485  0.482  0.489  0.485  0.486
## Compound14      -0.586  0.505  0.496  0.494  0.505  0.494  0.494  0.505  0.498
## Compound15      -0.585  0.497  0.503  0.494  0.497  0.500  0.494  0.497  0.504
## Type2           -0.103  0.000  0.002  0.000  0.000 -0.003  0.000  0.000 -0.001
## Garden2         -0.394  0.000 -0.001  0.000  0.000  0.001  0.000  0.000  0.000
## Days            -0.724  0.615  0.614  0.619  0.615  0.610  0.619  0.615  0.615
## Compound2:Days   0.512 -0.870 -0.434 -0.438 -0.435 -0.431 -0.438 -0.435 -0.435
## Compound3:Days   0.506 -0.429 -0.869 -0.433 -0.429 -0.426 -0.433 -0.429 -0.430
## Compound4:Days   0.512 -0.435 -0.434 -0.876 -0.435 -0.431 -0.438 -0.435 -0.435
## Compound5:Days   0.512 -0.435 -0.434 -0.438 -0.870 -0.431 -0.438 -0.435 -0.435
## Compound6:Days   0.497 -0.422 -0.421 -0.425 -0.422 -0.868 -0.425 -0.422 -0.422
## Compound7:Days   0.512 -0.435 -0.434 -0.438 -0.435 -0.431 -0.876 -0.435 -0.435
```

```
## Compound8:Days   0.512 -0.435 -0.434 -0.438 -0.435 -0.431 -0.438 -0.870 -0.435
## Compound9:Days   0.512 -0.435 -0.434 -0.438 -0.435 -0.431 -0.438 -0.435 -0.870
## Compound10:Days  0.504 -0.429 -0.429 -0.433 -0.429 -0.427 -0.433 -0.429 -0.431
## Compound11:Days  0.509 -0.432 -0.431 -0.434 -0.432 -0.428 -0.434 -0.432 -0.432
## Compound12:Days  0.512 -0.435 -0.434 -0.438 -0.435 -0.431 -0.438 -0.435 -0.435
## Compound13:Days  0.500 -0.425 -0.424 -0.428 -0.425 -0.422 -0.428 -0.425 -0.425
## Compound14:Days  0.506 -0.430 -0.430 -0.433 -0.430 -0.427 -0.433 -0.430 -0.431
## Compound15:Days  0.500 -0.425 -0.423 -0.428 -0.425 -0.421 -0.428 -0.425 -0.425
##                 Cmpn10 Cmpn11 Cmpn12 Cmpn13 Cmpn14 Cmpn15 Type2  Gardn2 Days
## Compound2
## Compound3
## Compound4
## Compound5
## Compound6
## Compound7
## Compound8
## Compound9
## Compound10
## Compound11       0.493
## Compound12       0.495  0.499
## Compound13       0.487  0.483  0.486
## Compound14       0.492  0.504  0.498  0.482
## Compound15       0.492  0.496  0.504  0.483  0.495
## Type2           -0.002  0.002 -0.001 -0.009  0.000 -0.001
## Garden2          0.000  0.001  0.000  0.002  0.000  0.000 -0.003
## Days             0.617  0.613  0.615  0.605  0.612  0.611  0.000  0.000
## Compound2:Days  -0.437 -0.434 -0.435 -0.428 -0.433 -0.432  0.000  0.000 -0.707
## Compound3:Days  -0.432 -0.428 -0.430 -0.424 -0.427 -0.427 -0.006  0.002 -0.700
## Compound4:Days  -0.437 -0.434 -0.435 -0.428 -0.433 -0.432  0.000  0.000 -0.707
## Compound5:Days  -0.437 -0.434 -0.435 -0.428 -0.433 -0.432  0.000  0.000 -0.707
## Compound6:Days  -0.423 -0.421 -0.422 -0.415 -0.420 -0.419  0.003 -0.002 -0.686
## Compound7:Days  -0.437 -0.434 -0.435 -0.428 -0.433 -0.432  0.000  0.000 -0.707
## Compound8:Days  -0.437 -0.434 -0.435 -0.428 -0.433 -0.432  0.000  0.000 -0.707
## Compound9:Days  -0.437 -0.434 -0.435 -0.428 -0.433 -0.432  0.000  0.000 -0.707
## Compound10:Days -0.873 -0.428 -0.431 -0.423 -0.427 -0.428  0.008  0.002 -0.699
## Compound11:Days -0.433 -0.870 -0.432 -0.425 -0.429 -0.429 -0.004 -0.001 -0.701
## Compound12:Days -0.437 -0.434 -0.870 -0.428 -0.433 -0.432  0.000  0.000 -0.707
## Compound13:Days -0.427 -0.424 -0.425 -0.876 -0.423 -0.423  0.000  0.000 -0.692
## Compound14:Days -0.431 -0.429 -0.431 -0.423 -0.867 -0.428 -0.007  0.002 -0.699
## Compound15:Days -0.426 -0.423 -0.425 -0.418 -0.422 -0.867  0.000  0.000 -0.690
##                 Cmp2:D Cmp3:D Cmp4:D Cmp5:D Cmp6:D Cmp7:D Cmp8:D Cmp9:D Cm10:D
## Compound2
## Compound3
## Compound4
## Compound5
## Compound6
## Compound7
## Compound8
## Compound9
## Compound10
## Compound11
## Compound12
## Compound13
## Compound14
```

```
## Compound15
## Type2
## Garden2
## Days
## Compound2:Days
## Compound3:Days   0.495
## Compound4:Days   0.500  0.495
## Compound5:Days   0.500  0.495  0.500
## Compound6:Days   0.485  0.480  0.485  0.485
## Compound7:Days   0.500  0.495  0.500  0.500  0.485
## Compound8:Days   0.500  0.495  0.500  0.500  0.485  0.500
## Compound9:Days   0.500  0.495  0.500  0.500  0.485  0.500  0.500
## Compound10:Days  0.494  0.489  0.494  0.494  0.479  0.494  0.494  0.494
## Compound11:Days  0.496  0.491  0.496  0.496  0.481  0.496  0.496  0.496  0.490
## Compound12:Days  0.500  0.495  0.500  0.500  0.485  0.500  0.500  0.500  0.494
## Compound13:Days  0.489  0.484  0.489  0.489  0.474  0.489  0.489  0.489  0.483
## Compound14:Days  0.494  0.489  0.494  0.494  0.479  0.494  0.494  0.494  0.488
## Compound15:Days  0.488  0.483  0.488  0.488  0.473  0.488  0.488  0.488  0.482
##                 Cm11:D Cm12:D Cm13:D Cm14:D
## Compound2
## Compound3
## Compound4
## Compound5
## Compound6
## Compound7
## Compound8
## Compound9
## Compound10
## Compound11
## Compound12
## Compound13
## Compound14
## Compound15
## Type2
## Garden2
## Days
## Compound2:Days
## Compound3:Days
## Compound4:Days
## Compound5:Days
## Compound6:Days
## Compound7:Days
## Compound8:Days
## Compound9:Days
## Compound10:Days
## Compound11:Days
## Compound12:Days  0.496
## Compound13:Days  0.485  0.489
## Compound14:Days  0.490  0.494  0.483
## Compound15:Days  0.484  0.488  0.477  0.482
##
## Standardized Within-Group Residuals:
##          Min           Q1          Med           Q3          Max
## -3.865204407 -0.673813254  0.003231877  0.662138149  3.184548504
```

```
##
## Number of Observations: 3692
## Number of Groups: 18
```