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BP

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1. Fv/Fm (szalka, concentration, yield) - yield.csv

* Kontola (brak hormonów ) - kontrola
* 2mg/ IAA 1mg/l K - alfa
* 2 mg/l IAA - beta
* 2 mg/l IAA 1 mg/l BAP - gamma
* 0,5 mg/l 2,4d 0,25mg/l bap - delta
* 2mg/l 2,4-D 1 mg/l BAP - epsilon
* 1 mg/l 2,4-D 0,5 mg/l BAP - dzeta

library(ggplot2)  
library(ggpubr)

## Loading required package: magrittr

yield = read.csv("./yield.csv")  
yield$szalka = as.factor(yield$szalka)  
yield$concentration = as.factor(yield$concentration)  
summary(yield)

## szalka concentration yield   
## 2 : 23 alfa :31 Min. :0.5600   
## 8 : 20 beta :38 1st Qu.:0.7900   
## 11 : 20 delta :33 Median :0.8200   
## 9 : 18 dzeta :43 Mean :0.8082   
## 6 : 16 epsilon :31 3rd Qu.:0.8400   
## 5 : 15 gamma :43 Max. :0.8700   
## (Other):143 kontrola:36

ggplot(data = yield) +   
 geom\_boxplot(aes(x=concentration, y=yield)) +  
 geom\_jitter(aes(x=concentration, y=yield, color=szalka)) +  
 xlab("Kombinacja hormonow") +   
 ylab("Fv/Fm")



* porownanie grup zapisane do pliku yield\_results.txt

kruskal.test(yield ~ concentration, data = yield)

##   
## Kruskal-Wallis rank sum test  
##   
## data: yield by concentration  
## Kruskal-Wallis chi-squared = 123.67, df = 6, p-value < 2.2e-16

results = compare\_means(yield ~ concentration, data = yield)  
write.table(results, "yield\_results.txt") # porownanie grup zapisane do pliku yield\_results.txt

1. Kiełkowanie nasion, rozwój kalusa

2.1 Hormony (takie samo oznaczenie jak w Fv/Fm)

* Kontola (brak hormonów ) - kontrola
* 2mg/ IAA 1mg/l K - alfa
* 2 mg/l IAA - beta
* 2 mg/l IAA 1 mg/l BAP - gamma
* 0,5 mg/l 2,4d 0,25mg/l bap - delta
* 2mg/l 2,4-D 1 mg/l BAP - epsilon
* 1 mg/l 2,4-D 0,5 mg/l BAP - dzeta

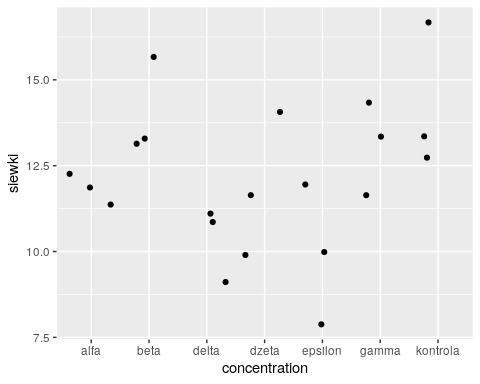
2.1 Czy w poszczególnych dniach ilość siewek/ kalusów jest różna?

library(ggplot2)  
library(ggpubr)  
  
kielkowanie = read.csv("./kielkowanie.csv")

2.1.1 Dzień 7

* siewki

ggplot(data = subset(kielkowanie, day == 7)) +  
 geom\_jitter(aes(x=concentration, y=siewki))



kruskal.test(siewki ~ concentration, data = subset(kielkowanie, day == 7))

##   
## Kruskal-Wallis rank sum test  
##   
## data: siewki by concentration  
## Kruskal-Wallis chi-squared = 13.177, df = 6, p-value = 0.04031

compare\_means(siewki ~ concentration, data = subset(kielkowanie, day == 7))

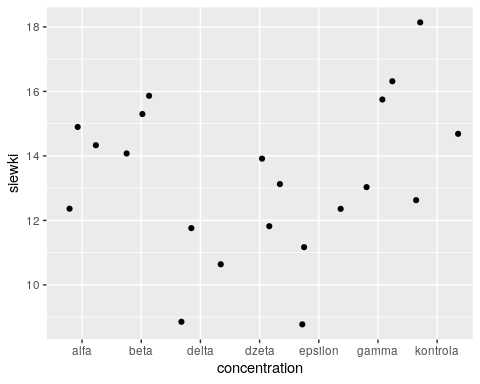
## # A tibble: 21 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 siewki alfa beta 0.0722 1 0.072 ns Wilcoxon  
## 2 siewki alfa delta 0.157 1 0.157 ns Wilcoxon  
## 3 siewki alfa dzeta 1 1 1.000 ns Wilcoxon  
## 4 siewki alfa epsilon 0.354 1 0.354 ns Wilcoxon  
## 5 siewki alfa gamma 0.164 1 0.164 ns Wilcoxon  
## 6 siewki alfa kontrola 0.0722 1 0.072 ns Wilcoxon  
## 7 siewki beta delta 0.0722 1 0.072 ns Wilcoxon  
## 8 siewki beta dzeta 0.376 1 0.376 ns Wilcoxon  
## 9 siewki beta epsilon 0.0765 1 0.077 ns Wilcoxon  
## 10 siewki beta gamma 0.643 1 0.643 ns Wilcoxon  
## # … with 11 more rows

* kalusy - niewidoczne

2.1.2 Dzień 14

* siewki

ggplot(data = subset(kielkowanie, day == 14)) +  
 geom\_jitter(aes(x=concentration, y=siewki))



kruskal.test(siewki ~ concentration, data = subset(kielkowanie, day == 14))

##   
## Kruskal-Wallis rank sum test  
##   
## data: siewki by concentration  
## Kruskal-Wallis chi-squared = 14.012, df = 6, p-value = 0.0295

compare\_means(siewki ~ concentration, data = subset(kielkowanie, day == 14))

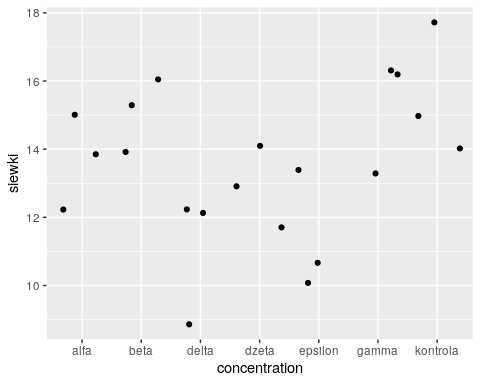
## # A tibble: 21 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 siewki alfa beta 0.369 1 0.369 ns Wilcoxon  
## 2 siewki alfa delta 0.121 1 0.121 ns Wilcoxon  
## 3 siewki alfa dzeta 0.653 1 0.653 ns Wilcoxon  
## 4 siewki alfa epsilon 0.121 1 0.121 ns Wilcoxon  
## 5 siewki alfa gamma 0.376 1 0.376 ns Wilcoxon  
## 6 siewki alfa kontrola 0.507 1 0.507 ns Wilcoxon  
## 7 siewki beta delta 0.1 1 0.100 ns Wilcoxon  
## 8 siewki beta dzeta 0.121 1 0.121 ns Wilcoxon  
## 9 siewki beta epsilon 0.1 1 0.100 ns Wilcoxon  
## 10 siewki beta gamma 1 1 1.000 ns Wilcoxon  
## # … with 11 more rows

* kalusy - niewidoczne

2.1.3 Dzień 21

* siewki

ggplot(data = subset(kielkowanie, day == 21)) +  
 geom\_jitter(aes(x=concentration, y=siewki))



kruskal.test(siewki ~ concentration, data = subset(kielkowanie, day == 21))

##   
## Kruskal-Wallis rank sum test  
##   
## data: siewki by concentration  
## Kruskal-Wallis chi-squared = 13.417, df = 6, p-value = 0.03687

compare\_means(siewki ~ concentration, data = subset(kielkowanie, day == 21))

## # A tibble: 21 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 siewki alfa beta 0.369 1 0.369 ns Wilcoxon  
## 2 siewki alfa delta 0.164 1 0.164 ns Wilcoxon  
## 3 siewki alfa dzeta 0.653 1 0.653 ns Wilcoxon  
## 4 siewki alfa epsilon 0.2 1 0.200 ns Wilcoxon  
## 5 siewki alfa gamma 0.376 1 0.376 ns Wilcoxon  
## 6 siewki alfa kontrola 0.369 1 0.369 ns Wilcoxon  
## 7 siewki beta delta 0.0765 1 0.077 ns Wilcoxon  
## 8 siewki beta dzeta 0.121 1 0.121 ns Wilcoxon  
## 9 siewki beta epsilon 0.1 1 0.100 ns Wilcoxon  
## 10 siewki beta gamma 1 1 1.000 ns Wilcoxon  
## # … with 11 more rows

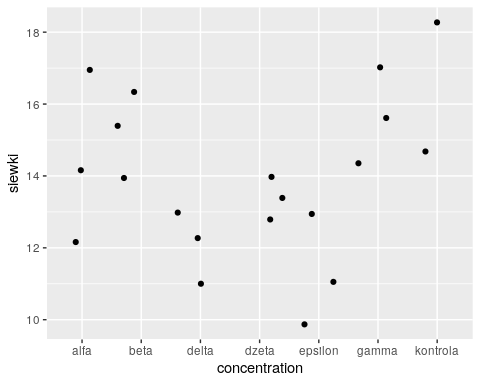
* kalusy - niewidoczne

2.1.4 Dzień 28

* siewki

ggplot(data = subset(kielkowanie, day == 28)) +  
 geom\_jitter(aes(x=concentration, y=siewki))

## Warning: Removed 1 rows containing missing values (geom\_point).



kruskal.test(siewki ~ concentration, data = subset(kielkowanie, day == 28))

##   
## Kruskal-Wallis rank sum test  
##   
## data: siewki by concentration  
## Kruskal-Wallis chi-squared = 13.226, df = 6, p-value = 0.03958

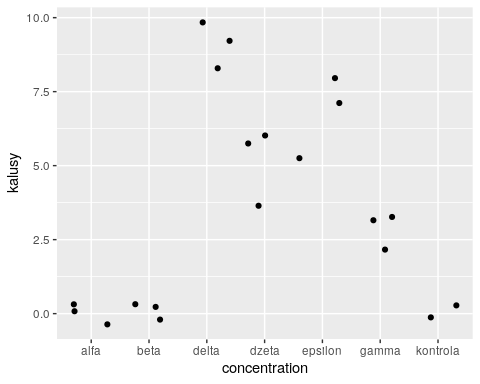
compare\_means(siewki ~ concentration, data = subset(kielkowanie, day == 28))

## # A tibble: 21 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 siewki alfa beta 0.825 1 0.82 ns Wilcoxon  
## 2 siewki alfa delta 0.268 1 0.27 ns Wilcoxon  
## 3 siewki alfa dzeta 0.822 1 0.82 ns Wilcoxon  
## 4 siewki alfa epsilon 0.2 1 0.20 ns Wilcoxon  
## 5 siewki alfa gamma 0.653 1 0.65 ns Wilcoxon  
## 6 siewki alfa kontrola 0.4 1 0.40 ns Wilcoxon  
## 7 siewki beta delta 0.1 1 0.10 ns Wilcoxon  
## 8 siewki beta dzeta 0.116 1 0.12 ns Wilcoxon  
## 9 siewki beta epsilon 0.1 1 0.10 ns Wilcoxon  
## 10 siewki beta gamma 0.653 1 0.65 ns Wilcoxon  
## # … with 11 more rows

* kalusy

ggplot(data = subset(kielkowanie, day == 28)) +  
 geom\_jitter(aes(x=concentration, y=kalusy))

## Warning: Removed 1 rows containing missing values (geom\_point).



kruskal.test(kalusy ~ concentration, data = subset(kielkowanie, day == 28))

##   
## Kruskal-Wallis rank sum test  
##   
## data: kalusy by concentration  
## Kruskal-Wallis chi-squared = 18.409, df = 6, p-value = 0.005287

compare\_means(kalusy ~ concentration, data = subset(kielkowanie, day == 28))

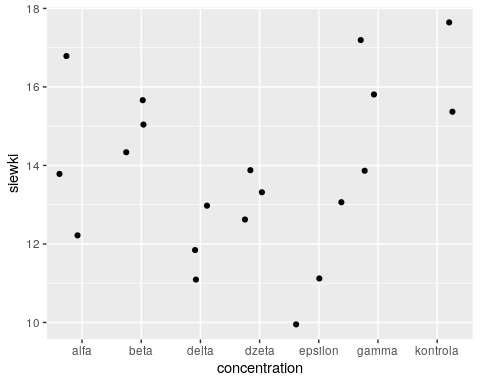
## # A tibble: 18 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 kalusy alfa delta 0.0636 1 0.064 ns Wilcoxon  
## 2 kalusy alfa dzeta 0.0593 1 0.059 ns Wilcoxon  
## 3 kalusy alfa epsilon 0.0636 1 0.064 ns Wilcoxon  
## 4 kalusy alfa gamma 0.0593 1 0.059 ns Wilcoxon  
## 5 kalusy beta delta 0.0636 1 0.064 ns Wilcoxon  
## 6 kalusy beta dzeta 0.0593 1 0.059 ns Wilcoxon  
## 7 kalusy beta epsilon 0.0636 1 0.064 ns Wilcoxon  
## 8 kalusy beta gamma 0.0593 1 0.059 ns Wilcoxon  
## 9 kalusy delta dzeta 0.0765 1 0.077 ns Wilcoxon  
## 10 kalusy delta epsilon 0.121 1 0.121 ns Wilcoxon  
## 11 kalusy delta gamma 0.0765 1 0.077 ns Wilcoxon  
## 12 kalusy delta kontrola 0.139 1 0.139 ns Wilcoxon  
## 13 kalusy dzeta epsilon 0.376 1 0.376 ns Wilcoxon  
## 14 kalusy dzeta gamma 0.0722 1 0.072 ns Wilcoxon  
## 15 kalusy dzeta kontrola 0.128 1 0.128 ns Wilcoxon  
## 16 kalusy epsilon gamma 0.0765 1 0.077 ns Wilcoxon  
## 17 kalusy epsilon kontrola 0.139 1 0.139 ns Wilcoxon  
## 18 kalusy gamma kontrola 0.128 1 0.128 ns Wilcoxon

2.1.5 Dzień 33

* siewki

ggplot(data = subset(kielkowanie, day == 33)) +  
 geom\_jitter(aes(x=concentration, y=siewki))

## Warning: Removed 1 rows containing missing values (geom\_point).



kruskal.test(siewki ~ concentration, data = subset(kielkowanie, day == 33))

##   
## Kruskal-Wallis rank sum test  
##   
## data: siewki by concentration  
## Kruskal-Wallis chi-squared = 13.226, df = 6, p-value = 0.03958

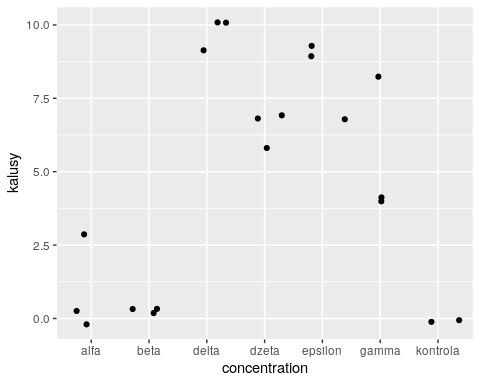
compare\_means(siewki ~ concentration, data = subset(kielkowanie, day == 33))

## # A tibble: 21 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 siewki alfa beta 0.825 1 0.82 ns Wilcoxon  
## 2 siewki alfa delta 0.268 1 0.27 ns Wilcoxon  
## 3 siewki alfa dzeta 0.822 1 0.82 ns Wilcoxon  
## 4 siewki alfa epsilon 0.2 1 0.20 ns Wilcoxon  
## 5 siewki alfa gamma 0.653 1 0.65 ns Wilcoxon  
## 6 siewki alfa kontrola 0.4 1 0.40 ns Wilcoxon  
## 7 siewki beta delta 0.1 1 0.10 ns Wilcoxon  
## 8 siewki beta dzeta 0.116 1 0.12 ns Wilcoxon  
## 9 siewki beta epsilon 0.1 1 0.10 ns Wilcoxon  
## 10 siewki beta gamma 0.653 1 0.65 ns Wilcoxon  
## # … with 11 more rows

* kalusy

ggplot(data = subset(kielkowanie, day == 33)) +  
 geom\_jitter(aes(x=concentration, y=kalusy))

## Warning: Removed 1 rows containing missing values (geom\_point).



kruskal.test(kalusy ~ concentration, data = subset(kielkowanie, day == 33))

##   
## Kruskal-Wallis rank sum test  
##   
## data: kalusy by concentration  
## Kruskal-Wallis chi-squared = 17.547, df = 6, p-value = 0.00747

compare\_means(kalusy ~ concentration, data = subset(kielkowanie, day == 33))

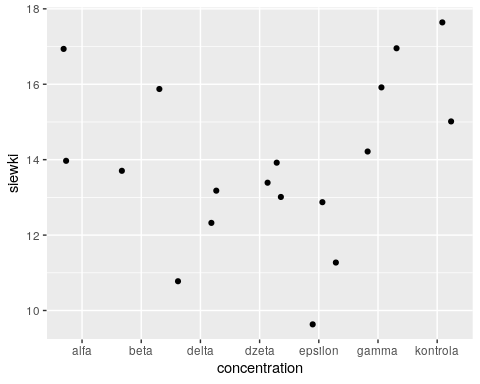
## # A tibble: 20 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 kalusy alfa beta 0.505 1 0.505 ns Wilcoxon  
## 2 kalusy alfa delta 0.0722 1 0.072 ns Wilcoxon  
## 3 kalusy alfa dzeta 0.0722 1 0.072 ns Wilcoxon  
## 4 kalusy alfa epsilon 0.0722 1 0.072 ns Wilcoxon  
## 5 kalusy alfa gamma 0.0722 1 0.072 ns Wilcoxon  
## 6 kalusy alfa kontrola 0.683 1 0.683 ns Wilcoxon  
## 7 kalusy beta delta 0.0593 1 0.059 ns Wilcoxon  
## 8 kalusy beta dzeta 0.0593 1 0.059 ns Wilcoxon  
## 9 kalusy beta epsilon 0.0593 1 0.059 ns Wilcoxon  
## 10 kalusy beta gamma 0.0593 1 0.059 ns Wilcoxon  
## 11 kalusy delta dzeta 0.0722 1 0.072 ns Wilcoxon  
## 12 kalusy delta epsilon 0.157 1 0.157 ns Wilcoxon  
## 13 kalusy delta gamma 0.0722 1 0.072 ns Wilcoxon  
## 14 kalusy delta kontrola 0.128 1 0.128 ns Wilcoxon  
## 15 kalusy dzeta epsilon 0.157 1 0.157 ns Wilcoxon  
## 16 kalusy dzeta gamma 0.653 1 0.653 ns Wilcoxon  
## 17 kalusy dzeta kontrola 0.128 1 0.128 ns Wilcoxon  
## 18 kalusy epsilon gamma 0.178 1 0.178 ns Wilcoxon  
## 19 kalusy epsilon kontrola 0.128 1 0.128 ns Wilcoxon  
## 20 kalusy gamma kontrola 0.128 1 0.128 ns Wilcoxon

2.1.6 Dzień 39

* siewki

ggplot(data = subset(kielkowanie, day == 39)) +  
 geom\_jitter(aes(x=concentration, y=siewki))

## Warning: Removed 3 rows containing missing values (geom\_point).



kruskal.test(siewki ~ concentration, data = subset(kielkowanie, day == 39))

##   
## Kruskal-Wallis rank sum test  
##   
## data: siewki by concentration  
## Kruskal-Wallis chi-squared = 13.687, df = 6, p-value = 0.03333

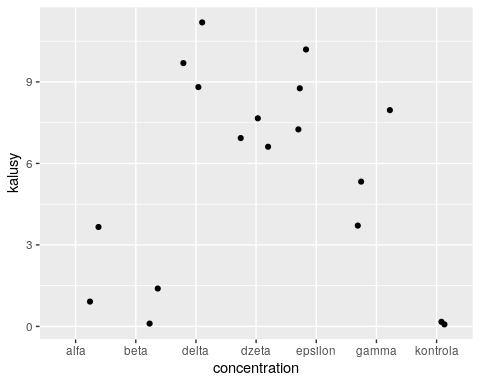
compare\_means(siewki ~ concentration, data = subset(kielkowanie, day == 39))

## # A tibble: 21 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 siewki alfa beta 1 1 1.00 ns Wilcoxon  
## 2 siewki alfa delta 0.2 1 0.20 ns Wilcoxon  
## 3 siewki alfa dzeta 0.224 1 0.22 ns Wilcoxon  
## 4 siewki alfa epsilon 0.2 1 0.20 ns Wilcoxon  
## 5 siewki alfa gamma 1 1 1.00 ns Wilcoxon  
## 6 siewki alfa kontrola 0.667 1 0.67 ns Wilcoxon  
## 7 siewki beta delta 0.2 1 0.20 ns Wilcoxon  
## 8 siewki beta dzeta 0.224 1 0.22 ns Wilcoxon  
## 9 siewki beta epsilon 0.2 1 0.20 ns Wilcoxon  
## 10 siewki beta gamma 0.761 1 0.76 ns Wilcoxon  
## # … with 11 more rows

* kalusy

ggplot(data = subset(kielkowanie, day == 39)) +  
 geom\_jitter(aes(x=concentration, y=kalusy))

## Warning: Removed 3 rows containing missing values (geom\_point).



kruskal.test(kalusy ~ concentration, data = subset(kielkowanie, day == 39))

##   
## Kruskal-Wallis rank sum test  
##   
## data: kalusy by concentration  
## Kruskal-Wallis chi-squared = 14.968, df = 6, p-value = 0.0205

compare\_means(kalusy ~ concentration, data = subset(kielkowanie, day == 39))

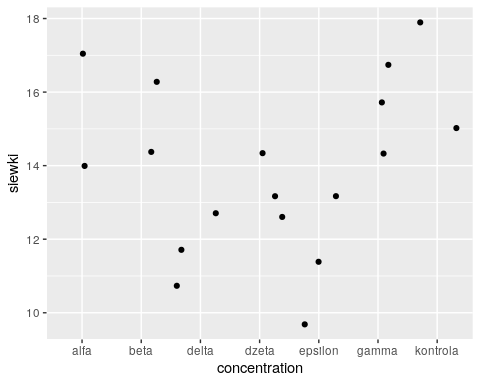
## # A tibble: 21 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 kalusy alfa beta 0.414 1 0.414 ns Wilcoxon  
## 2 kalusy alfa delta 0.2 1 0.200 ns Wilcoxon  
## 3 kalusy alfa dzeta 0.139 1 0.139 ns Wilcoxon  
## 4 kalusy alfa epsilon 0.2 1 0.200 ns Wilcoxon  
## 5 kalusy alfa gamma 0.236 1 0.236 ns Wilcoxon  
## 6 kalusy alfa kontrola 0.221 1 0.221 ns Wilcoxon  
## 7 kalusy beta delta 0.2 1 0.200 ns Wilcoxon  
## 8 kalusy beta dzeta 0.139 1 0.139 ns Wilcoxon  
## 9 kalusy beta epsilon 0.2 1 0.200 ns Wilcoxon  
## 10 kalusy beta gamma 0.2 1 0.200 ns Wilcoxon  
## # … with 11 more rows

2.1.7 Dzień 41

* siewki

ggplot(data = subset(kielkowanie, day == 41)) +  
 geom\_jitter(aes(x=concentration, y=siewki))

## Warning: Removed 3 rows containing missing values (geom\_point).



kruskal.test(siewki ~ concentration, data = subset(kielkowanie, day == 41))

##   
## Kruskal-Wallis rank sum test  
##   
## data: siewki by concentration  
## Kruskal-Wallis chi-squared = 13.687, df = 6, p-value = 0.03333

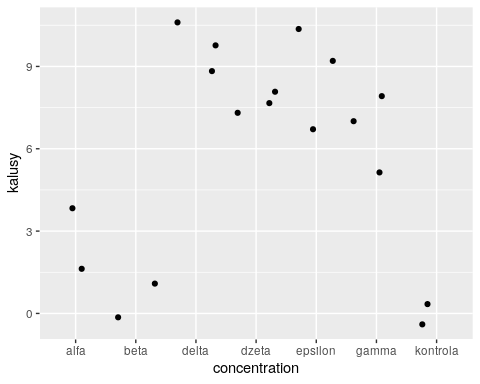
compare\_means(siewki ~ concentration, data = subset(kielkowanie, day == 41))

## # A tibble: 21 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 siewki alfa beta 1 1 1.00 ns Wilcoxon  
## 2 siewki alfa delta 0.2 1 0.20 ns Wilcoxon  
## 3 siewki alfa dzeta 0.224 1 0.22 ns Wilcoxon  
## 4 siewki alfa epsilon 0.2 1 0.20 ns Wilcoxon  
## 5 siewki alfa gamma 1 1 1.00 ns Wilcoxon  
## 6 siewki alfa kontrola 0.667 1 0.67 ns Wilcoxon  
## 7 siewki beta delta 0.2 1 0.20 ns Wilcoxon  
## 8 siewki beta dzeta 0.224 1 0.22 ns Wilcoxon  
## 9 siewki beta epsilon 0.2 1 0.20 ns Wilcoxon  
## 10 siewki beta gamma 0.761 1 0.76 ns Wilcoxon  
## # … with 11 more rows

* kalusy

ggplot(data = subset(kielkowanie, day == 41)) +  
 geom\_jitter(aes(x=concentration, y=kalusy))

## Warning: Removed 3 rows containing missing values (geom\_point).



kruskal.test(kalusy ~ concentration, data = subset(kielkowanie, day == 41))

##   
## Kruskal-Wallis rank sum test  
##   
## data: kalusy by concentration  
## Kruskal-Wallis chi-squared = 14.953, df = 6, p-value = 0.02063

compare\_means(kalusy ~ concentration, data = subset(kielkowanie, day == 41))

## # A tibble: 21 x 8  
## .y. group1 group2 p p.adj p.format p.signif method   
## <chr> <chr> <chr> <dbl> <dbl> <chr> <chr> <chr>   
## 1 kalusy alfa beta 0.333 1 0.333 ns Wilcoxon  
## 2 kalusy alfa delta 0.2 1 0.200 ns Wilcoxon  
## 3 kalusy alfa dzeta 0.139 1 0.139 ns Wilcoxon  
## 4 kalusy alfa epsilon 0.2 1 0.200 ns Wilcoxon  
## 5 kalusy alfa gamma 0.2 1 0.200 ns Wilcoxon  
## 6 kalusy alfa kontrola 0.221 1 0.221 ns Wilcoxon  
## 7 kalusy beta delta 0.2 1 0.200 ns Wilcoxon  
## 8 kalusy beta dzeta 0.139 1 0.139 ns Wilcoxon  
## 9 kalusy beta epsilon 0.2 1 0.200 ns Wilcoxon  
## 10 kalusy beta gamma 0.2 1 0.200 ns Wilcoxon  
## # … with 11 more rows