Correlation

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R Markdown

#chargement des library

```
library(tidyverse)
library(readr)
library(corrplot)
library(viridis)
library(ggplot2)
library(data.table)
library(stats)
library(car)
```

Chargement du jeu de donnée

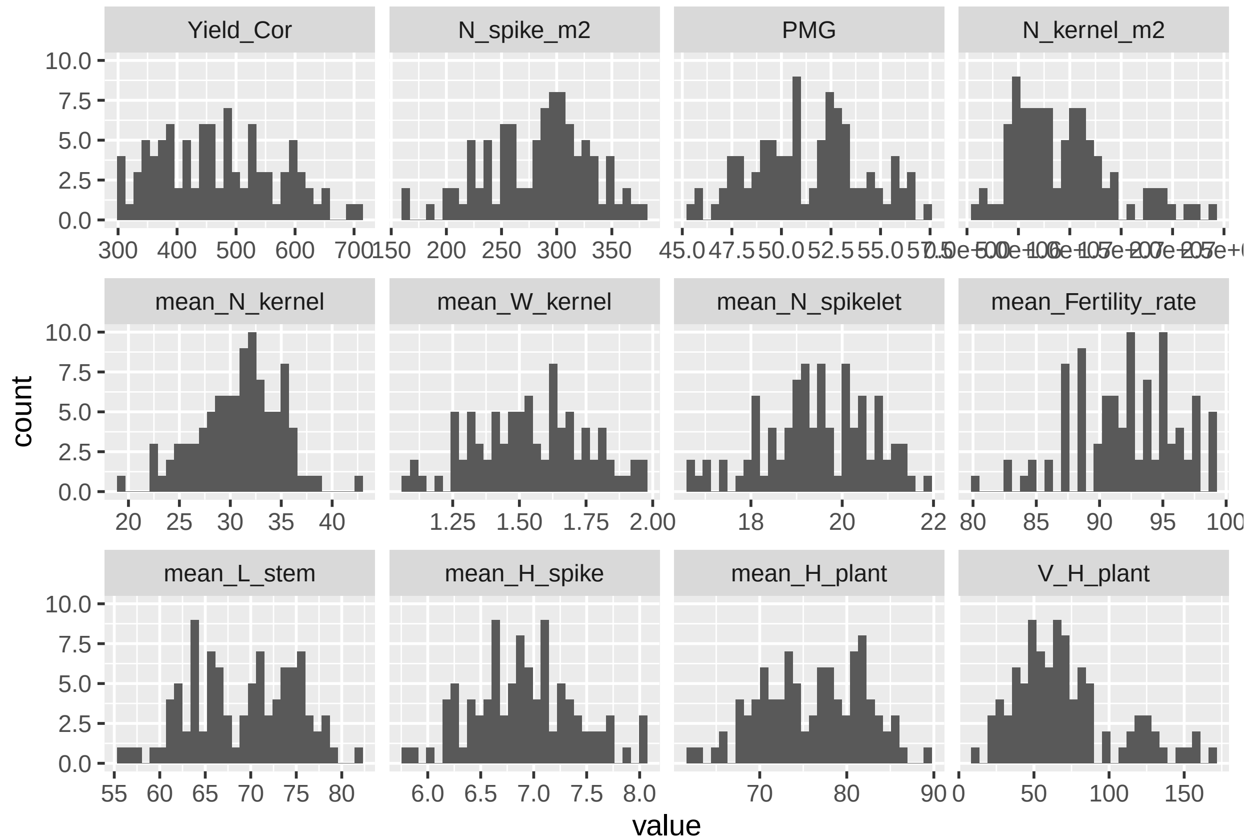
```
data_yield <- read.csv2("data_yield_plot.csv")
data_yield_R<-data_yield%>%
  filter()
```

Distribution of the traits

```
data_yield %>%
  select(-plot_ident,-Bloc)%>%
  melt(.) %>%
  ggplot(., aes(x=value,label=variable)) +
  geom_histogram() +
  facet_wrap(. ~ variable,scales="free_x")
```

```
## Warning in melt(.): The melt generic in data.table has been passed a data.frame
## and will attempt to redirect to the relevant reshape2 method; please note that
## reshape2 is deprecated, and this redirection is now deprecated as well. To
## continue using melt methods from reshape2 while both libraries are attached,
## e.g. melt.list, you can prepend the namespace like reshape2::melt(.). In the
## next version, this warning will become an error.
```

```
## Using Hydro_condition as id variables

## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

## Warning: Removed 10 rows containing non-finite values (stat_bin).
```

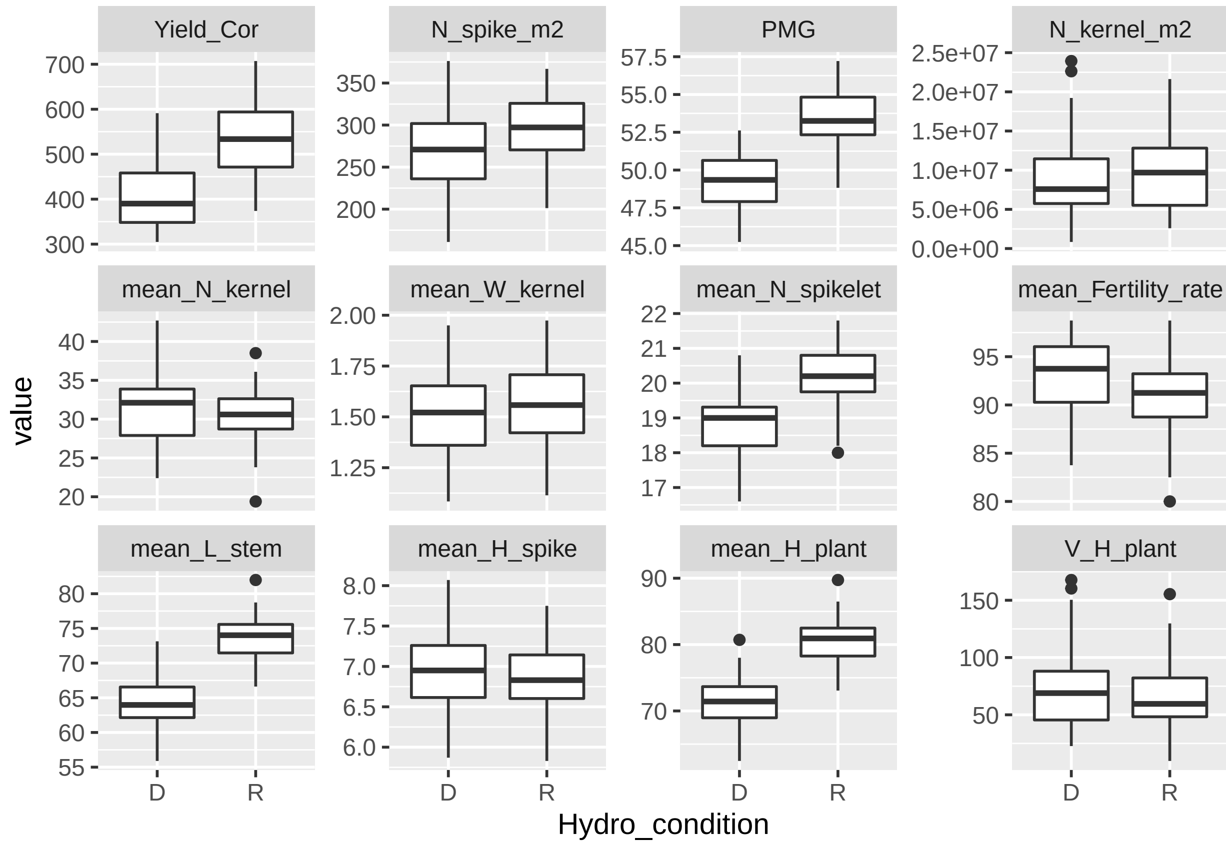


Boxplot according hydro_condition

```
data_yield%>%
  select(-plot_ident,-Bloc)%>%
  melt(.) %>%
  ggplot(., aes(x=Hydro_condition,y= value,label=variable)) +
  geom_boxplot() +
  facet_wrap(. ~ variable,scales="free_y")
```

```
## Warning in melt(.): The melt generic in data.table has been passed a data.frame
## and will attempt to redirect to the relevant reshape2 method; please note that
## reshape2 is deprecated, and this redirection is now deprecated as well. To
## continue using melt methods from reshape2 while both libraries are attached,
## e.g. melt.list, you can prepend the namespace like reshape2::melt(.). In the
## next version, this warning will become an error.
```

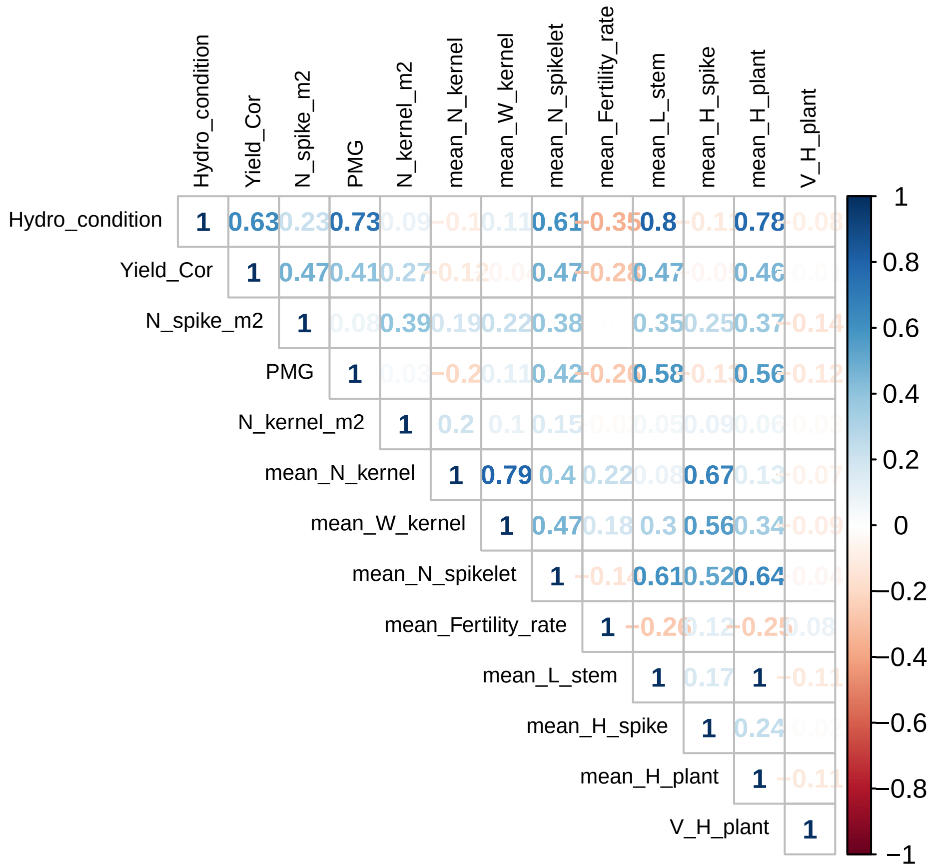
```
## Using Hydro_condition as id variables

## Warning: Removed 10 rows containing non-finite values (stat_boxplot).
```



Relation between the Yield and the other parameters

Correlation matrix

```r
#1=rainy, 2=drought
data_cor<-data_yield%>%
  select(-Bloc,-plot_ident)%>%
  mutate(Hydro_condition = ifelse(Hydro_condition=="R", 2, 1))%>%
  drop_na()
MCOR<-cor(data_cor)
corrplot(MCOR,type="upper",method="number", tl.cex=0.7,tl.col="black",number.cex=0.8)
```



Anova step by step

Le pbm de l'anova séparé que j'ai fais plus haut et que le modèle est plus stricte. En effet dans les résidus de chaque anova simple contient les autres facteurs qui peuvent être bien plus significatif. Et donc on peut observer une absence de significativité du PMG par exemple tout simplement parce que dans les residus on a le N_spike_m² qui est vachement significatif. Donc il est necessaire de faire l'anova avec l'ensemble des facteurs. ## Function graphique en regression

```
graph<- function(x){
  graph<-ggplot(data_yield, aes(x=x, y=Yield_Cor,col=Hydro_condition))+
  geom_point() +
  geom_smooth(method=lm, se=FALSE, fullrange=TRUE)
  return(graph)
}

res<-function(x){
res<-aov(Yield_Cor ~ Hydro_condition + x + Hydro_condition*x, data=data_yield)%>%
  summary
  return(res)  }
```

Relation between the yield components

Function graphical and regression

```
graphcor<- function(x,y){
  graph<-ggplot(data_yield, aes(x=y, y=x,col=Hydro_condition))+
  geom_point() +
  geom_smooth(method=lm, se=FALSE, fullrange=TRUE)
  return(graph)
}

rescor<-function(x,y){
  res<-aov(x ~ Hydro_condition + y + Hydro_condition*y, data=data_yield)%>%
  summary
  return(res)  }
```

Is there a relation between the N_spike_m² and the N_kernel_m²? (quite logical juste to be sure)

```
rescor(data_yield$N_kernel_m2,data_yield$N_spike_m2)
```

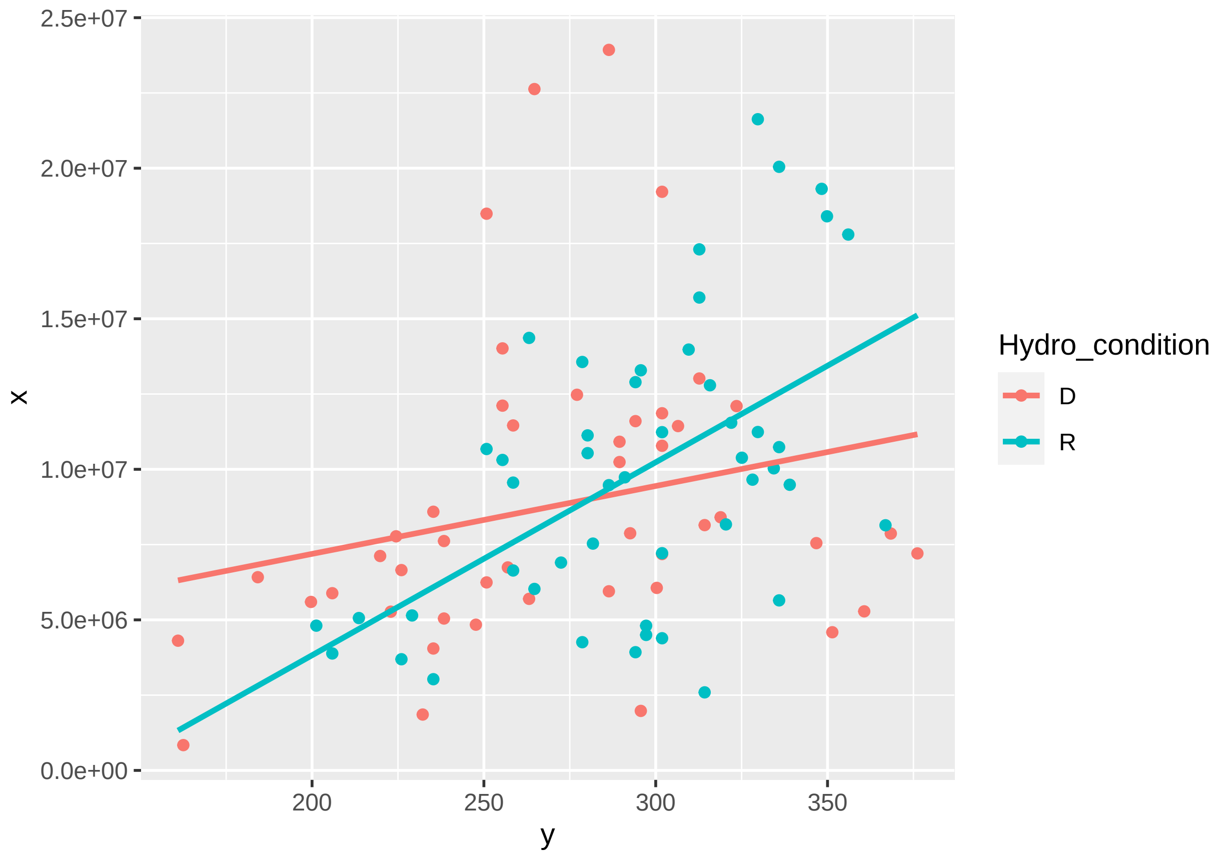
```
##                     Df    Sum Sq   Mean Sq F value   Pr(>F)    
## Hydro_condition      1 2.615e+13 2.615e+13   1.282 0.260627    
## y                    1 2.945e+14 2.945e+14  14.434 0.000263 ***
## Hydro_condition:y    1 7.985e+13 7.985e+13   3.914 0.050950 .  
## Residuals           90 1.836e+15 2.040e+13                     
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
```

```
graphcor(data_yield$N_kernel_m2,data_yield$N_spike_m2)
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## Warning: Removed 1 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```




```
#coefficient de correlation
cor(data_yield$N_kernel_m2,data_yield$N_spike_m2, use = "complete.obs")
```

```
## [1] 0.3782389
```

On a une forte correlation entre Nspike_m² and N_kernel_m² the more the N_spike_m² is the more the N_kernel_m² is, in both condition. (quite logical)

Is there a relation between the mean_N_kernel per spike and the N_kernel_m²? (quite logical juste to be sure)

```
rescor(data_yield$N_kernel_m2,data_yield$mean_N_kernel)
```

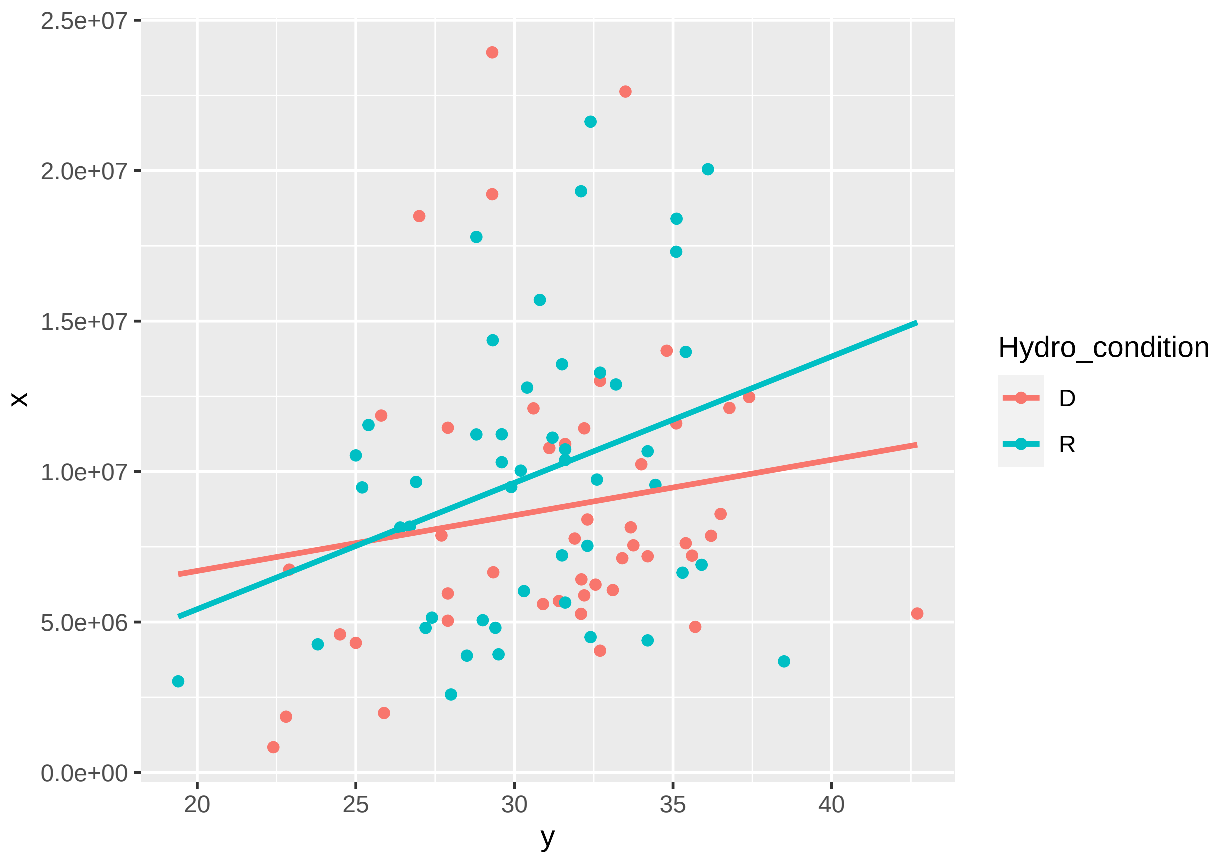
```
##                     Df    Sum Sq   Mean Sq F value Pr(>F)
## Hydro_condition      1 2.615e+13 2.615e+13   1.136 0.2893
## y                    1 1.201e+14 1.201e+14   5.219 0.0247 *
## Hydro_condition:y    1 1.981e+13 1.981e+13   0.861 0.3560
## Residuals           90 2.071e+15 2.301e+13
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
```

```r
graphcor(data_yield$N_kernel_m2,data_yield$mean_N_kernel)
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## Warning: Removed 1 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```



On a une forte correlation entre mean_N_kernel and N_kernel_m² the more the mean_N_kernel is the more the N_kernel_m² is, in both condition. (quite logical)

Is there a relation N_kernel_m2 and N_spike_m2 and mean_N_kernel per spike? (again quite a logical asumption)

```r
aov(N_kernel_m2 ~ N_spike_m2 * mean_N_kernel * Hydro_condition, data=data_yield)%>%
  summary
```

```
##                                            Df    Sum Sq   Mean Sq F value
## N_spike_m2                                  1 3.200e+14 3.200e+14  17.310
## mean_N_kernel                               1 5.338e+13 5.338e+13   2.887
## Hydro_condition                             1 3.848e+12 3.848e+12   0.208
## N_spike_m2:mean_N_kernel                    1 1.317e+13 1.317e+13   0.712
```

```
## N_spike_m2:Hydro_condition                1 9.250e+13 9.250e+13   5.004
## mean_N_kernel:Hydro_condition             1 2.503e+13 2.503e+13   1.354
## N_spike_m2:mean_N_kernel:Hydro_condition  1 1.390e+14 1.390e+14   7.521
## Residuals                                86 1.590e+15 1.849e+13
##                                            Pr(>F)
## N_spike_m2                               7.49e-05 ***
## mean_N_kernel                             0.09288 .
## Hydro_condition                           0.64939
## N_spike_m2:mean_N_kernel                  0.40099
## N_spike_m2:Hydro_condition                0.02788 *
## mean_N_kernel:Hydro_condition             0.24782
## N_spike_m2:mean_N_kernel:Hydro_condition  0.00742 **
## Residuals
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
```

The number of spike_m2 have a bigger impact on the N_kernel_m2 than the N_kernel/spike. So the variation of the N_kernel/m^2 observed is due to the reduction of the tillering in D and not a variation during the heading.

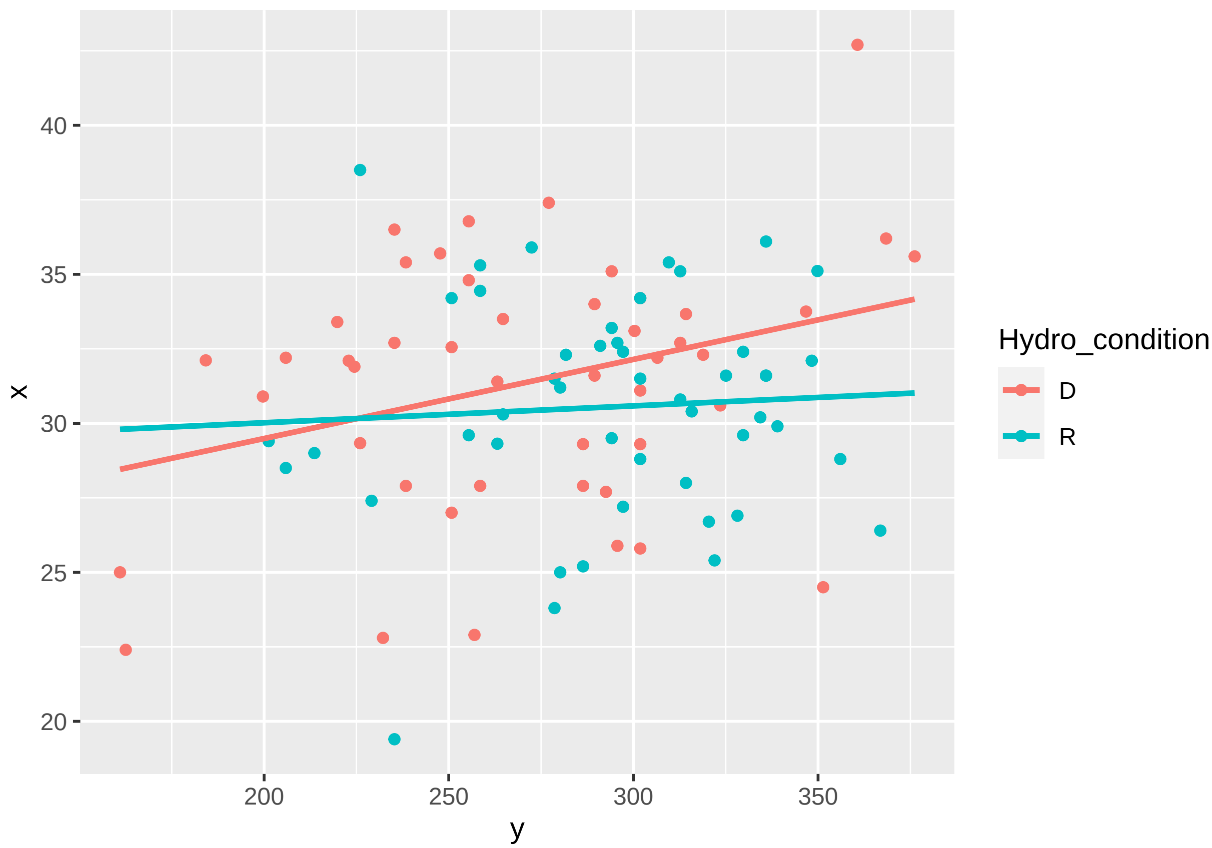
Is there a relation between the mean_N_kernel per spike and the N_spike/m^2 ?(that could enlighten the compesation process?)

```r
rescor(data_yield$mean_N_kernel,data_yield$N_spike_m2)
```

```
##                    Df Sum Sq Mean Sq F value Pr(>F)
## Hydro_condition     1   16.4   16.38   1.073  0.303
## y                   1   64.4   64.35   4.214  0.043 *
## Hydro_condition:y   1   20.2   20.17   1.321  0.253
## Residuals          90 1374.3   15.27
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
```

```r
graphcor(data_yield$mean_N_kernel,data_yield$N_spike_m2)
```

```
## `geom_smooth()` using formula 'y ~ x'

## Warning: Removed 1 rows containing non-finite values (stat_smooth).

## Warning: Removed 1 rows containing missing values (geom_point).
```



N_spike_m² and mean_N_kernel are positively correlated and the N_spike_m² have a significant impact on the mean_N_kernel. So the more spike /m², the higher is the number of kernel /spike in D condition. In R it seems that the number of kernel didn't change with the N_spike/m² (euuuh ça m'aurait arrangé l'inverse…)

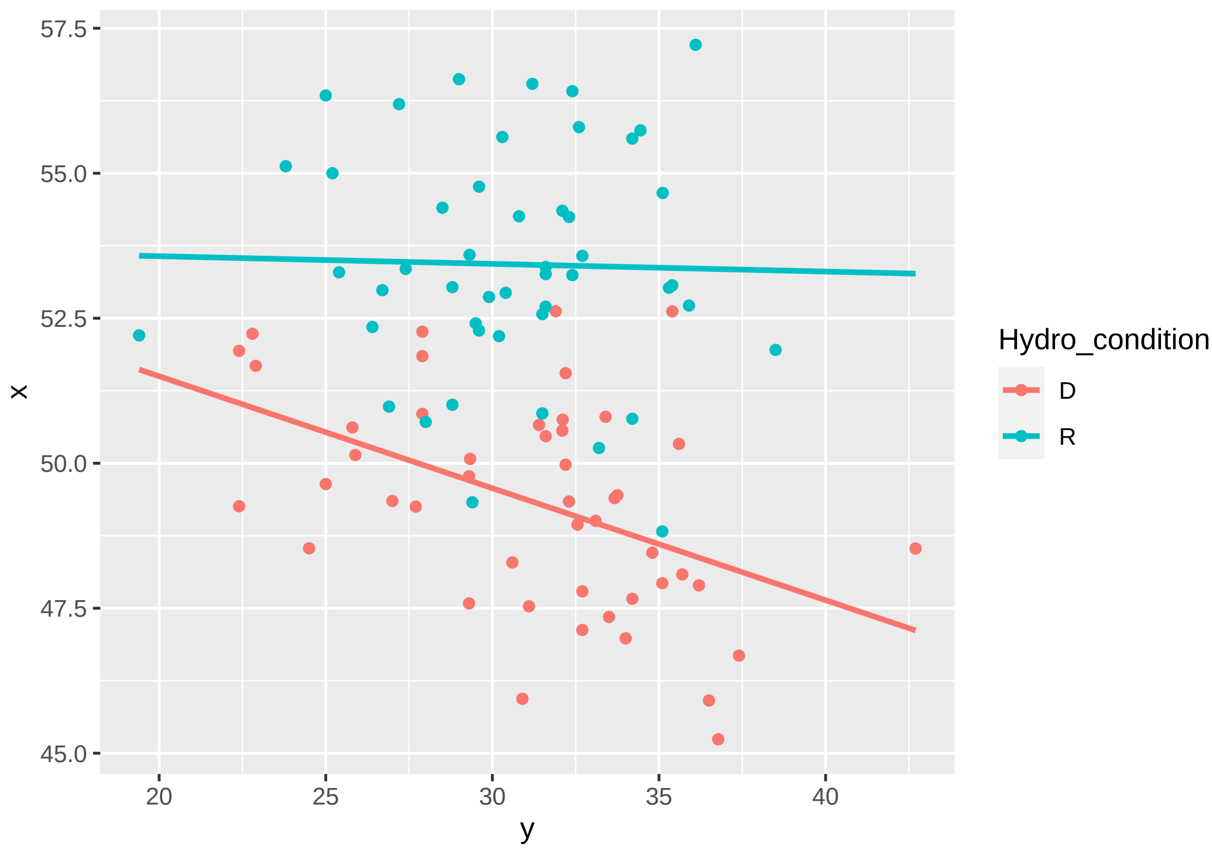
The PMG is the last step of the yield. There is no vegetative development, just kernel's growth, PMG acording to the mean_N_kernel/spike ?

```
rescor(data_yield$PMG,data_yield$mean_N_kernel)
```

```
##                    Df Sum Sq Mean Sq F value Pr(>F)    
## Hydro_condition     1  397.5   397.5 116.651 <2e-16 ***
## y                   1   21.8    21.8   6.385 0.0132 *  
## Hydro_condition:y   1   12.0    12.0   3.536 0.0633 .  
## Residuals          91  310.1     3.4                   
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
graphcor(data_yield$PMG,data_yield$mean_N_kernel)
```

```
## `geom_smooth()` using formula 'y ~ x'
```



There is an impact of the mean_N_kernel on the PMG. In D condition, the PMG decrease when the number of kernels/spike increase (logical) in stress condition the water supply is not enough to assure quantity and quality whereas in R condition the PMG can increase with the Nkernels (whereas we are still in stress codition but less stressful than D). Put how could it be possible that the N_kernel/spike is the same but the PMG change??

Analysis of the PMG acording to the N_kernel/m²

```
rescor(data_yield$PMG,data_yield$N_kernel_m2)
```

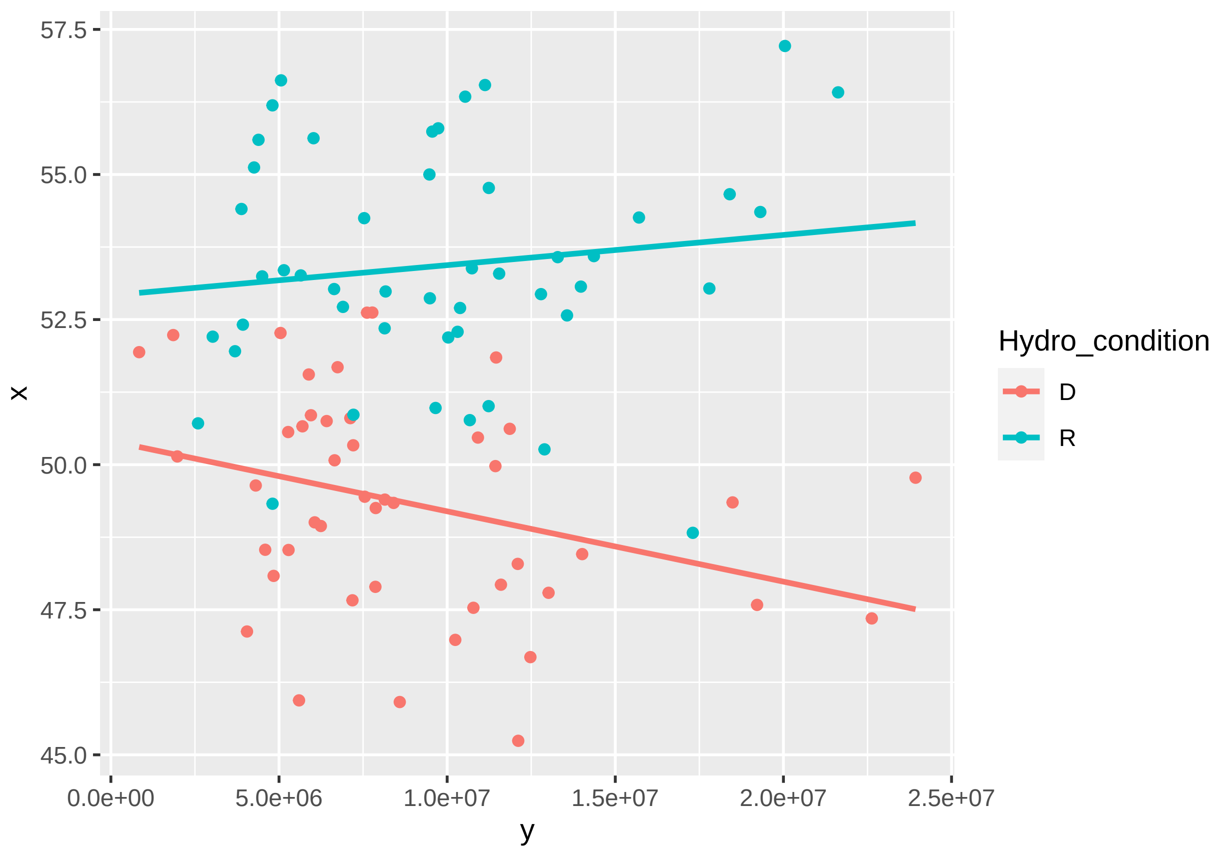
```
##                   Df Sum Sq Mean Sq F value Pr(>F)
## Hydro_condition    1  392.8   392.8 108.863 <2e-16 ***
## y                  1    2.5     2.5   0.704 0.4038
## Hydro_condition:y  1   16.6    16.6   4.594 0.0348 *
## Residuals         90  324.8     3.6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
```

```
graphcor(data_yield$PMG,data_yield$N_kernel_m2)
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## Warning: Removed 1 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```



No effect of the Nkernel_m² on the PMG itself, but an effect of the Interaction with the hydrocondition. Indeed in D condition if the N_kernel_m² increase, the PMG decrease. Whereas in R condition this not the case (seems to have no variation or slightly in the reverse way).In D condition there is not enough water supply as in R to allow Kernel growth in may/july (stress condition)and so less PMG.

HYPOTHESIS First stress sign in avril during the tillering, then compensation of the water supply. That is by reducingthe number of tillers there is sufficient ressources to maintain the heading (Nkernel/spike) in both condition. However the water supply continue to decrease along may and july, so during the filling of the kernel. And maybe it is this stress gap between R and D that explain the variation of the PMG.

We observed in the boxplot a real difference of the N_spikelet along the 2 conditions, is this variable is related to the components of the yield

The spikelet case…

N_spikelet/spike~N_spike/m²

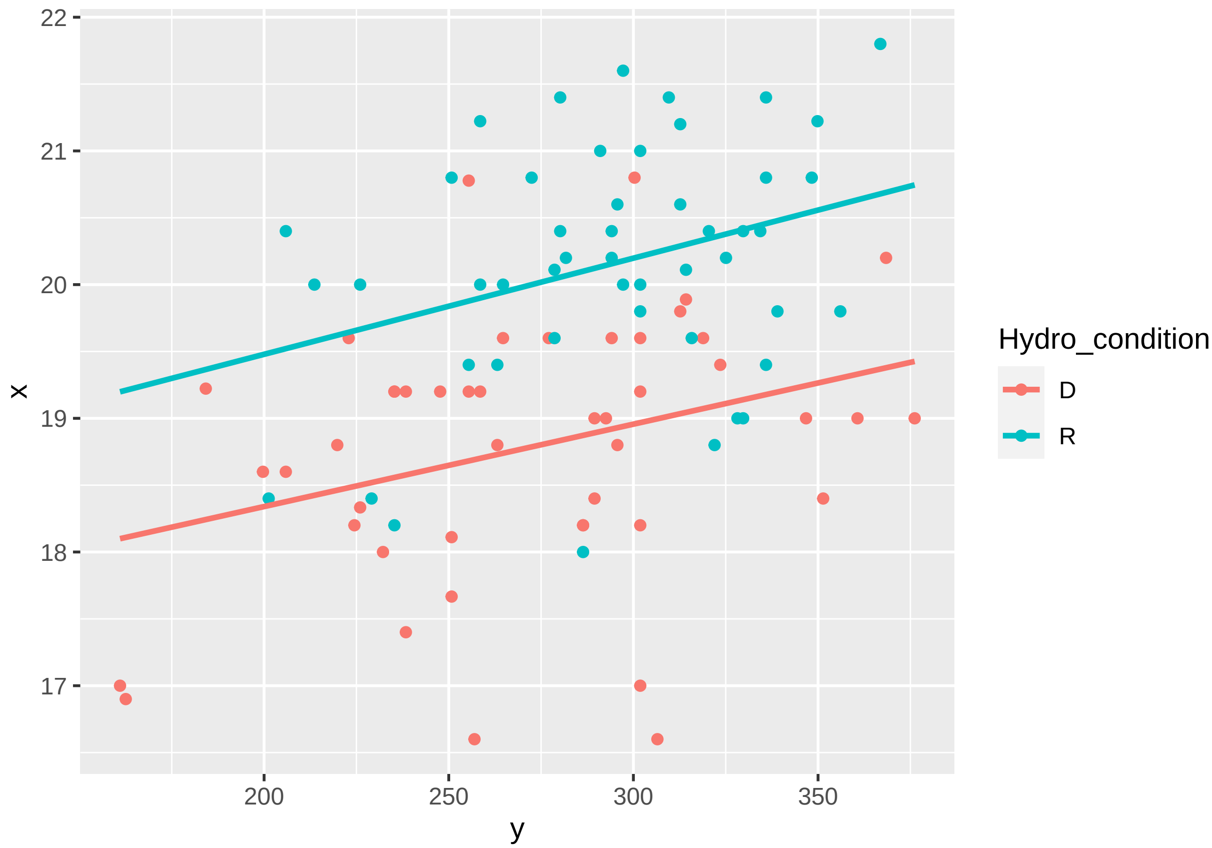
```
rescor(data_yield$mean_N_spikelet,data_yield$N_spike_m2)
```

```
##                   Df Sum Sq Mean Sq F value   Pr(>F)
## Hydro_condition    1  44.42   44.42  53.886 9.11e-11 ***
## y                  1   8.34    8.34  10.119  0.00201 **
```

```
## Hydro_condition:y  1   0.05    0.05   0.059  0.80818
## Residuals         90  74.19    0.82
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
```

```
graphcor(data_yield$mean_N_spikelet,data_yield$N_spike_m2)
```

```
## `geom_smooth()` using formula 'y ~ x'

## Warning: Removed 1 rows containing non-finite values (stat_smooth).

## Warning: Removed 1 rows containing missing values (geom_point).
```



The more N_spike/m², the more N_spikelet/spike. So quite logically we can link the spikelet reduction on D condition to the reduction of the tillering during the tillering.(pourquoi?)

N_spikelet and mean_N_kernel per spike

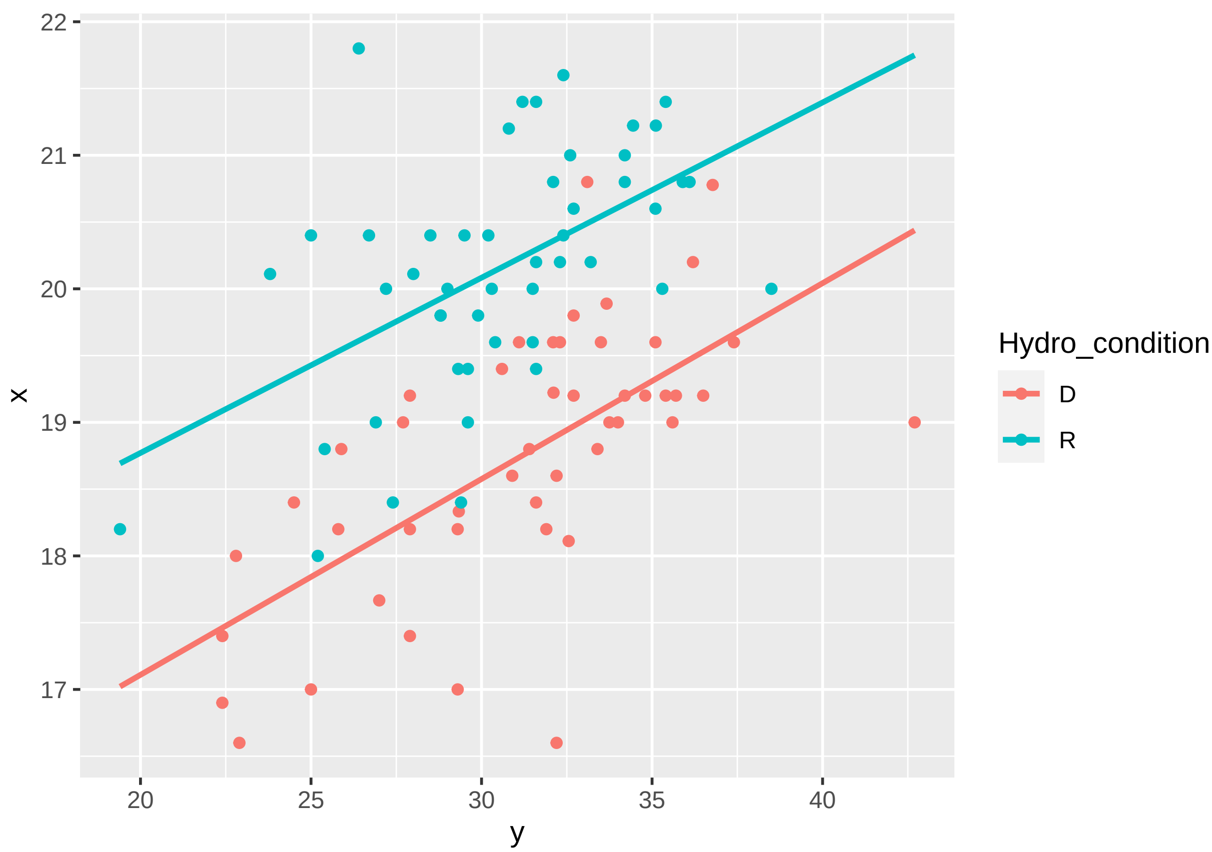
```
rescor(data_yield$mean_N_spikelet,data_yield$mean_N_kernel)
```

```
##                    Df Sum Sq Mean Sq F value   Pr(>F)
## Hydro_condition     1  46.84   46.84  78.814 5.69e-14 ***
```

```
## y                  1  30.27   30.27  50.921 2.26e-10 ***
## Hydro_condition:y  1   0.09    0.09   0.149      0.7
## Residuals         91  54.09    0.59
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
graphcor(data_yield$mean_N_spikelet,data_yield$mean_N_kernel)
```

```
## `geom_smooth()` using formula 'y ~ x'
```



the more spikelet, the more Nkernel/spike in both condition

Nspikelet model

```
aov(mean_N_spikelet~mean_N_kernel*N_spike_m2*Hydro_condition, data_yield)%>%
  summary
```

```
##                                      Df Sum Sq Mean Sq F value   Pr(>F)
## mean_N_kernel                         1  21.15   21.15  37.907 2.29e-08 ***
## N_spike_m2                            1  13.40   13.40  24.016 4.45e-06 ***
## Hydro_condition                       1  41.56   41.56  74.499 2.77e-13 ***
## mean_N_kernel:N_spike_m2              1   1.93    1.93   3.459   0.0663 .
## mean_N_kernel:Hydro_condition         1   0.00    0.00   0.000   0.9835
```

```
## N_spike_m2:Hydro_condition                1   0.48    0.48   0.868   0.3542
## mean_N_kernel:N_spike_m2:Hydro_condition  1   0.50    0.50   0.894   0.3471
## Residuals                                86  47.98    0.56
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
```

ANOVA Yield, Could we determine the impact of each yield components on the yield in this experiment?

```r
#anova avec interaction
anova<-aov(Yield_Cor ~  Hydro_condition * N_spike_m2 * N_kernel_m2   * mean_N_kernel * PMG , data=data_y
#estime le meilleur modèle
step(anova)
```

```
## Start:  AIC=814.87
## Yield_Cor ~ Hydro_condition * N_spike_m2 * N_kernel_m2 * mean_N_kernel *
##     PMG
##
##                                                             Df Sum of Sq    RSS
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel:PMG  1    434.86 298920
## <none>                                                                  298485
##                                                                AIC
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel:PMG 813.01
## <none>                                                     814.87
##
## Step:  AIC=813.01
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:PMG +
##     Hydro_condition:N_kernel_m2:PMG + N_spike_m2:N_kernel_m2:PMG +
##     Hydro_condition:mean_N_kernel:PMG + N_spike_m2:mean_N_kernel:PMG +
##     N_kernel_m2:mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel +
##     Hydro_condition:N_spike_m2:N_kernel_m2:PMG + Hydro_condition:N_spike_m2:mean_N_kernel:PMG +
##     Hydro_condition:N_kernel_m2:mean_N_kernel:PMG + N_spike_m2:N_kernel_m2:mean_N_kernel:PMG
##
##                                                         Df Sum of Sq    RSS
## - Hydro_condition:N_spike_m2:mean_N_kernel:PMG          1    377.97 299297
## - N_spike_m2:N_kernel_m2:mean_N_kernel:PMG              1    756.35 299676
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG            1   1041.16 299961
## - Hydro_condition:N_kernel_m2:mean_N_kernel:PMG         1   2607.99 301528
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1   2793.48 301713
## <none>                                                              298920
##                                                            AIC
## - Hydro_condition:N_spike_m2:mean_N_kernel:PMG          811.12
## - N_spike_m2:N_kernel_m2:mean_N_kernel:PMG              811.24
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG            811.33
```

```
## - Hydro_condition:N_kernel_m2:mean_N_kernel:PMG        811.81
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 811.87
## <none>                                                 813.01
##
## Step:  AIC=811.12
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:PMG +
##     Hydro_condition:N_kernel_m2:PMG + N_spike_m2:N_kernel_m2:PMG +
##     Hydro_condition:mean_N_kernel:PMG + N_spike_m2:mean_N_kernel:PMG +
##     N_kernel_m2:mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel +
##     Hydro_condition:N_spike_m2:N_kernel_m2:PMG + Hydro_condition:N_kernel_m2:mean_N_kernel:PMG +
##     N_spike_m2:N_kernel_m2:mean_N_kernel:PMG
##
##                                                         Df Sum of Sq    RSS
## - N_spike_m2:N_kernel_m2:mean_N_kernel:PMG              1    1626.4 300924
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG            1    1712.0 301009
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1    2599.6 301897
## - Hydro_condition:N_kernel_m2:mean_N_kernel:PMG         1    2658.4 301956
## <none>                                                              299297
##                                                            AIC
## - N_spike_m2:N_kernel_m2:mean_N_kernel:PMG             809.63
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG           809.65
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 809.93
## - Hydro_condition:N_kernel_m2:mean_N_kernel:PMG        809.95
## <none>                                                 811.12
##
## Step:  AIC=809.63
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:PMG +
##     Hydro_condition:N_kernel_m2:PMG + N_spike_m2:N_kernel_m2:PMG +
##     Hydro_condition:mean_N_kernel:PMG + N_spike_m2:mean_N_kernel:PMG +
##     N_kernel_m2:mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel +
##     Hydro_condition:N_spike_m2:N_kernel_m2:PMG + Hydro_condition:N_kernel_m2:mean_N_kernel:PMG
##
##                                                         Df Sum of Sq    RSS
## - N_spike_m2:mean_N_kernel:PMG                          1       2.2 300926
## - Hydro_condition:N_kernel_m2:mean_N_kernel:PMG         1    1103.9 302028
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG            1    4217.2 305141
## <none>                                                              300924
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1   12722.0 313646
##                                                            AIC
## - N_spike_m2:mean_N_kernel:PMG                         807.63
## - Hydro_condition:N_kernel_m2:mean_N_kernel:PMG        807.97
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG           808.92
```

```
## <none>                                                  809.63
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 811.48
##
## Step:  AIC=807.63
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:PMG +
##     Hydro_condition:N_kernel_m2:PMG + N_spike_m2:N_kernel_m2:PMG +
##     Hydro_condition:mean_N_kernel:PMG + N_kernel_m2:mean_N_kernel:PMG +
##     Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:N_kernel_m2:PMG
##     Hydro_condition:N_kernel_m2:mean_N_kernel:PMG
##
##                                                        Df Sum of Sq    RSS
## - Hydro_condition:N_kernel_m2:mean_N_kernel:PMG         1    1102.8 302029
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG            1    4703.0 305629
## <none>                                                              300926
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1   12858.0 313784
##                                                           AIC
## - Hydro_condition:N_kernel_m2:mean_N_kernel:PMG        805.97
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG           807.07
## <none>                                                 807.63
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 809.52
##
## Step:  AIC=805.97
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:PMG +
##     Hydro_condition:N_kernel_m2:PMG + N_spike_m2:N_kernel_m2:PMG +
##     Hydro_condition:mean_N_kernel:PMG + N_kernel_m2:mean_N_kernel:PMG +
##     Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:N_kernel_m2:PMG
##
##                                                        Df Sum of Sq    RSS
## - N_kernel_m2:mean_N_kernel:PMG                         1       3.0 302032
## - Hydro_condition:mean_N_kernel:PMG                     1    1233.2 303262
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG            1    3964.6 305994
## <none>                                                              302029
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1   12479.6 314508
##                                                           AIC
## - N_kernel_m2:mean_N_kernel:PMG                        803.97
## - Hydro_condition:mean_N_kernel:PMG                    804.35
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG           805.18
## <none>                                                 805.97
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 807.73
##
## Step:  AIC=803.97
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
```

```
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:PMG +
##     Hydro_condition:N_kernel_m2:PMG + N_spike_m2:N_kernel_m2:PMG +
##     Hydro_condition:mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel +
##     Hydro_condition:N_spike_m2:N_kernel_m2:PMG
##
##                                                      Df Sum of Sq    RSS
## - Hydro_condition:mean_N_kernel:PMG                   1    1402.7 303435
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG          1    4096.9 306129
## <none>                                                            302032
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1   13160.8 315193
##                                                         AIC
## - Hydro_condition:mean_N_kernel:PMG                  802.40
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG         803.22
## <none>                                               803.97
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 805.94
##
## Step:  AIC=802.4
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + mean_N_kernel:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:PMG +
##     Hydro_condition:N_kernel_m2:PMG + N_spike_m2:N_kernel_m2:PMG +
##     Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:N_kernel_m2:PM
##
##                                                      Df Sum of Sq    RSS
## - mean_N_kernel:PMG                                   1    3506.6 306941
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG          1    4926.0 308361
## <none>                                                            303435
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1   14987.6 318422
##                                                         AIC
## - mean_N_kernel:PMG                                  801.47
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG         801.90
## <none>                                               802.40
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 804.88
##
## Step:  AIC=801.47
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:PMG +
##     Hydro_condition:N_kernel_m2:PMG + N_spike_m2:N_kernel_m2:PMG +
##     Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:N_kernel_m2:PM
##
```

```
##                                                  Df Sum of Sq    RSS
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG           1    6488.8 313430
## <none>                                                             306941
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1   13151.6 320093
##                                                     AIC
## - Hydro_condition:N_spike_m2:N_kernel_m2:PMG          801.41
## <none>                                                801.47
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 803.37
##
## Step:  AIC=801.41
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_spike_m2:PMG +
##     Hydro_condition:N_kernel_m2:PMG + N_spike_m2:N_kernel_m2:PMG +
##     Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel
##
##                                                  Df Sum of Sq    RSS
## - Hydro_condition:N_spike_m2:PMG                       1     931.1 314361
## - N_spike_m2:N_kernel_m2:PMG                           1    2167.1 315597
## - Hydro_condition:N_kernel_m2:PMG                      1    4953.0 318383
## <none>                                                             313430
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1    7616.1 321046
##                                                     AIC
## - Hydro_condition:N_spike_m2:PMG                      799.69
## - N_spike_m2:N_kernel_m2:PMG                          800.05
## - Hydro_condition:N_kernel_m2:PMG                     800.87
## <none>                                                801.41
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 801.65
##
## Step:  AIC=799.69
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:PMG +
##     N_spike_m2:N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel
##
##                                                  Df Sum of Sq    RSS
## - N_spike_m2:N_kernel_m2:PMG                           1    2576.1 316937
## - Hydro_condition:N_kernel_m2:PMG                      1    4021.9 318383
## <none>                                                             314361
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1    8065.2 322426
##                                                     AIC
## - N_spike_m2:N_kernel_m2:PMG                          798.45
## - Hydro_condition:N_kernel_m2:PMG                     798.87
## <none>                                                799.69
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 800.05
##
```

```
## Step:  AIC=798.45
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_spike_m2:PMG + N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:PMG +
##     Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel
##
##                                                       Df Sum of Sq    RSS
## - N_spike_m2:PMG                                       1     765.7 317703
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1    5658.8 322596
## <none>                                                            316937
## - Hydro_condition:N_kernel_m2:PMG                      1    8999.8 325937
##                                                          AIC
## - N_spike_m2:PMG                                      796.67
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 798.09
## <none>                                                798.45
## - Hydro_condition:N_kernel_m2:PMG                     799.05
##
## Step:  AIC=796.67
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:PMG +
##     Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel
##
##                                                       Df Sum of Sq    RSS
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel  1    5713.2 323416
## <none>                                                            317703
## - Hydro_condition:N_kernel_m2:PMG                      1    9002.2 326705
##                                                          AIC
## - Hydro_condition:N_spike_m2:N_kernel_m2:mean_N_kernel 796.33
## <none>                                                796.67
## - Hydro_condition:N_kernel_m2:PMG                     797.27
##
## Step:  AIC=796.33
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:mean_N_kernel +
##     N_spike_m2:N_kernel_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:PMG
##
##                                             Df Sum of Sq    RSS    AIC
## - Hydro_condition:N_kernel_m2:mean_N_kernel  1      24.9 323441 794.34
## - N_spike_m2:N_kernel_m2:mean_N_kernel       1     227.8 323644 794.40
## - Hydro_condition:N_spike_m2:mean_N_kernel   1     971.2 324387 794.61
## - Hydro_condition:N_kernel_m2:PMG            1    6796.4 330212 796.26
```

```
## <none>                                                   323416 796.33
## - Hydro_condition:N_spike_m2:N_kernel_m2     1   17222.2 340638 799.16
##
## Step:  AIC=794.34
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + N_spike_m2:N_kernel_m2:mean_N_kernel +
##     Hydro_condition:N_kernel_m2:PMG
##
##                                            Df Sum of Sq    RSS    AIC
## - N_spike_m2:N_kernel_m2:mean_N_kernel      1     205.0 323646 792.40
## - Hydro_condition:N_spike_m2:mean_N_kernel  1    1012.2 324453 792.63
## <none>                                                  323441 794.34
## - Hydro_condition:N_kernel_m2:PMG           1    7487.3 330928 794.47
## - Hydro_condition:N_spike_m2:N_kernel_m2    1   17209.2 340650 797.16
##
## Step:  AIC=792.4
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_spike_m2:mean_N_kernel + Hydro_condition:N_kernel_m2:PMG
##
##                                            Df Sum of Sq    RSS    AIC
## - Hydro_condition:N_spike_m2:mean_N_kernel  1    1473.7 325120 790.82
## - N_kernel_m2:mean_N_kernel                 1    4793.3 328439 791.76
## <none>                                                  323646 792.40
## - Hydro_condition:N_kernel_m2:PMG           1    8281.8 331928 792.75
## - Hydro_condition:N_spike_m2:N_kernel_m2    1   17401.9 341048 795.27
##
## Step:  AIC=790.82
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + Hydro_condition:mean_N_kernel +
##     N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel + Hydro_condition:PMG +
##     N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_kernel_m2:PMG
##
##                                          Df Sum of Sq    RSS    AIC
## - Hydro_condition:mean_N_kernel           1    1149.6 326269 789.15
## <none>                                                325120 790.82
## - N_kernel_m2:mean_N_kernel               1   12376.5 337496 792.29
## - Hydro_condition:N_kernel_m2:PMG         1   12813.5 337933 792.41
## - N_spike_m2:mean_N_kernel                1   13866.2 338986 792.70
## - Hydro_condition:N_spike_m2:N_kernel_m2  1   15939.2 341059 793.27
##
## Step:  AIC=789.15
## Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 + mean_N_kernel +
##     PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel +
```

```
##     Hydro_condition:PMG + N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_kernel_m2:PMG
##
##                                          Df Sum of Sq    RSS    AIC
## <none>                                                326269 789.15
## - N_kernel_m2:mean_N_kernel               1     11641 337910 790.41
## - Hydro_condition:N_kernel_m2:PMG         1     12759 339029 790.72
## - N_spike_m2:mean_N_kernel                1     12864 339133 790.74
## - Hydro_condition:N_spike_m2:N_kernel_m2  1     14842 341111 791.28
```

```
## Call:
##    aov(formula = Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 +
##     mean_N_kernel + PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
##     N_spike_m2:N_kernel_m2 + N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel +
##     Hydro_condition:PMG + N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
##     Hydro_condition:N_kernel_m2:PMG, data = data_yield)
##
## Terms:
##                 Hydro_condition N_spike_m2 N_kernel_m2 mean_N_kernel      PMG
## Sum of Squares         378693.7   119069.4      6023.6       19356.5   2713.3
## Deg. of Freedom               1          1           1             1        1
##                 Hydro_condition:N_spike_m2 Hydro_condition:N_kernel_m2
## Sum of Squares                     12624.3                        12.4
## Deg. of Freedom                          1                           1
##                 N_spike_m2:N_kernel_m2 N_spike_m2:mean_N_kernel
## Sum of Squares                   333.0                   6632.9
## Deg. of Freedom                      1                        1
##                 N_kernel_m2:mean_N_kernel Hydro_condition:PMG N_kernel_m2:PMG
## Sum of Squares                     3704.0              8211.3           114.0
## Deg. of Freedom                         1                   1               1
##                 Hydro_condition:N_spike_m2:N_kernel_m2
## Sum of Squares                                 12725.3
## Deg. of Freedom                                      1
##                 Hydro_condition:N_kernel_m2:PMG Residuals
## Sum of Squares                          12759.4  326269.2
## Deg. of Freedom                               1        78
##
## Residual standard error: 64.67564
## Estimated effects may be unbalanced
## 2 observations deleted due to missingness
```

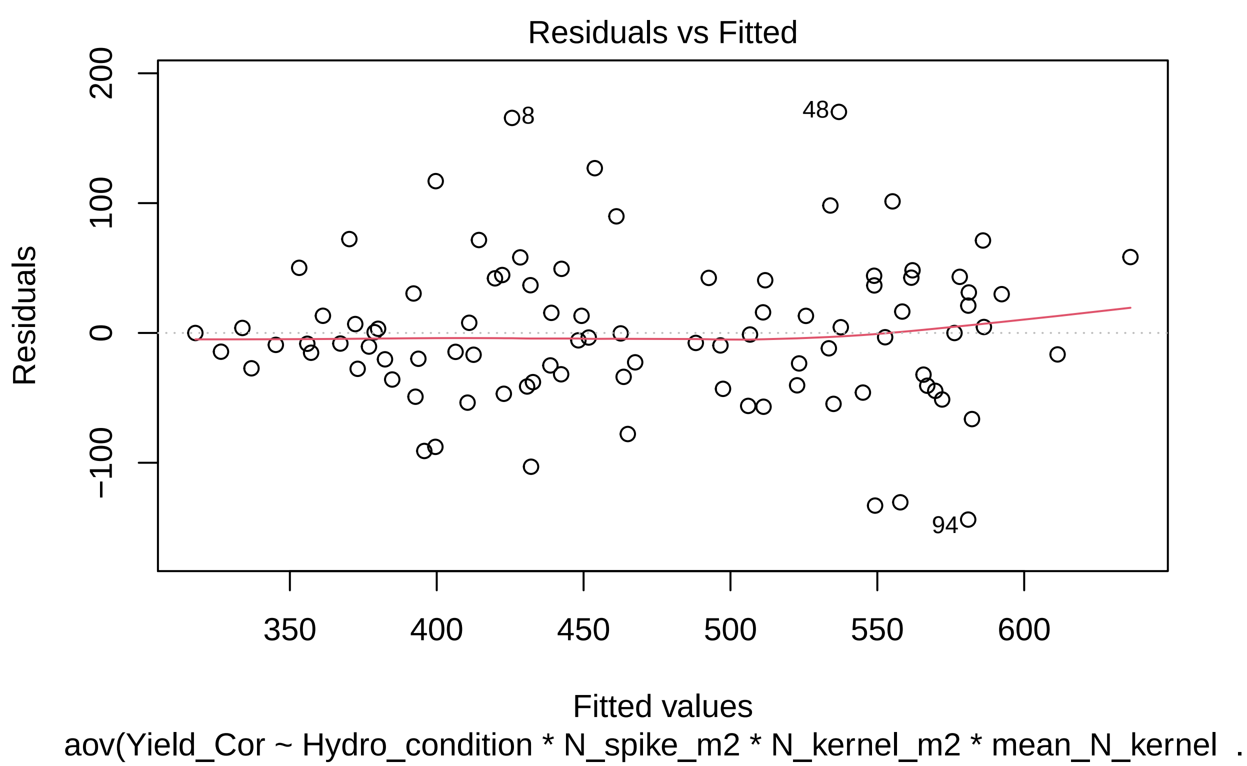
```
#Final model
resfinal<-aov(Yield_Cor ~ Hydro_condition + N_spike_m2 + N_kernel_m2 +
    mean_N_kernel + PMG + Hydro_condition:N_spike_m2 + Hydro_condition:N_kernel_m2 +
    N_spike_m2:N_kernel_m2 + N_spike_m2:mean_N_kernel + N_kernel_m2:mean_N_kernel +
    Hydro_condition:PMG + N_kernel_m2:PMG + Hydro_condition:N_spike_m2:N_kernel_m2 +
    Hydro_condition:N_kernel_m2:PMG, data = data_yield)

summary(resfinal)
```

```
##                                        Df Sum Sq Mean Sq F value   Pr(>F)
## Hydro_condition                         1 378694  378694  90.533 1.09e-14 ***
## N_spike_m2                              1 119069  119069  28.465 9.07e-07 ***
```

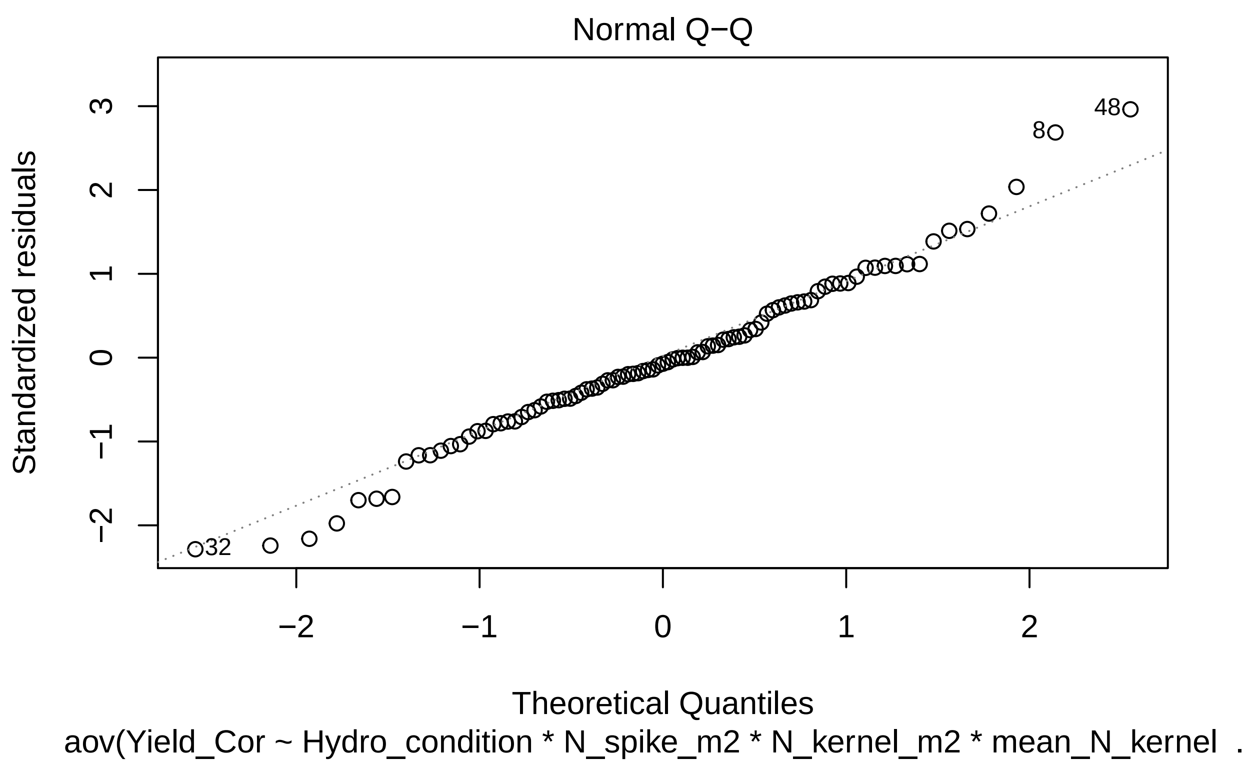
```
## N_kernel_m2                             1   6024    6024   1.440   0.2338
## mean_N_kernel                           1  19356   19356   4.627   0.0346 *
## PMG                                     1   2713    2713   0.649   0.4230
## Hydro_condition:N_spike_m2              1  12624   12624   3.018   0.0863 .
## Hydro_condition:N_kernel_m2             1     12      12   0.003   0.9567
## N_spike_m2:N_kernel_m2                  1    333     333   0.080   0.7786
## N_spike_m2:mean_N_kernel                1   6633    6633   1.586   0.2117
## N_kernel_m2:mean_N_kernel               1   3704    3704   0.885   0.3496
## Hydro_condition:PMG                     1   8211    8211   1.963   0.1652
## N_kernel_m2:PMG                         1    114     114   0.027   0.8693
## Hydro_condition:N_spike_m2:N_kernel_m2  1  12725   12725   3.042   0.0851 .
## Hydro_condition:N_kernel_m2:PMG         1  12759   12759   3.050   0.0847 .
## Residuals                              78 326269    4183
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 2 observations deleted due to missingness
```

The final model is the one that is the most explaining the yield. There is a lot of component but mainly the components that impact the most the yield is the N_spike_m², the hydro_condtion and the mean_N_kernel. the N_kernel_m² was really correlated to the N_spike_m² and the mean_N

```r
#indépendance des residus, elles sont centrées sur 0
plot(anova,1)
```



```r
# normalité des residus
plot(anova,2)
```



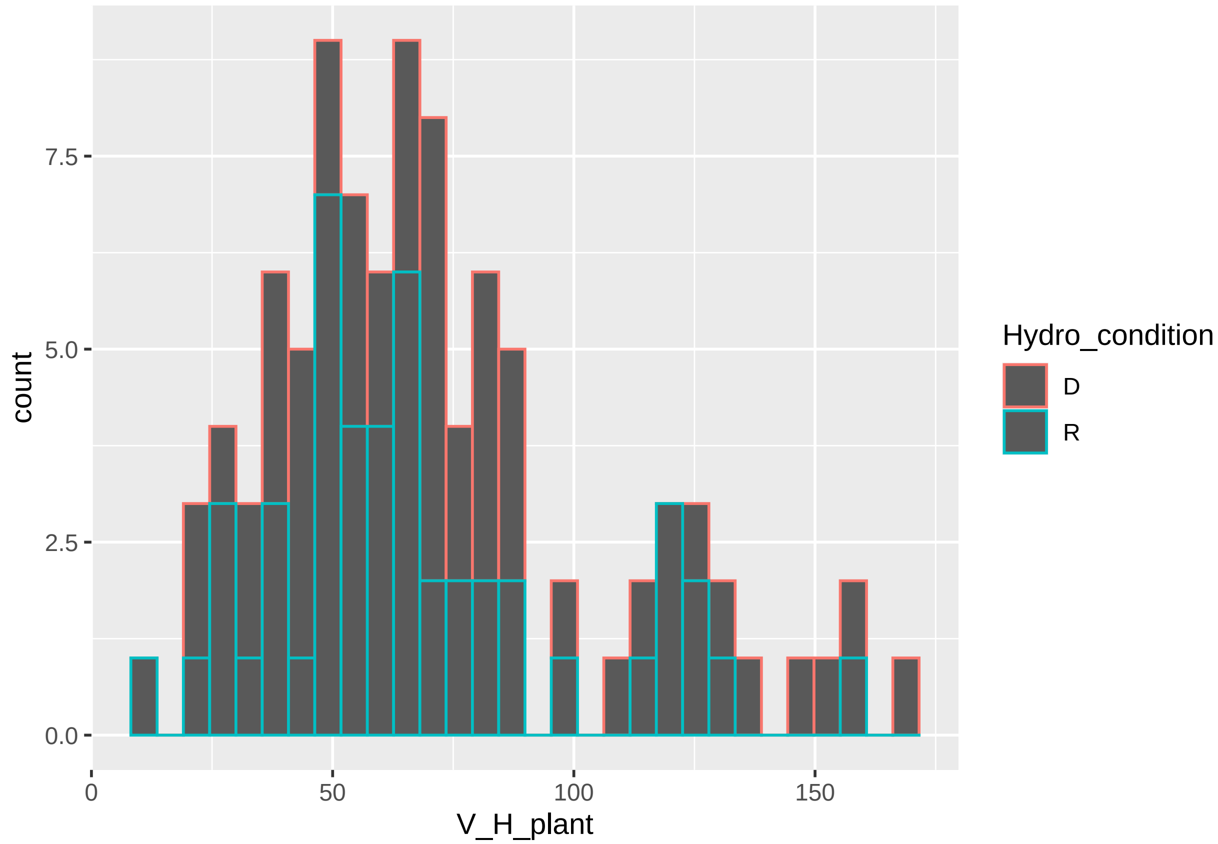
The height analysis

We are in mixture varieties and one of our hypothesis is to analysed if there is an impact of the height on the yield ? and what could be the biological mechanisism that explain this impact? the boxplot revealed a difference in the lenght of the stems but not of the spike between drought and rainy condition.An hypothesis is maybe beyond D condition the density is less due to the reduction of the tillering. So there is no need to use the plant plasticity for height to grow a lot to reach the light.If it is true, we expect that the V(H) in D condition will be lower than in R condition.

What is the variance of the height in each plot?is there small and high plant in each plot, is there a height diversity?

```r
ggplot(data_yield , aes(x=V_H_plant,col=Hydro_condition))+
  geom_histogram()
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



Indeed according to the variance there is a diversity of H among the plot. However it did not differ between D and R.

```r
res(data_yield$mean_L_stem)
```

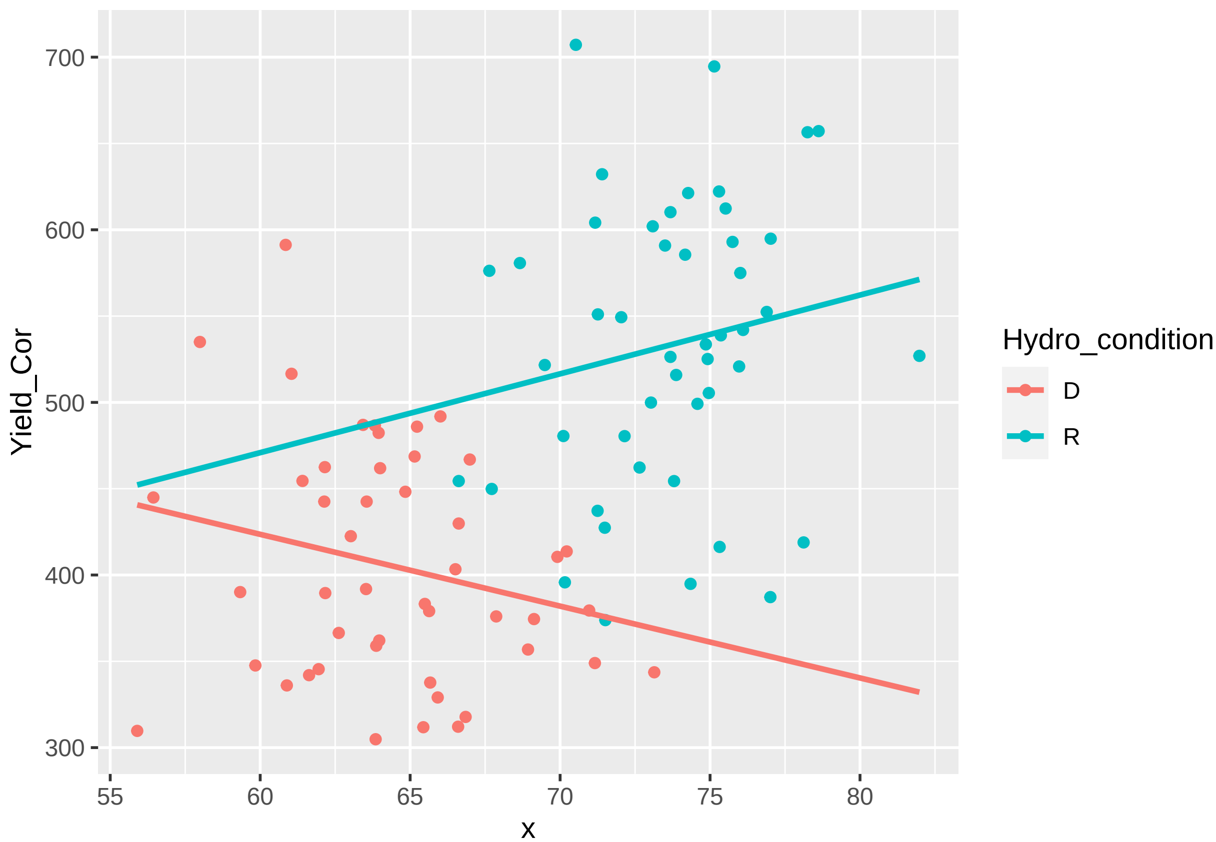
```
##                     Df Sum Sq Mean Sq F value   Pr(>F)    
## Hydro_condition      1 384780  384780  67.825 1.33e-12 ***
## x                    1    311     311   0.055   0.8154    
## Hydro_condition:x    1  19890   19890   3.506   0.0644 .  
## Residuals           90 510580    5673                     
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
```

```r
graph(data_yield$mean_L_stem)
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## Warning: Removed 1 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```



D : the heighier the stem is the less is the yield. That the ressources are given to the vegetative development and not the reproduction. (allocation of ressources) R: the heigher plants are the more productive! Competition? (since it is normally a more dense plot –>more tillers)

To justify this assumption we want to know if the heigher have the more kernel/spike?

```
res(data_yield$mean_H_spike)
```

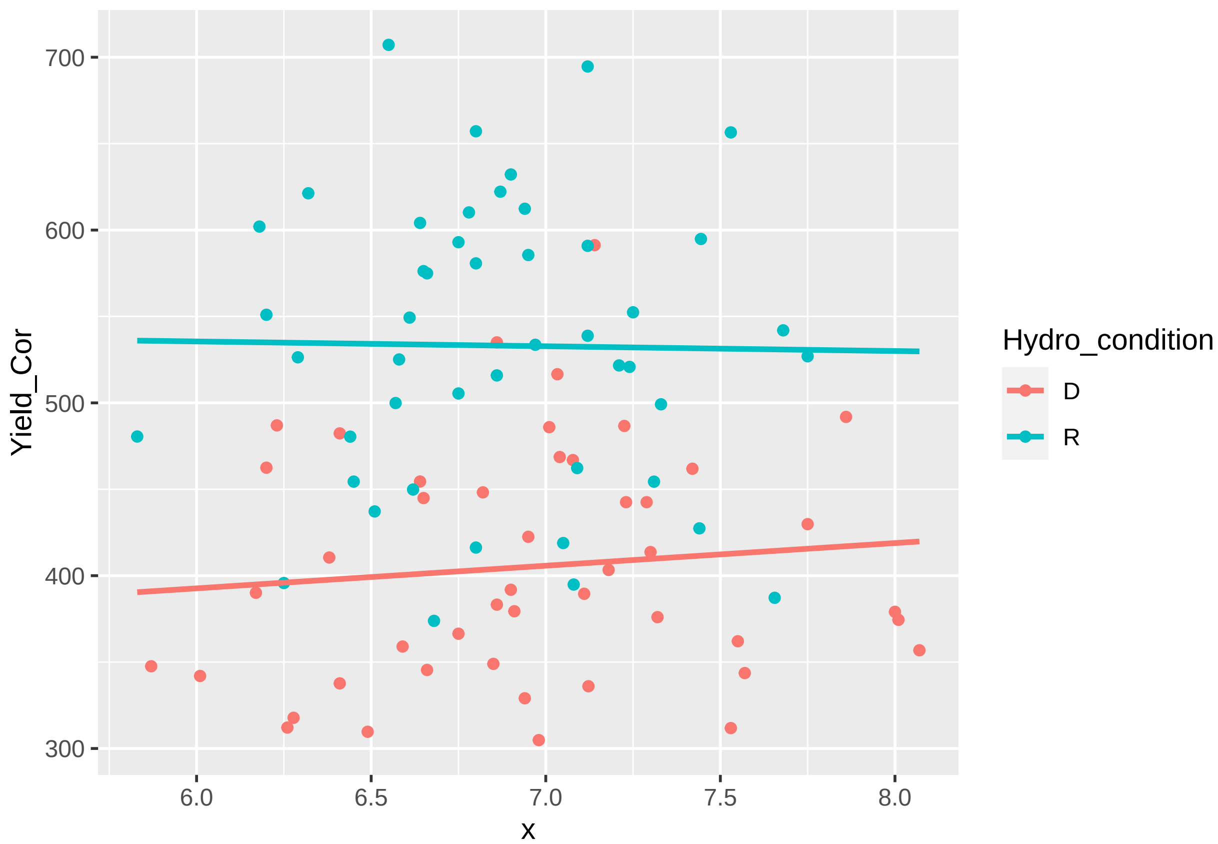
```
##                    Df Sum Sq Mean Sq F value   Pr(>F)    
## Hydro_condition     1 384780  384780  65.532 2.59e-12 ***
## x                   1   1037    1037   0.177    0.675    
## Hydro_condition:x   1   1297    1297   0.221    0.639    
## Residuals          90 528447    5872                     
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
```

```
graph(data_yield$mean_H_spike)
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## Warning: Removed 1 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```



Is the higher plants are the more productive?

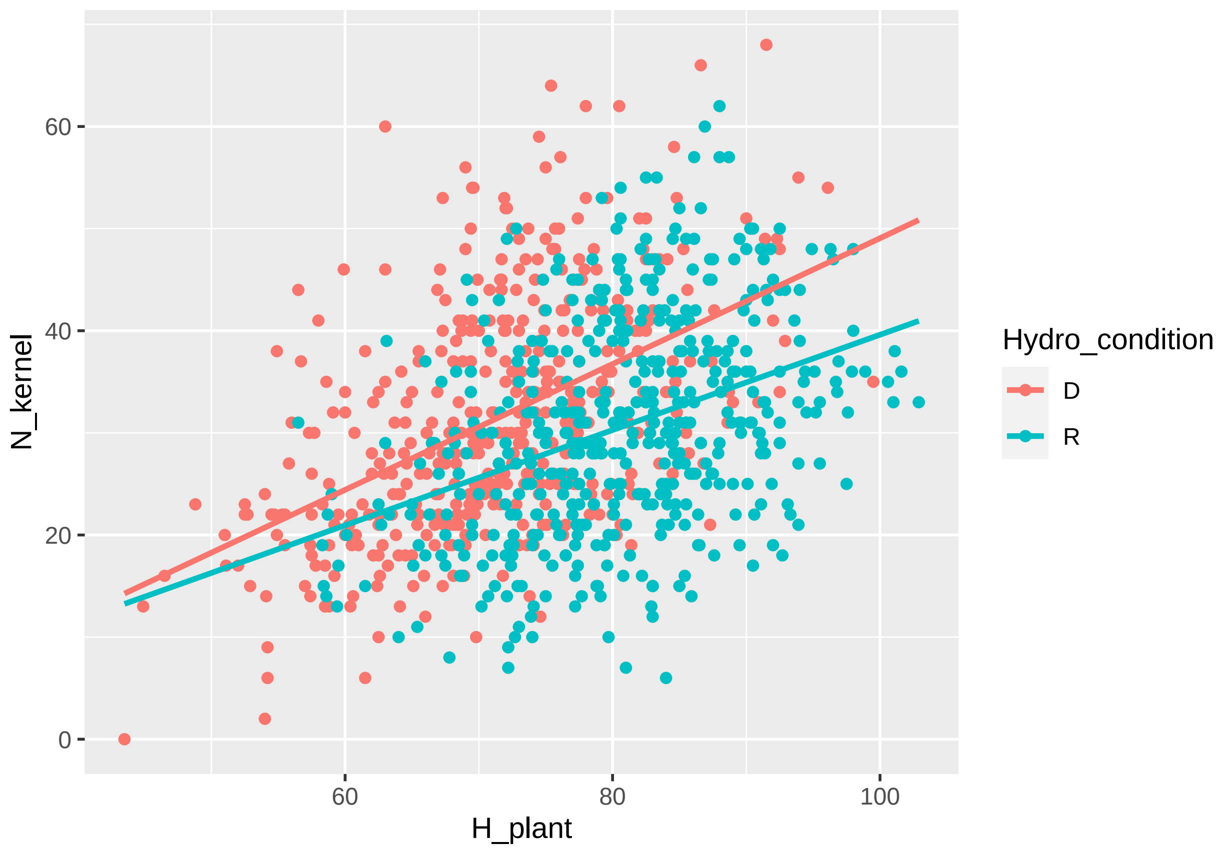
```
data_sample<-read.csv2("~/JRL/jrl/2_Farmer_seeds/2_Yield_data/sample_data/sample_data_outlier.csv")
```

```
res_H<-aov(N_kernel~Hydro_condition*H_plant,data_sample)%>%
  summary

ggplot(data_sample, aes(x=H_plant, y=N_kernel,col=Hydro_condition))+
  geom_point() +
  geom_smooth(method=lm, se=FALSE, fullrange=TRUE)
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## Warning: Removed 11 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 11 rows containing missing values (geom_point).
```



The heigher the plant is the heigher is the N_kernel/spike. However it is the case in both condition so the hypothesis of competition in R condition is not verified (*WHY heigher "pente" in D?*)