FNR 15N

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Contents

Necessary libraries

```
library(knitr)
library(ggplot2)
theme_set(theme_bw())
library(emmeans)
library(multcomp)
library(PLS205)
library(lme4)
library(lmerTest)
library(multcompView)
library(car)
library(Rmisc)
library(dplyr) #https://r4ds.had.co.nz/ (Chapter 3, Chapter 5, look at filter and select)
# https://bookdown.org/ansellbr/WEHI_tidyR_course_book/
library(stringr)
```

```r
library(data.table)
library(GGally)
library(formatR)
library(readxl)
library(mgcv)
```

Data Organisation

Read from excel

```r
FNR <- read_excel("soils_15N_maturity.xlsx", sheet = 1)
str(FNR)
```

```
## tibble [24 x 10] (S3: tbl_df/tbl/data.frame)
##  $ Field                       : chr [1:24] "CR" "CR" "CR" "RF" ...
##  $ Blk                         : chr [1:24] "1" "2" "3" "1" ...
##  $ Topdress                    : chr [1:24] "Y" "Y" "Y" "Y" ...
##  $ DAS                         : chr [1:24] "127" "127" "127" "127" ...
##  $ soil_recovery_fert_N        : num [1:24] 4.98 4.95 4.01 6.25 6.54 ...
##  $ soil_recovery_fert_N_percent: num [1:24] 16.6 16.5 13.4 20.8 21.8 ...
##  $ crop_recovery_fert_N        : num [1:24] 10.23 8.86 9.14 11.52 11.34 ...
##  $ crop_recovery_fert_N_percent: num [1:24] 34.1 29.5 30.5 38.4 37.8 ...
##  $ total_fertN_recovery        : num [1:24] 50.7 46 43.8 59.2 59.6 ...
##  $ Year                        : num [1:24] 2021 2021 2021 2021 2021 ...
```

Clean up variables

```r
FNR <- mutate_if(FNR, is.character, as.factor)
FNR$Blk <- as.factor(FNR$Blk)
FNR$Year <- as.factor(FNR$Year)

str(FNR)
```

```
## tibble [24 x 10] (S3: tbl_df/tbl/data.frame)
##  $ Field                       : Factor w/ 2 levels "CR","RF": 1 1 1 2 2 2 1 1 1 2 ...
##  $ Blk                         : Factor w/ 6 levels "1","2","3","4",..: 1 2 3 1 2 3 1 2 3 1 ...
##  $ Topdress                    : Factor w/ 2 levels "N","Y": 2 2 2 2 2 2 1 1 1 1 ...
##  $ DAS                         : Factor w/ 1 level "127": 1 1 1 1 1 1 1 1 1 1 ...
##  $ soil_recovery_fert_N        : num [1:24] 4.98 4.95 4.01 6.25 6.54 ...
##  $ soil_recovery_fert_N_percent: num [1:24] 16.6 16.5 13.4 20.8 21.8 ...
##  $ crop_recovery_fert_N        : num [1:24] 10.23 8.86 9.14 11.52 11.34 ...
##  $ crop_recovery_fert_N_percent: num [1:24] 34.1 29.5 30.5 38.4 37.8 ...
##  $ total_fertN_recovery        : num [1:24] 50.7 46 43.8 59.2 59.6 ...
##  $ Year                        : Factor w/ 2 levels "2021","2022": 1 1 1 1 1 1 1 1 1 1 ...
```

Sub dataset for "preplant" and "topdress"

```
preplant <- FNR %>% filter(Topdress == "N")
str(preplant)
```

```
## tibble [12 x 10] (S3: tbl_df/tbl/data.frame)
##  $ Field                      : Factor w/ 2 levels "CR","RF": 1 1 1 2 2 2 1 1 1 2 ...
##  $ Blk                        : Factor w/ 6 levels "1","2","3","4",..: 1 2 3 1 2 3 4 5 6 4 ...
##  $ Topdress                   : Factor w/ 2 levels "N","Y": 1 1 1 1 1 1 1 1 1 1 ...
##  $ DAS                        : Factor w/ 1 level "127": 1 1 1 1 1 1 1 1 1 1 ...
##  $ soil_recovery_fert_N       : num [1:12] 31.2 23.5 24.2 34 39.1 ...
##  $ soil_recovery_fert_N_percent: num [1:12] 20.8 15.7 16.1 22.7 26.1 ...
##  $ crop_recovery_fert_N       : num [1:12] 58.1 42.5 49.4 56.1 50.6 ...
##  $ crop_recovery_fert_N_percent: num [1:12] 38.7 28.4 32.9 37.4 33.8 ...
##  $ total_fertN_recovery       : num [1:12] 59.5 44 49 60.1 59.8 ...
##  $ Year                       : Factor w/ 2 levels "2021","2022": 1 1 1 1 1 1 2 2 2 2 ...
```

```
topdress <- FNR %>% filter(Topdress == "Y")
str(topdress)
```

```
## tibble [12 x 10] (S3: tbl_df/tbl/data.frame)
##  $ Field                      : Factor w/ 2 levels "CR","RF": 1 1 1 2 2 2 1 1 1 2 ...
##  $ Blk                        : Factor w/ 6 levels "1","2","3","4",..: 1 2 3 1 2 3 4 5 6 4 ...
##  $ Topdress                   : Factor w/ 2 levels "N","Y": 2 2 2 2 2 2 2 2 2 2 ...
##  $ DAS                        : Factor w/ 1 level "127": 1 1 1 1 1 1 1 1 1 1 ...
##  $ soil_recovery_fert_N       : num [1:12] 4.98 4.95 4.01 6.25 6.54 ...
##  $ soil_recovery_fert_N_percent: num [1:12] 16.6 16.5 13.4 20.8 21.8 ...
##  $ crop_recovery_fert_N       : num [1:12] 10.23 8.86 9.14 11.52 11.34 ...
##  $ crop_recovery_fert_N_percent: num [1:12] 34.1 29.5 30.5 38.4 37.8 ...
##  $ total_fertN_recovery       : num [1:12] 50.7 46 43.8 59.2 59.6 ...
##  $ Year                       : Factor w/ 2 levels "2021","2022": 1 1 1 1 1 1 2 2 2 2 ...
```

Preplant FNR

Continuous Rice

```
preplant_CR <- preplant %>% filter(Field == "CR")
mean(preplant_CR$crop_recovery_fert_N_percent)
```

```
## [1] 28.9668
```

```
mean(preplant_CR$soil_recovery_fert_N_percent)
```

```
## [1] 22.07258
```

```r
mean(preplant_CR$total_fertN_recovery)
```

```
## [1] 51.03938
```

Fallow Rice

```r
preplant_RF <- preplant %>% filter(Field == "RF")
mean(preplant_RF$crop_recovery_fert_N_percent)
```

```
## [1] 30.66233
```

```r
mean(preplant_RF$soil_recovery_fert_N_percent)
```

```
## [1] 25.50177
```

```r
mean(preplant_RF$total_fertN_recovery)
```

```
## [1] 56.1641
```

Testing for preplant

```r
preplant_model <- lmer(total_fertN_recovery~Field*Year+(1|Blk), data = preplant)
```

```
## boundary (singular) fit: see help('isSingular')
```

```r
anova(preplant_model)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##            Sum Sq Mean Sq NumDF DenDF F value Pr(>F)
## Field      78.789  78.789     1     8  1.9903 0.1960
## Year       25.255  25.255     1     8  0.6380 0.4475
## Field:Year 32.178  32.178     1     8  0.8129 0.3936
```

```r
preplant_means <- emmeans(preplant_model, spec ='Field')
```

```
## NOTE: Results may be misleading due to involvement in interactions
```

```r
preplant_effects <- contrast(preplant_means, method = 'pairwise', adjust = "tukey")
cld(preplant_means)
```

```
##  Field emmean   SE df lower.CL upper.CL .group
##  CR      51.0 2.57  8     45.1     57.0  1
##  RF      56.2 2.57  8     50.2     62.1  1
##
```

```
## Results are averaged over the levels of: Year
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
## significance level used: alpha = 0.05
## NOTE: If two or more means share the same grouping symbol,
##       then we cannot show them to be different.
##       But we also did not show them to be the same.
```

```
summary(preplant_effects)
```

```
##  contrast estimate   SE df t.ratio p.value
##  CR - RF     -5.12 3.63  4  -1.411  0.2311
##
## Results are averaged over the levels of: Year
## Degrees-of-freedom method: kenward-roger
```

Topdress FNR

Continuous Rice

```
topdress_CR <- topdress %>% filter(Field == "CR")
mean(topdress_CR$crop_recovery_fert_N_percent)
```

```
## [1] 28.24514
```

```
mean(topdress_CR$soil_recovery_fert_N_percent)
```

```
## [1] 17.63424
```

```
mean(topdress_CR$total_fertN_recovery)
```

```
## [1] 45.87937
```

Fallow Rice

```
topdress_RF <- topdress %>% filter(Field == "RF")
mean(topdress_RF$crop_recovery_fert_N_percent)
```

```
## [1] 37.62093
```

```
mean(topdress_RF$soil_recovery_fert_N_percent)
```

```
## [1] 20.49374
```

```r
mean(topdress_RF$total_fertN_recovery)
```

```
## [1] 58.11467
```

Testing for topdress

```r
topdress_model <- lmer(total_fertN_recovery~Field*Year+(1|Blk), data = topdress)

anova(topdress_model)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##            Sum Sq Mean Sq NumDF DenDF F value  Pr(>F)
## Field      449.11  449.11     1     4  9.7585 0.03539 *
## Year        44.61   44.61     1     4  0.9694 0.38058
## Field:Year 176.03  176.03     1     4  3.8249 0.12215
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
topdress_means <- emmeans(topdress_model, spec ='Field')
```

```
## NOTE: Results may be misleading due to involvement in interactions
```

```r
topdress_effects <- contrast(topdress_means, method = 'pairwise', adjust = "tukey")
cld(topdress_means)
```

```
##  Field emmean   SE   df lower.CL upper.CL .group
##  CR      45.9 3.51 7.01     37.6     54.2  1
##  RF      58.1 3.51 7.01     49.8     66.4   2
##
## Results are averaged over the levels of: Year
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
## significance level used: alpha = 0.05
## NOTE: If two or more means share the same grouping symbol,
##       then we cannot show them to be different.
##       But we also did not show them to be the same.
```

```r
summary(topdress_effects)
```

```
##  contrast estimate   SE df t.ratio p.value
##  CR - RF     -12.2 3.92  4  -3.124  0.0354
##
## Results are averaged over the levels of: Year
## Degrees-of-freedom method: kenward-roger
```