# Plant Population \_Poukawa

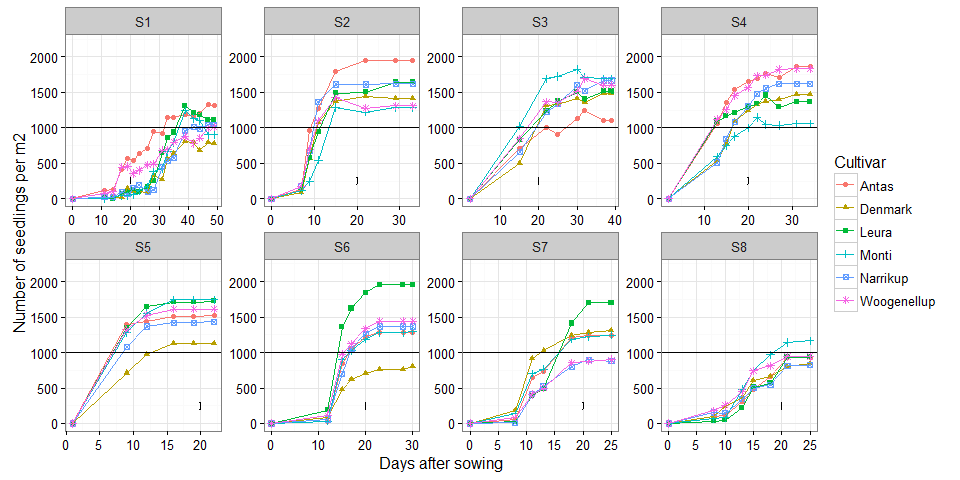
CT, March 11, 2016

Purpose:

-Analysis of plant population – Poukawa site (variable “**Final Pop**” seedlings per 1 sq meter)

- Design : Six cultivars, 3 block/reps, 8 sowing dates

# define factors   
df\_emerg$ Cultivar <- as.factor(df\_emerg$Cultivar)  
df\_emerg$Block <- as.factor(df\_emerg$Block)  
  
 df\_emerg <- df\_emerg %>%  
 mutate(SowingDate = dmy(SowingDate),   
 ReadingDate = dmy(ReadingDate),  
 PlantPop = (Sub1+Sub2+Sub3)/3/0.01)  
  
#Graph it   
## logical: returning NA

  
  
df\_emerg\_perc3 <- df\_emerg %>%  
group\_by(Plot) %>%  
mutate(**FinalPop**= round(max(PlantPop)\*1,digits=2))  
  
head(df\_emerg\_perc3)

summary (df\_emerg\_perc3)

## SowTreat **Cultivar** **Block**  Plot   
## S1 :306 Antas :216 1:432 1 : 17   
## S4 :180 Denmark :216 2:432 2 : 17   
## S2 :144 Leura :216 3:432 3 : 17   
## S3 :144 Monti :216 4 : 17   
## S6 :144 Narrikup :216 5 : 17   
## S8 :144 Woogenellup:216 6 : 17   
## (Other):234 (Other):1194   
## SowingDate ReadingDate DAS   
## Min. :2016-02-19 Min. :2016-02-19 Min. : 0.00   
## 1st Qu.:2016-03-30 1st Qu.:2016-04-07 1st Qu.:12.00   
## Median :2016-07-05 Median :2016-07-21 Median :19.50   
## Mean :2016-07-07 Mean :2016-07-27 Mean :20.03   
## 3rd Qu.:2016-10-11 3rd Qu.:2016-10-31 3rd Qu.:28.00   
## Max. :2017-01-05 Max. :2017-01-30 Max. :49.00   
##   
## Sub1 Sub2 Sub3 PlantPop   
## Min. : 0.000 Min. : 0.000 Min. : 0.000 Min. : 0.0   
## 1st Qu.: 1.000 1st Qu.: 2.000 1st Qu.: 2.000 1st Qu.: 166.7   
## Median : 8.000 Median : 7.000 Median : 8.000 Median : 866.7   
## Mean : 8.755 Mean : 8.155 Mean : 8.628 Mean : 851.3   
## 3rd Qu.:14.000 3rd Qu.:13.000 3rd Qu.:14.000 3rd Qu.:1366.7   
## Max. :25.000 Max. :25.000 Max. :25.000 Max. :2466.7   
##   
## **FinalPop**   
## Min. : 233.3   
## 1st Qu.: 966.7   
## Median :1366.7   
## Mean :1353.9   
## 3rd Qu.:1633.3   
## Max. :2466.7   
##

write.table(df\_emerg\_perc3, "df\_emerg\_perc3.txt")

then select each sowing date individually

# ANOVAS

-with pure numbers;

- stats for each sowing date as a unique experiment;

-Multiple comparisons using Fisher’s unprotected LSD test ( Saville, 2015).

## Sowing Date 1

df\_emerg\_S1 <-df\_emerg\_perc3 %>%  
filter(SowTreat=="S1")   
summary (df\_emerg\_S1)   
##   
## Sub3 PlantPop **FinalPop** transf\_no   
## Min. : 0.000 Min. : 0.00 Min. : 800 Min. : 800   
## 1st Qu.: 0.000 1st Qu.: 66.67 1st Qu.: 900 1st Qu.: 900   
## Median : 4.000 Median : 433.33 Median :1000 Median :1000   
## Mean : 5.222 Mean : 525.27 Mean :1165 Mean :1165   
## 3rd Qu.: 8.000 3rd Qu.: 833.33 3rd Qu.:1433 3rd Qu.:1433   
## Max. :25.000 Max. :1800.00 Max. :1800 Max. :1800   
##

summary(my.anova)

## Df Sum Sq Mean Sq F value Pr(>F)   
## Cultivar 5 9109693 1821939 58.4 <2e-16 \*\*\*  
## Block 2 12323921 6161961 197.5 <2e-16 \*\*\*  
## Residuals 298 9297573 31200   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#Means separation   
(LSD.test(my.anova, c("Cultivar"), alpha= 0.05, p.adj="none") )

## $statistics  
## Mean CV MSerror LSD  
## 1164.814 15.16422 31199.91 68.83702  
##   
## $parameters  
## Df ntr t.value alpha test name.t  
## 298 6 1.967957 0.05 Fisher-LSD Cultivar  
##   
## $means  
## transf\_no std r LCL UCL Min Max  
## Antas 1400.000 344.41423 51 1351.3249 1448.6751 966.67 1800.00  
## Denmark 900.000 82.46211 51 851.3249 948.6751 800.00 1000.00  
## Leura 1311.110 301.52652 51 1262.4349 1359.7851 900.00 1600.00  
## Monti 1244.443 280.76458 51 1195.7682 1293.1185 1000.00 1633.33  
## Narrikup 1122.220 269.78888 51 1073.5449 1170.8951 933.33 1500.00  
## Woogenellup 1011.110 253.92063 51 962.4349 1059.7851 833.33 1366.67  
##   
## $comparison  
## NULL  
##   
## $groups  
**## trt means M  
## 1 Antas 1400.000 a  
## 2 Leura 1311.110 b  
## 3 Monti 1244.443 b  
## 4 Narrikup 1122.220 c  
## 5 Woogenellup 1011.110 d  
## 6 Denmark 900.000 e**

## Sowing Date 2

df\_emerg\_S1 <-df\_emerg\_perc3 %>%  
filter(SowTreat=="S2")   
   
## Sub3 PlantPop **FinalPop**   
## Min. : 0.00 Min. : 0.0 Min. :1200   
## 1st Qu.: 3.00 1st Qu.: 258.3 1st Qu.:1433   
## Median :12.00 Median :1166.7 Median :1567   
## Mean :11.36 Mean : 985.9 Mean :1617   
## 3rd Qu.:18.00 3rd Qu.:1466.7 3rd Qu.:1733   
## Max. :25.00 Max. :2333.3 Max. :2333   
summary(my.anova)

## Df Sum Sq Mean Sq F value Pr(>F)   
## Cultivar 5 5717018 1143404 36.52 < 2e-16 \*\*\*  
## Block 2 856276 428138 13.68 3.88e-06 \*\*\*  
## Residuals 136 4257765 31307   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#Means separation   
(LSD.test(my.anova, c("Cultivar"), alpha= 0.05, p.adj="none") )

## $statistics  
## Mean CV MSerror LSD  
## 1616.667 10.94463 31307.1 101.0091  
##   
## $parameters  
## Df ntr t.value alpha test name.t  
## 136 6 1.977561 0.05 Fisher-LSD Cultivar  
## $means  
## transf\_no std r LCL UCL Min Max  
## Antas 1977.777 262.77253 24 1906.352 2049.201 1733.33 2333.33  
## Denmark 1466.670 144.46302 24 1395.246 1538.094 1266.67 1566.67  
## Leura 1644.447 256.82155 24 1573.022 1715.871 1466.67 2000.00  
## Monti 1411.110 57.87654 24 1339.686 1482.534 1333.33 1466.67  
## Narrikup 1744.443 115.74974 24 1673.019 1815.868 1633.33 1900.00  
## Woogenellup 1455.553 222.99250 24 1384.129 1526.978 1200.00 1733.33  
##   
## $comparison  
## NULL  
##   
## $groups  
**## trt means M  
## 1 Antas 1977.777 a  
## 2 Narrikup 1744.443 b  
## 3 Leura 1644.447 b  
## 4 Denmark 1466.670 c  
## 5 Woogenellup 1455.553 c  
## 6 Monti 1411.110 c**

## Sowing Date 3

df\_emerg\_S1 <-df\_emerg\_perc3 %>%  
filter(SowTreat=="S3")

##   
## Sub3 PlantPop **FinalPop** transf\_no   
## Min. : 0.00 Min. : 0.0 Min. : 900 Min. : 900   
## 1st Qu.: 5.00 1st Qu.: 858.3 1st Qu.:1433 1st Qu.:1433   
## Median :12.00 Median :1300.0 Median :1683 Median :1683   
## Mean :11.67 Mean :1175.7 Mean :1606 Mean :1606   
## 3rd Qu.:17.00 3rd Qu.:1641.7 3rd Qu.:1867 3rd Qu.:1867   
## Max. :25.00 Max. :2400.0 Max. :2400 Max. :2400   
##

my.anova <- aov(transf\_no ~ Cultivar + Block,   
 data = file.subset)  
  
summary(my.anova)

## Df Sum Sq Mean Sq F value Pr(>F)   
## Cultivar 5 4721471 944294 7.758 1.9e-06 \*\*\*  
## Block 2 719984 359992 2.957 0.0553 .   
## Residuals 136 16554169 121722   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#Means separation   
(LSD.test(my.anova, c("Cultivar"), alpha= 0.05, p.adj="none") )

## $statistics  
## Mean CV MSerror LSD  
## 1605.556 21.72996 121721.8 199.1698  
##   
## $parameters  
## Df ntr t.value alpha test name.t  
## 136 6 1.977561 0.05 Fisher-LSD Cultivar  
##   
## $means  
## transf\_no std r LCL UCL Min Max  
## Antas 1255.557 443.38197 24 1114.722 1396.391 900.00 1866.67  
## Denmark 1511.110 656.93427 24 1370.276 1651.944 900.00 2400.00  
## Leura 1655.557 84.93688 24 1514.722 1796.391 1566.67 1766.67  
## Monti 1822.223 64.20900 24 1681.389 1963.058 1733.33 1866.67  
## Narrikup 1688.890 272.87621 24 1548.056 1829.724 1500.00 2066.67  
## Woogenellup 1699.997 192.61736 24 1559.162 1840.831 1433.33 1833.33  
##   
## $comparison  
## NULL  
##   
## $groups  
**## trt means M  
## 1 Monti 1822.223 a  
## 2 Woogenellup 1699.997 ab  
## 3 Narrikup 1688.890 ab  
## 4 Leura 1655.557 ab  
## 5 Denmark 1511.110 b  
## 6 Antas 1255.557 c**

## Sowing Date 4

df\_emerg\_S1 <-df\_emerg\_perc3 %>%  
filter(SowTreat=="S4")

## Sub3 PlantPop **FinalPop** transf\_no   
## Min. : 0.00 Min. : 0.0 Min. : 666.7 Min. : 666.7   
## 1st Qu.: 8.00 1st Qu.: 866.7 1st Qu.:1233.3 1st Qu.:1233.3   
## Median :12.50 Median :1233.3 Median :1583.3 Median :1583.3   
## Mean :11.94 Mean :1188.7 Mean :1577.8 Mean :1577.8   
## 3rd Qu.:17.00 3rd Qu.:1633.3 3rd Qu.:1933.3 3rd Qu.:1933.3   
## Max. :25.00 Max. :2466.7 Max. :2466.7 Max. :2466.7   
##

my.anova <- aov(transf\_no ~ Cultivar + Block,   
 data = file.subset)  
  
summary(my.anova)

## Df Sum Sq Mean Sq F value Pr(>F)   
## Cultivar 5 10437101 2087420 17.41 6.29e-14 \*\*\*  
## Block 2 7470284 3735142 31.15 2.86e-12 \*\*\*  
## Residuals 172 20626042 119919   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#Means separation   
(LSD.test(my.anova, c("Cultivar"), alpha= 0.05, p.adj="none") )

## $statistics  
## Mean CV MSerror LSD  
## 1577.778 21.94814 119918.8 176.487  
##   
## $parameters  
## Df ntr t.value alpha test name.t  
## 172 6 1.973852 0.05 Fisher-LSD Cultivar  
##   
## $means  
## transf\_no std r LCL UCL Min Max  
## Antas 1866.670 462.37766 30 1741.875 1991.465 1266.67 2366.67  
## Denmark 1466.667 199.61726 30 1341.872 1591.462 1200.00 1666.67  
## Leura 1455.557 444.92426 30 1330.762 1580.352 1066.67 2066.67  
## Monti 1177.777 403.36731 30 1052.982 1302.572 666.67 1633.33  
## Narrikup 1655.557 591.34010 30 1530.762 1780.352 1133.33 2466.67  
## Woogenellup 1844.443 69.66184 30 1719.648 1969.238 1766.67 1933.33  
##   
## $comparison  
## NULL  
##   
## **$groups  
## trt means M  
## 1 Antas 1866.670 a  
## 2 Woogenellup 1844.443 a  
## 3 Narrikup 1655.557 b  
## 4 Denmark 1466.667 c  
## 5 Leura 1455.557 c  
## 6 Monti 1177.777 d**

## Sowing Date 5

df\_emerg\_S1 <-df\_emerg\_perc3 %>%  
filter(SowTreat=="S5")

## Sub3 PlantPop **FinalPop** transf\_no   
## Min. : 0.00 Min. : 0.0 Min. : 666.7 Min. : 666.7   
## 1st Qu.: 7.00 1st Qu.: 966.7 1st Qu.:1366.7 1st Qu.:1366.7   
## Median :12.00 Median :1383.3 Median :1500.0 Median :1500.0   
## Mean :10.98 Mean :1195.4 Mean :1531.5 Mean :1531.5   
## 3rd Qu.:16.25 3rd Qu.:1533.3 3rd Qu.:1766.7 3rd Qu.:1766.7   
## Max. :23.00 Max. :2200.0 Max. :2200.0 Max. :2200.0   
##

my.anova <- aov(transf\_no ~ Cultivar + Block,   
 data = file.subset)  
  
summary(my.anova)

## Df Sum Sq Mean Sq F value Pr(>F)   
## Cultivar 5 4575146 915029 10.145 7.03e-08 \*\*\*  
## Block 2 438514 219257 2.431 0.0931   
## Residuals 100 9019249 90192   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#Means separation   
(LSD.test(my.anova, c("Cultivar"), alpha= 0.05, p.adj="none") )

## $statistics  
## Mean CV MSerror LSD  
## 1531.482 19.6098 90192.49 198.6092  
##   
## $parameters  
## Df ntr t.value alpha test name.t  
## 100 6 1.983972 0.05 Fisher-LSD Cultivar  
##   
## $means  
## transf\_no std r LCL UCL Min Max  
## Antas 1533.333 196.0388 18 1392.8954 1673.771 1366.67 1800.00  
## Denmark 1133.337 477.7398 18 992.8988 1273.775 666.67 1766.67  
## Leura 1722.223 347.9154 18 1581.7854 1862.661 1466.67 2200.00  
## Monti 1744.443 217.5314 18 1604.0054 1884.881 1533.33 2033.33  
## Narrikup 1444.443 106.0265 18 1304.0054 1584.881 1300.00 1533.33  
## Woogenellup 1611.113 331.7617 18 1470.6754 1751.551 1366.67 2066.67  
##   
## $comparison  
## NULL  
##   
## $groups  
## trt means M  
## **1 Monti 1744.443 a  
## 2 Leura 1722.223 ab  
## 3 Woogenellup 1611.113 abc  
## 4 Antas 1533.333 bc  
## 5 Narrikup 1444.443 c  
## 6 Denmark 1133.337 d**

## Sowing Date 6

df\_emerg\_S1 <-df\_emerg\_perc3 %>%  
filter(SowTreat=="S6")   
## Sub3 PlantPop **FinalPop** transf\_no   
## Min. : 0.000 Min. : 0.0 Min. : 766.7 Min. : 766.7   
## 1st Qu.: 3.000 1st Qu.: 400.0 1st Qu.: 966.7 1st Qu.: 966.7   
## Median :10.000 Median : 933.3 Median :1300.0 Median :1300.0   
## Mean : 9.417 Mean : 920.4 Mean :1359.3 Mean :1359.3   
## 3rd Qu.:14.000 3rd Qu.:1416.7 3rd Qu.:1700.0 3rd Qu.:1700.0   
## Max. :25.000 Max. :2300.0 Max. :2300.0 Max. :2300.0   
##

my.anova <- aov(transf\_no ~ Cultivar + Block,   
 data = file.subset)  
  
summary(my.anova)

## Df Sum Sq Mean Sq F value Pr(>F)   
## Cultivar 5 16418694 3283739 147.5 <2e-16 \*\*\*  
## Block 2 6626188 3313094 148.8 <2e-16 \*\*\*  
## Residuals 136 3027145 22258   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#Means separation   
(LSD.test(my.anova, c("Cultivar"), alpha= 0.05, p.adj="none") )

## $statistics  
## Mean CV MSerror LSD  
## 1359.259 10.97602 22258.42 85.16995  
##   
## $parameters  
## Df ntr t.value alpha test name.t  
## 136 6 1.977561 0.05 Fisher-LSD Cultivar  
##   
## $means  
## transf\_no std r LCL UCL Min Max  
## Antas 1288.890 294.66584 24 1228.6658 1349.1142 966.67 1666.67  
## Denmark 800.000 27.79914 24 739.7758 860.2242 766.67 833.33  
## Leura 1955.553 278.48363 24 1895.3291 2015.7776 1633.33 2300.00  
## Monti 1300.000 320.62536 24 1239.7758 1360.2242 1000.00 1733.33  
## Narrikup 1366.667 327.78171 24 1306.4424 1426.8909 933.33 1700.00  
## Woogenellup 1444.443 210.51080 24 1384.2191 1504.6676 1266.67 1733.33  
##   
## $comparison  
## NULL  
##   
## $groups  
**## trt means M  
## 1 Leura 1955.553 a  
## 2 Woogenellup 1444.443 b  
## 3 Narrikup 1366.667 bc  
## 4 Monti 1300.000 c  
## 5 Antas 1288.890 c  
## 6 Denmark 800.000 d**

## Sowing Date 7

df\_emerg\_S1 <-df\_emerg\_perc3 %>%  
filter(SowTreat=="S7")

##   
## Sub3 PlantPop **FinalPop** transf\_no   
## Min. : 0.000 Min. : 0.0 Min. : 666.7 Min. : 666.7   
## 1st Qu.: 1.000 1st Qu.: 141.7 1st Qu.: 866.7 1st Qu.: 866.7   
## Median : 6.500 Median : 700.0 Median :1100.0 Median :1100.0   
## Mean : 6.897 Mean : 695.8 Mean :1216.7 Mean :1216.7   
## 3rd Qu.:11.000 3rd Qu.:1066.7 3rd Qu.:1500.0 3rd Qu.:1500.0   
## Max. :25.000 Max. :2333.3 Max. :2333.3 Max. :2333.3   
##

my.anova <- aov(transf\_no ~ Cultivar + Block,   
 data = file.subset)  
  
summary(my.anova)

## Df Sum Sq Mean Sq F value Pr(>F)   
## Cultivar 5 9337130 1867426 18.89 9.19e-14 \*\*\*  
## Block 2 2118113 1059056 10.71 5.30e-05 \*\*\*  
## Residuals 118 11663990 98847   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#Means separation   
(LSD.test(my.anova, c("Cultivar"), alpha= 0.05, p.adj="none") )

## $statistics  
## Mean CV MSerror LSD  
## 1216.668 25.84107 98847.37 192.1378  
##   
## $parameters  
## Df ntr t.value alpha test name.t  
## 118 6 1.980272 0.05 Fisher-LSD Cultivar  
##   
## $means  
## transf\_no std r LCL UCL Min Max  
## Antas 1244.4467 279.3500 21 1108.5847 1380.309 866.67 1500.00  
## Denmark 1311.1100 545.3144 21 1175.2481 1446.972 766.67 2033.33  
## Leura 1700.0000 469.1574 21 1564.1381 1835.862 1266.67 2333.33  
## Monti 1244.4433 216.6231 21 1108.5814 1380.305 1033.33 1533.33  
## Narrikup 900.0033 127.8019 21 764.1414 1035.865 766.67 1066.67  
## Woogenellup 900.0033 174.1647 21 764.1414 1035.865 666.67 1066.67  
##   
## $comparison  
## NULL  
##   
## $groups  
**## trt means M  
## 1 Leura 1700.0000 a  
## 2 Denmark 1311.1100 b  
## 3 Antas 1244.4467 b  
## 4 Monti 1244.4433 b  
## 5 Narrikup 900.0033 c  
## 6 Woogenellup 900.0033 c**

## Sowing Date 8

df\_emerg\_S1 <-df\_emerg\_perc3 %>%  
filter(SowTreat=="S8")

## Sub3 PlantPop  **FinalPop** transf\_no   
## Min. : 0.00 Min. : 0.00 Min. : 233.3 Min. : 233.3   
## 1st Qu.: 0.00 1st Qu.: 66.67 1st Qu.: 833.3 1st Qu.: 833.3   
## Median : 3.00 Median : 416.67 Median : 966.7 Median : 966.7   
## Mean : 4.91 Mean : 472.22 Mean : 942.6 Mean : 942.6   
## 3rd Qu.: 7.25 3rd Qu.: 833.33 3rd Qu.:1066.7 3rd Qu.:1066.7   
## Max. :24.00 Max. :1433.33 Max. :1433.3 Max. :1433.3   
##

my.anova <- aov(transf\_no ~ Cultivar + Block,   
 data = file.subset)  
  
summary(my.anova)

## Df Sum Sq Mean Sq F value Pr(>F)   
## Cultivar 5 1738767 347753 5.258 0.00019 \*\*\*  
## Block 2 2223180 1111590 16.807 3e-07 \*\*\*  
## Residuals 136 8994637 66137   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#Means separation   
(LSD.test(my.anova, c("Cultivar"), alpha= 0.05, p.adj="none") )

## $statistics  
## Mean CV MSerror LSD  
## 942.5933 27.28337 66137.03 146.812  
##   
## $parameters  
## Df ntr t.value alpha test name.t  
## 136 6 1.977561 0.05 Fisher-LSD Cultivar  
##   
## $means  
## transf\_no std r LCL UCL Min Max  
## Antas 933.3367 127.40441 24 829.5249 1037.1484 766.67 1066.67  
## Denmark 855.5533 489.76774 24 751.7416 959.3651 233.33 1400.00  
## Leura 933.3333 73.55907 24 829.5216 1037.1451 833.33 1000.00  
## Monti 1166.6667 194.61127 24 1062.8549 1270.4784 1000.00 1433.33  
## Narrikup 822.2233 307.50442 24 718.4116 926.0351 433.33 1166.67  
## Woogenellup 944.4467 306.24075 24 840.6349 1048.2584 566.67 1300.00  
##   
## $comparison  
## NULL  
##   
## $groups  
**## trt means M  
## 1 Monti 1166.6667 a  
## 2 Woogenellup 944.4467 b  
## 3 Antas 933.3367 b  
## 4 Leura 933.3333 b  
## 5 Denmark 855.5533 b  
## 6 Narrikup 822.2233 b**

REFERENCE

Saville, D. J. 2015. Multiple Comparison Procedures—Cutting the Gordian Knot. Agron. J. 107:730-735. doi:10.2134/agronj2012.0394