

# Estudo Solução vs Ponta - Nebraska

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```
nozzle <- read_csv("nozzle_NE.csv") %>%  
  mutate_if(is.character, as.factor)
```

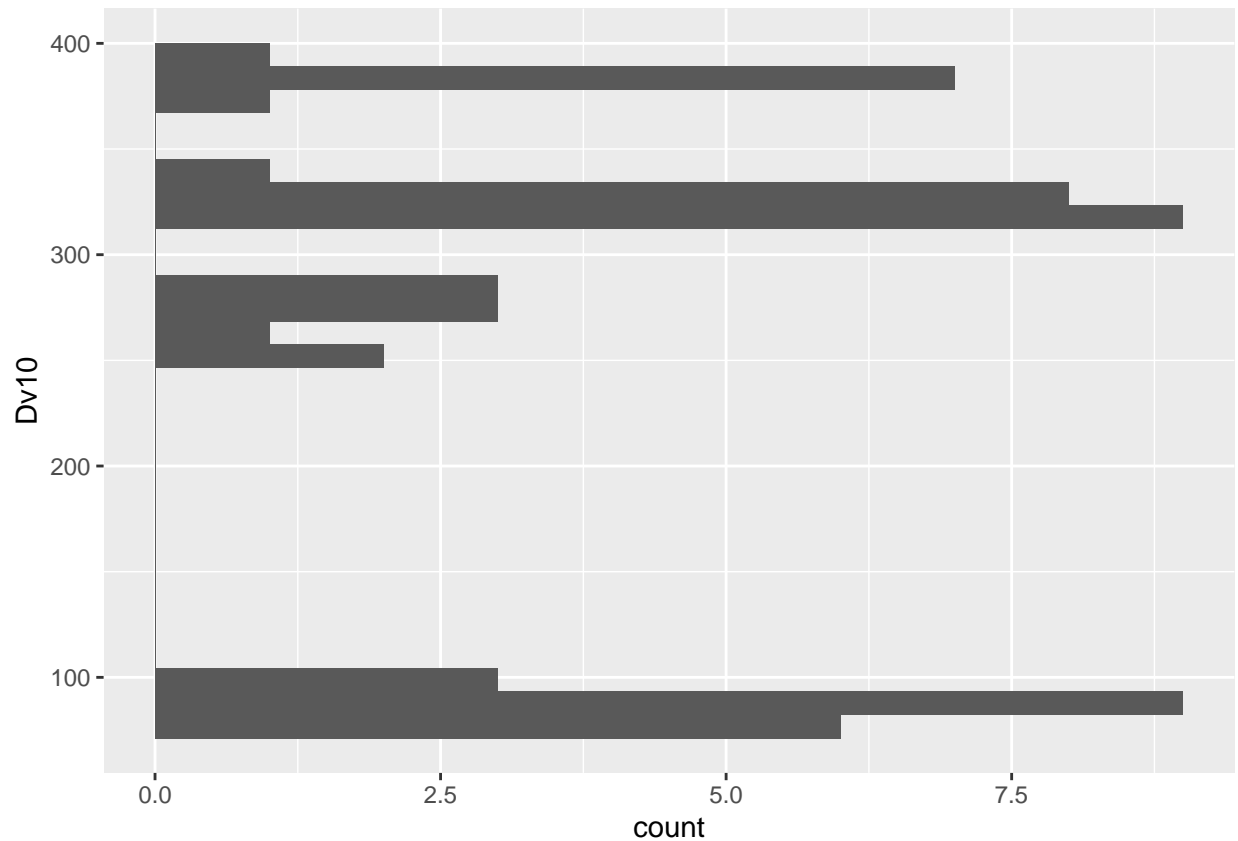
```
## Parsed with column specification:  
## cols(  
##   .default = col_double(),  
##   Date = col_character(),  
##   Time = col_time(format = ""),  
##   Solution = col_character(),  
##   Nozzle = col_character(),  
##   `Nozzle Orientation` = col_character()  
## )  
  
## See spec(...) for full column specifications.
```

## Dv10

Primeiramente, olhamos a distribuição dos dados

```
ggplot(nozzle) + aes(y=Dv10) + geom_histogram()
```

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



Esse dado tem uma distribuição que não segue a distribuição, então vamos usar distribuição Gamma no modelo.

```
#homogeneity of variances
leveneTest(Dv10 ~ Solution * Nozzle, data = nozzle)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##      Df F value Pr(>F)
## group 17  0.6917 0.7899
##      36
```

P-valor > 0.05, o que significa que existe homogeneidade da variancia.

```
#Modelo
# Fatorial Solucao vs Nozzle
# Experimento em DIC, Não existe necessidade de usar random effects
model10 <- glm(Dv10 ~ Solution * Nozzle, data= nozzle, family = Gamma(link = "inverse"))
```

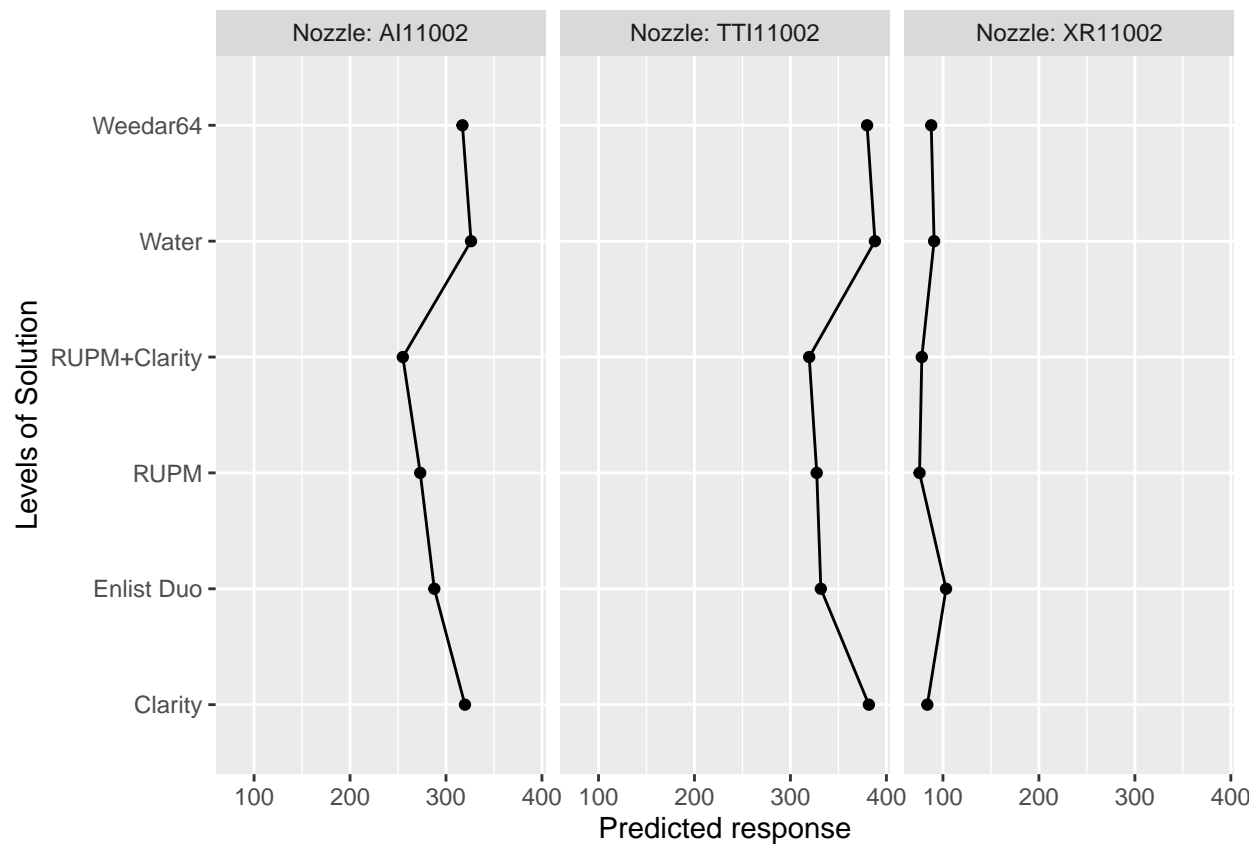
```
#Anova
Anova(model10)
```

```
## Analysis of Deviance Table (Type II tests)
##
## Response: Dv10
##      LR Chisq Df Pr(>Chisq)
```

```
## Solution          4185  5  < 2.2e-16 ***
## Nozzle            262897  2  < 2.2e-16 ***
## Solution:Nozzle    2671 10  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Existe interacao entre Nozzle e Solution

```
emmip(model10, ~ Solution|Nozzle, type="response") +
  coord_flip()
```



```
lsmeans10 <- emmeans(model10, ~ Solution|Nozzle, cont="pairwise", adjust="none", type="response", alpha=0.05)
```

## Note: Use 'contrast(regrid(object), ...)' to obtain contrasts of back-transformed estimates

```
lsmeans10
```

```
## $emmeans
## Nozzle = AI11002:
## Solution      response      SE df asymp.LCL asymp.UCL
## Clarity       319.8 1.512 Inf   316.8    322.8
## Enlist Duo    287.8 1.361 Inf   285.2    290.5
## RUPM          273.2 1.292 Inf   270.7    275.7
## RUPM+Clarity  255.0 1.206 Inf   252.7    257.4
```

```

## Water          326.1 1.542 Inf      323.1      329.2
## Weedar64       317.2 1.500 Inf      314.3      320.1
##
## Nozzle = TTI11002:
## Solution      response      SE  df asymp.LCL asymp.UCL
## Clarity       381.7 1.805 Inf      378.2      385.3
## Enlist Duo    331.7 1.568 Inf      328.7      334.8
## RUPM          327.4 1.548 Inf      324.4      330.5
## RUPM+Clarity  319.6 1.511 Inf      316.6      322.5
## Water        388.1 1.835 Inf      384.5      391.7
## Weedar64     379.9 1.796 Inf      376.4      383.4
##
## Nozzle = XR11002:
## Solution      response      SE  df asymp.LCL asymp.UCL
## Clarity       83.7 0.396 Inf      82.9      84.5
## Enlist Duo    103.2 0.488 Inf     102.3      104.2
## RUPM          75.6 0.357 Inf      74.9      76.3
## RUPM+Clarity  78.0 0.369 Inf      77.2      78.7
## Water        90.8 0.429 Inf      89.9      91.6
## Weedar64     87.8 0.415 Inf      87.0      88.6
##
## Confidence level used: 0.95
## Intervals are back-transformed from the inverse scale
##
## $contrasts
## Nozzle = AI11002:
## contrast              estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo   -3.47e-04 2.21e-05 Inf -15.697 <.0001
## Clarity - RUPM         -5.33e-04 2.28e-05 Inf -23.429 <.0001
## Clarity - RUPM+Clarity -7.94e-04 2.37e-05 Inf -33.479 <.0001
## Clarity - Water        6.08e-05 2.07e-05 Inf  2.935 0.0033
## Clarity - Weedar64     -2.56e-05 2.10e-05 Inf -1.221 0.2221
## Enlist Duo - RUPM      -1.86e-04 2.39e-05 Inf -7.812 <.0001
## Enlist Duo - RUPM+Clarity -4.47e-04 2.48e-05 Inf -18.045 <.0001
## Enlist Duo - Water     4.08e-04 2.19e-05 Inf 18.608 <.0001
## Enlist Duo - Weedar64  3.21e-04 2.22e-05 Inf 14.484 <.0001
## RUPM - RUPM+Clarity    -2.61e-04 2.54e-05 Inf -10.274 <.0001
## RUPM - Water          5.94e-04 2.26e-05 Inf 26.313 <.0001
## RUPM - Weedar64       5.08e-04 2.28e-05 Inf 22.226 <.0001
## RUPM+Clarity - Water   8.55e-04 2.35e-05 Inf 36.314 <.0001
## RUPM+Clarity - Weedar64 7.68e-04 2.38e-05 Inf 32.294 <.0001
## Water - Weedar64      -8.64e-05 2.08e-05 Inf -4.155 <.0001
##
## Nozzle = TTI11002:
## contrast              estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo   -3.95e-04 1.89e-05 Inf -20.926 <.0001
## Clarity - RUPM         -4.35e-04 1.90e-05 Inf -22.840 <.0001
## Clarity - RUPM+Clarity -5.10e-04 1.93e-05 Inf -26.419 <.0001
## Clarity - Water        4.27e-05 1.74e-05 Inf  2.460 0.0139
## Clarity - Weedar64     -1.27e-05 1.76e-05 Inf -0.725 0.4683
## Enlist Duo - RUPM      -3.94e-05 2.03e-05 Inf -1.941 0.0523
## Enlist Duo - RUPM+Clarity -1.15e-04 2.05e-05 Inf -5.579 <.0001
## Enlist Duo - Water     4.38e-04 1.88e-05 Inf 23.351 <.0001
## Enlist Duo - Weedar64  3.82e-04 1.89e-05 Inf 20.209 <.0001

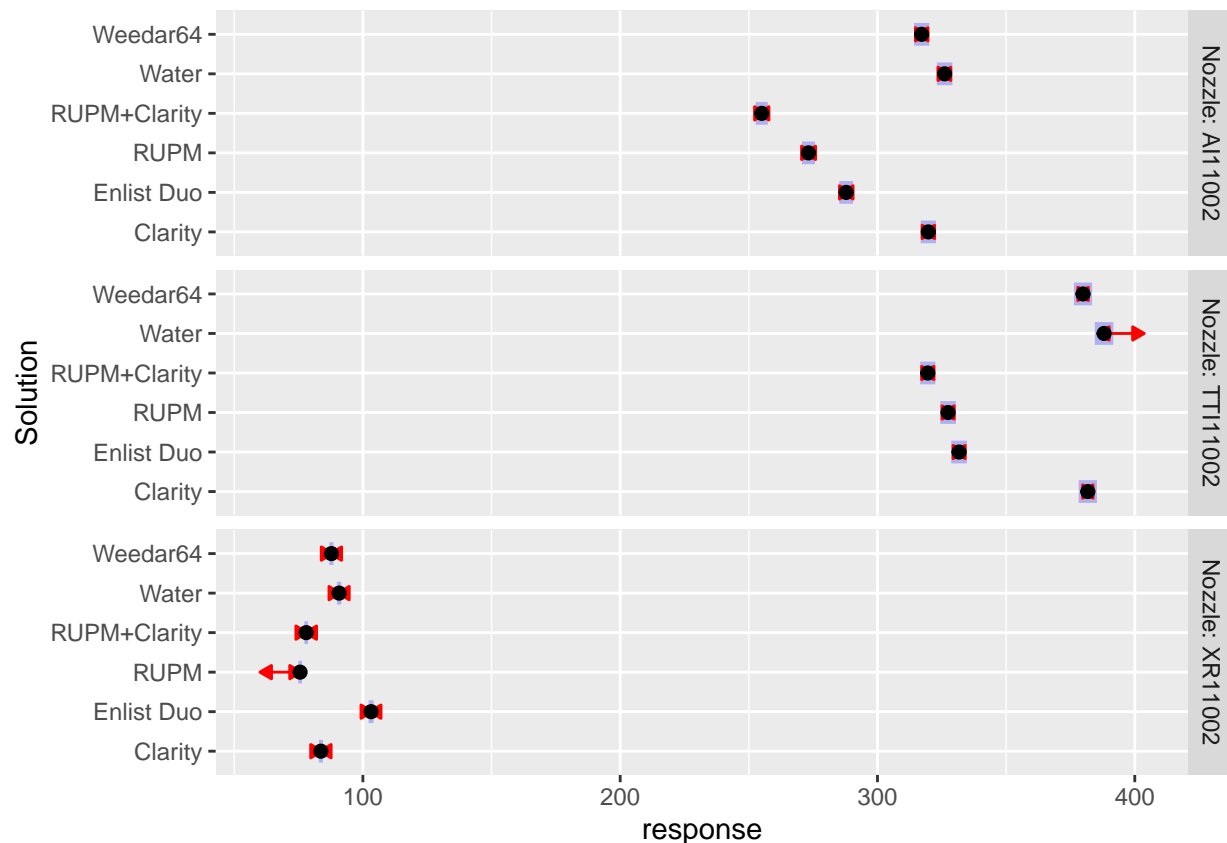
```

```

## RUPM - RUPM+Clarity      -7.52e-05 2.07e-05 Inf  -3.640 0.0003
## RUPM - Water              4.77e-04 1.89e-05 Inf  25.260 <.0001
## RUPM - Weedar64           4.22e-04 1.91e-05 Inf  22.125 <.0001
## RUPM+Clarity - Water      5.52e-04 1.92e-05 Inf  28.826 <.0001
## RUPM+Clarity - Weedar64   4.97e-04 1.93e-05 Inf  25.707 <.0001
## Water - Weedar64          -5.55e-05 1.74e-05 Inf  -3.185 0.0014
##
## Nozzle = XR11002:
## contrast                  estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo      2.26e-03 7.27e-05 Inf  31.074 <.0001
## Clarity - RUPM            -1.28e-03 8.43e-05 Inf -15.187 <.0001
## Clarity - RUPM+Clarity    -8.77e-04 8.29e-05 Inf -10.578 <.0001
## Clarity - Water           9.31e-04 7.69e-05 Inf  12.119 <.0001
## Clarity - Weedar64        5.57e-04 7.81e-05 Inf   7.133 <.0001
## Enlist Duo - RUPM         -3.54e-03 7.75e-05 Inf -45.663 <.0001
## Enlist Duo - RUPM+Clarity -3.14e-03 7.60e-05 Inf -41.275 <.0001
## Enlist Duo - Water        -1.33e-03 6.94e-05 Inf -19.156 <.0001
## Enlist Duo - Weedar64     -1.70e-03 7.07e-05 Inf -24.089 <.0001
## RUPM - RUPM+Clarity       4.03e-04 8.71e-05 Inf   4.629 <.0001
## RUPM - Water              2.21e-03 8.14e-05 Inf  27.167 <.0001
## RUPM - Weedar64           1.84e-03 8.26e-05 Inf  22.253 <.0001
## RUPM+Clarity - Water      1.81e-03 8.00e-05 Inf  22.617 <.0001
## RUPM+Clarity - Weedar64   1.43e-03 8.11e-05 Inf  17.675 <.0001
## Water - Weedar64          -3.75e-04 7.49e-05 Inf  -4.998 <.0001
##
## Note: contrasts are still on the inverse scale

plot(lsmmeans10, ~ Solution|Nozzle, comparisons=TRUE, type="response", alpha=0.05, adjust="none")

```



Veja a comparacao LSD das solucoes dentro de cada Ponta (nozzle). As letras mostram as diferencas entre as soluções.

```
cld10 <-CLD(lsmmeans10, alpha=0.05, Letters=letters, adjust="none", reversed = TRUE)
```

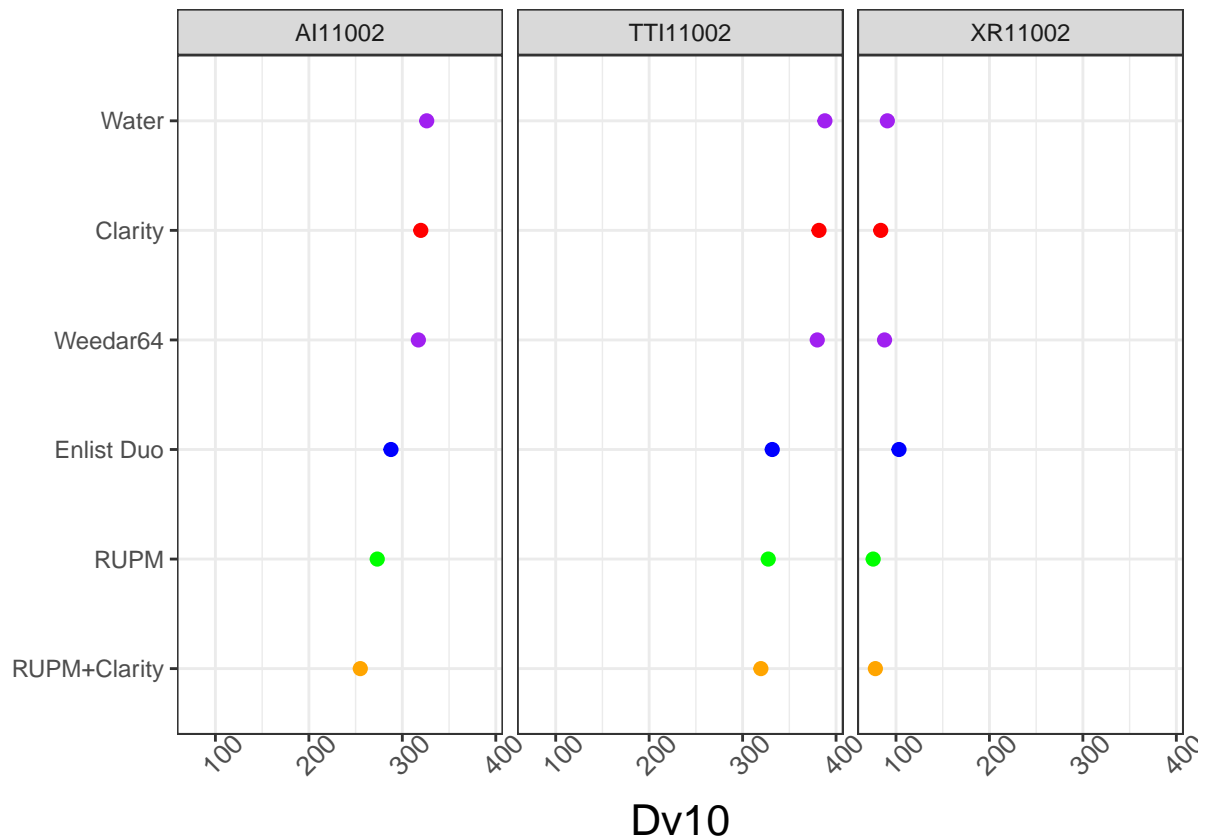
## Note: Use 'contrast(regrid(object), ...)' to obtain contrasts of back-transformed estimates

```
cld10
```

```
## Nozzle = AI11002:
## Solution      response      SE  df  asymp.LCL  asymp.UCL  .group
## Water         326.1  1.542  Inf    323.1    329.2    a
## Clarity        319.8  1.512  Inf    316.8    322.8    b
## Weedar64       317.2  1.500  Inf    314.3    320.1    b
## Enlist Duo     287.8  1.361  Inf    285.2    290.5    c
## RUPM           273.2  1.292  Inf    270.7    275.7    d
## RUPM+Clarity   255.0  1.206  Inf    252.7    257.4    e
##
## Nozzle = TT11002:
## Solution      response      SE  df  asymp.LCL  asymp.UCL  .group
## Water         388.1  1.835  Inf    384.5    391.7    a
## Clarity        381.7  1.805  Inf    378.2    385.3    b
## Weedar64       379.9  1.796  Inf    376.4    383.4    b
## Enlist Duo     331.7  1.568  Inf    328.7    334.8    c
## RUPM           327.4  1.548  Inf    324.4    330.5    c
```

```
## RUPM+Clarity    319.6 1.511 Inf      316.6      322.5      d
##
## Nozzle = XR11002:
## Solution      response      SE df asymp.LCL asymp.UCL .group
## Enlist Duo     103.2 0.488 Inf      102.3      104.2      a
## Water          90.8 0.429 Inf      89.9       91.6       b
## Weedar64       87.8 0.415 Inf      87.0       88.6       c
## Clarity        83.7 0.396 Inf      82.9       84.5       d
## RUPM+Clarity   78.0 0.369 Inf      77.2       78.7       e
## RUPM           75.6 0.357 Inf      74.9       76.3       f
##
## Confidence level used: 0.95
## Intervals are back-transformed from the inverse scale
## Note: contrasts are still on the inverse scale
## significance level used: alpha = 0.05
```

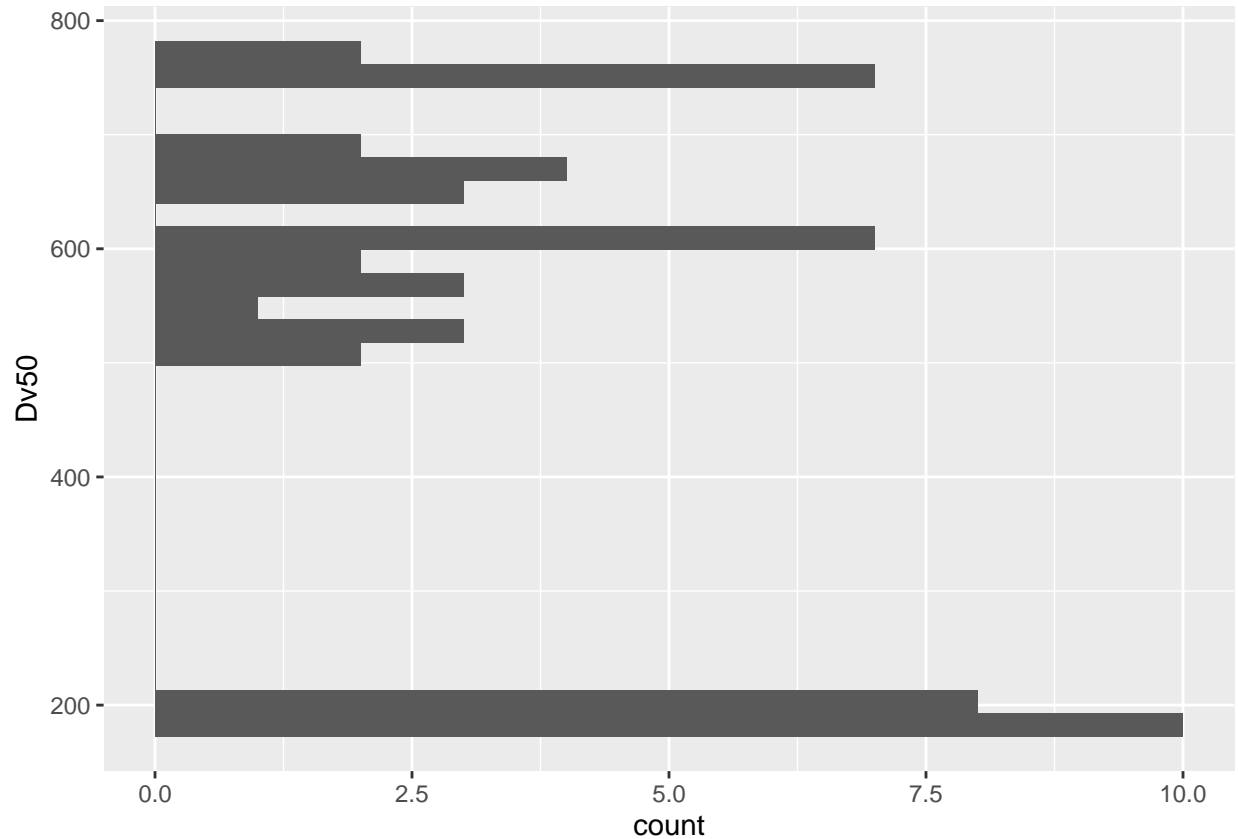
```
nd10 <- as.data.frame(lsmmeans10$emmeans)
ggplot(nd10, aes(x=reorder(Solution,response), y=response, color=Solution)) + facet_grid(~Nozzle) +
  geom_point(size=2) +
  scale_color_manual(values=c("red", "blue", "green", "orange", "purple", "purple")) +
  theme_bw() + labs(y="Dv10", x="") +
  geom_linerange(aes(ymin = asymp.LCL, ymax = asymp.UCL), size=1.5) +
  theme(axis.title = element_text(size=16),
        axis.text.x = element_text(size=10, angle = 45),
        legend.position = "none") + coord_flip()
```



## Dv50

```
ggplot(nozzle) + aes(y=Dv50) + geom_histogram()
```

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



```
#homogeineity of variances  
leveneTest(Dv50 ~ Solution * Nozzle, data = nozzle)
```

```
## Levene's Test for Homogeneity of Variance (center = median)  
##      Df F value Pr(>F)  
## group 17  0.8243 0.6569  
##      36
```

```
model150 <- glm(Dv50 ~ Solution * Nozzle, data= nozzle, family = Gamma(link = "inverse"))
```

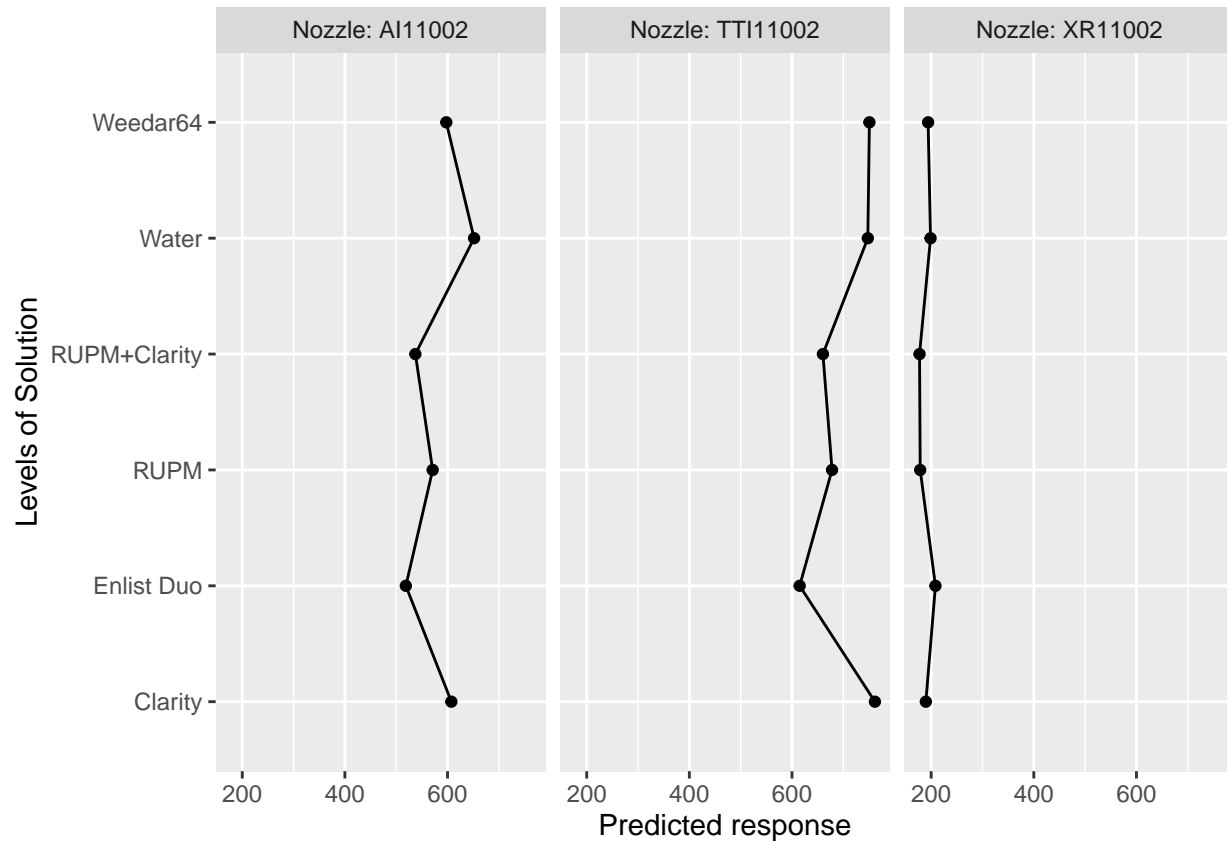
```
#summary(model10)  
Anova(model150)
```

```
## Analysis of Deviance Table (Type II tests)  
##  
## Response: Dv50
```



```
##                LR Chisq Df Pr(>Chisq)
## Solution          6084  5  < 2.2e-16 ***
## Nozzle            464036  2  < 2.2e-16 ***
## Solution:Nozzle    2390 10  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmip(model50, ~ Solution|Nozzle, type="response") +
  coord_flip()
```



```
lsmeans50 <- emmeans(model50, ~ Solution|Nozzle, cont="pairwise", adjust="none", type="response", alpha=0.05)
```

```
## Note: Use 'contrast(regrid(object), ...)' to obtain contrasts of back-transformed estimates
```

```
lsmeans50
```

```
## $emmeans
## Nozzle = AI11002:
##   Solution      response      SE df asymp.LCL asymp.UCL
##   Clarity        607 1.999 Inf      604      611
##   Enlist Duo      519 1.707 Inf      515      522
##   RUPM            571 1.879 Inf      567      575
##   RUPM+Clarity    537 1.768 Inf      534      541
##   Water          652 2.145 Inf      648      656
```

```

## Weedar64          598 1.967 Inf          594          601
##
## Nozzle = TTI11002:
## Solution      response      SE df asymp.LCL asymp.UCL
## Clarity        762 2.506 Inf          757          767
## Enlist Duo      615 2.024 Inf          611          619
## RUPM            678 2.231 Inf          674          682
## RUPM+Clarity    660 2.173 Inf          656          665
## Water          748 2.461 Inf          743          753
## Weedar64       751 2.471 Inf          746          756
##
## Nozzle = XR11002:
## Solution      response      SE df asymp.LCL asymp.UCL
## Clarity        190 0.624 Inf          188          191
## Enlist Duo      208 0.686 Inf          207          210
## RUPM            179 0.588 Inf          178          180
## RUPM+Clarity    177 0.584 Inf          176          179
## Water          199 0.654 Inf          198          200
## Weedar64       194 0.639 Inf          193          195
##
## Confidence level used: 0.95
## Intervals are back-transformed from the inverse scale
##
## $contrasts
## Nozzle = AI11002:
## contrast              estimate      SE df z.ratio p.value
## Clarity - Enlist Duo    -2.81e-04 8.34e-06 Inf -33.735 <.0001
## Clarity - RUPM          -1.05e-04 7.91e-06 Inf -13.259 <.0001
## Clarity - RUPM+Clarity  -2.15e-04 8.18e-06 Inf -26.265 <.0001
## Clarity - Water         1.12e-04 7.41e-06 Inf  15.101 <.0001
## Clarity - Weedar64      -2.72e-05 7.73e-06 Inf  -3.522 0.0004
## Enlist Duo - RUPM        1.77e-04 8.57e-06 Inf  20.600 <.0001
## Enlist Duo - RUPM+Clarity 6.67e-05 8.82e-06 Inf   7.561 <.0001
## Enlist Duo - Water       3.93e-04 8.11e-06 Inf  48.503 <.0001
## Enlist Duo - Weedar64    2.54e-04 8.40e-06 Inf  30.262 <.0001
## RUPM - RUPM+Clarity     -1.10e-04 8.41e-06 Inf -13.067 <.0001
## RUPM - Water            2.17e-04 7.66e-06 Inf  28.283 <.0001
## RUPM - Weedar64         7.77e-05 7.97e-06 Inf   9.743 <.0001
## RUPM+Clarity - Water     3.27e-04 7.94e-06 Inf  41.146 <.0001
## RUPM+Clarity - Weedar64  1.88e-04 8.24e-06 Inf  22.772 <.0001
## Water - Weedar64       -1.39e-04 7.47e-06 Inf -18.609 <.0001
##
## Nozzle = TTI11002:
## contrast              estimate      SE df z.ratio p.value
## Clarity - Enlist Duo    -3.13e-04 6.88e-06 Inf -45.530 <.0001
## Clarity - RUPM          -1.62e-04 6.50e-06 Inf -24.916 <.0001
## Clarity - RUPM+Clarity  -2.02e-04 6.60e-06 Inf -30.551 <.0001
## Clarity - Water         -2.44e-05 6.17e-06 Inf  -3.952 0.0001
## Clarity - Weedar64      -1.89e-05 6.15e-06 Inf  -3.067 0.0022
## Enlist Duo - RUPM        1.51e-04 7.22e-06 Inf  20.935 <.0001
## Enlist Duo - RUPM+Clarity 1.12e-04 7.31e-06 Inf  15.266 <.0001
## Enlist Duo - Water       2.89e-04 6.93e-06 Inf  41.680 <.0001
## Enlist Duo - Weedar64    2.94e-04 6.92e-06 Inf  42.543 <.0001
## RUPM - RUPM+Clarity     -3.96e-05 6.96e-06 Inf  -5.694 <.0001

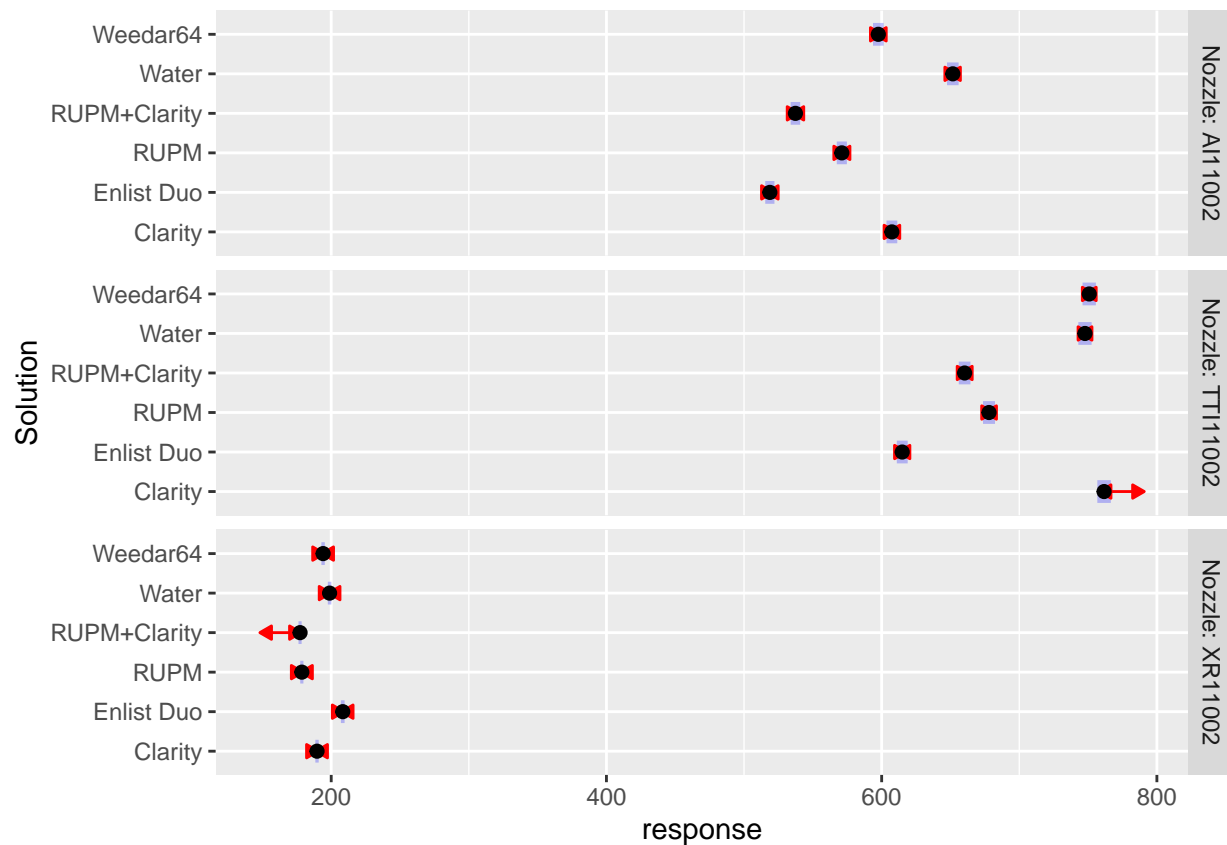
```

```

## RUPM - Water          1.38e-04 6.55e-06 Inf  20.992 <.0001
## RUPM - Weedar64       1.43e-04 6.54e-06 Inf  21.872 <.0001
## RUPM+Clarity - Water  1.77e-04 6.65e-06 Inf  26.643 <.0001
## RUPM+Clarity - Weedar64 1.83e-04 6.64e-06 Inf  27.519 <.0001
## Water - Weedar64      5.50e-06 6.21e-06 Inf   0.885 0.3761
##
## Nozzle = XR11002:
## contrast              estimate          SE  df z.ratio p.value
## Clarity - Enlist Duo    4.73e-04 2.35e-05 Inf  20.164 <.0001
## Clarity - RUPM          -3.25e-04 2.53e-05 Inf -12.854 <.0001
## Clarity - RUPM+Clarity  -3.66e-04 2.54e-05 Inf -14.415 <.0001
## Clarity - Water         2.42e-04 2.40e-05 Inf  10.103 <.0001
## Clarity - Weedar64      1.20e-04 2.43e-05 Inf   4.945 <.0001
## Enlist Duo - RUPM       -7.98e-04 2.43e-05 Inf -32.903 <.0001
## Enlist Duo - RUPM+Clarity -8.39e-04 2.44e-05 Inf -34.444 <.0001
## Enlist Duo - Water      -2.31e-04 2.29e-05 Inf -10.089 <.0001
## Enlist Duo - Weedar64   -3.53e-04 2.32e-05 Inf -15.240 <.0001
## RUPM - RUPM+Clarity     -4.09e-05 2.61e-05 Inf  -1.565 0.1176
## RUPM - Water            5.67e-04 2.48e-05 Inf  22.917 <.0001
## RUPM - Weedar64         4.45e-04 2.50e-05 Inf  17.784 <.0001
## RUPM+Clarity - Water    6.08e-04 2.49e-05 Inf  24.470 <.0001
## RUPM+Clarity - Weedar64 4.86e-04 2.51e-05 Inf  19.341 <.0001
## Water - Weedar64       -1.22e-04 2.37e-05 Inf  -5.162 <.0001
##
## Note: contrasts are still on the inverse scale

plot(lsmmeans50, ~ Solution|Nozzle, comparisons=TRUE, type="response", alpha=0.05, adjust="none")

```



```
cld50 <-CLD(lsmmeans50, alpha=0.05, Letters=letters, adjust="none", reversed = TRUE)
```

## Note: Use 'contrast(regrid(object), ...)' to obtain contrasts of back-transformed estimates

```
cld50
```

```
## Nozzle = AI11002:
```

Solution	response	SE	df	asympt.LCL	asympt.UCL	.group
Water	652	2.145	Inf	648	656	a
Clarity	607	1.999	Inf	604	611	b
Weedar64	598	1.967	Inf	594	601	c
RUPM	571	1.879	Inf	567	575	d
RUPM+Clarity	537	1.768	Inf	534	541	e
Enlist Duo	519	1.707	Inf	515	522	f

```
##
```

```
## Nozzle = TT11002:
```

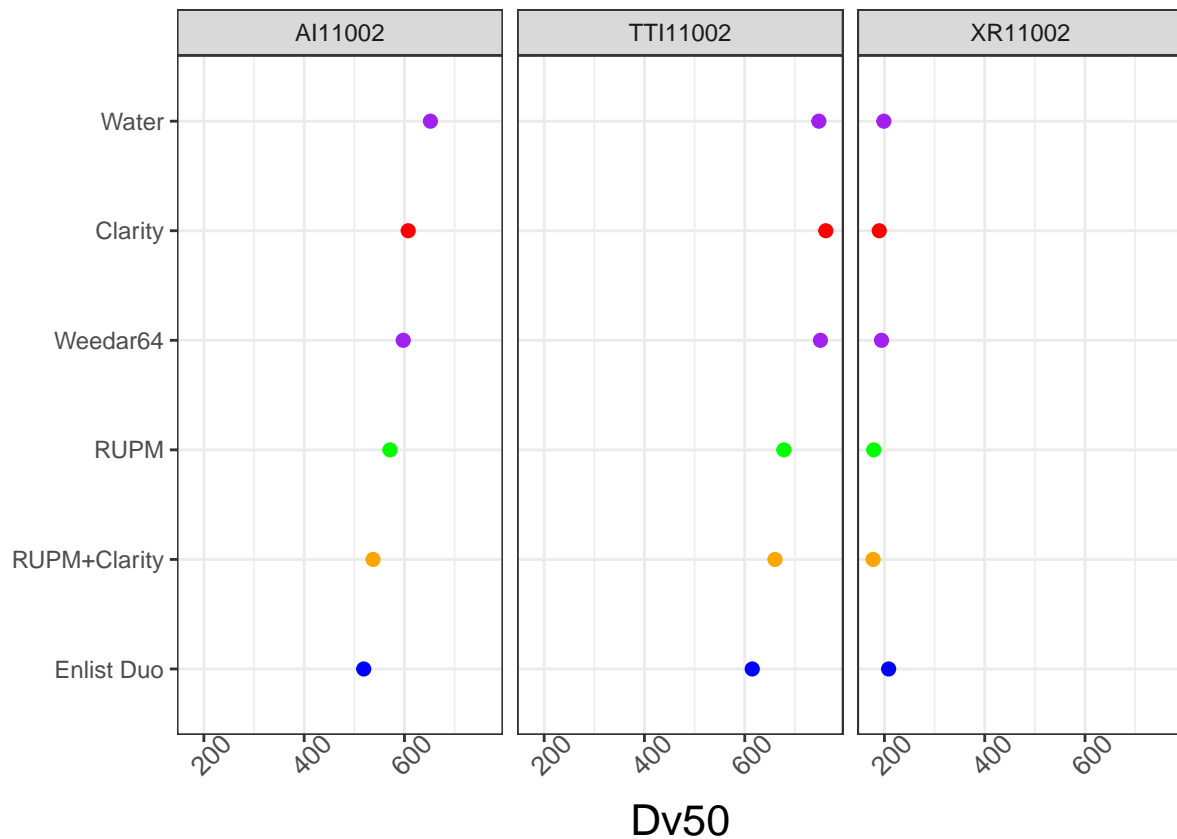
Solution	response	SE	df	asympt.LCL	asympt.UCL	.group
Clarity	762	2.506	Inf	757	767	a
Weedar64	751	2.471	Inf	746	756	b
Water	748	2.461	Inf	743	753	b
RUPM	678	2.231	Inf	674	682	c
RUPM+Clarity	660	2.173	Inf	656	665	d
Enlist Duo	615	2.024	Inf	611	619	e

```
##
```

```
## Nozzle = XR11002:
```

```
## Solution      response      SE df asymp.LCL asymp.UCL .group
## Enlist Duo    208 0.686 Inf      207      210 a
## Water         199 0.654 Inf      198      200 b
## Weedar64      194 0.639 Inf      193      195 c
## Clarity       190 0.624 Inf      188      191 d
## RUPM          179 0.588 Inf      178      180 e
## RUPM+Clarity  177 0.584 Inf      176      179 e
##
## Confidence level used: 0.95
## Intervals are back-transformed from the inverse scale
## Note: contrasts are still on the inverse scale
## significance level used: alpha = 0.05
```

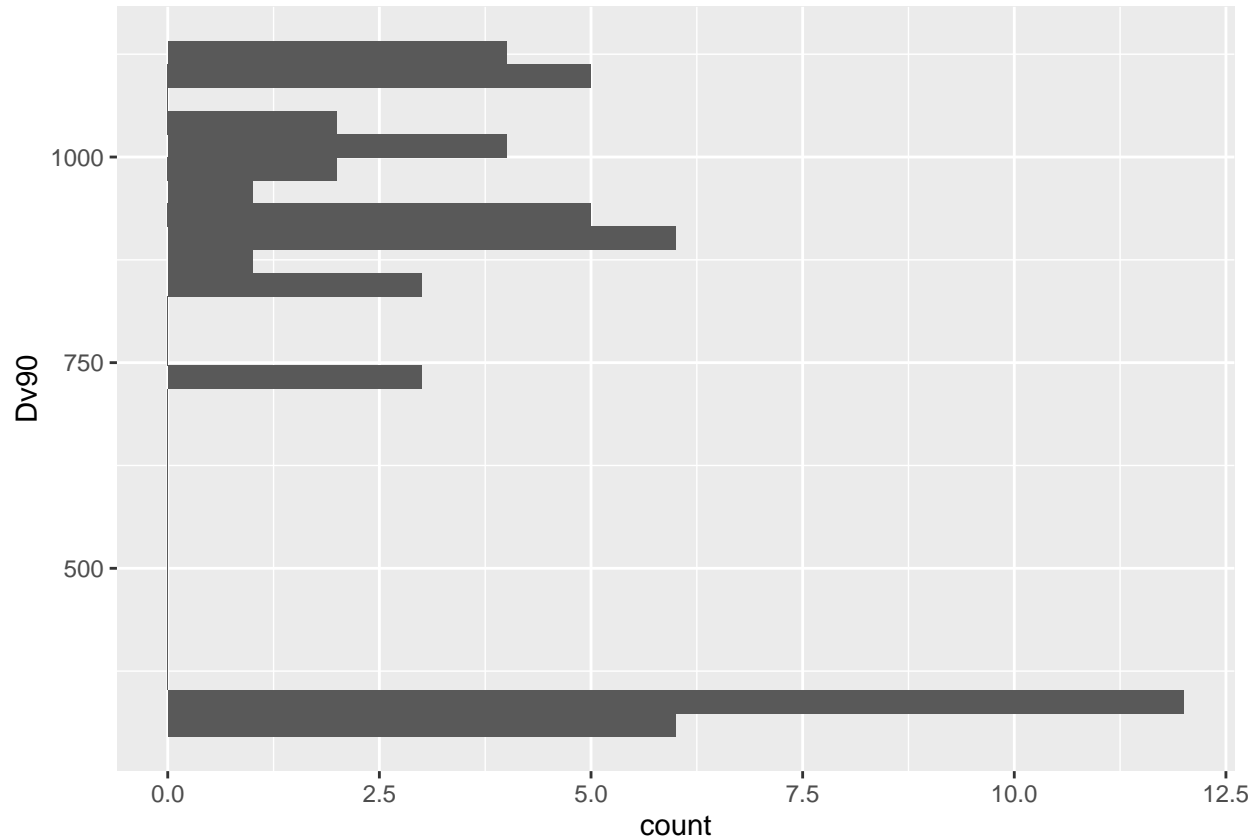
```
nd50 <- as.data.frame(lsmmeans50$emmeans)
ggplot(nd50, aes(x=reorder(Solution,response), y=response, color=Solution)) + facet_grid(~Nozzle) +
  geom_point(size=2) +
  scale_color_manual(values=c("red", "blue", "green", "orange", "purple", "purple")) +
  theme_bw() + labs(y="Dv50", x="") +
  geom_linerange(aes(ymin = asymp.LCL, ymax = asymp.UCL), size=1.5) +
  theme(axis.title = element_text(size=16),
        axis.text.x = element_text(size=10, angle = 45),
        legend.position = "none") + coord_flip()
```



## Dv90

```
ggplot(nozzle) + aes(y=Dv90) + geom_histogram()
```

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



```
#homogeineity of variances  
leveneTest(Dv90 ~ Solution * Nozzle, data = nozzle)
```

```
## Levene's Test for Homogeneity of Variance (center = median)  
##      Df F value Pr(>F)  
## group 17  1.0674 0.4184  
##      36
```

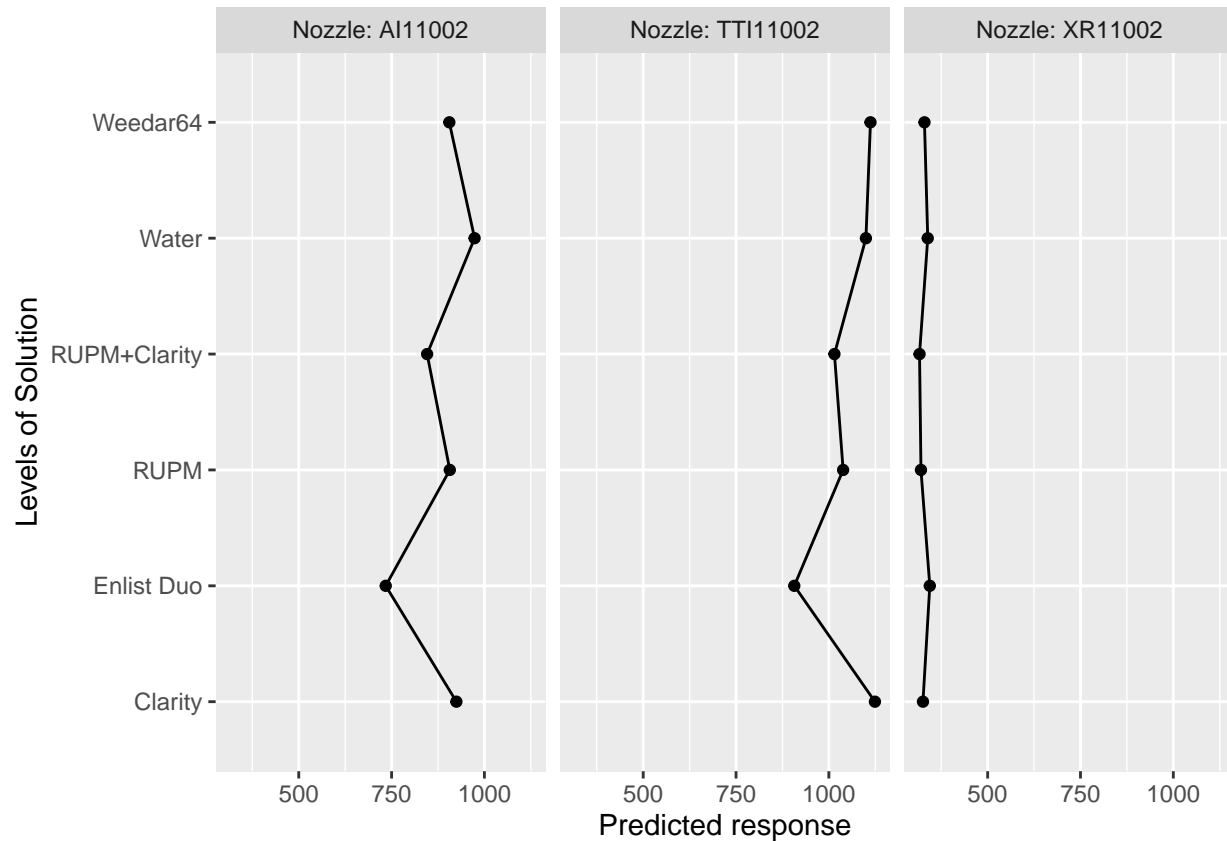
```
model190 <- glm(Dv90 ~ Solution * Nozzle, data= nozzle, family = Gamma(link = "inverse"))
```

```
#summary(model10)  
Anova(model190)
```

```
## Analysis of Deviance Table (Type II tests)  
##  
## Response: Dv90
```

```
##               LR Chisq Df Pr(>Chisq)
## Solution      1493   5  < 2.2e-16 ***
## Nozzle        91309  2  < 2.2e-16 ***
## Solution:Nozzle 405 10  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmip(model90, ~ Solution|Nozzle, type="response") +
  coord_flip()
```



```
lsmeans90 <- emmeans(model90, ~ Solution|Nozzle, cont="pairwise", adjust="none", type="response", alpha=0.05)
```

```
## Note: Use 'contrast(regrid(object), ...)' to obtain contrasts of back-transformed estimates
```

```
lsmeans90
```

```
## $emmeans
## Nozzle = AI11002:
##   Solution      response      SE   df asymp.LCL asymp.UCL
##   Clarity        925 6.17 Inf      913      937
##   Enlist Duo      734 4.90 Inf      725      744
##   RUPM            907 6.05 Inf      895      919
##   RUPM+Clarity    846 5.64 Inf      835      857
##   Water           974 6.49 Inf      961      986
```

```

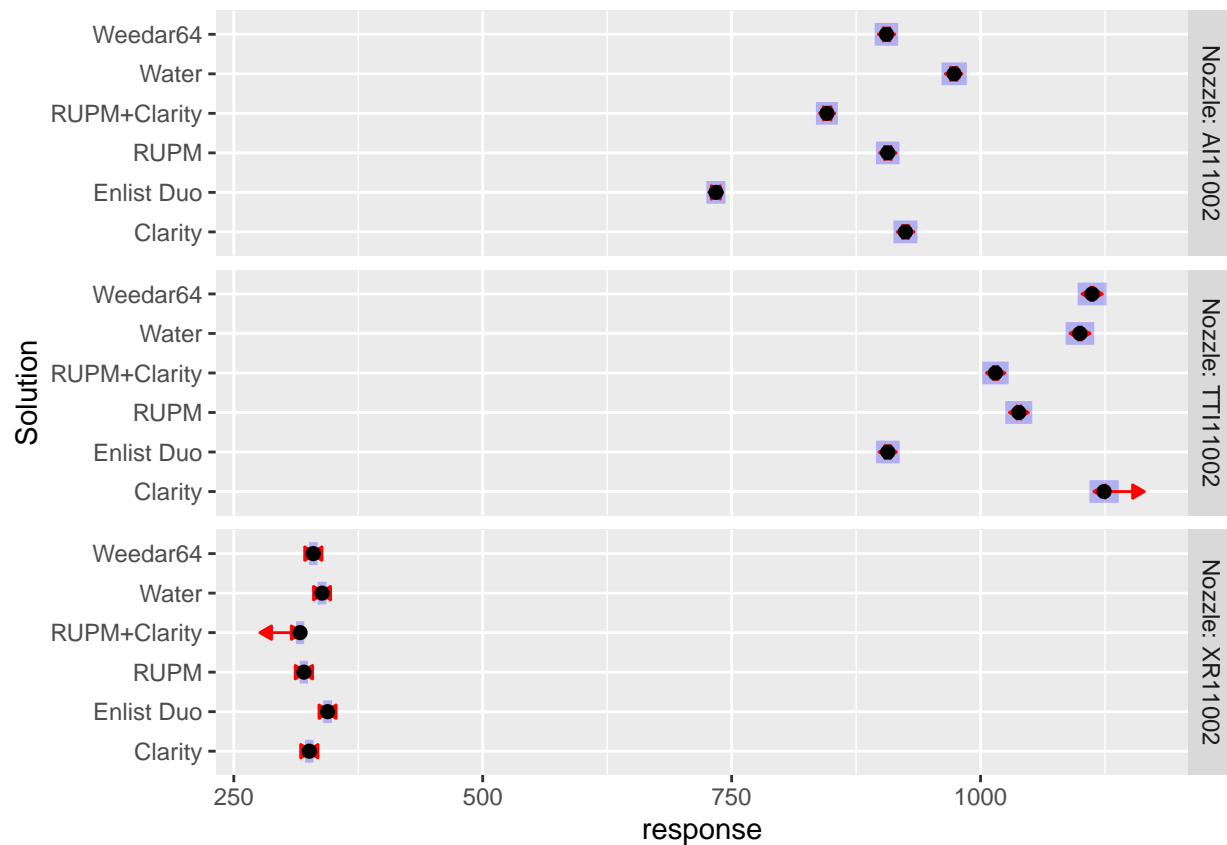
## Weedar64          905 6.04 Inf          894          917
##
## Nozzle = TTI11002:
## Solution      response    SE  df asymp.LCL asymp.UCL
## Clarity        1124 7.50 Inf          1110          1139
## Enlist Duo      907 6.05 Inf          895          919
## RUPM            1038 6.93 Inf          1025          1052
## RUPM+Clarity    1015 6.77 Inf          1002          1028
## Water           1100 7.33 Inf          1086          1114
## Weedar64        1112 7.42 Inf          1098          1127
##
## Nozzle = XR11002:
## Solution      response    SE  df asymp.LCL asymp.UCL
## Clarity        326 2.17 Inf          322          330
## Enlist Duo      344 2.30 Inf          340          349
## RUPM            320 2.14 Inf          316          325
## RUPM+Clarity    317 2.11 Inf          312          321
## Water           339 2.26 Inf          334          343
## Weedar64        330 2.20 Inf          326          334
##
## Confidence level used: 0.95
## Intervals are back-transformed from the inverse scale
##
## $contrasts
## Nozzle = AI11002:
## contrast                estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo      -2.80e-04 1.16e-05 Inf -24.171 <.0001
## Clarity - RUPM             -2.12e-05 1.03e-05 Inf  -2.057 0.0397
## Clarity - RUPM+Clarity     -1.01e-04 1.07e-05 Inf  -9.435 <.0001
## Clarity - Water            5.44e-05 9.95e-06 Inf   5.471 <.0001
## Clarity - Weedar64         -2.28e-05 1.03e-05 Inf  -2.210 0.0271
## Enlist Duo - RUPM          2.59e-04 1.17e-05 Inf  22.175 <.0001
## Enlist Duo - RUPM+Clarity  1.80e-04 1.20e-05 Inf  14.924 <.0001
## Enlist Duo - Water         3.35e-04 1.14e-05 Inf  29.426 <.0001
## Enlist Duo - Weedar64      2.58e-04 1.17e-05 Inf  22.026 <.0001
## RUPM - RUPM+Clarity        -7.96e-05 1.08e-05 Inf  -7.386 <.0001
## RUPM - Water               7.56e-05 1.01e-05 Inf   7.523 <.0001
## RUPM - Weedar64           -1.59e-06 1.04e-05 Inf  -0.153 0.8788
## RUPM+Clarity - Water       1.55e-04 1.04e-05 Inf  14.863 <.0001
## RUPM+Clarity - Weedar64    7.81e-05 1.08e-05 Inf   7.234 <.0001
## Water - Weedar64          -7.72e-05 1.01e-05 Inf  -7.675 <.0001
##
## Nozzle = TTI11002:
## contrast                estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo      -2.13e-04 9.45e-06 Inf -22.546 <.0001
## Clarity - RUPM             -7.34e-05 8.74e-06 Inf  -8.394 <.0001
## Clarity - RUPM+Clarity     -9.56e-05 8.85e-06 Inf -10.801 <.0001
## Clarity - Water           -1.96e-05 8.48e-06 Inf  -2.315 0.0206
## Clarity - Weedar64        -9.64e-06 8.44e-06 Inf  -1.143 0.2531
## Enlist Duo - RUPM          1.40e-04 9.76e-06 Inf  14.301 <.0001
## Enlist Duo - RUPM+Clarity  1.17e-04 9.86e-06 Inf  11.905 <.0001
## Enlist Duo - Water         1.93e-04 9.53e-06 Inf  20.289 <.0001
## Enlist Duo - Weedar64      2.03e-04 9.49e-06 Inf  21.433 <.0001
## RUPM - RUPM+Clarity        -2.22e-05 9.19e-06 Inf  -2.418 0.0156

```



```
## RUPM - Water          5.38e-05 8.83e-06 Inf    6.086 <.0001
## RUPM - Weedar64       6.38e-05 8.79e-06 Inf    7.256 <.0001
## RUPM+Clarity - Water  7.60e-05 8.94e-06 Inf    8.497 <.0001
## RUPM+Clarity - Weedar64 8.60e-05 8.90e-06 Inf    9.665 <.0001
## Water - Weedar64      1.00e-05 8.53e-06 Inf    1.173 0.2410
##
## Nozzle = XR11002:
## contrast              estimate      SE  df  z.ratio p.value
## Clarity - Enlist Duo    1.64e-04 2.82e-05 Inf    5.816 <.0001
## Clarity - RUPM          -5.21e-05 2.92e-05 Inf   -1.785 0.0743
## Clarity - RUPM+Clarity  -8.99e-05 2.94e-05 Inf   -3.062 0.0022
## Clarity - Water         1.16e-04 2.84e-05 Inf    4.081 <.0001
## Clarity - Weedar64      3.73e-05 2.88e-05 Inf    1.297 0.1947
## Enlist Duo - RUPM       -2.16e-04 2.84e-05 Inf   -7.596 <.0001
## Enlist Duo - RUPM+Clarity -2.54e-04 2.86e-05 Inf   -8.869 <.0001
## Enlist Duo - Water      -4.80e-05 2.76e-05 Inf   -1.737 0.0824
## Enlist Duo - Weedar64   -1.27e-04 2.80e-05 Inf   -4.521 <.0001
## RUPM - RUPM+Clarity     -3.78e-05 2.96e-05 Inf   -1.277 0.2015
## RUPM - Water            1.68e-04 2.87e-05 Inf    5.864 <.0001
## RUPM - Weedar64         8.94e-05 2.90e-05 Inf    3.081 0.0021
## RUPM+Clarity - Water    2.06e-04 2.88e-05 Inf    7.138 <.0001
## RUPM+Clarity - Weedar64 1.27e-04 2.92e-05 Inf    4.358 <.0001
## Water - Weedar64       -7.86e-05 2.82e-05 Inf   -2.785 0.0054
##
## Note: contrasts are still on the inverse scale
```

```
plot(lsmmeans90, ~ Solution|Nozzle, comparisons=TRUE, type="response", alpha=0.05, adjust="none")
```



```
cld90 <-CLD(lsmmeans90, alpha=0.05, Letters=letters, adjust="none", reversed = TRUE)
```

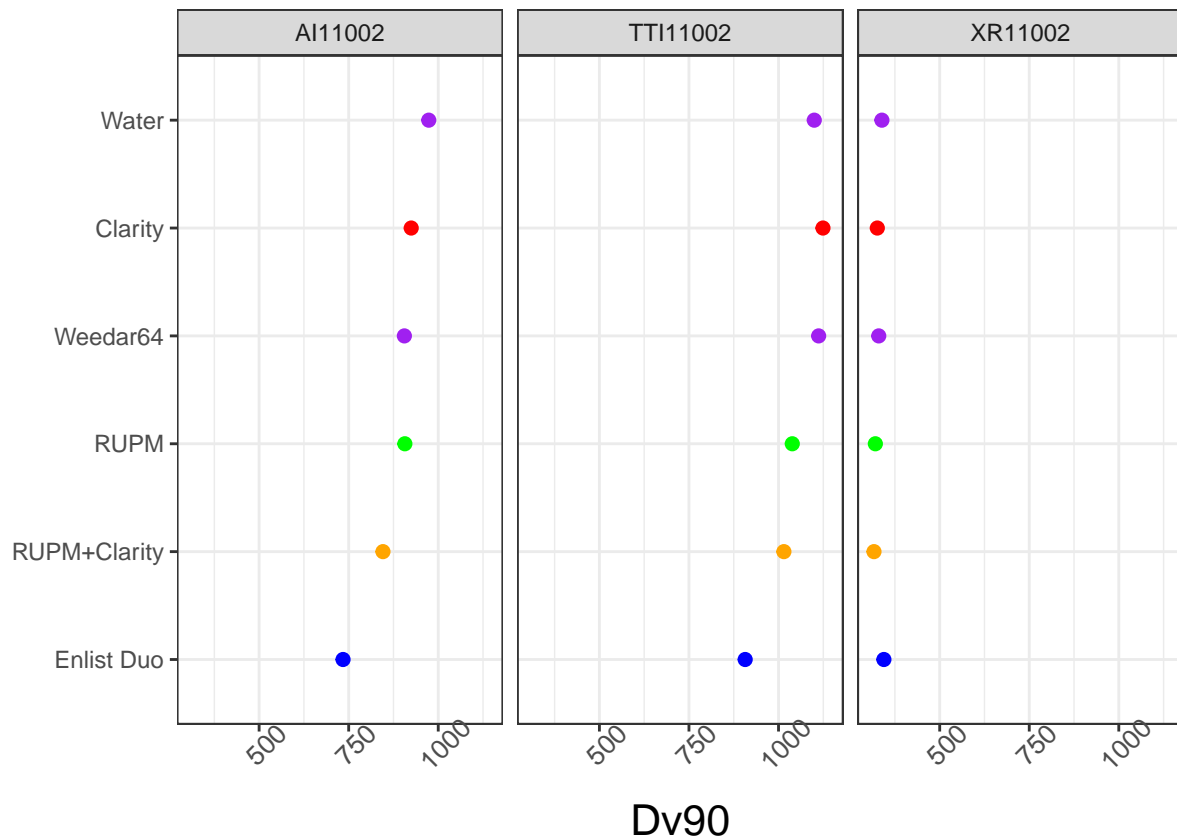
## Note: Use 'contrast(regrid(object), ...)' to obtain contrasts of back-transformed estimates

```
cld90
```

```
## Nozzle = AI11002:
## Solution      response    SE  df asymp.LCL asymp.UCL .group
## Water         974  6.49  Inf      961      986    a
## Clarity        925  6.17  Inf      913      937    b
## RUPM           907  6.05  Inf      895      919    c
## Weedar64       905  6.04  Inf      894      917    c
## RUPM+Clarity   846  5.64  Inf      835      857    d
## Enlist Duo     734  4.90  Inf      725      744    e
##
## Nozzle = TT11002:
## Solution      response    SE  df asymp.LCL asymp.UCL .group
## Clarity       1124  7.50  Inf     1110     1139    a
## Weedar64      1112  7.42  Inf     1098     1127   ab
## Water         1100  7.33  Inf     1086     1114    b
## RUPM          1038  6.93  Inf     1025     1052    c
## RUPM+Clarity  1015  6.77  Inf     1002     1028    d
## Enlist Duo     907  6.05  Inf      895      919    e
##
## Nozzle = XR11002:
```

```
## Solution      response    SE  df asymp.LCL asymp.UCL .group
## Enlist Duo      344 2.30 Inf      340      349    a
## Water           339 2.26 Inf      334      343    a
## Weedar64        330 2.20 Inf      326      334    b
## Clarity          326 2.17 Inf      322      330   bc
## RUPM             320 2.14 Inf      316      325   cd
## RUPM+Clarity    317 2.11 Inf      312      321    d
##
## Confidence level used: 0.95
## Intervals are back-transformed from the inverse scale
## Note: contrasts are still on the inverse scale
## significance level used: alpha = 0.05
```

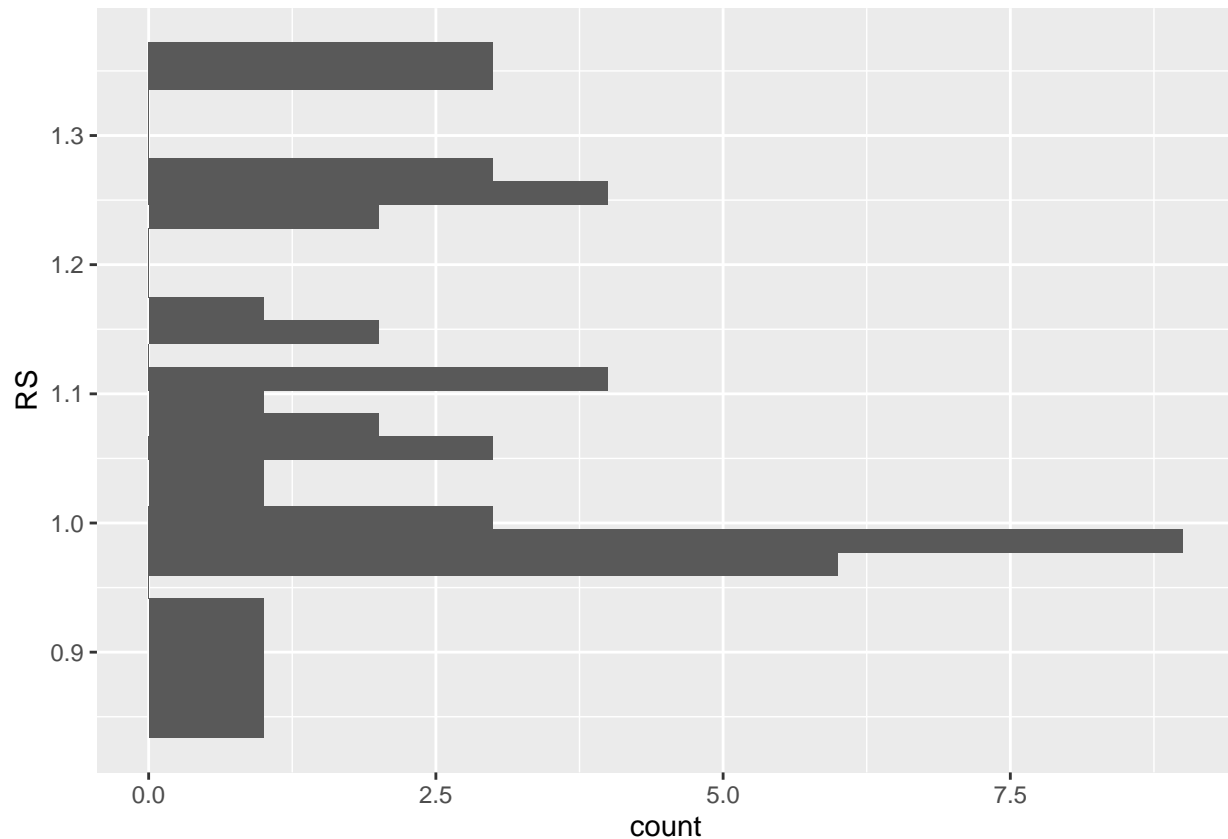
```
nd90 <- as.data.frame(lsmmeans90$emmeans)
ggplot(nd90, aes(x=reorder(Solution,response), y=response, color=Solution)) + facet_grid(~Nozzle) +
  geom_point(size=2) +
  scale_color_manual(values=c("red", "blue", "green", "orange", "purple", "purple")) +
  theme_bw() + labs(y="Dv90", x="") +
  geom_linerange(aes(ymin = asymp.LCL, ymax = asymp.UCL), size=1.5) +
  theme(axis.title = element_text(size=16),
        axis.text.x = element_text(size=10, angle = 45),
        legend.position = "none") + coord_flip()
```



## R/S

```
ggplot(nozzle) + aes(y=RS) + geom_histogram()
```

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



```
#homogeineity of variances  
leveneTest(RS ~ Solution * Nozzle, data = nozzle)
```

```
## Levene's Test for Homogeneity of Variance (center = median)  
##      Df F value Pr(>F)  
## group 17  0.6572 0.8215  
##      36
```

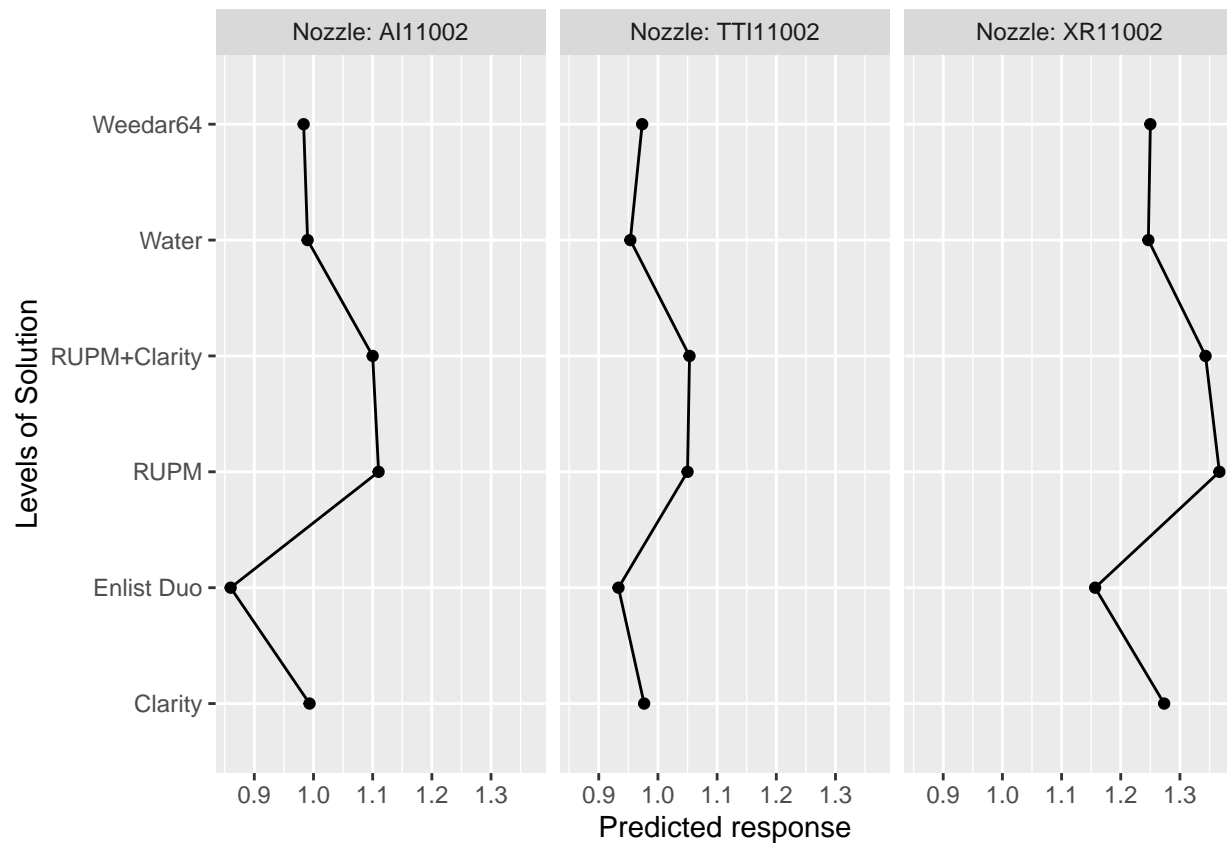
```
modelRS <- glm(RS ~ Solution * Nozzle + (1|Rep), data= nozzle, family = Gamma(link = "inverse"))
```

```
#summary(model10)  
Anova(modelRS)
```

```
## Analysis of Deviance Table (Type II tests)  
##  
## Response: RS
```

```
##                LR Chisq Df Pr(>Chisq)
## Solution          820.06  5  < 2.2e-16 ***
## Nozzle            3087.48  2  < 2.2e-16 ***
## 1 | Rep              0
## Solution:Nozzle    110.22 10  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmip(modelRS, ~ Solution|Nozzle, type="response") +
  coord_flip()
```



```
lsmeansRS <- emmeans(modelRS, ~ Solution|Nozzle, cont="pairwise", adjust="none", type="response", alpha=0.05)
```

## Note: Use 'contrast(regrid(object), ...)' to obtain contrasts of back-transformed estimates

```
lsmeansRS
```

```
## $emmeans
## Nozzle = AI11002:
##   Solution    response      SE df asymp.LCL asymp.UCL
##   Clarity      0.993 0.00880 Inf    0.976    1.011
##   Enlist Duo    0.860 0.00762 Inf    0.845    0.875
##   RUPM          1.110 0.00983 Inf    1.091    1.130
##   RUPM+Clarity  1.100 0.00975 Inf    1.081    1.119
```

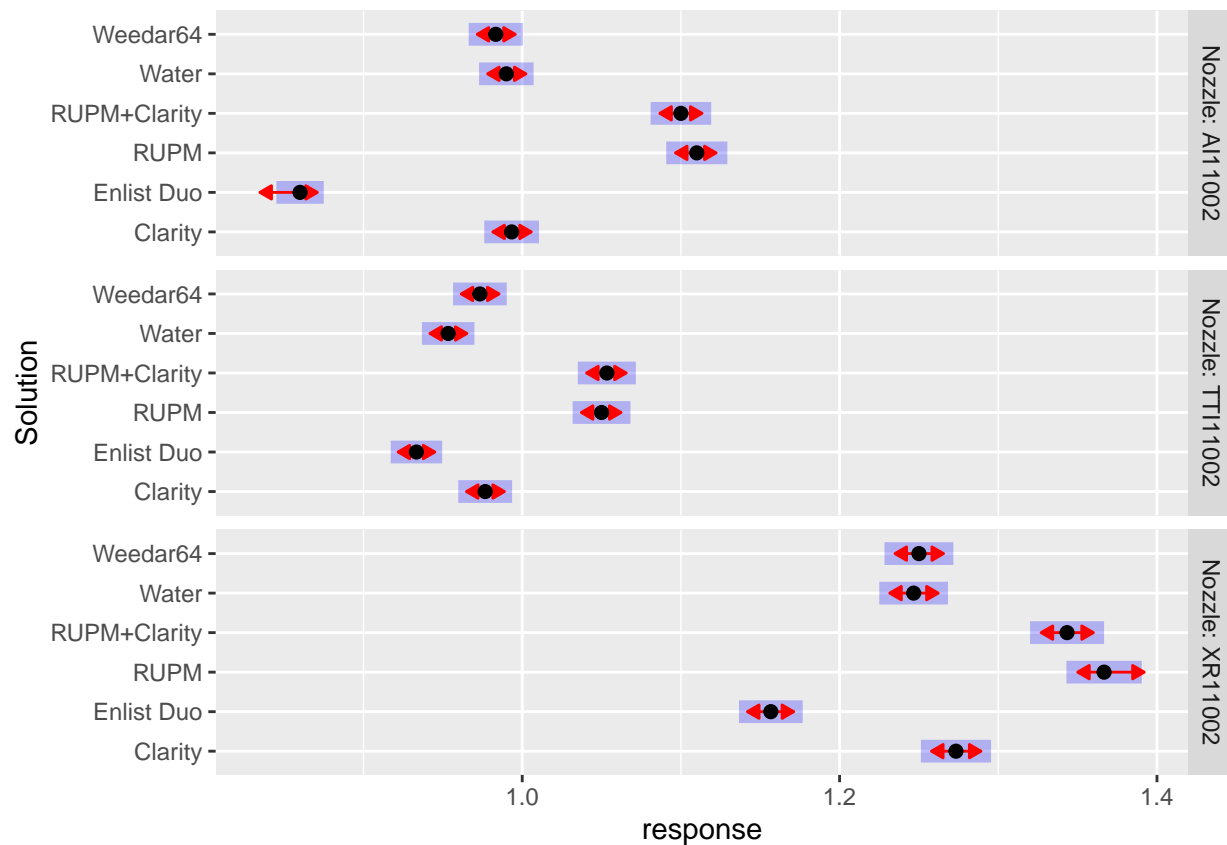
```

## Water          0.990 0.00877 Inf      0.973      1.007
## Weedar64       0.983 0.00871 Inf      0.967      1.001
##
## Nozzle = TTI11002:
## Solution      response      SE  df asymp.LCL asymp.UCL
## Clarity       0.977 0.00865 Inf      0.960      0.994
## Enlist Duo    0.933 0.00827 Inf      0.917      0.950
## RUPM          1.050 0.00930 Inf      1.032      1.069
## RUPM+Clarity  1.053 0.00933 Inf      1.035      1.072
## Water        0.953 0.00845 Inf      0.937      0.970
## Weedar64     0.973 0.00862 Inf      0.957      0.991
##
## Nozzle = XR11002:
## Solution      response      SE  df asymp.LCL asymp.UCL
## Clarity       1.273 0.01128 Inf      1.252      1.296
## Enlist Duo    1.157 0.01025 Inf      1.137      1.177
## RUPM          1.367 0.01211 Inf      1.343      1.391
## RUPM+Clarity  1.343 0.01190 Inf      1.320      1.367
## Water        1.247 0.01104 Inf      1.225      1.269
## Weedar64     1.250 0.01107 Inf      1.229      1.272
##
## Confidence level used: 0.95
## Intervals are back-transformed from the inverse scale
##
## $contrasts
## Nozzle = AI11002:
## contrast      estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo -0.15608 0.01363 Inf -11.454 <.0001
## Clarity - RUPM        0.10581 0.01197 Inf   8.841 <.0001
## Clarity - RUPM+Clarity 0.09762 0.01202 Inf   8.123 <.0001
## Clarity - Water      -0.00339 0.01263 Inf  -0.268 0.7885
## Clarity - Weedar64   -0.01024 0.01268 Inf  -0.808 0.4193
## Enlist Duo - RUPM     0.26189 0.01303 Inf  20.096 <.0001
## Enlist Duo - RUPM+Clarity 0.25370 0.01308 Inf  19.401 <.0001
## Enlist Duo - Water    0.15269 0.01365 Inf  11.190 <.0001
## Enlist Duo - Weedar64 0.14584 0.01369 Inf  10.657 <.0001
## RUPM - RUPM+Clarity  -0.00819 0.01134 Inf  -0.722 0.4701
## RUPM - Water         -0.10920 0.01199 Inf  -9.107 <.0001
## RUPM - Weedar64      -0.11605 0.01204 Inf  -9.641 <.0001
## RUPM+Clarity - Water -0.10101 0.01204 Inf  -8.390 <.0001
## RUPM+Clarity - Weedar64 -0.10786 0.01208 Inf  -8.925 <.0001
## Water - Weedar64     -0.00685 0.01270 Inf  -0.539 0.5897
##
## Nozzle = TTI11002:
## contrast      estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo -0.04754 0.01313 Inf  -3.621 0.0003
## Clarity - RUPM        0.07151 0.01239 Inf   5.772 <.0001
## Clarity - RUPM+Clarity 0.07452 0.01237 Inf   6.024 <.0001
## Clarity - Water      -0.02506 0.01299 Inf  -1.930 0.0536
## Clarity - Weedar64   -0.00351 0.01285 Inf  -0.273 0.7850
## Enlist Duo - RUPM     0.11905 0.01270 Inf   9.374 <.0001
## Enlist Duo - RUPM+Clarity 0.12206 0.01268 Inf   9.624 <.0001
## Enlist Duo - Water    0.02248 0.01328 Inf   1.692 0.0906
## Enlist Duo - Weedar64 0.04403 0.01315 Inf   3.348 0.0008

```

```
## RUPM - RUPM+Clarity      0.00301 0.01191 Inf    0.253 0.8003
## RUPM - Water              -0.09657 0.01255 Inf   -7.694 <.0001
## RUPM - Weedar64          -0.07502 0.01241 Inf   -6.044 <.0001
## RUPM+Clarity - Water     -0.09958 0.01253 Inf   -7.945 <.0001
## RUPM+Clarity - Weedar64 -0.07803 0.01239 Inf   -6.296 <.0001
## Water - Weedar64         0.02155 0.01301 Inf    1.657 0.0975
##
## Nozzle = XR11002:
## contrast                estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo    -0.07921 0.01035 Inf   -7.655 <.0001
## Clarity - RUPM          0.05363 0.00951 Inf    5.640 <.0001
## Clarity - RUPM+Clarity  0.04092 0.00959 Inf    4.269 <.0001
## Clarity - Water        -0.01680 0.00995 Inf   -1.689 0.0912
## Clarity - Weedar64     -0.01466 0.00993 Inf   -1.476 0.1399
## Enlist Duo - RUPM       0.13285 0.01003 Inf   13.239 <.0001
## Enlist Duo - RUPM+Clarity 0.12014 0.01011 Inf   11.886 <.0001
## Enlist Duo - Water      0.06241 0.01045 Inf    5.974 <.0001
## Enlist Duo - Weedar64   0.06455 0.01044 Inf    6.186 <.0001
## RUPM - RUPM+Clarity    -0.01271 0.00925 Inf   -1.374 0.1693
## RUPM - Water           -0.07043 0.00962 Inf   -7.322 <.0001
## RUPM - Weedar64        -0.06829 0.00961 Inf   -7.110 <.0001
## RUPM+Clarity - Water   -0.05772 0.00970 Inf   -5.954 <.0001
## RUPM+Clarity - Weedar64 -0.05558 0.00968 Inf   -5.741 <.0001
## Water - Weedar64       0.00214 0.01004 Inf    0.213 0.8312
##
## Note: contrasts are still on the inverse scale
```

```
plot(lsmmeansRS, ~ Solution|Nozzle, comparisons=TRUE, type="response", alpha=0.05, adjust="none")
```



```
cldRS <-CLD(lsmmeansRS, alpha=0.05, Letters=letters, adjust="none", reversed = TRUE)
```

## Note: Use 'contrast(regrid(object), ...)' to obtain contrasts of back-transformed estimates

```
cldRS
```

```
## Nozzle = AI11002:
```

Solution	response	SE	df	asympt.LCL	asympt.UCL	.group
RUPM	1.110	0.00983	Inf	1.091	1.130	a
RUPM+Clarity	1.100	0.00975	Inf	1.081	1.119	a
Clarity	0.993	0.00880	Inf	0.976	1.011	b
Water	0.990	0.00877	Inf	0.973	1.007	b
Weedar64	0.983	0.00871	Inf	0.967	1.001	b
Enlist Duo	0.860	0.00762	Inf	0.845	0.875	c

```
##
```

```
## Nozzle = TT11002:
```

Solution	response	SE	df	asympt.LCL	asympt.UCL	.group
RUPM+Clarity	1.053	0.00933	Inf	1.035	1.072	a
RUPM	1.050	0.00930	Inf	1.032	1.069	a
Clarity	0.977	0.00865	Inf	0.960	0.994	b
Weedar64	0.973	0.00862	Inf	0.957	0.991	b
Water	0.953	0.00845	Inf	0.937	0.970	bc
Enlist Duo	0.933	0.00827	Inf	0.917	0.950	c

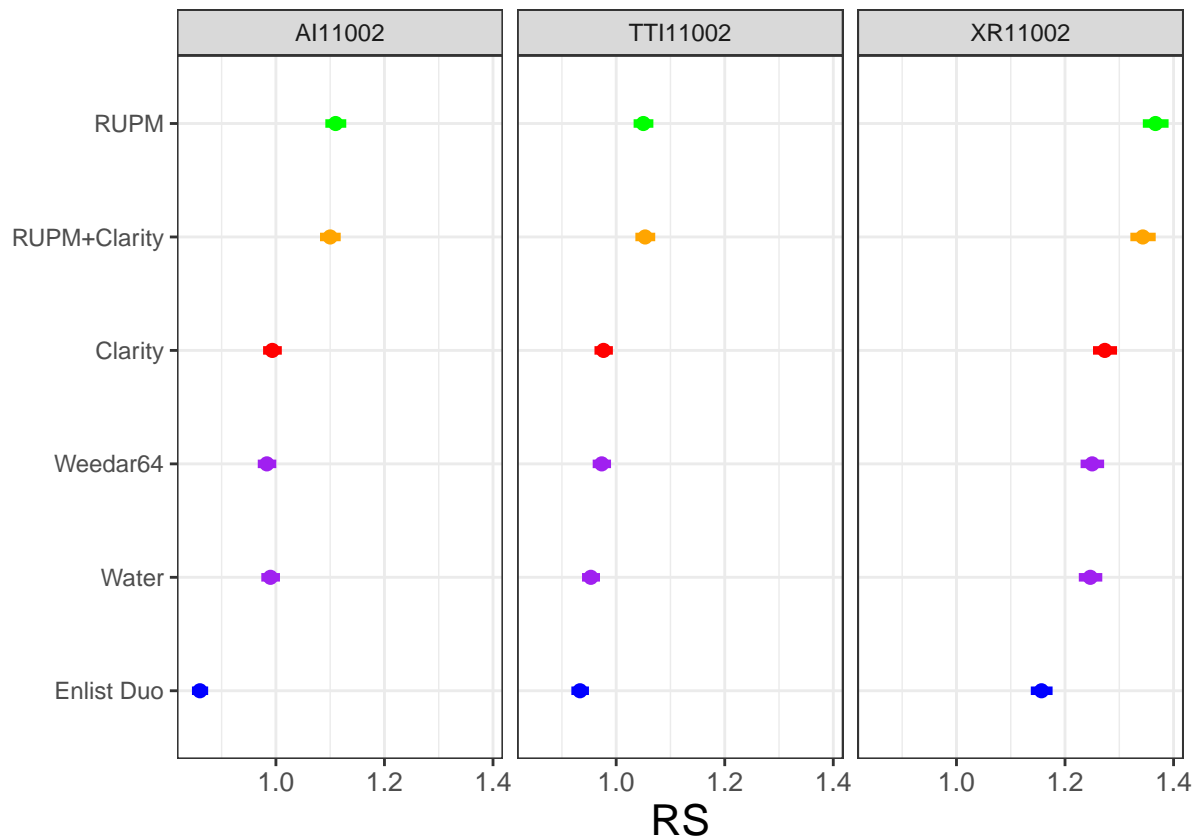
```
##
```

```
## Nozzle = XR11002:
```



```
## Solution      response      SE  df asymp.LCL asymp.UCL .group
## RUPM          1.367 0.01211 Inf    1.343    1.391    a
## RUPM+Clarity  1.343 0.01190 Inf    1.320    1.367    a
## Clarity       1.273 0.01128 Inf    1.252    1.296    b
## Weedar64     1.250 0.01107 Inf    1.229    1.272    b
## Water        1.247 0.01104 Inf    1.225    1.269    b
## Enlist Duo    1.157 0.01025 Inf    1.137    1.177    c
##
## Confidence level used: 0.95
## Intervals are back-transformed from the inverse scale
## Note: contrasts are still on the inverse scale
## significance level used: alpha = 0.05
```

```
ndRS <- as.data.frame(lsmmeansRS$emmeans)
ggplot(ndRS, aes(x=reorder(Solution,response), y=response, color=Solution)) + facet_grid(~Nozzle) +
  geom_point(size=2) +
  scale_color_manual(values=c("red", "blue", "green", "orange", "purple", "purple")) +
  theme_bw() + labs(y="RS", x="") +
  geom_linerange(aes(ymin = asymp.LCL, ymax = asymp.UCL), size=1.5) +
  theme(axis.title = element_text(size=16),
        axis.text.x = element_text(size=10),
        legend.position = "none") + coord_flip()
```



## Driftable fines

Driftable fines é em percentagem. Nesse caso vamos usar a distribuição Beta.

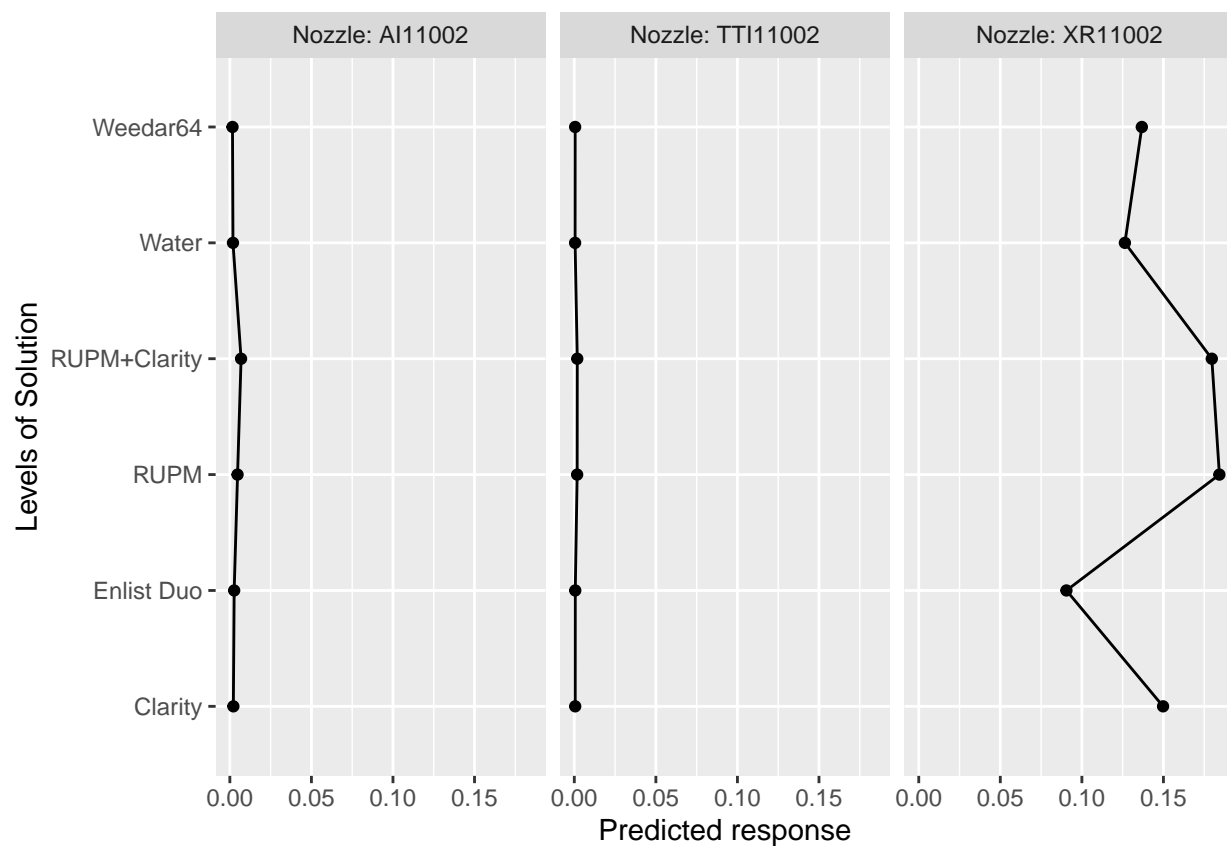
Driftable fines < 100

```
#Modelo com dois fatores Solution vs Nozzle  
model100 <- betareg(Driftable100 ~ Solution * Nozzle, data=nozzle, link = "logit")
```

```
Anova(model100)
```

```
## Analysis of Deviance Table (Type II tests)  
##  
## Response: Driftable100  
##           Df    Chisq Pr(>Chisq)  
## Solution      5  5447.65 < 2.2e-16 ***  
## Nozzle        2  44446.88 < 2.2e-16 ***  
## Solution:Nozzle 10   412.65 < 2.2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmip(model100, ~ Solution | Nozzle, type="response") +  
  coord_flip()
```

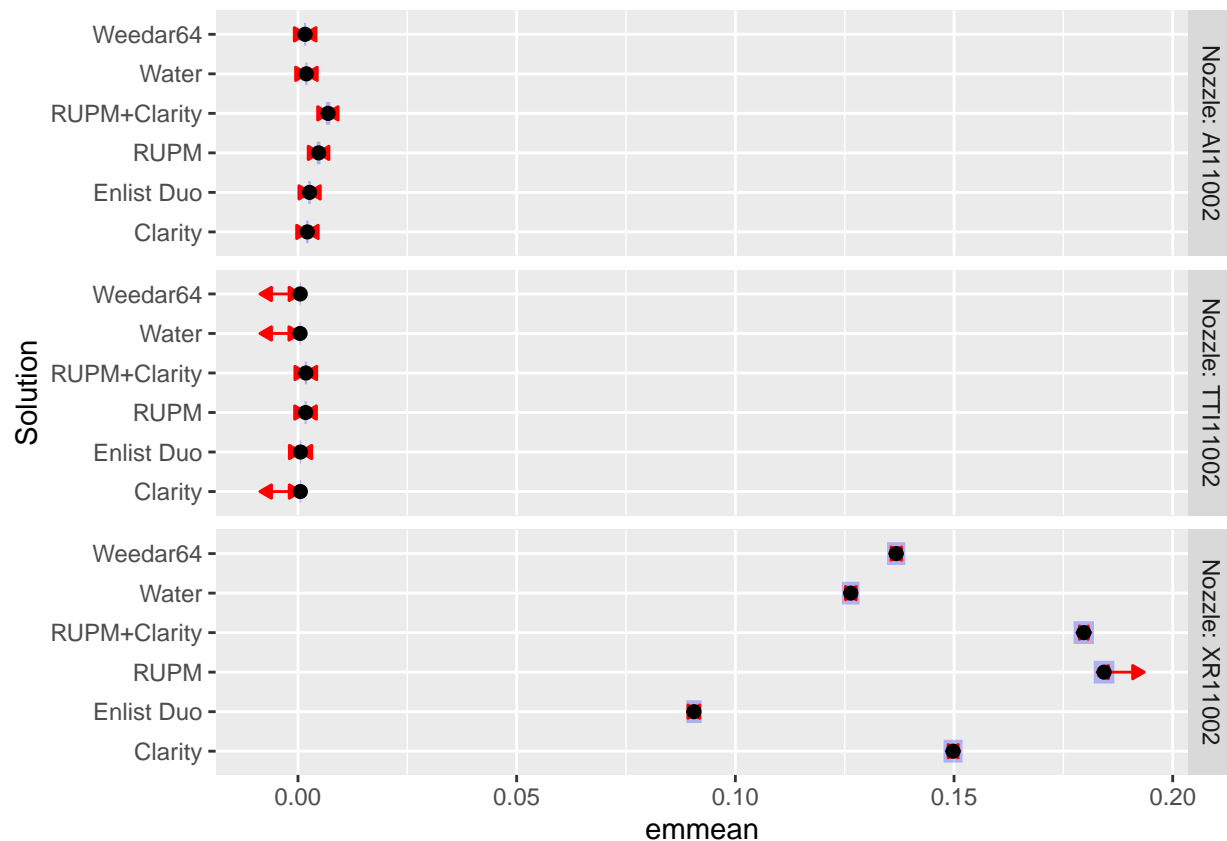


```
lsmeans100 <- emmeans(model100, ~ Solution | Nozzle, cont="pairwise", adjust="none", type="response", a
lsmeans100
```

```
## $emmeans
## Nozzle = AI11002:
## Solution      emmean      SE df asymp.LCL asymp.UCL
## Clarity       0.002146 1.43e-04 Inf  0.001865  0.002426
## Enlist Duo    0.002647 1.59e-04 Inf  0.002336  0.002959
## RUPM          0.004714 2.12e-04 Inf  0.004298  0.005129
## RUPM+Clarity  0.006879 2.56e-04 Inf  0.006377  0.007381
## Water        0.001914 1.35e-04 Inf  0.001650  0.002179
## Weedar64      0.001623 1.24e-04 Inf  0.001379  0.001866
##
## Nozzle = TTI11002:
## Solution      emmean      SE df asymp.LCL asymp.UCL
## Clarity       0.000546 7.15e-05 Inf  0.000405  0.000686
## Enlist Duo    0.000579 7.37e-05 Inf  0.000434  0.000723
## RUPM          0.001743 1.29e-04 Inf  0.001491  0.001996
## RUPM+Clarity  0.001813 1.31e-04 Inf  0.001555  0.002070
## Water        0.000478 6.69e-05 Inf  0.000347  0.000610
## Weedar64      0.000514 6.94e-05 Inf  0.000378  0.000650
##
## Nozzle = XR11002:
## Solution      emmean      SE df asymp.LCL asymp.UCL
## Clarity       0.149775 1.11e-03 Inf  0.147606  0.151944
## Enlist Duo    0.090530 8.90e-04 Inf  0.088786  0.092274
## RUPM          0.184307 1.20e-03 Inf  0.181951  0.186664
## RUPM+Clarity  0.179664 1.19e-03 Inf  0.177331  0.181997
## Water        0.126376 1.03e-03 Inf  0.124357  0.128396
## Weedar64      0.136767 1.07e-03 Inf  0.134678  0.138855
##
## Confidence level used: 0.95
##
## $contrasts
## Nozzle = AI11002:
## contrast      estimate      SE df z.ratio p.value
## Clarity - Enlist Duo    -5.02e-04 2.14e-04 Inf  -2.347 0.0189
## Clarity - RUPM          -2.57e-03 2.56e-04 Inf -10.040 <.0001
## Clarity - RUPM+Clarity  -4.73e-03 2.93e-04 Inf -16.141 <.0001
## Clarity - Water         2.31e-04 1.97e-04 Inf   1.176 0.2398
## Clarity - Weedar64      5.23e-04 1.89e-04 Inf   2.760 0.0058
## Enlist Duo - RUPM       -2.07e-03 2.65e-04 Inf  -7.797 <.0001
## Enlist Duo - RUPM+Clarity -4.23e-03 3.01e-04 Inf -14.043 <.0001
## Enlist Duo - Water      7.33e-04 2.09e-04 Inf   3.515 0.0004
## Enlist Duo - Weedar64   1.02e-03 2.02e-04 Inf   5.079 <.0001
## RUPM - RUPM+Clarity     -2.17e-03 3.32e-04 Inf  -6.514 <.0001
## RUPM - Water           2.80e-03 2.51e-04 Inf  11.134 <.0001
## RUPM - Weedar64        3.09e-03 2.46e-04 Inf  12.575 <.0001
## RUPM+Clarity - Water    4.96e-03 2.89e-04 Inf  17.151 <.0001
## RUPM+Clarity - Weedar64 5.26e-03 2.85e-04 Inf  18.469 <.0001
## Water - Weedar64       2.92e-04 1.84e-04 Inf   1.589 0.1120
##
```

```
## Nozzle = TTI11002:
## contrast      estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo -3.33e-05 1.03e-04 Inf -0.324 0.7456
## Clarity - RUPM -1.20e-03 1.47e-04 Inf -8.129 <.0001
## Clarity - RUPM+Clarity -1.27e-03 1.50e-04 Inf -8.471 <.0001
## Clarity - Water 6.72e-05 9.78e-05 Inf 0.687 0.4922
## Clarity - Weedar64 3.13e-05 9.96e-05 Inf 0.315 0.7530
## Enlist Duo - RUPM -1.16e-03 1.48e-04 Inf -7.846 <.0001
## Enlist Duo - RUPM+Clarity -1.23e-03 1.51e-04 Inf -8.190 <.0001
## Enlist Duo - Water 1.00e-04 9.94e-05 Inf 1.010 0.3123
## Enlist Duo - Weedar64 6.46e-05 1.01e-04 Inf 0.639 0.5229
## RUPM - RUPM+Clarity -6.92e-05 1.84e-04 Inf -0.376 0.7068
## RUPM - Water 1.26e-03 1.45e-04 Inf 8.716 <.0001
## RUPM - Weedar64 1.23e-03 1.46e-04 Inf 8.400 <.0001
## RUPM+Clarity - Water 1.33e-03 1.47e-04 Inf 9.051 <.0001
## RUPM+Clarity - Weedar64 1.30e-03 1.49e-04 Inf 8.739 <.0001
## Water - Weedar64 -3.58e-05 9.63e-05 Inf -0.372 0.7097
##
## Nozzle = XR11002:
## contrast      estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo 5.92e-02 1.42e-03 Inf 41.725 <.0001
## Clarity - RUPM -3.45e-02 1.63e-03 Inf -21.133 <.0001
## Clarity - RUPM+Clarity -2.99e-02 1.63e-03 Inf -18.390 <.0001
## Clarity - Water 2.34e-02 1.51e-03 Inf 15.476 <.0001
## Clarity - Weedar64 1.30e-02 1.54e-03 Inf 8.468 <.0001
## Enlist Duo - RUPM -9.38e-02 1.50e-03 Inf -62.696 <.0001
## Enlist Duo - RUPM+Clarity -8.91e-02 1.49e-03 Inf -59.974 <.0001
## Enlist Duo - Water -3.58e-02 1.36e-03 Inf -26.332 <.0001
## Enlist Duo - Weedar64 -4.62e-02 1.39e-03 Inf -33.309 <.0001
## RUPM - RUPM+Clarity 4.64e-03 1.69e-03 Inf 2.744 0.0061
## RUPM - Water 5.79e-02 1.58e-03 Inf 36.586 <.0001
## RUPM - Weedar64 4.75e-02 1.61e-03 Inf 29.593 <.0001
## RUPM+Clarity - Water 5.33e-02 1.57e-03 Inf 33.846 <.0001
## RUPM+Clarity - Weedar64 4.29e-02 1.60e-03 Inf 26.851 <.0001
## Water - Weedar64 -1.04e-02 1.48e-03 Inf -7.010 <.0001
```

```
plot(lsmeans100, comparisons=TRUE, type="response", alpha=0.05, adjust="none")
```



```
cld100 <-CLD(lsmmeans100, alpha=0.05, Letters=letters, adjust="none", reversed = TRUE)
```

```
cld100
```

```
## Nozzle = AI11002:
```

Solution	emmean	SE	df	asympt.LCL	asympt.UCL	.group
RUPM+Clarity	0.006879	2.56e-04	Inf	0.006377	0.007381	a
RUPM	0.004714	2.12e-04	Inf	0.004298	0.005129	b
Enlist Duo	0.002647	1.59e-04	Inf	0.002336	0.002959	c
Clarity	0.002146	1.43e-04	Inf	0.001865	0.002426	d
Water	0.001914	1.35e-04	Inf	0.001650	0.002179	de
Weedar64	0.001623	1.24e-04	Inf	0.001379	0.001866	e

```
## Nozzle = TTI11002:
```

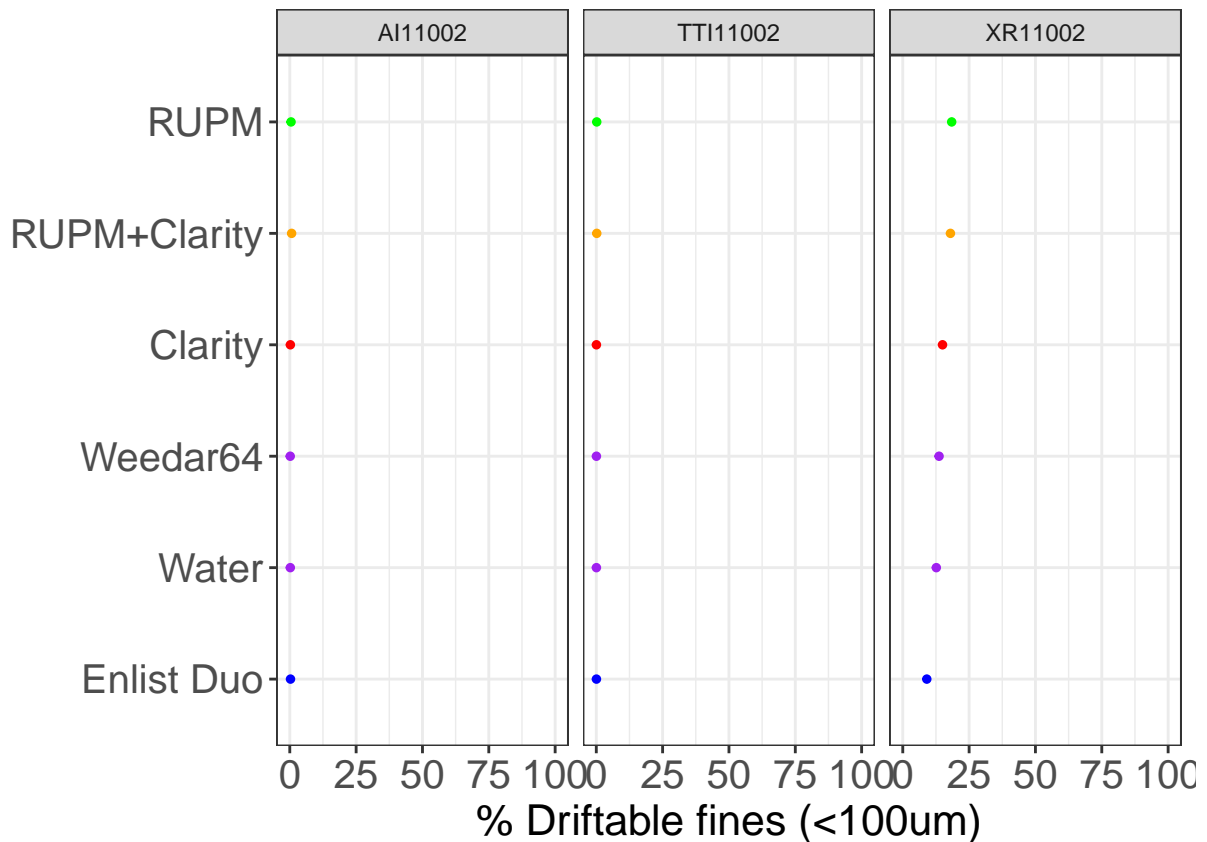
Solution	emmean	SE	df	asympt.LCL	asympt.UCL	.group
RUPM+Clarity	0.001813	1.31e-04	Inf	0.001555	0.002070	a
RUPM	0.001743	1.29e-04	Inf	0.001491	0.001996	a
Enlist Duo	0.000579	7.37e-05	Inf	0.000434	0.000723	b
Clarity	0.000546	7.15e-05	Inf	0.000405	0.000686	b
Weedar64	0.000514	6.94e-05	Inf	0.000378	0.000650	b
Water	0.000478	6.69e-05	Inf	0.000347	0.000610	b

```
## Nozzle = XR11002:
```

Solution	emmean	SE	df	asympt.LCL	asympt.UCL	.group
RUPM	0.184307	1.20e-03	Inf	0.181951	0.186664	a
RUPM+Clarity	0.179664	1.19e-03	Inf	0.177331	0.181997	b

```
## Clarity      0.149775 1.11e-03 Inf  0.147606  0.151944    c
## Weedar64    0.136767 1.07e-03 Inf  0.134678  0.138855    d
## Water       0.126376 1.03e-03 Inf  0.124357  0.128396    e
## Enlist Duo  0.090530 8.90e-04 Inf  0.088786  0.092274    f
##
## Confidence level used: 0.95
## significance level used: alpha = 0.05
```

```
nd100 <- as.data.frame(lsmeans100$emmeans)
ggplot(nd100, aes(x=reorder(Solution,emmean), y=emmean*100, color=Solution)) + facet_grid(~Nozzle) +
geom_point(size=1) + ylim(0,100) +
scale_color_manual(values=c("red", "blue", "green", "orange", "purple", "purple")) +
theme_bw() + labs(y="% Driftable fines (<100um)", x="") +
geom_linerange(aes(ymin = asymp.LCL*100, ymax = asymp.UCL*100), size=1.5) +
theme(axis.title = element_text(size=16),
axis.text = element_text(size=15),
legend.position = "none") +
coord_flip()
```



Driftable fines < 200

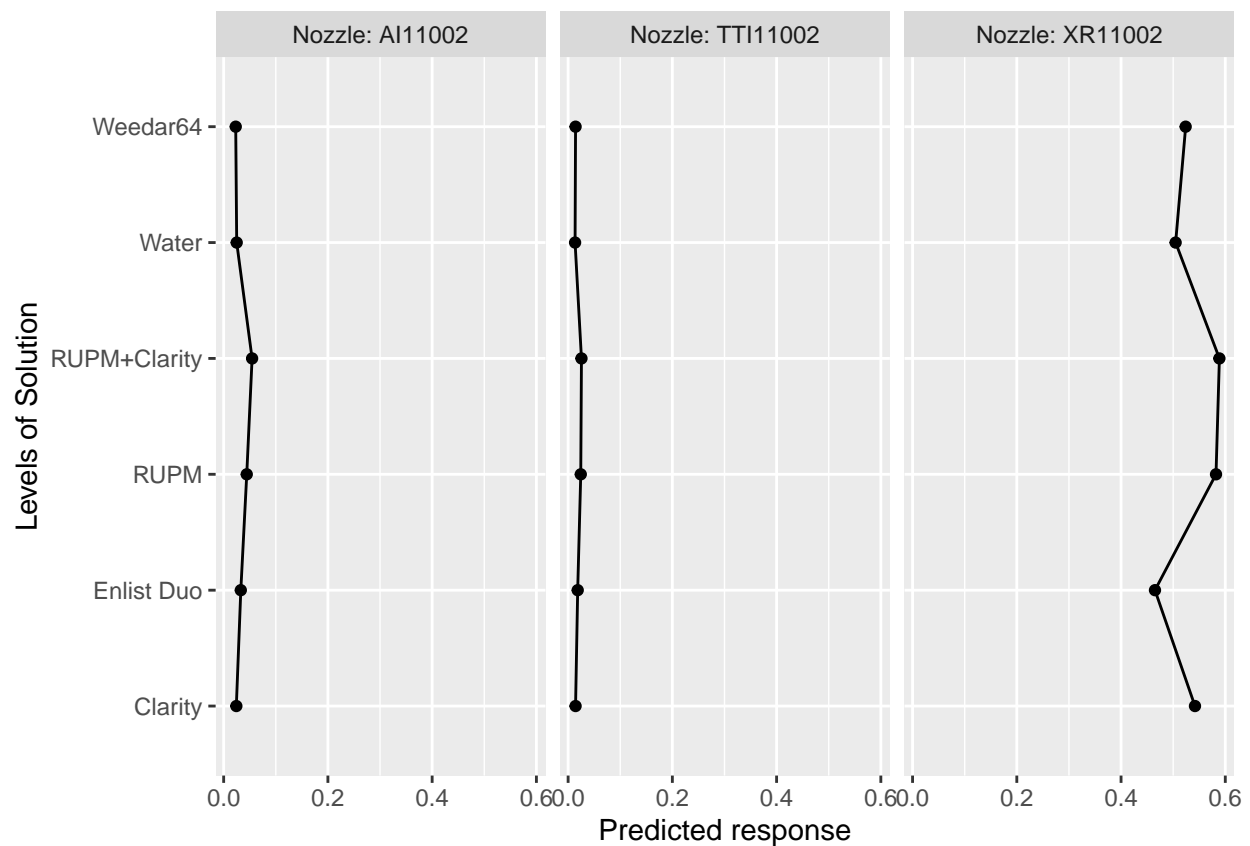
```
model200 <- betareg(Driftable200 ~ Solution * Nozzle, data=nozzle, link = "logit")
```

```
Anova(model200)
```

```
## Analysis of Deviance Table (Type II tests)
```

```
##
## Response: Driftable200
##           Df    Chisq Pr(>Chisq)
## Solution      5   6742.1 < 2.2e-16 ***
## Nozzle        2 377774.7 < 2.2e-16 ***
## Solution:Nozzle 10  1606.9 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmip(model200, ~ Solution | Nozzle, type="response") +
  coord_flip()
```



```
lsmeans200 <- emmeans(model200, ~ Solution | Nozzle, cont="pairwise", adjust="none", type="response", a
lsmeans200
```

```
## $emmeans
## Nozzle = AI11002:
##   Solution      emmean      SE df asymp.LCL asymp.UCL
##   Clarity      0.02430 0.0004653 Inf  0.02339  0.02522
##   Enlist Duo    0.03288 0.0005388 Inf  0.03182  0.03394
##   RUPM          0.04428 0.0006216 Inf  0.04306  0.04549
##   RUPM+Clarity  0.05454 0.0006863 Inf  0.05320  0.05589
##   Water        0.02498 0.0004715 Inf  0.02405  0.02590
##   Weedar64     0.02312 0.0004541 Inf  0.02223  0.02401
```

```

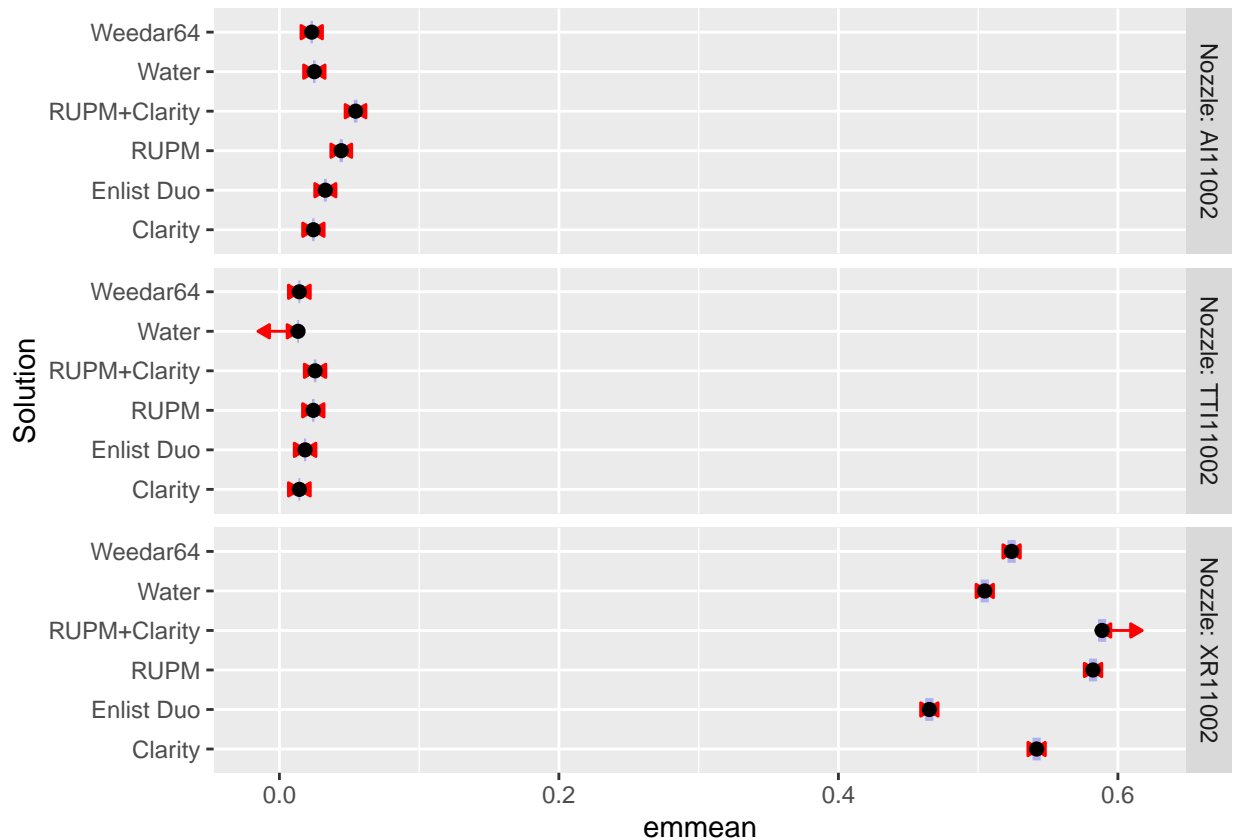
##
## Nozzle = TTI11002:
## Solution      emmean      SE  df asymp.LCL asymp.UCL
## Clarity       0.01428 0.0003584 Inf  0.01358  0.01498
## Enlist Duo    0.01838 0.0004058 Inf  0.01758  0.01918
## RUPM          0.02426 0.0004649 Inf  0.02335  0.02517
## RUPM+Clarity  0.02558 0.0004770 Inf  0.02464  0.02651
## Water         0.01336 0.0003469 Inf  0.01268  0.01404
## Weedar64      0.01428 0.0003584 Inf  0.01357  0.01498
##
## Nozzle = XR11002:
## Solution      emmean      SE  df asymp.LCL asymp.UCL
## Clarity       0.54183 0.0015058 Inf  0.53888  0.54478
## Enlist Duo    0.46507 0.0015074 Inf  0.46211  0.46802
## RUPM          0.58220 0.0014906 Inf  0.57928  0.58512
## RUPM+Clarity  0.58867 0.0014872 Inf  0.58575  0.59158
## Water         0.50470 0.0015111 Inf  0.50174  0.50766
## Weedar64      0.52394 0.0015094 Inf  0.52098  0.52689
##
## Confidence level used: 0.95
##
## $contrasts
## Nozzle = AI11002:
## contrast      estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo -8.57e-03 0.000712 Inf -12.044 <.0001
## Clarity - RUPM        -2.00e-02 0.000776 Inf -25.722 <.0001
## Clarity - RUPM+Clarity -3.02e-02 0.000829 Inf -36.473 <.0001
## Clarity - Water       -6.74e-04 0.000662 Inf -1.017 0.3090
## Clarity - Weedar64    1.18e-03 0.000650 Inf  1.815 0.0695
## Enlist Duo - RUPM     -1.14e-02 0.000823 Inf -13.855 <.0001
## Enlist Duo - RUPM+Clarity -2.17e-02 0.000873 Inf -24.832 <.0001
## Enlist Duo - Water     7.90e-03 0.000716 Inf  11.034 <.0001
## Enlist Duo - Weedar64  9.75e-03 0.000705 Inf  13.843 <.0001
## RUPM - RUPM+Clarity   -1.03e-02 0.000926 Inf -11.090 <.0001
## RUPM - Water          1.93e-02 0.000780 Inf  24.734 <.0001
## RUPM - Weedar64       2.12e-02 0.000770 Inf  27.477 <.0001
## RUPM+Clarity - Water  2.96e-02 0.000833 Inf  35.510 <.0001
## RUPM+Clarity - Weedar64 3.14e-02 0.000823 Inf  38.183 <.0001
## Water - Weedar64      1.85e-03 0.000655 Inf  2.832 0.0046
##
## Nozzle = TTI11002:
## contrast      estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo -4.10e-03 0.000541 Inf -7.576 <.0001
## Clarity - RUPM        -9.98e-03 0.000587 Inf -17.005 <.0001
## Clarity - RUPM+Clarity -1.13e-02 0.000597 Inf -18.938 <.0001
## Clarity - Water       9.16e-04 0.000499 Inf  1.837 0.0662
## Clarity - Weedar64    1.39e-06 0.000507 Inf  0.003 0.9978
## Enlist Duo - RUPM     -5.88e-03 0.000617 Inf -9.528 <.0001
## Enlist Duo - RUPM+Clarity -7.20e-03 0.000626 Inf -11.493 <.0001
## Enlist Duo - Water     5.02e-03 0.000534 Inf  9.400 <.0001
## Enlist Duo - Weedar64  4.10e-03 0.000541 Inf  7.579 <.0001
## RUPM - RUPM+Clarity   -1.32e-03 0.000666 Inf -1.979 0.0478
## RUPM - Water          1.09e-02 0.000580 Inf  18.789 <.0001
## RUPM - Weedar64       9.98e-03 0.000587 Inf  17.007 <.0001

```



```
## RUPM+Clarity - Water      1.22e-02 0.000590 Inf  20.712 <.0001
## RUPM+Clarity - Weedar64   1.13e-02 0.000597 Inf  18.941 <.0001
## Water - Weedar64         -9.15e-04 0.000499 Inf   -1.834 0.0666
##
## Nozzle = XR11002:
## contrast      estimate      SE  df z.ratio p.value
## Clarity - Enlist Duo    7.68e-02 0.002131 Inf  36.028 <.0001
## Clarity - RUPM          -4.04e-02 0.002119 Inf -19.051 <.0001
## Clarity - RUPM+Clarity  -4.68e-02 0.002116 Inf -22.128 <.0001
## Clarity - Water         3.71e-02 0.002133 Inf  17.407 <.0001
## Clarity - Weedar64      1.79e-02 0.002132 Inf   8.394 <.0001
## Enlist Duo - RUPM       -1.17e-01 0.002120 Inf -55.252 <.0001
## Enlist Duo - RUPM+Clarity -1.24e-01 0.002118 Inf -58.368 <.0001
## Enlist Duo - Water      -3.96e-02 0.002134 Inf -18.569 <.0001
## Enlist Duo - Weedar64   -5.89e-02 0.002133 Inf -27.596 <.0001
## RUPM - RUPM+Clarity     -6.47e-03 0.002106 Inf  -3.071 0.0021
## RUPM - Water            7.75e-02 0.002123 Inf  36.513 <.0001
## RUPM - Weedar64         5.83e-02 0.002121 Inf  27.465 <.0001
## RUPM+Clarity - Water    8.40e-02 0.002120 Inf  39.604 <.0001
## RUPM+Clarity - Weedar64  6.47e-02 0.002119 Inf  30.548 <.0001
## Water - Weedar64       -1.92e-02 0.002136 Inf   -9.006 <.0001
```

```
plot(lsmmeans200, comparisons=TRUE, type="response", alpha=0.05, adjust="none")
```



```
cld200 <-CLD(lsmmeans200, alpha=0.05, Letters=letters, adjust="none", reversed = TRUE)
```

```
cld200
```

```
## Nozzle = AI11002:
```

Solution	emmean	SE	df	asympt.LCL	asympt.UCL	.group
RUPM+Clarity	0.05454	0.0006863	Inf	0.05320	0.05589	a
RUPM	0.04428	0.0006216	Inf	0.04306	0.04549	b
Enlist Duo	0.03288	0.0005388	Inf	0.03182	0.03394	c
Water	0.02498	0.0004715	Inf	0.02405	0.02590	d
Clarity	0.02430	0.0004653	Inf	0.02339	0.02522	de
Weedar64	0.02312	0.0004541	Inf	0.02223	0.02401	e

```
##
```

```
## Nozzle = TTI11002:
```

Solution	emmean	SE	df	asympt.LCL	asympt.UCL	.group
RUPM+Clarity	0.02558	0.0004770	Inf	0.02464	0.02651	a
RUPM	0.02426	0.0004649	Inf	0.02335	0.02517	b
Enlist Duo	0.01838	0.0004058	Inf	0.01758	0.01918	c
Clarity	0.01428	0.0003584	Inf	0.01358	0.01498	d
Weedar64	0.01428	0.0003584	Inf	0.01357	0.01498	d
Water	0.01336	0.0003469	Inf	0.01268	0.01404	d

```
##
```

```
## Nozzle = XR11002:
```

Solution	emmean	SE	df	asympt.LCL	asympt.UCL	.group
RUPM+Clarity	0.58867	0.0014872	Inf	0.58575	0.59158	a
RUPM	0.58220	0.0014906	Inf	0.57928	0.58512	b
Clarity	0.54183	0.0015058	Inf	0.53888	0.54478	c
Weedar64	0.52394	0.0015094	Inf	0.52098	0.52689	d
Water	0.50470	0.0015111	Inf	0.50174	0.50766	e
Enlist Duo	0.46507	0.0015074	Inf	0.46211	0.46802	f

```
##
```

```
## Confidence level used: 0.95
```

```
## significance level used: alpha = 0.05
```

```
nd200 <- as.data.frame(lsmmeans200$emmeans)
```

```
ggplot(nd200, aes(x=reorder(Solution,emmean), y=emmean*100, color=Solution)) + facet_grid(~Nozzle) +
  geom_point(size=1) + ylim(0,100) +
  scale_color_manual(values=c("red", "blue", "green", "orange", "purple", "purple")) +
  theme_bw() + labs(y="% Driftable fines (<200um)", x="") +
  geom_linerange(aes(ymin = asympt.LCL*100, ymax = asympt.UCL*100), size=1.5) +
  theme(axis.title = element_text(size=16),
        axis.text = element_text(size=15),
        legend.position = "none") +
  coord_flip()
```

