

Estudos no tunel baixo

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```
dat14 <- read_csv("data_14dat.csv") %>%
  pivot_longer(cols=6:20, names_to = "distance", values_to = "injury")

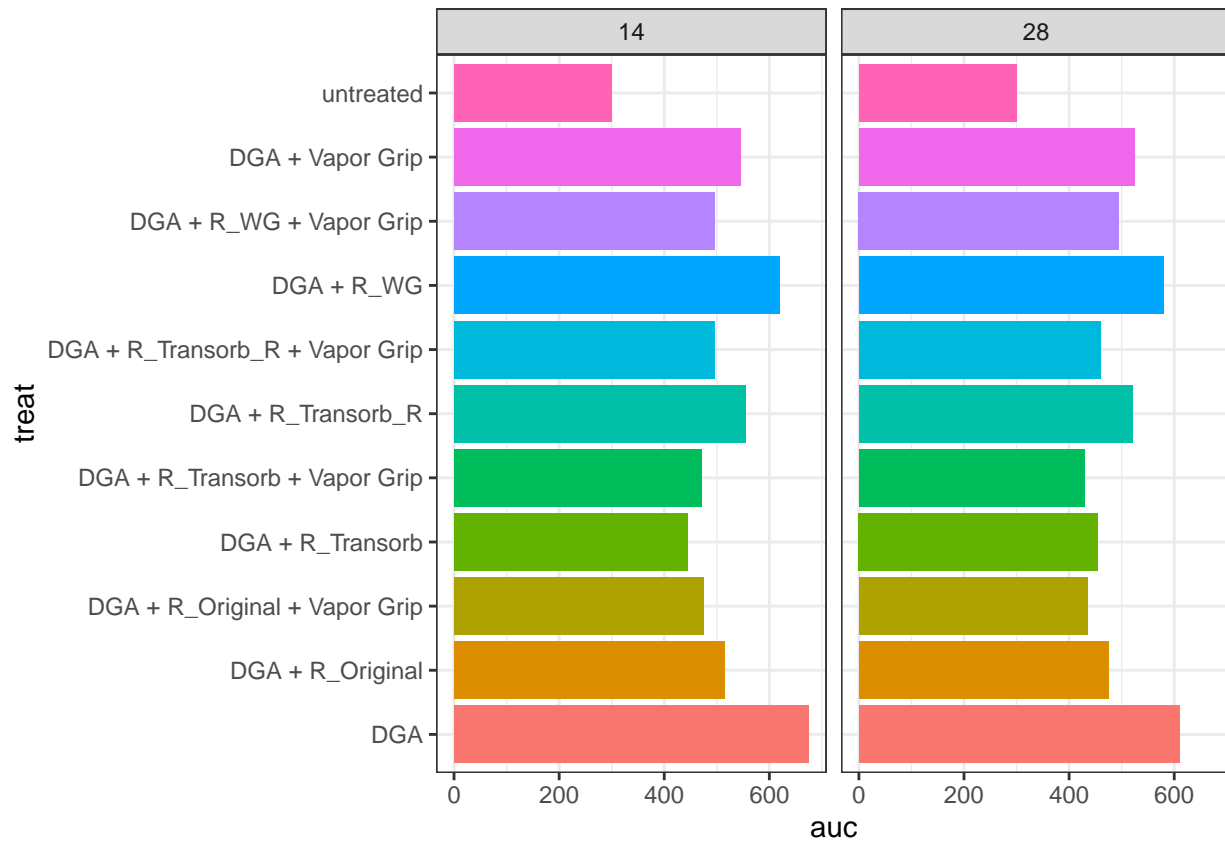
dat28 <- read_csv("data_28dat.csv") %>%
  pivot_longer(cols=6:20, names_to = "distance", values_to = "injury")

data <- bind_rows(dat14, dat28) %>%
  mutate(distance = as.double(distance)) %>%
  mutate_if(is.character, factor) %>%
  mutate(dat = factor(dat),
         unit = factor(unit))

Data = data %>%
  filter(unit=="88")
#plot(Data$distance, Data$injury)
audps(Data$injury, Data$distance, type="absolute")

## evaluation
##      460

data %>%
  ggplot(aes(x=treat, y=auc, fill=treat)) + geom_bar(stat = "summary", show.legend = FALSE) +
  facet_grid(~ dat) + theme_bw() + coord_flip() +
  scale_color_brewer(palette = "Paired") +
  ggsave("Figure.png", height=6, width=12)
```



```

dat <- data %>%
  mutate(auc = (auc / 100) - 3) %>%
  filter(treat != "untreated")

bartlett.test(auc ~ treat, data=dat)

##
## Bartlett test of homogeneity of variances
##
## data: auc by treat
## Bartlett's K-squared = 148.01, df = 9, p-value < 2.2e-16

leveneTest(auc ~ treat, data=dat)

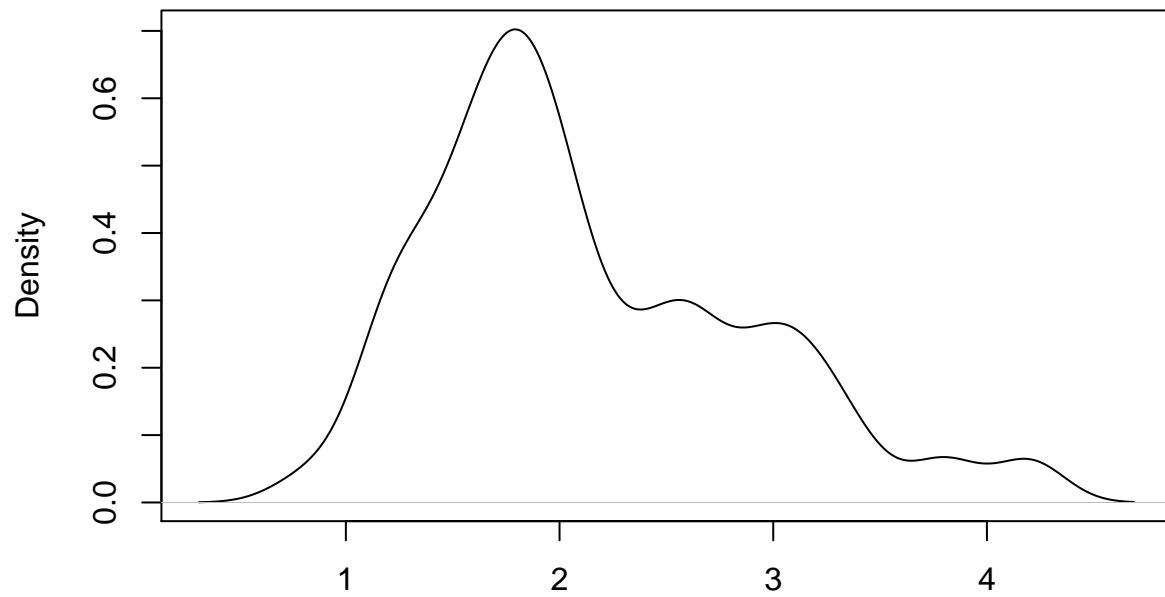
## Levene's Test for Homogeneity of Variance (center = median)
##      Df F value    Pr(>F)
## group  9 12.828 < 2.2e-16 ***
##      1190
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

dat <- dat %>%
  mutate(tauc = sqrt(auc))

plot(density(dat$auc))

```

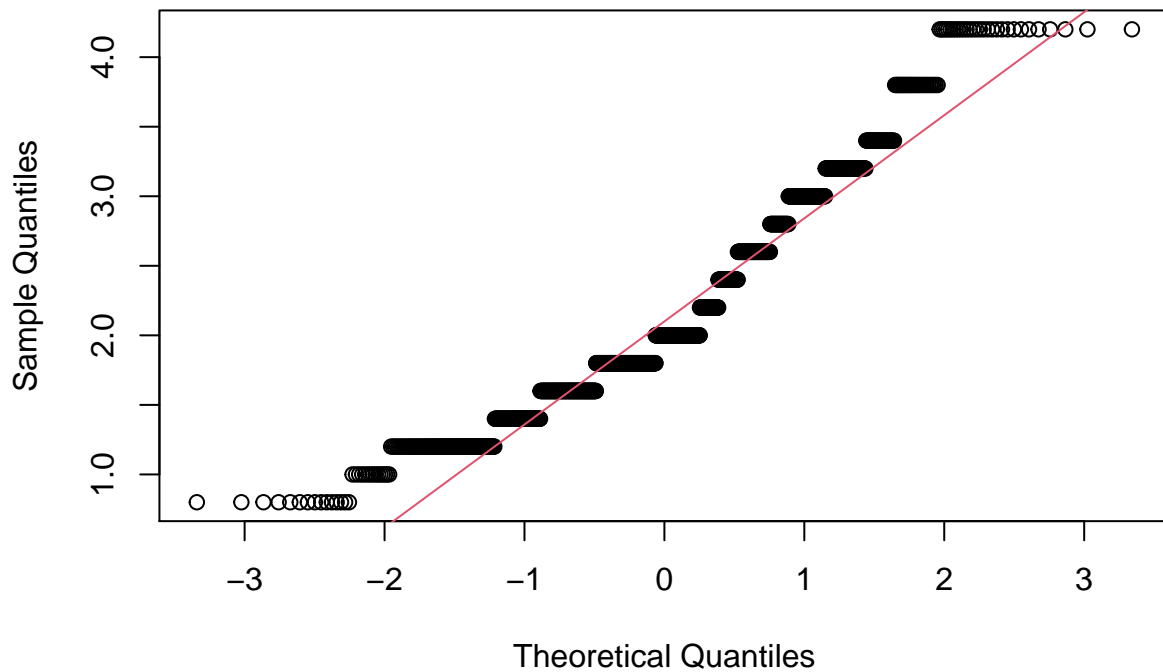
density.default(x = dat\$auc)



N = 1200 Bandwidth = 0.1627

```
qqnorm(dat$auc); qqline(dat$auc, col=2)
```

Normal Q-Q Plot



```
#pearson.test(dat$auc)
#leveneTest(auc ~ TrtDes, data=Data2)

#ggdensity(dat$auc, Main = "Density Plot", xlab = "AUDPS")

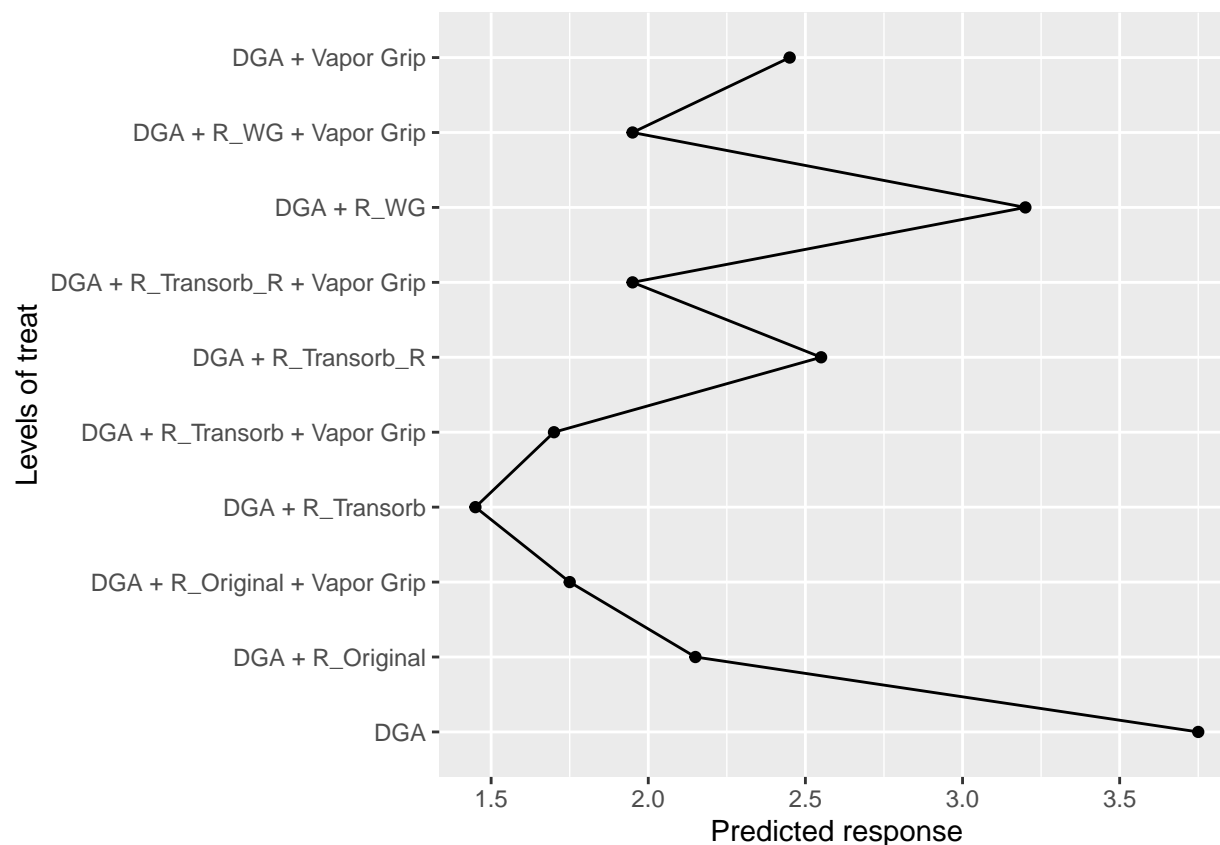
#model using sqrt transformation

dat14 <- dat %>% filter(dat == "14")

model=lmer(auc ~ treat + (1|rep), data=dat14)
anova(model, test.statistic = "F")

## Type III Analysis of Variance Table with Satterthwaite's method
##      Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## treat 278.94  30.993     9   587  165.78 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

emmip(model, ~ treat, type="response") + coord_flip()
```



```
lsmeans <- emmeans(model, ~ treat, adjust="none", contr="pairwise")
lsmeans
```

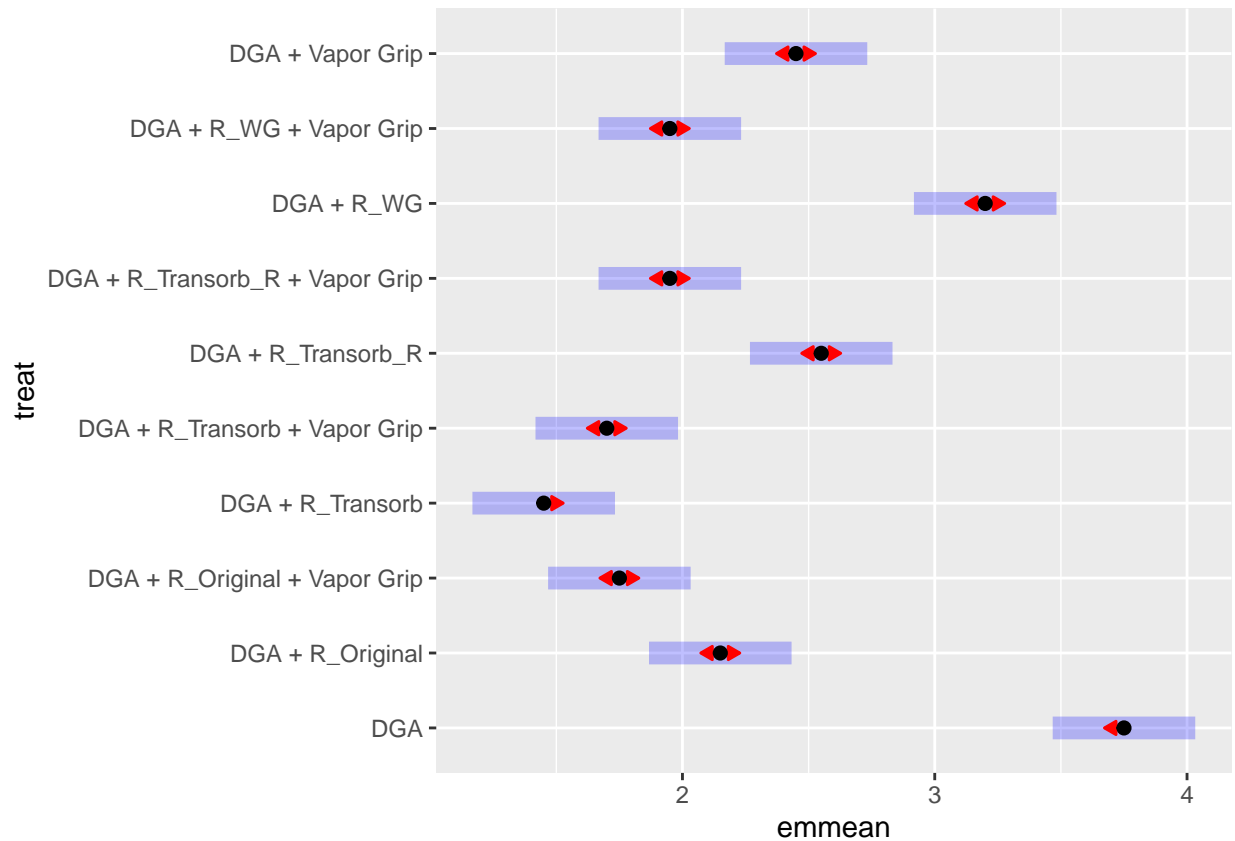
```
## $emmeans
##      treat      emmean    SE    df lower.CL upper.CL
##  DGA              3.75 0.11  5.06     3.47     4.03
##  DGA + R_Original    2.15 0.11  5.06     1.87     2.43
##  DGA + R_Original + Vapor Grip  1.75 0.11  5.06     1.47     2.03
##  DGA + R_Transorb    1.45 0.11  5.06     1.17     1.73
##  DGA + R_Transorb + Vapor Grip  1.70 0.11  5.06     1.42     1.98
##  DGA + R_Transorb_R    2.55 0.11  5.06     2.27     2.83
##  DGA + R_Transorb_R + Vapor Grip  1.95 0.11  5.06     1.67     2.23
##  DGA + R_WG          3.20 0.11  5.06     2.92     3.48
##  DGA + R_WG + Vapor Grip  1.95 0.11  5.06     1.67     2.23
##  DGA + Vapor Grip    2.45 0.11  5.06     2.17     2.73
##
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
##
## $contrasts
##      contrast      estimate
##  DGA - (DGA + R_Original)      1.60
##  DGA - (DGA + R_Original + Vapor Grip)  2.00
##  DGA - (DGA + R_Transorb)      2.30
##  DGA - (DGA + R_Transorb + Vapor Grip)  2.05
##  DGA - (DGA + R_Transorb_R)      1.20
##  DGA - (DGA + R_Transorb_R + Vapor Grip)  1.80
```

##	DGA - (DGA + R_WG)	0.55
##	DGA - (DGA + R_WG + Vapor Grip)	1.80
##	DGA - (DGA + Vapor Grip)	1.30
##	(DGA + R_Original) - (DGA + R_Original + Vapor Grip)	0.40
##	(DGA + R_Original) - (DGA + R_Transorb)	0.70
##	(DGA + R_Original) - (DGA + R_Transorb + Vapor Grip)	0.45
##	(DGA + R_Original) - (DGA + R_Transorb_R)	-0.40
##	(DGA + R_Original) - (DGA + R_Transorb_R + Vapor Grip)	0.20
##	(DGA + R_Original) - (DGA + R_WG)	-1.05
##	(DGA + R_Original) - (DGA + R_WG + Vapor Grip)	0.20
##	(DGA + R_Original) - (DGA + Vapor Grip)	-0.30
##	(DGA + R_Original + Vapor Grip) - (DGA + R_Transorb)	0.30
##	(DGA + R_Original + Vapor Grip) - (DGA + R_Transorb + Vapor Grip)	0.05
##	(DGA + R_Original + Vapor Grip) - (DGA + R_Transorb_R)	-0.80
##	(DGA + R_Original + Vapor Grip) - (DGA + R_Transorb_R + Vapor Grip)	-0.20
##	(DGA + R_Original + Vapor Grip) - (DGA + R_WG)	-1.45
##	(DGA + R_Original + Vapor Grip) - (DGA + R_WG + Vapor Grip)	-0.20
##	(DGA + R_Original + Vapor Grip) - (DGA + Vapor Grip)	-0.70
##	(DGA + R_Transorb) - (DGA + R_Transorb + Vapor Grip)	-0.25
##	(DGA + R_Transorb) - (DGA + R_Transorb_R)	-1.10
##	(DGA + R_Transorb) - (DGA + R_Transorb_R + Vapor Grip)	-0.50
##	(DGA + R_Transorb) - (DGA + R_WG)	-1.75
##	(DGA + R_Transorb) - (DGA + R_WG + Vapor Grip)	-0.50
##	(DGA + R_Transorb) - (DGA + Vapor Grip)	-1.00
##	(DGA + R_Transorb + Vapor Grip) - (DGA + R_Transorb_R)	-0.85
##	(DGA + R_Transorb + Vapor Grip) - (DGA + R_Transorb_R + Vapor Grip)	-0.25
##	(DGA + R_Transorb + Vapor Grip) - (DGA + R_WG)	-1.50
##	(DGA + R_Transorb + Vapor Grip) - (DGA + R_WG + Vapor Grip)	-0.25
##	(DGA + R_Transorb + Vapor Grip) - (DGA + Vapor Grip)	-0.75
##	(DGA + R_Transorb_R) - (DGA + R_Transorb_R + Vapor Grip)	0.60
##	(DGA + R_Transorb_R) - (DGA + R_WG)	-0.65
##	(DGA + R_Transorb_R) - (DGA + R_WG + Vapor Grip)	0.60
##	(DGA + R_Transorb_R) - (DGA + Vapor Grip)	0.10
##	(DGA + R_Transorb_R + Vapor Grip) - (DGA + R_WG)	-1.25
##	(DGA + R_Transorb_R + Vapor Grip) - (DGA + R_WG + Vapor Grip)	0.00
##	(DGA + R_Transorb_R + Vapor Grip) - (DGA + Vapor Grip)	-0.50
##	(DGA + R_WG) - (DGA + R_WG + Vapor Grip)	1.25
##	(DGA + R_WG) - (DGA + Vapor Grip)	0.75
##	(DGA + R_WG + Vapor Grip) - (DGA + Vapor Grip)	-0.50
##	SE df t.ratio p.value	
##	0.0789 587 20.268 <.0001	
##	0.0789 587 25.335 <.0001	
##	0.0789 587 29.136 <.0001	
##	0.0789 587 25.969 <.0001	
##	0.0789 587 15.201 <.0001	
##	0.0789 587 22.802 <.0001	
##	0.0789 587 6.967 <.0001	
##	0.0789 587 22.802 <.0001	
##	0.0789 587 16.468 <.0001	
##	0.0789 587 5.067 <.0001	
##	0.0789 587 8.867 <.0001	
##	0.0789 587 5.700 <.0001	
##	0.0789 587 -5.067 <.0001	
##	0.0789 587 2.534 0.0116	

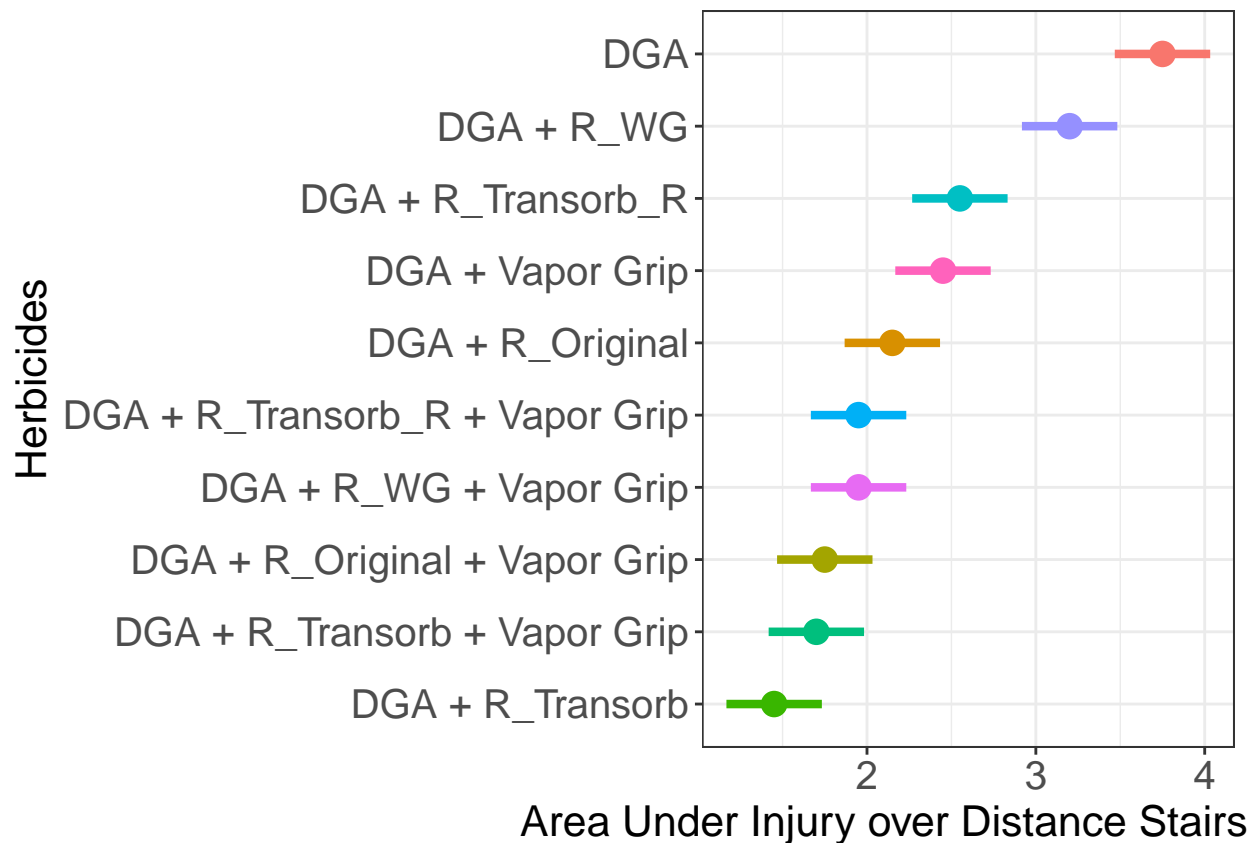
```

## 0.0789 587 -13.301 <.0001
## 0.0789 587 2.534 0.0116
## 0.0789 587 -3.800 0.0002
## 0.0789 587 3.800 0.0002
## 0.0789 587 0.633 0.5267
## 0.0789 587 -10.134 <.0001
## 0.0789 587 -2.534 0.0116
## 0.0789 587 -18.368 <.0001
## 0.0789 587 -2.534 0.0116
## 0.0789 587 -8.867 <.0001
## 0.0789 587 -3.167 0.0016
## 0.0789 587 -13.934 <.0001
## 0.0789 587 -6.334 <.0001
## 0.0789 587 -22.168 <.0001
## 0.0789 587 -6.334 <.0001
## 0.0789 587 -12.668 <.0001
## 0.0789 587 -10.768 <.0001
## 0.0789 587 -3.167 0.0016
## 0.0789 587 -19.002 <.0001
## 0.0789 587 -3.167 0.0016
## 0.0789 587 -9.501 <.0001
## 0.0789 587 7.601 <.0001
## 0.0789 587 -8.234 <.0001
## 0.0789 587 7.601 <.0001
## 0.0789 587 1.267 0.2057
## 0.0789 587 -15.835 <.0001
## 0.0789 587 0.000 1.0000
## 0.0789 587 -6.334 <.0001
## 0.0789 587 15.835 <.0001
## 0.0789 587 9.501 <.0001
## 0.0789 587 -6.334 <.0001
##
## Degrees-of-freedom method: kenward-roger
plot(lsmeans, ~ herbicide, comparisons=TRUE, alpha=0.05, adjust="none")

```



```
nd <- as.data.frame(lsmmeans$emmeans)
ggplot(nd, aes(x=reorder(treat,emmean), y=emmean, color=treat)) +
  geom_point(size=4) +
  #scale_color_manual(values=c("red", "blue", "green", "orange", "purple")) +
  theme_bw() + labs(y="Area Under Injury over Distance Stairs (AUIDS)", x="Herbicides") +
  geom_linerange(aes(ymin = lower.CL, ymax = upper.CL), size=1.5) +
  theme(axis.title = element_text(size=16),
        axis.text = element_text(size=15),
        legend.position = "none") +
  coord_flip() +
  ggsave("injury_auc_14.png", units="in", width=10, height=6, dpi=600)
```

```
cld <- CLD(lsmmeans$emmeans, alpha=0.05, Letters=letters, adjust="none", reversed = TRUE)
```

```
cld
```

```
## treat          emmean  SE   df lower.CL upper.CL .group
## DGA             3.75 0.11 5.06    3.47    4.03    a
## DGA + R_WG       3.20 0.11 5.06    2.92    3.48    b
## DGA + R_Transorb_R 2.55 0.11 5.06    2.27    2.83    c
## DGA + Vapor Grip 2.45 0.11 5.06    2.17    2.73    c
## DGA + R_Original 2.15 0.11 5.06    1.87    2.43    d
## DGA + R_Transorb_R + Vapor Grip 1.95 0.11 5.06    1.67    2.23    e
## DGA + R_WG + Vapor Grip 1.95 0.11 5.06    1.67    2.23    e
## DGA + R_Original + Vapor Grip 1.75 0.11 5.06    1.47    2.03    f
## DGA + R_Transorb + Vapor Grip 1.70 0.11 5.06    1.42    1.98    f
## DGA + R_Transorb 1.45 0.11 5.06    1.17    1.73    g
```

```
## Degrees-of-freedom method: kenward-roger
```

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

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

```
#model using sqrt transformation
```

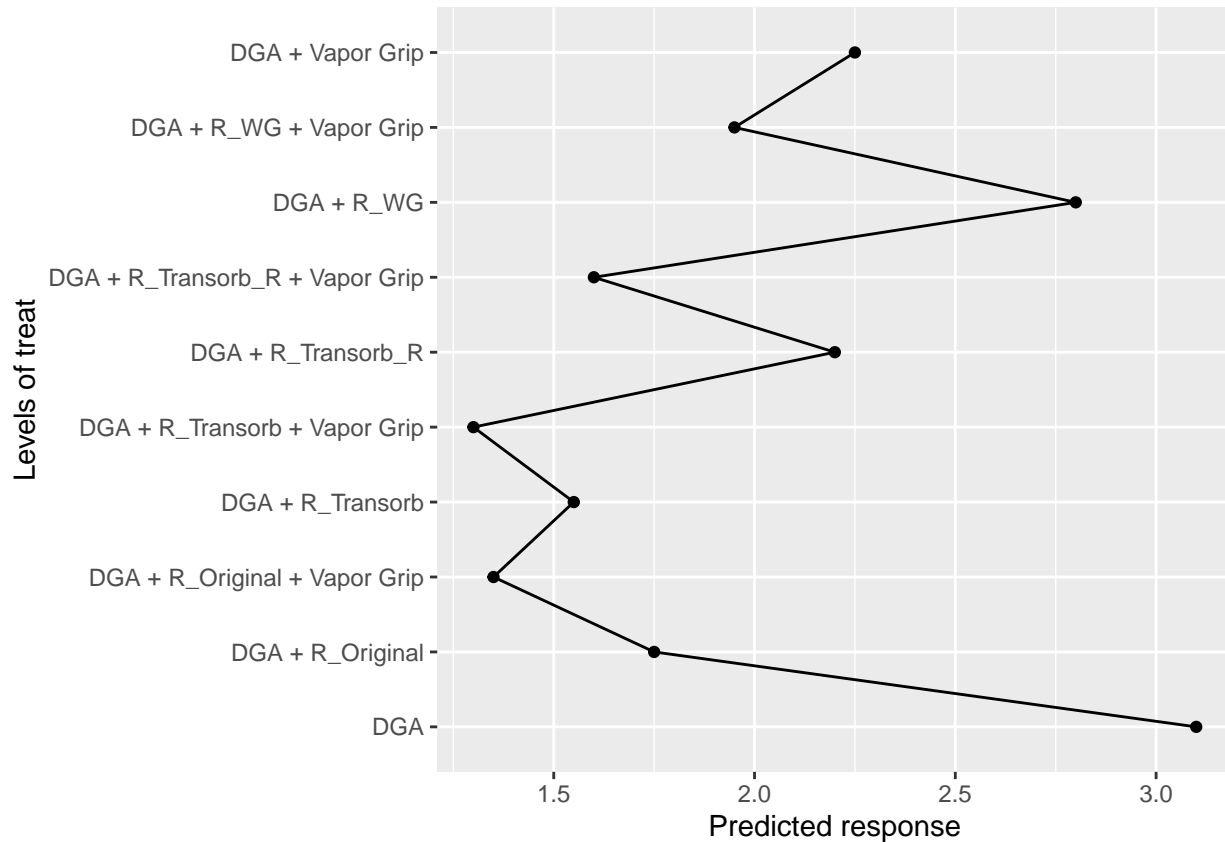
```
dat28 <- dat %>% filter(dat == "28")
```

```
model=lmer(auc ~ treat + (1|rep), data=dat28)
```

```
anova(model, test.statistic = "F")
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##      Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## treat 197.41  21.935     9   587  375.99 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmip(model, ~ treat, type="response") + coord_flip()
```



```
lsmeans <- emmeans(model, ~ treat, adjust="none", contr="pairwise")
lsmeans
```

```
## $emmeans
##      treat      emmean    SE    df lower.CL upper.CL
## DGA      3.10 0.0988 3.62    2.81    3.39
## DGA + R_Original 1.75 0.0988 3.62    1.46    2.04
## DGA + R_Original + Vapor Grip 1.35 0.0988 3.62    1.06    1.64
## DGA + R_Transorb 1.55 0.0988 3.62    1.26    1.84
## DGA + R_Transorb + Vapor Grip 1.30 0.0988 3.62    1.01    1.59
## DGA + R_Transorb_R 2.20 0.0988 3.62    1.91    2.49
## DGA + R_Transorb_R + Vapor Grip 1.60 0.0988 3.62    1.31    1.89
## DGA + R_WG      2.80 0.0988 3.62    2.51    3.09
## DGA + R_WG + Vapor Grip 1.95 0.0988 3.62    1.66    2.24
## DGA + Vapor Grip 2.25 0.0988 3.62    1.96    2.54
##
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
##
```

```

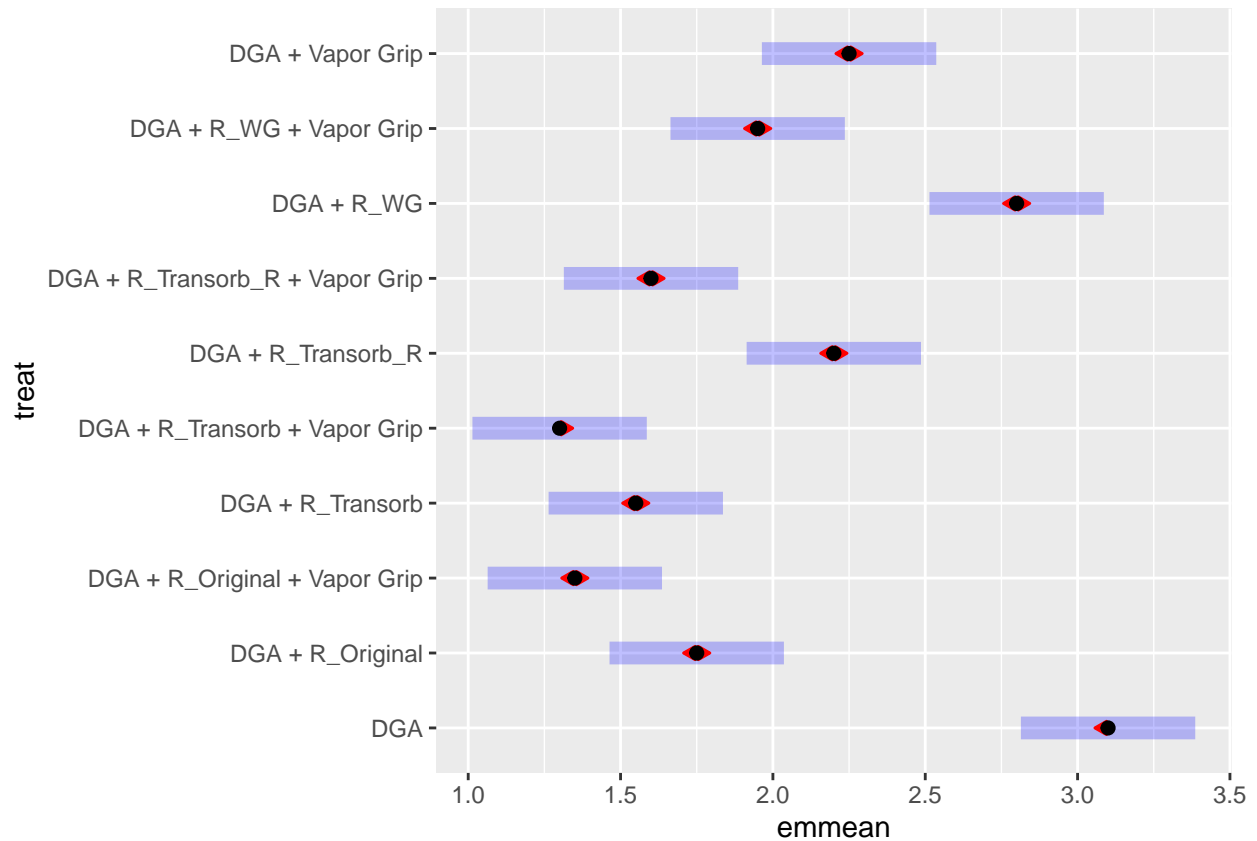
## $contrasts
## contrast estimate
## DGA - (DGA + R_Original) 1.35
## DGA - (DGA + R_Original + Vapor Grip) 1.75
## DGA - (DGA + R_Transorb) 1.55
## DGA - (DGA + R_Transorb + Vapor Grip) 1.80
## DGA - (DGA + R_Transorb_R) 0.90
## DGA - (DGA + R_Transorb_R + Vapor Grip) 1.50
## DGA - (DGA + R_WG) 0.30
## DGA - (DGA + R_WG + Vapor Grip) 1.15
## DGA - (DGA + Vapor Grip) 0.85
## (DGA + R_Original) - (DGA + R_Original + Vapor Grip) 0.40
## (DGA + R_Original) - (DGA + R_Transorb) 0.20
## (DGA + R_Original) - (DGA + R_Transorb + Vapor Grip) 0.45
## (DGA + R_Original) - (DGA + R_Transorb_R) -0.45
## (DGA + R_Original) - (DGA + R_Transorb_R + Vapor Grip) 0.15
## (DGA + R_Original) - (DGA + R_WG) -1.05
## (DGA + R_Original) - (DGA + R_WG + Vapor Grip) -0.20
## (DGA + R_Original) - (DGA + Vapor Grip) -0.50
## (DGA + R_Original + Vapor Grip) - (DGA + R_Transorb) -0.20
## (DGA + R_Original + Vapor Grip) - (DGA + R_Transorb + Vapor Grip) 0.05
## (DGA + R_Original + Vapor Grip) - (DGA + R_Transorb_R) -0.85
## (DGA + R_Original + Vapor Grip) - (DGA + R_Transorb_R + Vapor Grip) -0.25
## (DGA + R_Original + Vapor Grip) - (DGA + R_WG) -1.45
## (DGA + R_Original + Vapor Grip) - (DGA + R_WG + Vapor Grip) -0.60
## (DGA + R_Original + Vapor Grip) - (DGA + Vapor Grip) -0.90
## (DGA + R_Transorb) - (DGA + R_Transorb + Vapor Grip) 0.25
## (DGA + R_Transorb) - (DGA + R_Transorb_R) -0.65
## (DGA + R_Transorb) - (DGA + R_Transorb_R + Vapor Grip) -0.05
## (DGA + R_Transorb) - (DGA + R_WG) -1.25
## (DGA + R_Transorb) - (DGA + R_WG + Vapor Grip) -0.40
## (DGA + R_Transorb) - (DGA + Vapor Grip) -0.70
## (DGA + R_Transorb + Vapor Grip) - (DGA + R_Transorb_R) -0.90
## (DGA + R_Transorb + Vapor Grip) - (DGA + R_Transorb_R + Vapor Grip) -0.30
## (DGA + R_Transorb + Vapor Grip) - (DGA + R_WG) -1.50
## (DGA + R_Transorb + Vapor Grip) - (DGA + R_WG + Vapor Grip) -0.65
## (DGA + R_Transorb + Vapor Grip) - (DGA + Vapor Grip) -0.95
## (DGA + R_Transorb_R) - (DGA + R_Transorb_R + Vapor Grip) 0.60
## (DGA + R_Transorb_R) - (DGA + R_WG) -0.60
## (DGA + R_Transorb_R) - (DGA + R_WG + Vapor Grip) 0.25
## (DGA + R_Transorb_R) - (DGA + Vapor Grip) -0.05
## (DGA + R_Transorb_R + Vapor Grip) - (DGA + R_WG) -1.20
## (DGA + R_Transorb_R + Vapor Grip) - (DGA + R_WG + Vapor Grip) -0.35
## (DGA + R_Transorb_R + Vapor Grip) - (DGA + Vapor Grip) -0.65
## (DGA + R_WG) - (DGA + R_WG + Vapor Grip) 0.85
## (DGA + R_WG) - (DGA + Vapor Grip) 0.55
## (DGA + R_WG + Vapor Grip) - (DGA + Vapor Grip) -0.30
## SE df t.ratio p.value
## 0.0441 587 30.614 <.0001
## 0.0441 587 39.684 <.0001
## 0.0441 587 35.149 <.0001
## 0.0441 587 40.818 <.0001
## 0.0441 587 20.409 <.0001
## 0.0441 587 34.015 <.0001

```

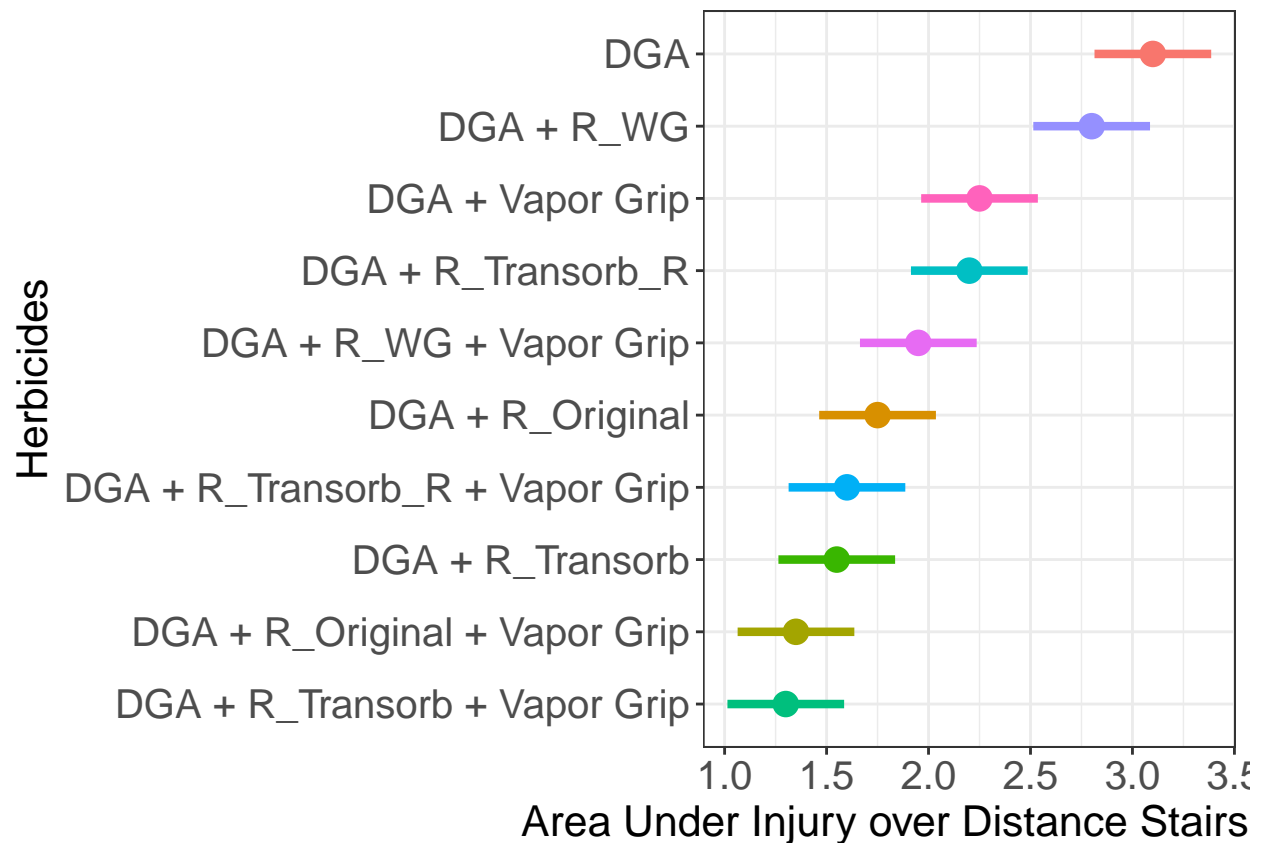
```

## 0.0441 587 6.803 <.0001
## 0.0441 587 26.078 <.0001
## 0.0441 587 19.275 <.0001
## 0.0441 587 9.071 <.0001
## 0.0441 587 4.535 <.0001
## 0.0441 587 10.205 <.0001
## 0.0441 587 -10.205 <.0001
## 0.0441 587 3.402 0.0007
## 0.0441 587 -23.811 <.0001
## 0.0441 587 -4.535 <.0001
## 0.0441 587 -11.338 <.0001
## 0.0441 587 -4.535 <.0001
## 0.0441 587 1.134 0.2573
## 0.0441 587 -19.275 <.0001
## 0.0441 587 -5.669 <.0001
## 0.0441 587 -32.881 <.0001
## 0.0441 587 -13.606 <.0001
## 0.0441 587 -20.409 <.0001
## 0.0441 587 5.669 <.0001
## 0.0441 587 -14.740 <.0001
## 0.0441 587 -1.134 0.2573
## 0.0441 587 -28.346 <.0001
## 0.0441 587 -9.071 <.0001
## 0.0441 587 -15.874 <.0001
## 0.0441 587 -20.409 <.0001
## 0.0441 587 -6.803 <.0001
## 0.0441 587 -34.015 <.0001
## 0.0441 587 -14.740 <.0001
## 0.0441 587 -21.543 <.0001
## 0.0441 587 13.606 <.0001
## 0.0441 587 -13.606 <.0001
## 0.0441 587 5.669 <.0001
## 0.0441 587 -1.134 0.2573
## 0.0441 587 -27.212 <.0001
## 0.0441 587 -7.937 <.0001
## 0.0441 587 -14.740 <.0001
## 0.0441 587 19.275 <.0001
## 0.0441 587 12.472 <.0001
## 0.0441 587 -6.803 <.0001
##
## Degrees-of-freedom method: kenward-roger
plot(lsmmeans, ~ herbicide, comparisons=TRUE, alpha=0.05, adjust="none")

```



```
nd <- as.data.frame(lsmmeans$emmeans)
ggplot(nd, aes(x=reorder(treat,emmean), y=emmean, color=treat)) +
  geom_point(size=4) +
  #scale_color_manual(values=c("red", "blue", "green", "orange", "purple")) +
  theme_bw() + labs(y="Area Under Injury over Distance Stairs (AUIDS)", x="Herbicides") +
  geom_linerange(aes(ymin = lower.CL, ymax = upper.CL), size=1.5) +
  theme(axis.title = element_text(size=16),
        axis.text = element_text(size=15),
        legend.position = "none") +
  coord_flip() +
  ggsave("injury_auc_28.png", units="in", width=10, height=6, dpi=600)
```



```
cld <-CLD(lsmmeans$emmeans, alpha=0.05, Letters=letters, adjust="none", reversed = TRUE)
```

```
cld
```

```
## treat          emmean      SE    df lower.CL upper.CL .group
## DGA              3.10 0.0988 3.62     2.81     3.39      a
## DGA + R_WG        2.80 0.0988 3.62     2.51     3.09      b
## DGA + Vapor Grip  2.25 0.0988 3.62     1.96     2.54      c
## DGA + R_Transorb_R 2.20 0.0988 3.62     1.91     2.49      c
## DGA + R_WG + Vapor Grip 1.95 0.0988 3.62     1.66     2.24      d
## DGA + R_Original  1.75 0.0988 3.62     1.46     2.04      e
## DGA + R_Transorb_R + Vapor Grip 1.60 0.0988 3.62     1.31     1.89      f
## DGA + R_Transorb  1.55 0.0988 3.62     1.26     1.84      f
## DGA + R_Original + Vapor Grip 1.35 0.0988 3.62     1.06     1.64      g
## DGA + R_Transorb + Vapor Grip 1.30 0.0988 3.62     1.01     1.59      g
##
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
## significance level used: alpha = 0.05
```