### 3. Fitting additional models using DI()

#### Fitting more flexible models using DI() function

##### Adding interaction of treatment with each species ID effect

$$y =β\_{1}P\_{1}+β\_{2}P\_{2}+β\_{3}P\_{3}+β\_{4}P\_{4}+ω\_{GL}\left[\left(P\_{1}+P\_{2}\right)\left(P\_{3}+P\_{4}\right)\right]+ω\_{G}\left(P\_{1}P\_{2}\right)+ω\_{L}\left(P\_{3}P\_{4}\right)+$$

$$β\_{1}^{'}P\_{1}X\_{N} +β\_{2}^{'}P\_{2}X\_{N}+β\_{3}^{'}P\_{3}X\_{N} +β\_{4}^{'}P\_{4}X\_{N} +ϵ $$

# Most parameters are same as autoDI
mod1 <- DI(y = "yield", prop = c("p1", "p2", "p3", "p4"),
 data = model\_data, FG = c("G", "G", "L", "L"),
 # We now need to specify the interaction structure to fit
 DImodel = "FG",
 # Specify any additional terms/interactions here
 # We add an interaction of treatment with each species
 extra\_formula = ~ (p1 + p2 + p3 + p4):treatF)

summary(mod1)

##### Adding interaction of treatment with each interaction

# Interaction of treatment with the FG interaction terms
mod2 <- DI(y = "yield", prop = c("p1", "p2", "p3", "p4"),
 DImodel = "FG", FG = c("G", "G", "L", "L"),
 extra\_formula = ~ (FG\_):treatF, data = model\_data)

summary(mod2)

##### Adding interaction of treatment with both, species ID and interaction effects

$$y =β\_{1}P\_{1}+β\_{2}P\_{2}+β\_{3}P\_{3}+β\_{4}P\_{4}+ω\_{GL}\left[\left(P\_{1}+P\_{2}\right)\left(P\_{3}+P\_{4}\right)\right]+ω\_{G}\left(P\_{1}P\_{2}\right)+ω\_{L}\left(P\_{3}P\_{4}\right)+$$

$$ω\_{GL}^{'}\left[\left(P\_{1}+P\_{2}\right)\left(P\_{3}+P\_{4}\right)\right]X\_{N}+ω\_{G}\left(P\_{1}P\_{2}\right)X\_{N}+ω\_{L}\left(P\_{3}P\_{4}\right)X\_{N}+ϵ $$

# Adding an interaction term of treatment with everything in the model
mod3 <- DI(y = "yield", prop = c("p1", "p2", "p3", "p4"),
 DImodel = "FG", FG = c("G", "G", "L", "L"),
 extra\_formula = ~ (p1 + p2 + p3 + p4 + FG\_):treatF,
 data = model\_data)

summary(mod3)

###### Adding specific interaction terms

$$y =β\_{1}P\_{1}+β\_{2}P\_{2}+β\_{3}P\_{3}+β\_{4}P\_{4}+ω\_{GL}\left[\left(P\_{1}+P\_{2}\right)\left(P\_{3}+P\_{4}\right)\right]+ω\_{G}\left(P\_{1}P\_{2}\right)+ω\_{L}\left(P\_{3}P\_{4}\right)+$$

$$β\_{1}^{'}P\_{1}X\_{N} +β\_{2}^{'}P\_{2}X\_{N}+ω\_{GL}^{'}\left[\left(P\_{1}+P\_{2}\right)\left(P\_{3}+P\_{4}\right)\right]X\_{N}+ϵ $$

# We will add interaction terms with specific identity and interaction terms # For that we need to add the interaction terms to the data first

# The DI\_data can be used to accomplish this
# Same parameters as autoDI and DI functions
FG\_ints <- DI\_data(prop = c("p1", "p2", "p3", "p4"),
 FG = c("G", "G", "L", "L"),
 data = model\_data,
 # what is used to specify desired interaction structure
 what = "FG")

# Add these interactions to the model\_data
model\_data <- bind\_cols(model\_data, FG\_ints)

# We add interaction of treatment with p1, p2 and the between FG interaction
mod4 <- DI(y = "yield", prop = c("p1", "p2", "p3", "p4"),
 DImodel = "FG", FG = c("G", "G", "L", "L"),
 extra\_formula = ~ (p1 + p2 + bfg\_G\_L):treatF,
 data = model\_data)

summary(mod4)