# Thriving in a Water-limited Environment: Relationships among Dehydration Tolerance Traits of California Chapparal Shrubs

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Mentor: Mr. Jacob Spriester

“Team Chaparral”

Dr. R. Brandon Pratt’s Lab
CSU Bakersfield, Biology

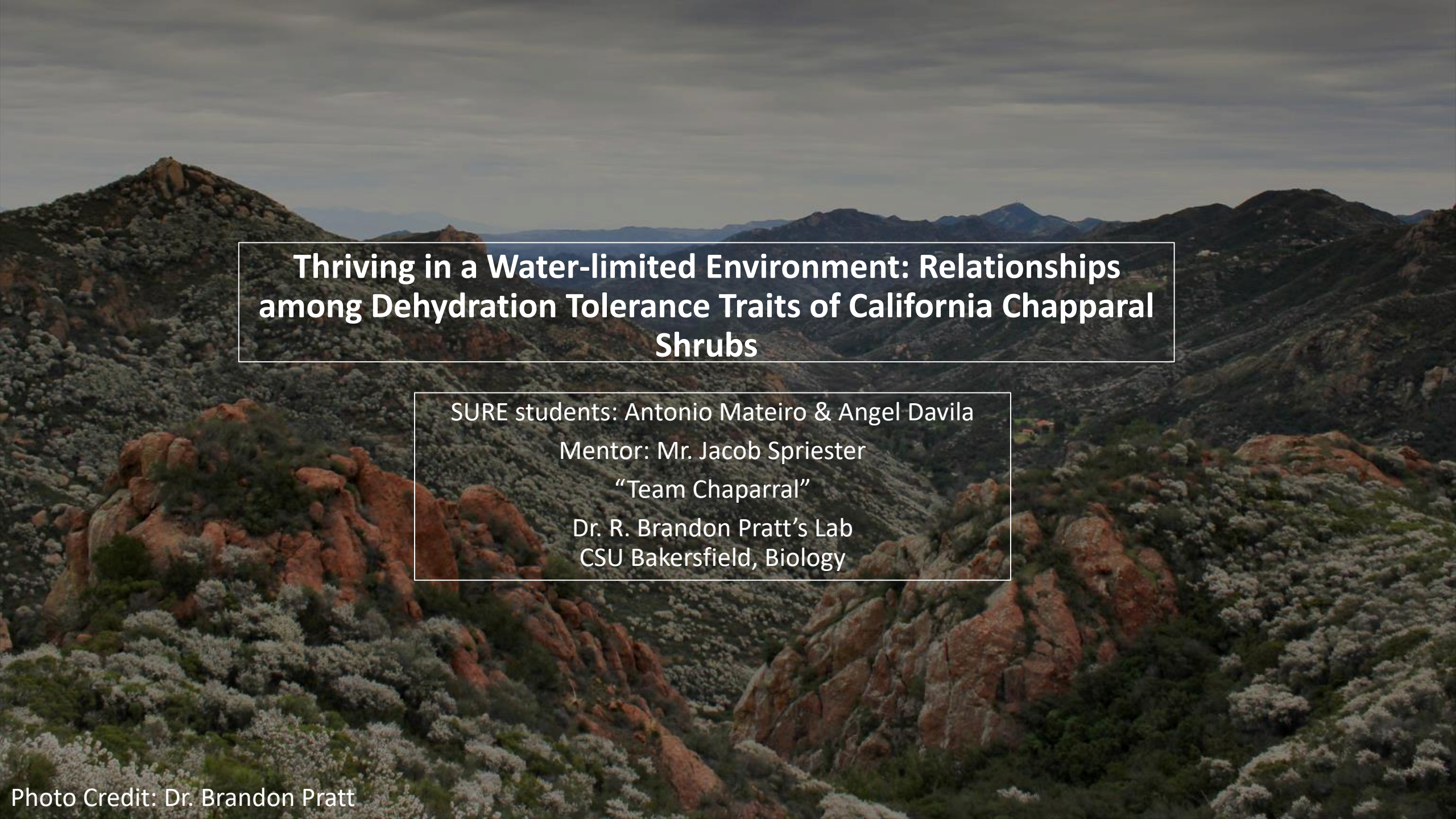

Photo Credit: Dr. Brandon Pratt

# Acknowledgments


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# Frameworks for Understanding Plant Function: Tradeoffs

- Resource Use Characteristics (Tortoise vs. Hare)
- Leaf Economics Spectrum
- Dehydration Tolerance/Avoidance Spectrum

Photo Credit : Wikipedia User, “Chaparralian”

# Hypotheses and Predictions (Angel)

$H_a$: Embolism resistance and the Turgor Loss Point are key defining traits of dehydration tolerance.

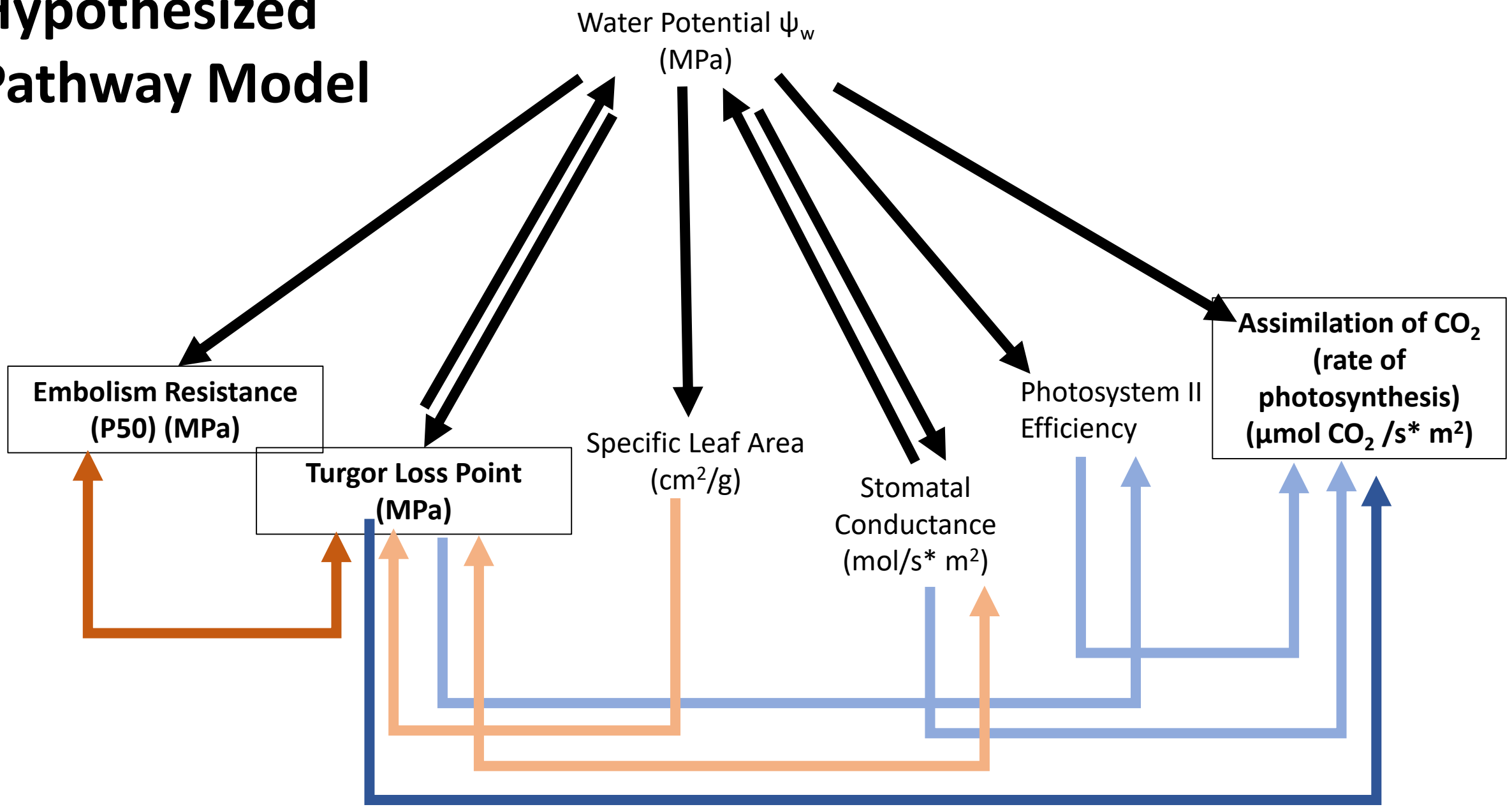
$P_a$: P50 and Turgor Loss Point have a positive relationship.

# Hypotheses and Predictions (Antonio)

$H_a$: There is a trade-off between turgor loss point and carbon assimilation rate.

$P_a$: There is a positive relationship between turgor loss point and $A_{net}$.

# Hypothesized Pathway Model




# Methods

Photo Credit: Dr. Brandon Pratt

***Adenostoma fasciculatum***

***Cercocarpus betuloides***

Photos credit to Dr. Anna Jacobsen

***Ceanothus crassifolius***

***Ceanothus spinosus***

Photos credit to Dr. Anna Jacobsen

***Fremontodendron californicum***

***Malosma laurina***

Photos credit to Dr. Anna Jacobsen

| Species |
| --- |
| *Adenostoma fasciculatum* |
| *Cerocarpus betuloides* |
| *Ceanothus crassifolius* |
| *Ceanothus spinosus* |
| *Fremontodendron californicum* |
| *Malosma laurina* |


Photo credit: Dr. Brandon Pratt

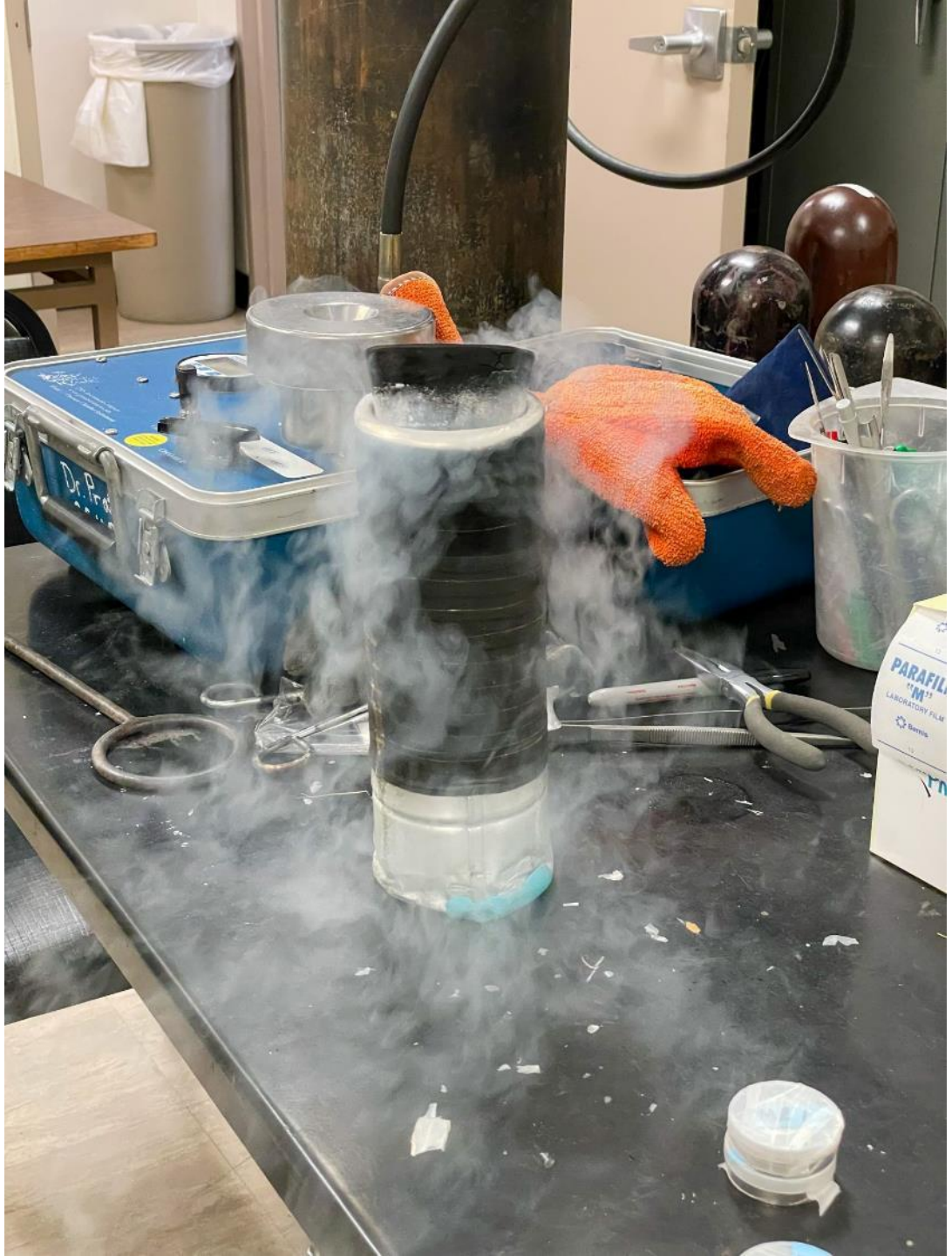


Photo credit: Dr. Brandon Pratt

Photo credit: Dr. Brandon Pratt & Angel Davila, respectively

# Results

```
  theme_classic()+
  labs(x= "Turgor Pressure MPa", y=expression(paste(A[net]~(mu*mol~CO[2]/m^2%.%s))))+
  theme(axis.title = element_text(size=18))+
  theme(axis.text = element_text(size=14))+
  theme(legend.text=element_text(size=14))+
  theme(legend.title = element_text(size=14))


ggplot(df_full, aes(x=pres_pot, y=phi_ps2))+   #Turgor vs Photosystem II
  geom_point(aes(shape=spp),size=3.5)+
  geom_smooth(method=lm, se=T, color="blue", size=2)+
  #xlim(0.035, 0.8)+
  theme_classic()+
  labs(x= "Turgor Pressure MPa", y="Photosystem II Efficiency")+
  theme(axis.title = element_text(size=18))+
  theme(axis.text = element_text(size=14))+
  theme(legend.text=element_text(size=14))+
  theme(legend.title = element_text(size=14))

ggplot(df_full, aes(x=cond, y=anet_area))+
  geom_point(aes(shape=spp),size=3.5)+
  geom_smooth(method=lm, se=T, color="blue", size=2)+
  #xlim(0.035, 0.8)+
  theme_classic()+
  labs(x=expression(paste(g[s]~(mmol/m^2%.%s))), y=expression(paste(A[net]~(mu*mol~CO[2]/m^2%.%s))))+
  theme(axis.title = element_text(size=18))+
  theme(axis.text = element_text(size=14))+
  theme(legend.text=element_text(size=14))+
  theme(legend.title = element_text(size=14))

lpstat<-lm(df_full$anet_area~df_full$cond)
summary(lpstat)

#Adenostoma faciculatum
#Cercocarpus betuoides
#ceanothus crassifolius
#ceanothus spinosus
```

```
lm(formula = df_full$anet_area ~ df_full$cond)

Residuals:
    Min      1Q  Median      3Q     Max
-2.8953 -0.7809 -0.0271  0.5776  3.4402

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)    1.5222     0.5556   2.740   0.0123 *
df_full$cond  73.3660     9.2448   7.936 9.37e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.516 on 21 degrees of freedom
                                                    0.738
F-statistic: 62.98 on 1 and 21 DF,  p-value: 9.366e-08
```

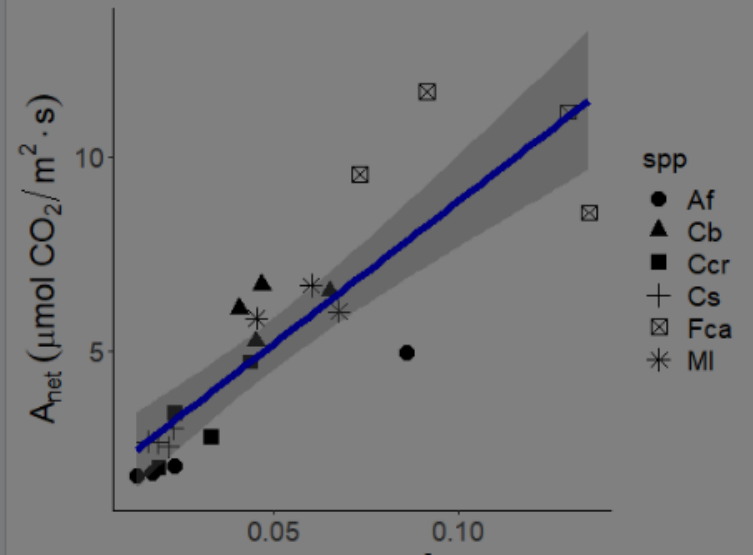
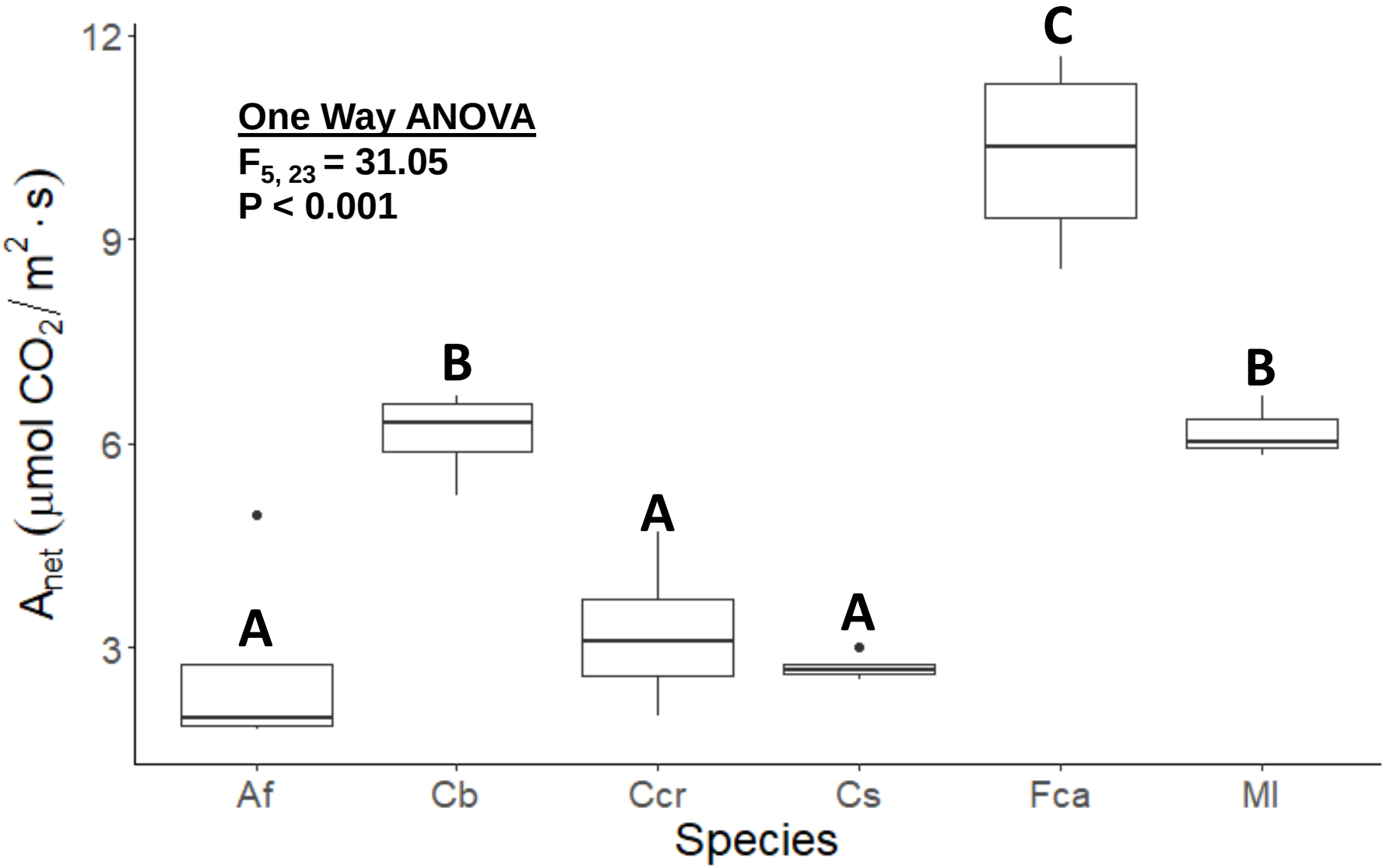
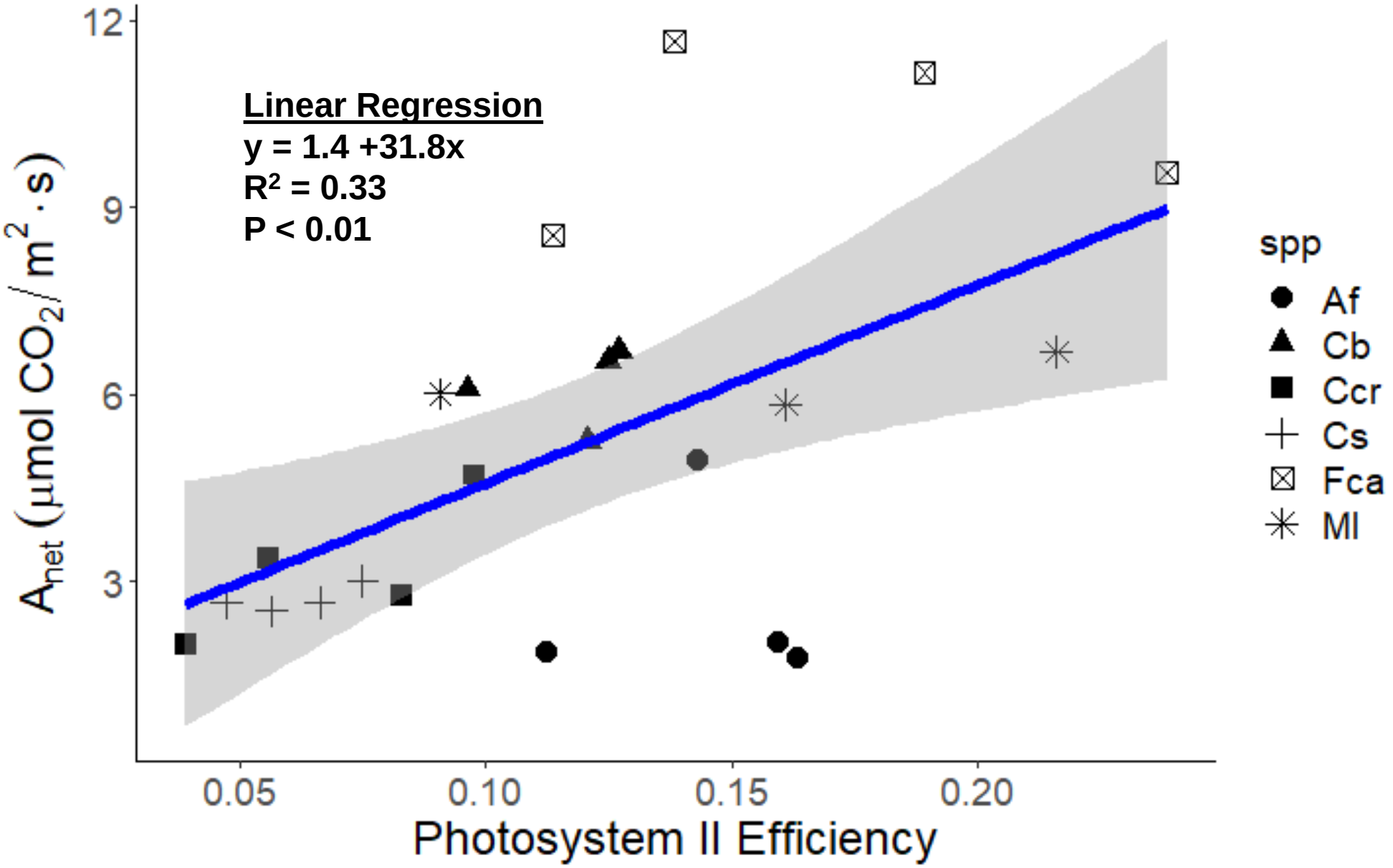
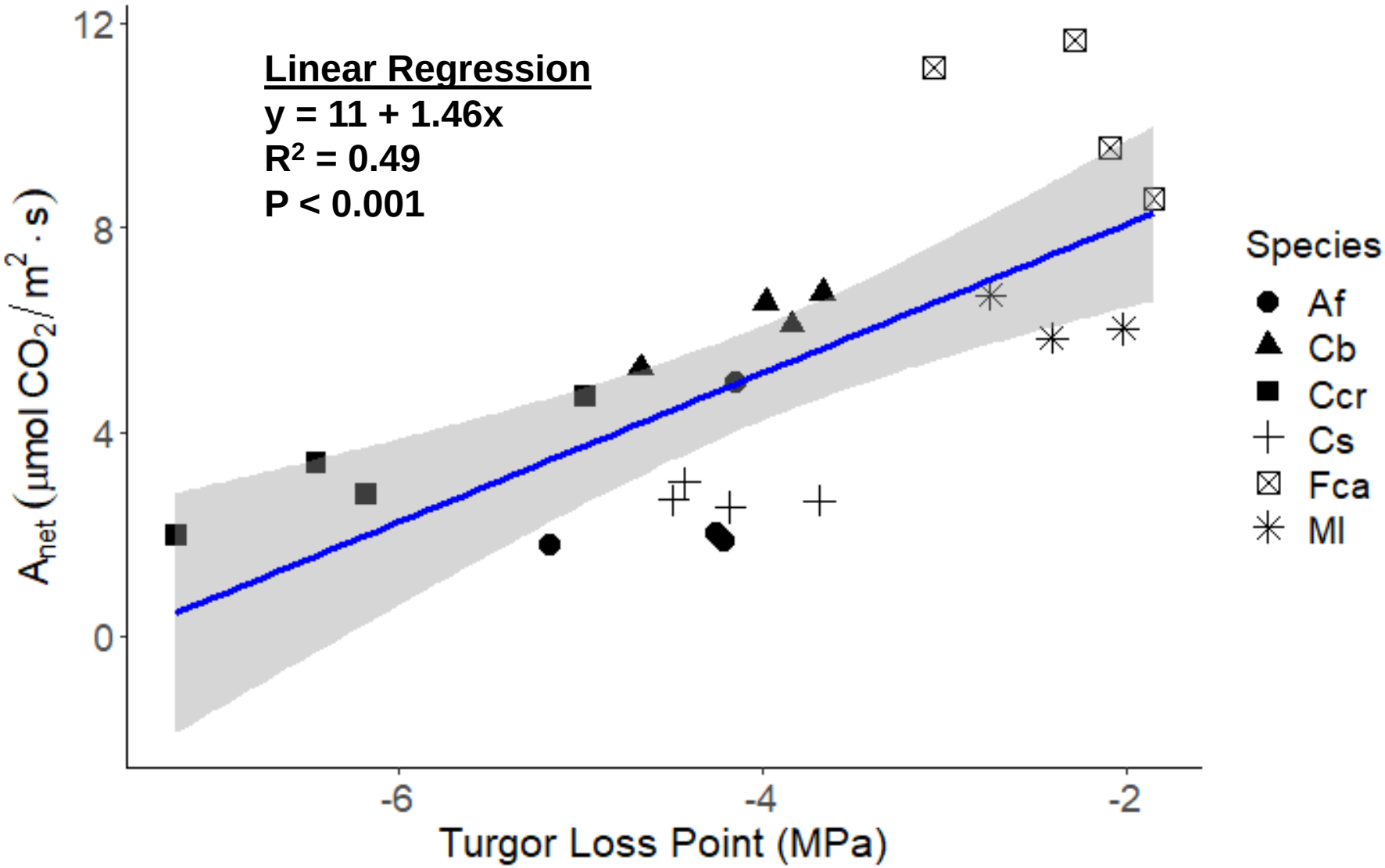
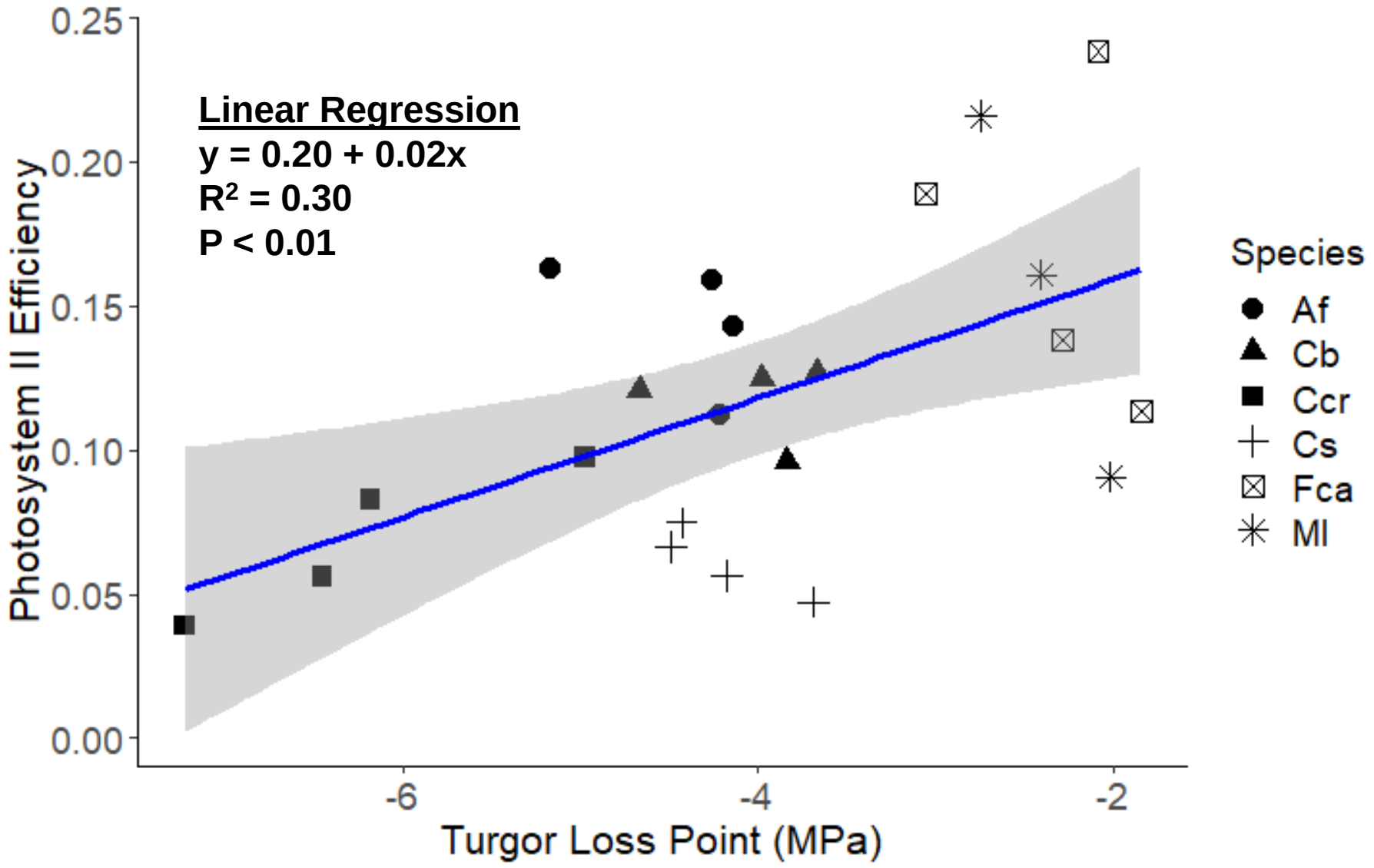


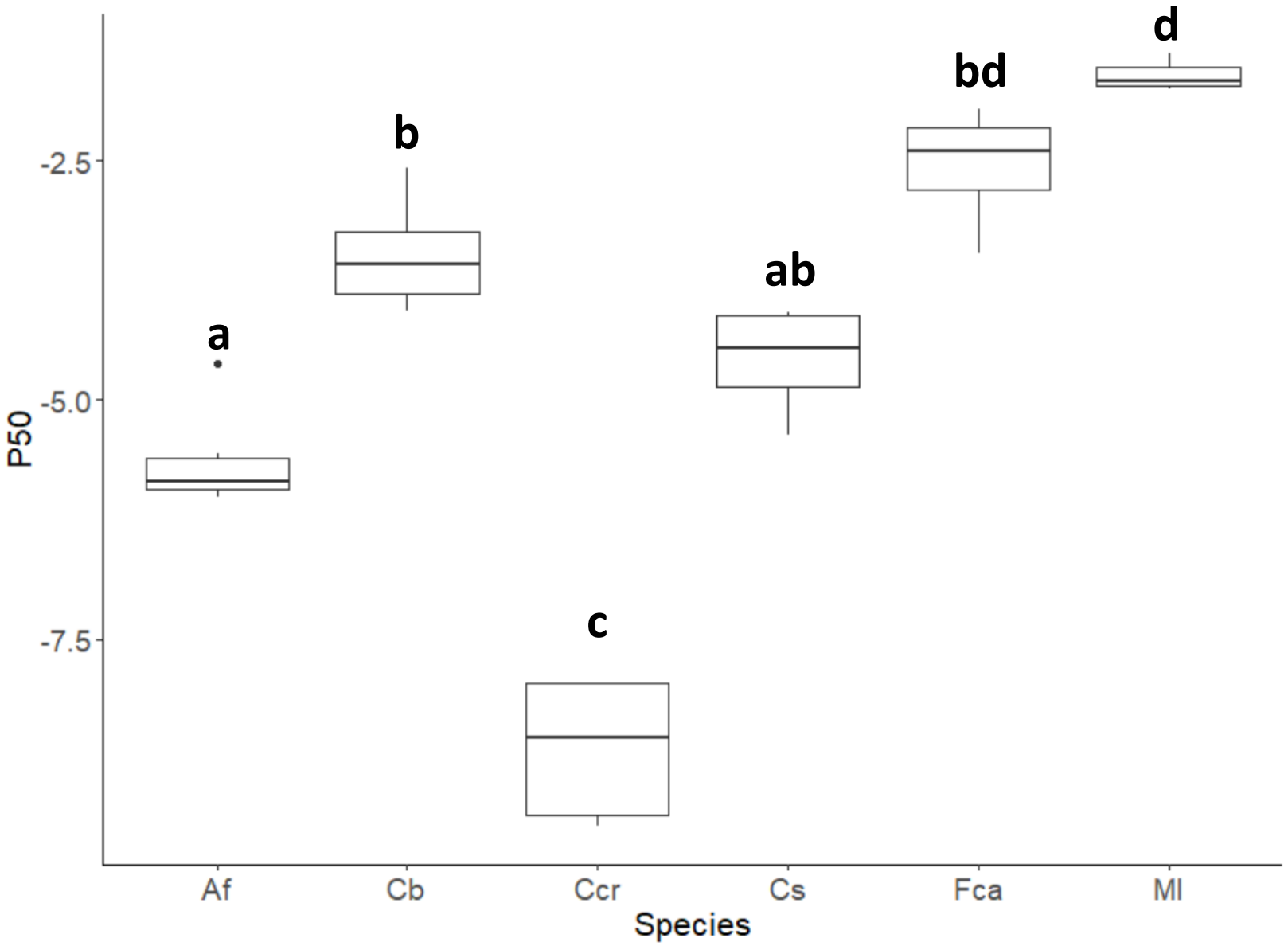

Photo credit: Antonio Mateiro


One Way ANOVA
$F_{5, 23} = 31.05$
P < 0.001
$A_{net}$ (µmol $CO_2$/ $m^2 \cdot s$)
12
9
6
3
A
B
A
A
C
B
Af
Cb
Ccr
Cs
Fca
Ml
Species

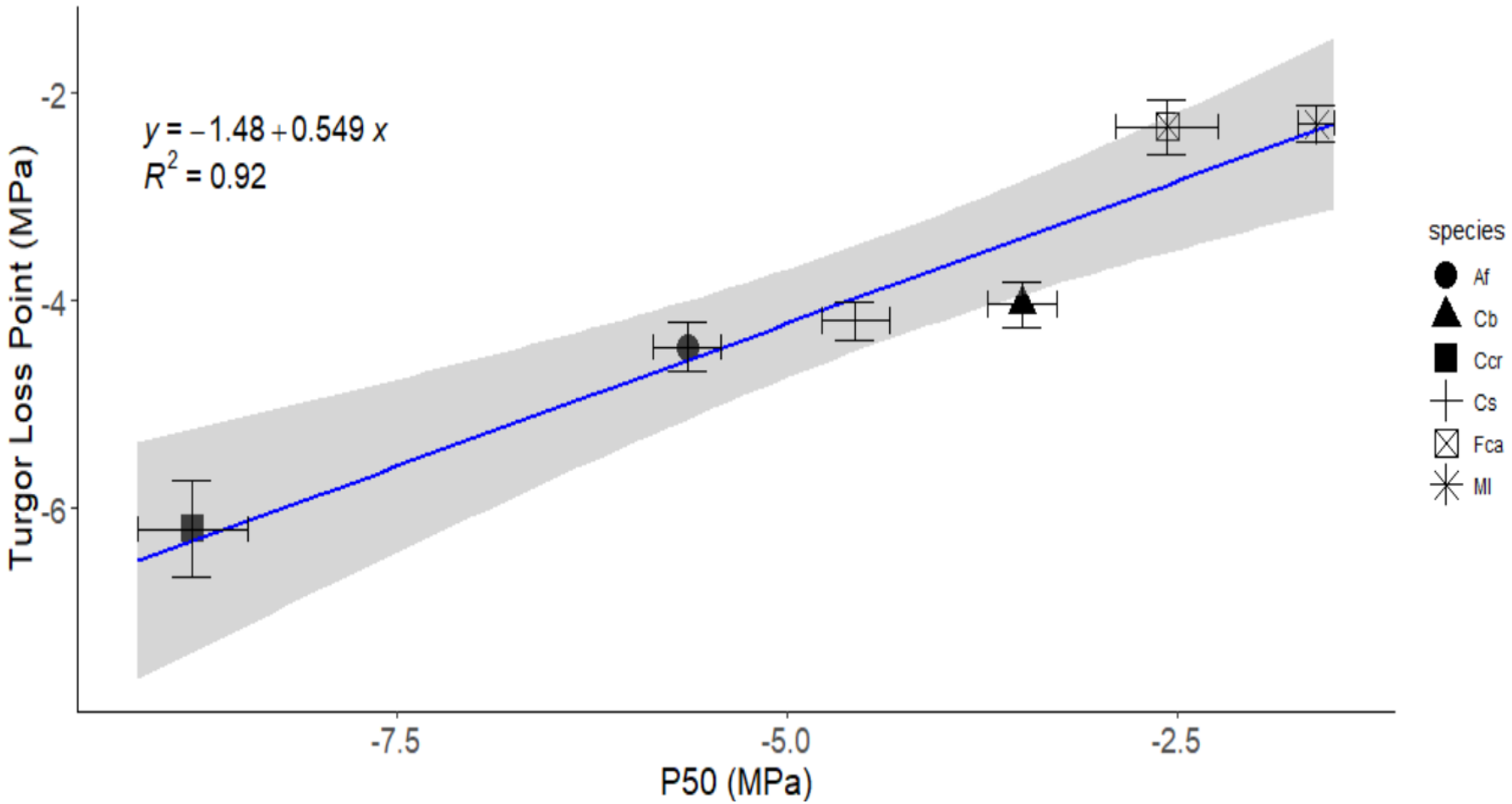

Linear Regression
y = 1.4 +31.8x
R² = 0.33
P < 0.01
12
9
6
3
0.05
0.10
0.15
0.20
Photosystem II Efficiency
Anet (µmol CO2/ m2 · s)
spp
Af
Cb
Ccr
Cs
Fca
Ml


Linear Regression
y = 11 + 1.46x
R² = 0.49
P < 0.001
12
8
4
0
-6
-4
-2
Turgor Loss Point (MPa)
Anet (µmol CO2 / m2 · s)
Species
Af
Cb
Ccr
Cs
Fca
Ml

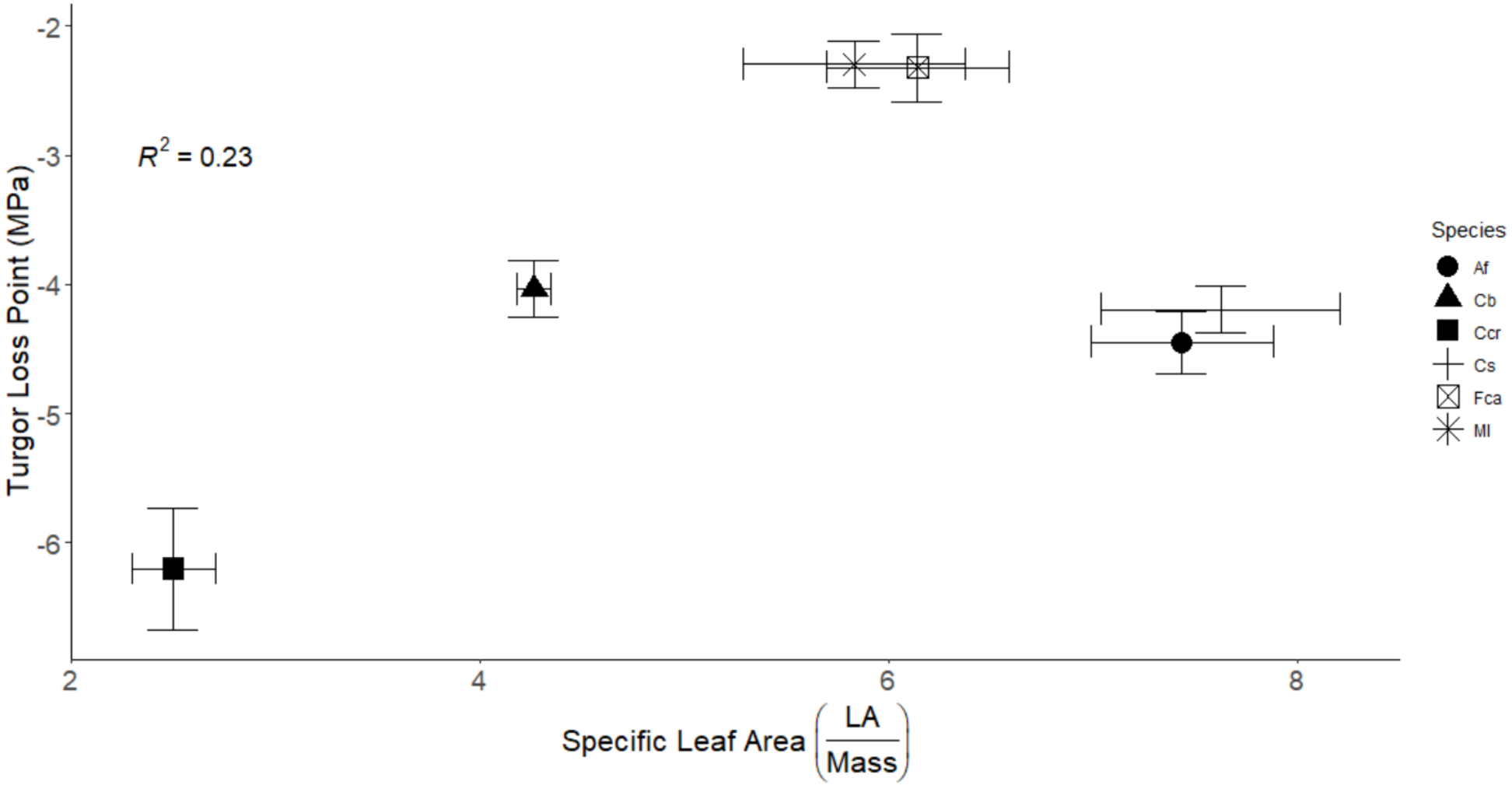

Linear Regression
y = 0.20 + 0.02x
R² = 0.30
P < 0.01
Photosystem II Efficiency
0.25
0.20
0.15
0.10
0.05
0.00
-6
-4
-2
Turgor Loss Point (MPa)
Species
Af
Cb
Ccr
Cs
Fca
Ml




One-way ANOVA:
P-Value= $p<0.001$,
$F_{5,23}=82.45$

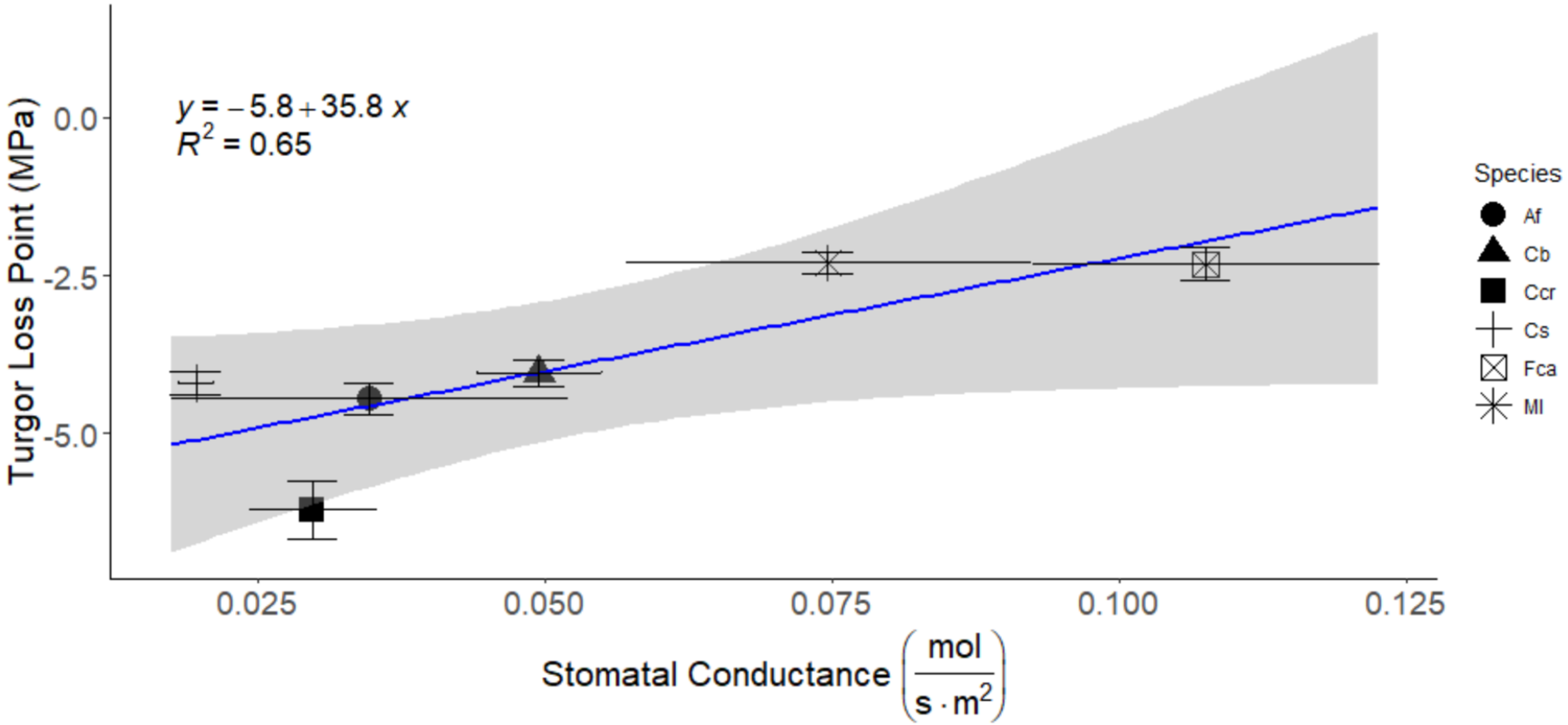


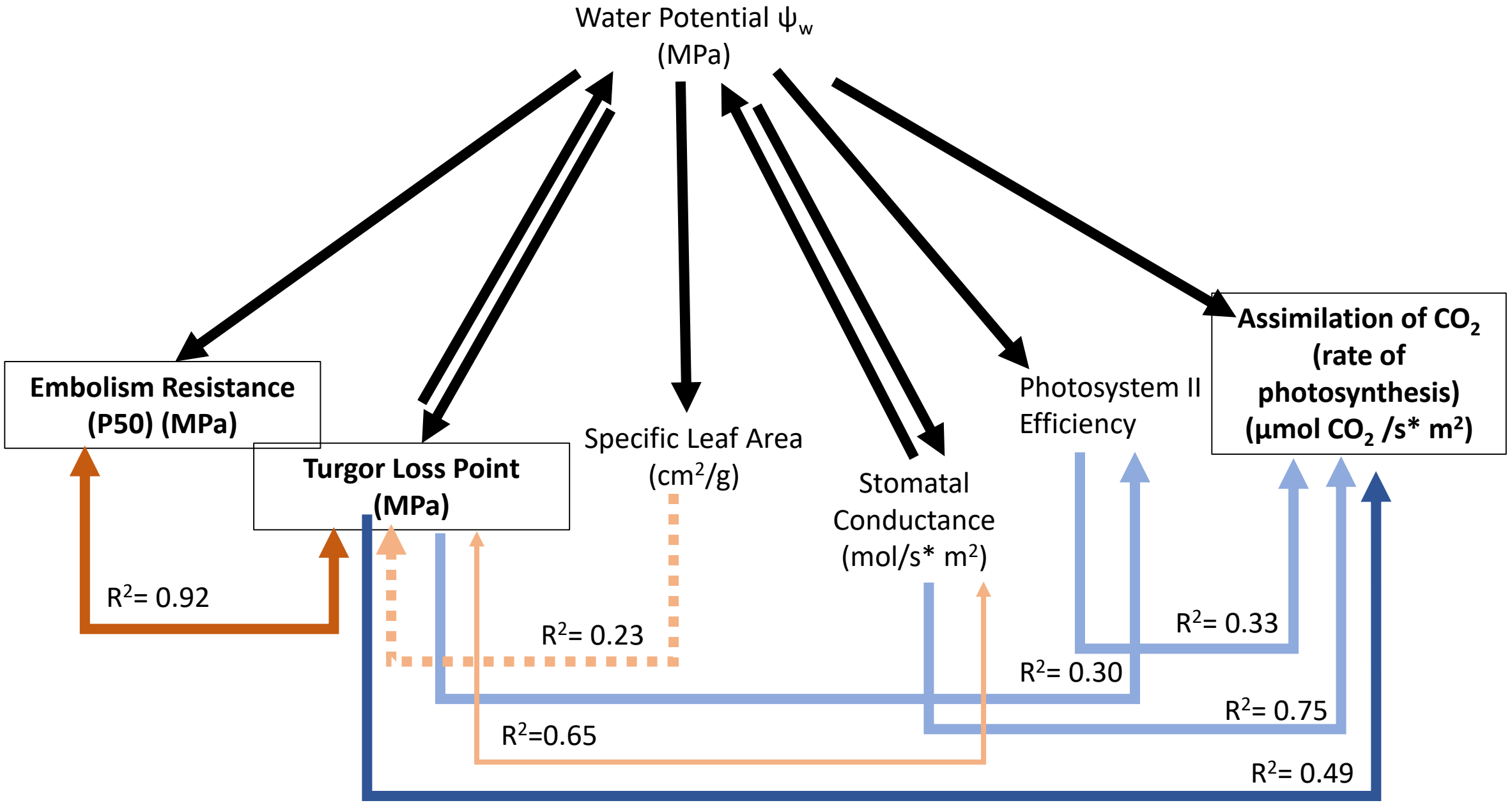

Linear Regression
p-value: 0.002




Linear regression
p-value: 0.332

Linear Regression
p-value: 0.054




Water Potential $\psi_w$ (MPa)
Embolism Resistance (P50) (MPa)
Turgor Loss Point (MPa)
Specific Leaf Area ($cm^2/g$)
Stomatal Conductance ($mol/s^* m^2$)
Photosystem II Efficiency
Assimilation of $CO_2$ (rate of photosynthesis) ($\mu mol\ CO_2\ /s^*\ m^2$)
$R^2$= 0.92
$R^2$= 0.23
$R^2$=0.65
$R^2$= 0.30
$R^2$= 0.33
$R^2$= 0.75
$R^2$= 0.49

# Conclusions

- Chapparal shrubs must make tradeoffs between different traits.

- Further research should be done to investigate the causes for the relationships exhibited in our research.