Preliminary data analysis of harvest data

Wednesday, March 25, 2015

10:18 AM

Data can be found in excel file ""Greenhouse experiment data sheet", sheet "Harvest Analysis".

Seeds per seed head:

> gh<-read.delim("clipboard")

> attach(gh)

> names(gh)

[1] "Block" "Pop" "LatOrder"

[4] "Light" "Herbivory" "Seeds.SH"

[7] "Harvest.Date" "Avg..tiller.length"

> library(sciplot)

> library(lme4)

Loading required package: lattice

Loading required package: Matrix

> m1<-lmer(Seeds.SH~Herbivory\*Light\*LatOrder+(1|Block)

> library(car)

> Anova(m1)

Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Seeds.SH

Chisq Df Pr(>Chisq)

Herbivory 36.6573 1 1.408e-09 \*\*\*

Light 113.8555 1 < 2.2e-16 \*\*\*

LatOrder 6.4099 1 0.01135 \*

Herbivory:Light 0.0115 1 0.91450

Herbivory:LatOrder 3.8757 1 0.04899 \*

Light:LatOrder 3.0953 1 0.07852 .

Herbivory:Light:LatOrder 0.3606 1 0.54815

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

> qqnorm(residuals(m1))

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> plot(fitted(m1),residuals(m1))

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fitted(ml)

> library(lmerTest)

Attaching package: ‘lmerTest’

The following object(s) are masked from ‘package:lme4’:

lmer

The following object(s) are masked from ‘package:stats’:

step

> step(m1)

Random effects:

Chi.sq Chi.DF elim.num p.value

(1 | Block) 7.9 1 0 0.005 \*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Fixed effects:

Sum Sq Mean Sq NumDF DenDF F.value elim.num Pr(>F)

Herbivory 5002.48 5002.48 1 179.0 3.6210 0 0.0587 .

Light 24925.78 24925.78 1 29.5 117.9585 0 7.81e-12 \*\*\*

LatOrder 1394.90 1394.90 1 333.5 6.6015 0 0.0106 \*

Herbivory:Light 2.43 2.43 1 28.5 0.0115 2 0.9154

Herbivory:LatOrder 1039.68 1039.68 1 333.5 4.7593 0 0.0298 \*

Light:LatOrder 673.98 673.98 1 332.3 3.1005 3 0.0792 .

Herbivory:Light:LatOrder 78.53 78.53 1 331.2 0.3606 1 0.5486

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Least squares means:

Herbivory Light Estimate Standard Error DF t-value Lower CI Upper CI p-value

Herbivory N 1.0 NA 54.45 1.53 29.7 35.6 51.3 57.6 <2e-16 \*\*\*

Herbivory Y 2.0 NA 41.15 1.53 29.5 27.0 38.0 44.3 <2e-16 \*\*\*

Light ambient NA 1.0 59.57 1.53 29.7 39.0 56.4 62.7 <2e-16 \*\*\*

Light shade NA 2.0 36.03 1.52 29.5 23.6 32.9 39.1 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Differences of LSMEANS:

Estimate Standard Error DF t-value Lower CI Upper CI p-value

Herbivory N-Y 13.3 2.17 29.5 6.14 8.88 17.7 <2e-16 \*\*\*

Light ambient-shade 23.5 2.17 29.5 10.86 19.11 28.0 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Final model:

lme4::lmer(formula = Seeds.SH ~ Herbivory + Light + LatOrder +

(1 | Block) + Herbivory:LatOrder, REML = reml, contrasts = l)

> library(sciplot)

> HerbPop<-bargraph.CI(LatOrder,Seeds.SH,group=Herbivory,ylab="Number of seeds per seed head",legend=TRUE,err.width=0.05,xlab="Pop",data=gh)

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#### Average tiller length

> step(m2)

Random effects:

Chi.sq Chi.DF elim.num p.value

(1 | Block) 142 1 0 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Fixed effects:

Sum Sq Mean Sq NumDF DenDF F.value elim.num Pr(>F)

Herbivory 1388.9 1388.9 1 29 7.676 0 0.009661 \*\*

Light 4257.6 4257.6 1 29 16.108 0 0.000385 \*\*\*

LatOrder 9644.1 9644.1 1 343 38.187 0 1.82e-09 \*\*\*

Herbivory:Light 462.7 462.7 1 28 1.819 4 0.188275

Herbivory:LatOrder 89.9 89.9 1 342 0.355 3 0.551575

Light:LatOrder 31.1 31.1 1 341 0.123 2 0.726394

Herbivory:Light:LatOrder 36.7 36.7 1 340 0.144 1 0.704102

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Least squares means:

Herbivory Light Estimate Standard Error DF t-value Lower CI Upper CI p-value

Herbivory N 1.0 NA 83.82 3.92 29.1 21.4 75.8 91.8 <2e-16 \*\*\*

Herbivory Y 2.0 NA 68.39 3.92 29.0 17.4 60.4 76.4 <2e-16 \*\*\*

Light ambient NA 1.0 87.28 3.92 29.1 22.2 79.3 95.3 <2e-16 \*\*\*

Light shade NA 2.0 64.93 3.92 29.0 16.6 56.9 73.0 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Differences of LSMEANS:

Estimate Standard Error DF t-value Lower CI Upper CI p-value

Herbivory N-Y 15.4 5.57 29.0 2.77 4.04 26.8 0.01 \*\*

Light ambient-shade 22.3 5.57 29.0 4.01 10.96 33.7 4e-04 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Final model:

lme4::lmer(formula = Avg..tiller.length ~ Herbivory + Light +

LatOrder + (1 | Block), REML = reml, contrasts = l)

> qqnorm(residuals(m2))

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> plot(fitted(m2),residuals(m2))

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fitted(m2)

> m2.2<-lmer(log(Avg..tiller.length)~Herbivory\*Light\*LatOrder+(1|Block))

> qqnorm(residuals(m2.2))

> plot(fitted(m2.2),residuals(m2.2))

> m2.3<-lmer(sqrt(Avg..tiller.length)~Herbivory\*Light\*LatOrder+(1|Block))

> qqnorm(residuals(m2.3))

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> plot(fitted(m2.3),residuals(m2.3))

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fitted(m23)

> step(m2.3)

Random effects:

Chi.sq Chi.DF elim.num p.value

(1 | Block) 139 1 0 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Fixed effects:

Sum Sq Mean Sq NumDF DenDF F.value elim.num Pr(>F)

Herbivory 5.26511 5.26511 1 29 8.7068 0 0.00621 \*\*

Light 15.21715 15.21715 1 29 17.4073 0 0.00025 \*\*\*

LatOrder 36.34596 36.34596 1 343 44.2003 0 1.17e-10 \*\*\*

Herbivory:Light 1.86270 1.86270 1 28 2.2463 4 0.14511

Herbivory:LatOrder 0.04798 0.04798 1 342 0.0582 3 0.80958

Light:LatOrder 0.00981 0.00981 1 341 0.0119 2 0.91336

Herbivory:Light:LatOrder 0.23563 0.23563 1 340 0.2843 1 0.59425

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Least squares means:

Herbivory Light Estimate Standard Error DF t-value Lower CI Upper CI p-value

Herbivory N 1.0 NA 9.069 0.224 29.1 40.5 8.61 9.53 <2e-16 \*\*\*

Herbivory Y 2.0 NA 8.132 0.224 29.0 36.4 7.67 8.59 <2e-16 \*\*\*

Light ambient NA 1.0 9.262 0.224 29.1 41.4 8.80 9.72 <2e-16 \*\*\*

Light shade NA 2.0 7.938 0.224 29.0 35.5 7.48 8.39 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Differences of LSMEANS:

Estimate Standard Error DF t-value Lower CI Upper CI p-value

Herbivory N-Y 0.9 0.318 29.0 2.95 0.287 1.59 0.006 \*\*

Light ambient-shade 1.3 0.318 29.0 4.17 0.675 1.97 2e-04 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Final model:

lme4::lmer(formula = sqrt(Avg..tiller.length) ~ Herbivory + Light +

LatOrder + (1 | Block), REML = reml, contrasts = l)

> library(sciplot)

> Tiller<-bargraph.CI(Herbivory,Avg..tiller.length,group=Light,ylab="Average tiller length (cm)",legend=TRUE,err.width=0.05,ylim=c(0,100),xlab="Herbivory",data=gh)

>

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> library(visreg)

> visreg(m2.3,"LatOrder",scale="response",rug=FALSE,partial=TRUE,xlab="Population",ylab="Average tiller length",points=list(cex=2, pch="+"))

Please note that you are attempting to plot a 'main effect' in a model that contains an interaction. This is potentially misleading; you may wish to

consider using the 'by' argument.

Conditions used in construction of plot

Herbivory: Y

Light: shade

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#### Harvest date (i.e. senescence)

> m3<-lmer(Harvest.Date~Herbivory\*Light\*LatOrder+(1|Block))

> step(m3)

Random effects:

Chi.sq Chi.DF elim.num p.value

(1 | Block) 305 1 0 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Fixed effects:

Sum Sq Mean Sq NumDF DenDF F.value elim.num Pr(>F)

Herbivory 2.28 2.28 1 29 0.00856 4 0.9269

Light 281.49 281.49 1 30 4.52067 0 0.0418 \*

LatOrder 1473.20 1473.20 1 337 21.84198 0 4.29e-06 \*\*\*

Herbivory:Light 46.46 46.46 1 28 0.71362 2 0.4054

Herbivory:LatOrder 51.19 51.19 1 335 1.28793 3 0.2572

Light:LatOrder 268.39 268.39 1 336 3.46806 5 0.0634 .

Herbivory:Light:LatOrder 122.14 122.14 1 334 1.83167 1 0.1768

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Least squares means:

Light Estimate Standard Error DF t-value Lower CI Upper CI p-value

Light ambient 1.0 41947.1 3.0 30.1 13972.7 41941 41953 <2e-16 \*\*\*

Light shade 2.0 41956.2 3.0 30.0 13979.1 41950 41962 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Differences of LSMEANS:

Estimate Standard Error DF t-value Lower CI Upper CI p-value

Light ambient-shade -9 4.25 30 -2.13 -17.7 -0.357 0.04 \*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Final model:

lme4::lmer(formula = Harvest.Date ~ Light + LatOrder + (1 | Block),

REML = reml, contrasts = l)

Warning messages:

1: In model.matrix.default(mt, mf, contrasts) :

variable 'Herbivory' is absent, its contrast will be ignored

2: In model.matrix.default(mt, mf, contrasts) :

variable 'Herbivory' is absent, its contrast will be ignored

3: In model.matrix.default(mt, mf, contrasts) :

variable 'Herbivory' is absent, its contrast will be ignored

4: In model.matrix.default(mt, mf, contrasts) :

variable 'Herbivory' is absent, its contrast will be ignored

> qqnorm(residuals(m3))

Machine generated alternative text:
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Theoretical Quantiles

> plot(fitted(m3),residuals(m3))

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> Harvest<-bargraph.CI(LatOrder,Harvest.Date,group=Light,ylab="Harvest Date",legend=TRUE,err.width=0.05,ylim=c(41920,41970),xlab="Pop",data=gh)

>

It's important to use LatOrder because the numbers actually mean something in this case (latitude) instead of population number, which are arbitrary.

### Y/N refers to herbivory

#### obviously this graph does not include the significant block effect, but does not change conclusions.

Square-root transformed looks slightly better, but conclusions are the same.

Graph obviously does not include significant effect of block, and raw data (non-transformed) are used

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