

Supplementary Material 4 to The short-term effects of experimental forestry treatments on site conditions in an oak-hornbeam forest

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Supplementary Material 4 – Results of the linear mixed effects models presented in Table 2

The performed linear mixed effects models were based on the data uploaded as a spreadsheet file including five sheets (Supplementary Material – ‘Original data’). The following datasets (with the listed variables) were used for modeling:

1. table ‘microclimate_12d_relative’ -> data frame ‘d15’:
relative light variables (PAR_mean and PAR_iqr); treatment; month; block
2. table ‘microclimate_24h_relative’ -> data frame ‘s15’:
relative microclimate variables (except PAR_mean and PAR_iqr); treatment; month; block
3. table ‘difn_relative’ -> data frame ‘difn15’:
dDIFN; block
4. table ‘litter_and_soil_relative’ -> data frame ‘soil15’:
relative litter and soil variables (dpH, dhy, ...); treatment; season; block

The applied data transformations were also marked here, transformed variables were indicated as ‘tr’.

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dPAR mean

```
> d15$trPAR_mean<-(d15$PAR_mean)^(1/3)

> mPnull<-lme(trPAR_mean~1,random=~1|block,data=d15,na.action = na.omit,method="ML")
> mP3ML<-lme(trPAR_mean~treatment+month+treatment:month,random=~1|block,data=d15,na.action = na.omit,method="ML")

> anova(mPnull,mP3ML)
      Model df      AIC      BIC    logLik    Test  L.Ratio p-value
mPnull      1  3 723.1733 732.7186 -358.5866
mP3ML       2 34 330.4628 438.6434 -131.2314 1 vs 2 454.7105 <.0001

> anova(mP3ML)
              numDF  denDF  F-value  p-value
(Intercept)         1    141 5083.660 <.0001
treatment            3    141  225.579 <.0001
month                7    141  133.928 <.0001
treatment:month     21    141   8.941 <.0001

> summary(mP3ML)
Linear mixed-effects model fit by maximum likelihood
Data: d15
      AIC      BIC    logLik
330.4628 438.6434 -131.2314

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:  0.1589048 0.4939506

Fixed effects: trPAR_mean ~ treatment + month + treatment:month
              Value Std.Error  DF   t-value p-value
(Intercept)    6.307165 0.2338978 141  26.965480 0.0000
treatmentG     -1.903597 0.3148882 141  -6.045310 0.0000
treatmentP     -1.981939 0.3148882 141  -6.294103 0.0000
treatmentR     -1.476665 0.3306484 141  -4.465968 0.0000
month201504    -0.031940 0.3306792 141  -0.096589 0.9232
month201505     2.622392 0.3306792 141   7.930321 0.0000
month201506     3.469623 0.3148882 141  11.018585 0.0000
month201507     3.211871 0.3148882 141  10.200035 0.0000
month201508     3.049611 0.3148882 141   9.684742 0.0000
month201509    -0.485823 0.3148882 141  -1.542842 0.1251
month201510    -1.516775 0.3306792 141  -4.586849 0.0000
treatmentG:month201504 0.494555 0.4566217 141   1.083073 0.2806
treatmentP:month201504 -0.109556 0.4566217 141  -0.239927 0.8107
treatmentR:month201504 -1.046732 0.4675078 141  -2.238961 0.0267
treatmentG:month201505 0.159909 0.4566217 141   0.350200 0.7267
treatmentP:month201505 -0.811505 0.4566217 141  -1.777194 0.0777
treatmentR:month201505 -2.388549 0.4675078 141  -5.109110 0.0000
treatmentG:month201506 -0.113560 0.4453192 141  -0.255009 0.7991
treatmentP:month201506 -1.484431 0.4453192 141  -3.333409 0.0011
treatmentR:month201506 -2.606875 0.4677070 141  -5.573736 0.0000
treatmentG:month201507 -0.794277 0.4453192 141  -1.783613 0.0766
treatmentP:month201507 -1.647353 0.4453192 141  -3.699264 0.0003
treatmentR:month201507 -2.275697 0.4565994 141  -4.984013 0.0000
treatmentG:month201508 -1.468495 0.4453192 141  -3.297623 0.0012
treatmentP:month201508 -1.757484 0.4453192 141  -3.946572 0.0001
treatmentR:month201508 -1.429688 0.4565994 141  -3.131166 0.0021
```

```
treatmentG:month201509 0.319482 0.4453192 141 0.717424 0.4743
treatmentP:month201509 -0.089741 0.4453192 141 -0.201520 0.8406
treatmentR:month201509 -0.695017 0.4565994 141 -1.522160 0.1302
treatmentG:month201510 0.368726 0.4831141 141 0.763227 0.4466
treatmentP:month201510 1.290500 0.5087486 141 2.536616 0.0123
treatmentR:month201510 2.341058 0.5649740 141 4.143657 0.0001
```

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-4.48787717	-0.45423041	0.07687197	0.51177246	2.42080437

Number of Observations: 178

Number of Groups: 6

```
> r.squaredLR(mp3ML)
[1] 0.9222731
attr(,"adj.r.squared")
[1] 0.9389784
```

dPAR IQR

```
> d15$trPAR_iqr<-log(d15$PAR_iqr)

> mPinull<-lme(trPAR_iqr~1,random=~1|block,data=d15,na.action = na.omit,method="ML")
> mPi3ML<-lme(trPAR_iqr~treatment+month+treatment:month,random=~1|block,data=d15,na.action = na.omit,method="ML")

> anova(mPinull,mPi3ML)
      Model df      AIC      BIC    logLik   Test  L.Ratio p-value
mPinull     1   3 516.2638 525.8426 -255.13188
mPi3ML      2 34 234.5663 343.1268  -83.28313 1 vs 2 343.6975  <.0001

> anova(mPi3ML)
              numDF denDF  F-value  p-value
(Intercept)         1    143  8385.122  <.0001
treatment            3    143   114.259  <.0001
month                7    143    57.575  <.0001
treatment:month     21    143     6.292  <.0001

> summary(mPi3ML)
Linear mixed-effects model fit by maximum likelihood
Data: d15
      AIC      BIC    logLik
234.5663 343.1268 -83.28313

Random effects:
Formula: ~1 | block
(Intercept) Residual
StdDev:    0.1055402 0.3766609

Fixed effects: trPAR_iqr ~ treatment + month + treatment:month
              Value Std.Error  DF   t-value p-value
(Intercept)    5.536124 0.1761135 143  31.434971  0.0000
treatmentG     -0.893883 0.2398255 143  -3.727222  0.0003
treatmentP     -0.907955 0.2398255 143  -3.785901  0.0002
treatmentR     -0.618957 0.2518064 143  -2.458066  0.0152
month201504    -0.282928 0.2518264 143  -1.123504  0.2631
month201505     1.217033 0.2518264 143   4.832828  0.0000
month201506     1.449148 0.2398255 143   6.042509  0.0000
month201507     1.312494 0.2398255 143   5.472707  0.0000
month201508     1.480521 0.2398255 143   6.173327  0.0000
month201509     0.023717 0.2398255 143   0.098892  0.9214
month201510    -0.614782 0.2518264 143  -2.441291  0.0159
treatmentG:month201504 0.208065 0.3477539 143   0.598311  0.5506
treatmentP:month201504 -0.332612 0.3477539 143  -0.956458  0.3405
treatmentR:month201504 -0.945693 0.3560367 143  -2.656167  0.0088
treatmentG:month201505 -0.051676 0.3477539 143  -0.148600  0.8821
treatmentP:month201505 -0.611592 0.3477539 143  -1.758691  0.0808
treatmentR:month201505 -1.655013 0.3560367 143  -4.648433  0.0000
treatmentG:month201506 0.365030 0.3391644 143   1.076263  0.2836
treatmentP:month201506 -0.908307 0.3391644 143  -2.678072  0.0083
treatmentR:month201506 -1.538498 0.3477394 143  -4.424284  0.0000
treatmentG:month201507 -0.201649 0.3391644 143  -0.594545  0.5531
treatmentP:month201507 -0.798750 0.3391644 143  -2.355051  0.0199
treatmentR:month201507 -1.187860 0.3477394 143  -3.415948  0.0008
treatmentG:month201508 -0.770721 0.3391644 143  -2.272411  0.0246
treatmentP:month201508 -0.802837 0.3391644 143  -2.367104  0.0193
treatmentR:month201508 -0.489373 0.3477394 143  -1.407298  0.1615
```

```
treatmentG:month201509 -0.206065 0.3391644 143 -0.607566 0.5444
treatmentP:month201509 -0.502751 0.3391644 143 -1.482324 0.1405
treatmentR:month201509 -0.850733 0.3477394 143 -2.446467 0.0156
treatmentG:month201510 -0.264001 0.3679207 143 -0.717550 0.4742
treatmentP:month201510 -0.112508 0.3679267 143 -0.305789 0.7602
treatmentR:month201510 1.354109 0.4301849 143 3.147738 0.0020
```

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-3.51089476	-0.46887460	0.07091374	0.54077183	2.77227758

Number of Observations: 180

Number of Groups: 6

```
> r.squaredLR(mPi3ML)
```

```
[1] 0.8518353
```

```
attr(,"adj.r.squared")
```

```
[1] 0.9049854
```

*d*DIFN

```
> difn15$trdDIFN<-(difn15$dDIFN)^(1/2)

> mDnull<-lme(trdDIFN~1,random=~1|block,data=difn15,na.action = na.omit,method="ML")
> mD3ML<-lme(trdDIFN~treatment,random=~1|block,data=difn15,na.action = na.omit,method="ML")

> anova(mDnull,mD3ML)
      Model df      AIC      BIC    logLik    Test  L.Ratio p-value
mDnull      1  3 91.21820 94.20540 -42.60910
mD3ML       2  6 68.13255 74.10694 -28.06628 1 vs 2 29.08565  <.0001

> anova(mD3ML)
              numDF  denDF    F-value    p-value
(Intercept)      1     12    228.93313    <.0001
treatment        3     12     21.69977    <.0001

> summary(mD3ML)
Linear mixed-effects model fit by maximum likelihood
Data: difn15
      AIC      BIC    logLik
68.13255 74.10694 -28.06628

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:  0.5698924 0.8686845

Fixed effects: trdDIFN ~ treatment
              Value Std.Error DF   t-value    p-value
(Intercept)  8.316971 0.5194685 12   16.010540    0e+00
treatmentG   -3.164695 0.6142527 12   -5.152107    2e-04
treatmentP   -3.780272 0.6142527 12   -6.154262    0e+00
treatmentR   -4.639628 0.6142527 12   -7.553290    0e+00

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-2.55649608 -0.49213651 -0.01994385  0.39083599  1.68987576

Number of Observations: 20
Number of Groups: 5

> r.squaredLR(mD3ML)
[1] 0.7664321
attr(,"adj.r.squared")
[1] 0.7774008
```

dAir temperature mean

```
> mTnull<-lme(T_mean~1,random=~1|block,data=s15,na.action = na.omit,method="ML")
> mT3ML<-lme(T_mean~treatment+month+treatment:month,random=~1|block,data=s15,na.action = na.omit,method="ML")
```

```
> anova(mTnull,mT3ML)
```

	Model	df	AIC	BIC	logLik	Test	L.Ratio	p-value
mTnull	1	3	1.23807	10.81694	2.38096			
mT3ML	2	34	-210.06650	-101.50596	139.03325	1 vs 2	273.3046	<.0001

```
> anova(mT3ML)
```

	numDF	denDF	F-value	p-value
(Intercept)	1	143	67.86236	<.0001
treatment	3	143	21.88822	<.0001
month	7	143	54.08176	<.0001
treatment:month	21	143	4.90293	<.0001

```
> summary(mT3ML)
```

Linear mixed-effects model fit by maximum likelihood

Data: s15

	AIC	BIC	logLik
	-210.0665	-101.506	139.0332

Random effects:

Formula: ~1 | block

(Intercept) Residual

StdDev: 0.04675113 0.1083118

Fixed effects: T_mean ~ treatment + month + treatment:month

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.0206667	0.05311341	143	0.389104	0.6978
treatmentG	0.0076667	0.06896367	143	0.111170	0.9116
treatmentP	-0.0531667	0.06896367	143	-0.770937	0.4420
treatmentR	-0.0393084	0.07242592	143	-0.542740	0.5882
month201504	0.1133471	0.07243472	143	1.564817	0.1198
month201505	0.4461471	0.07243472	143	6.159299	0.0000
month201506	0.5606667	0.06896367	143	8.129884	0.0000
month201507	0.5845000	0.06896367	143	8.475477	0.0000
month201508	0.4641667	0.06896367	143	6.730597	0.0000
month201509	0.0926667	0.06896367	143	1.343703	0.1812
month201510	-0.2670529	0.07243472	143	-3.686808	0.0003
treatmentG:month201504	-0.0510138	0.10001388	143	-0.510067	0.6108
treatmentP:month201504	-0.0231804	0.10001388	143	-0.231772	0.8170
treatmentR:month201504	-0.0350387	0.10240164	143	-0.342169	0.7327
treatmentG:month201505	-0.1488138	0.10001388	143	-1.487931	0.1390
treatmentP:month201505	-0.1701471	0.10001388	143	-1.701235	0.0911
treatmentR:month201505	-0.2266720	0.10240164	143	-2.213558	0.0284
treatmentG:month201506	-0.2596667	0.09752936	143	-2.662446	0.0086
treatmentP:month201506	-0.3341667	0.09752936	143	-3.426319	0.0008
treatmentR:month201506	-0.0413146	0.10244999	143	-0.403266	0.6874
treatmentG:month201507	-0.3998333	0.09752936	143	-4.099620	0.0001
treatmentP:month201507	-0.2993333	0.09752936	143	-3.069161	0.0026
treatmentR:month201507	-0.0808582	0.10000751	143	-0.808521	0.4201
treatmentG:month201508	-0.3928333	0.09752936	143	-4.027847	0.0001
treatmentP:month201508	-0.2873333	0.09752936	143	-2.946121	0.0038
treatmentR:month201508	-0.0226916	0.10000751	143	-0.226898	0.8208
treatmentG:month201509	-0.0751667	0.09752936	143	-0.770708	0.4422
treatmentP:month201509	-0.0318333	0.09752936	143	-0.326397	0.7446


```
treatmentR:month201509 -0.0391916 0.10000751 143 -0.391886 0.6957
treatmentG:month201510 0.1569333 0.10228965 143 1.534205 0.1272
treatmentP:month201510 0.1717679 0.10581750 143 1.623247 0.1067
treatmentR:month201510 0.4552343 0.12377249 143 3.677993 0.0003
```

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.698133477	-0.473165992	-0.003562067	0.455713159	3.410932496

Number of Observations: 180

Number of Groups: 6

```
> r.squaredLR(mT3ML)
[1] 0.7811178
attr(,"adj.r.squared")
[1] -30.13287
```

dAir temperature IQR

```
> s15$trT_iqr<-log(s15$T_iqr)

> mTinull<-lme(trT_iqr~1,random=~1|block,data=s15,na.action = na.omit,method="ML")
> mTi3ML<-lme(trT_iqr~treatment+month+treatment:month,random=~1|block,data=s15,na.action = na.omit,method="ML")

> anova(mTinull,mTi3ML)
      Model df      AIC      BIC    logLik   Test  L.Ratio p-value
mTinull     1   3 396.4188 405.9977 -195.20939
mTi3ML      2  34 193.2593 301.8198  -62.62964 1 vs 2 265.1595  <.0001

> anova(mTi3ML)
      numDF denDF    F-value    p-value
(Intercept)      1    143   296.31518    <.0001
treatment         3    143   44.48722    <.0001
month             7    143   47.13941    <.0001
treatment:month  21    143    2.01593    0.0086

> summary(mTi3ML)
Linear mixed-effects model fit by maximum likelihood
Data: s15
      AIC      BIC    logLik
193.2593 301.8198 -62.62964

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:  0.05518311 0.3393501

Fixed effects: trT_iqr ~ treatment + month + treatment:month
      Value Std.Error DF t-value p-value
(Intercept) -1.0932605 0.1547908 143 -7.062825 0.0000
treatmentG -0.3942679 0.2160691 143 -1.824730 0.0701
treatmentP -0.1159109 0.2160691 143 -0.536453 0.5925
treatmentR -0.0263417 0.2267698 143 -0.116160 0.9077
month201504 0.5120399 0.2267768 143 2.257903 0.0255
month201505 1.0543172 0.2267768 143 4.649141 0.0000
month201506 1.7784723 0.2160691 143 8.231033 0.0000
month201507 1.6764826 0.2160691 143 7.759010 0.0000
month201508 1.5393552 0.2160691 143 7.124364 0.0000
month201509 0.4646518 0.2160691 143 2.150478 0.0332
month201510 0.5909168 0.2267768 143 2.605720 0.0101
treatmentG:month201504 -0.3333801 0.3132309 143 -1.064327 0.2890
treatmentP:month201504 -0.6229504 0.3132309 143 -1.988790 0.0486
treatmentR:month201504 -0.6839986 0.3206597 143 -2.133098 0.0346
treatmentG:month201505 -0.1399803 0.3132309 143 -0.446892 0.6556
treatmentP:month201505 -0.6343280 0.3132309 143 -2.025113 0.0447
treatmentR:month201505 -0.5986213 0.3206597 143 -1.866843 0.0640
treatmentG:month201506 -0.6744945 0.3055679 143 -2.207347 0.0289
treatmentP:month201506 -0.7817592 0.3055679 143 -2.558381 0.0116
treatmentR:month201506 -0.5741061 0.3207422 143 -1.789930 0.0756
treatmentG:month201507 -0.9030978 0.3055679 143 -2.955473 0.0037
treatmentP:month201507 -0.7201375 0.3055679 143 -2.356718 0.0198
treatmentR:month201507 -0.6713218 0.3132258 143 -2.143252 0.0338
treatmentG:month201508 -0.9058396 0.3055679 143 -2.964446 0.0036
treatmentP:month201508 -0.7716505 0.3055679 143 -2.525300 0.0127
treatmentR:month201508 -0.2558309 0.3132258 143 -0.816762 0.4154
```

```
treatmentG:month201509 -0.5072820 0.3055679 143 -1.660128 0.0991
treatmentP:month201509 -0.6423525 0.3055679 143 -2.102159 0.0373
treatmentR:month201509 -0.9186686 0.3132258 143 -2.932927 0.0039
treatmentG:month201510 -0.0888185 0.3204823 143 -0.277140 0.7821
treatmentP:month201510 -0.3088562 0.3313859 143 -0.932014 0.3529
treatmentR:month201510 0.1885288 0.3871864 143 0.486920 0.6271
```

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-2.90188812	-0.46587184	0.01401479	0.61457108	3.17760242

Number of Observations: 180

Number of Groups: 6

```
> r.squaredLR(mTi3ML)
```

```
[1] 0.7707881
```

```
attr(,"adj.r.squared")
```

```
[1] 0.8702514
```

dRelative humidity mean

```
> s15j<-s15[!(s15$month=="201510"),]
> s15j$trRH_mean<-log((-s15j$RH_mean)+7)

> mRnull<-lme(trRH_mean~1,random=~1|block,data=s15j,na.action = na.omit,method="ML")
> mR3ML<-lme(trRH_mean~treatment+month+treatment:month,random=~1|block,data=s15j,na.action = na.omit,method="ML")

> anova(mRnull,mR3ML)
      Model df      AIC      BIC    logLik   Test  L.Ratio p-value
mRnull      1   3 -65.84370 -56.81180  35.92185
mR3ML       2  30 -57.93954  32.37952  58.96977 1 vs 2  46.09584  0.0124

> anova(mR3ML)
      numDF denDF    F-value    p-value
(Intercept)      1    117   1268.4481   <.0001
treatment         3    117     5.1768   0.0021
month             6    117     2.9385   0.0105
treatment:month  18    117     0.6090   0.8866

> summary(mR3ML)
Linear mixed-effects model fit by maximum likelihood
Data: s15j
      AIC      BIC    logLik
-57.93954  32.37952  58.96977

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:   0.1186146  0.1545796

Fixed effects: trRH_mean ~ treatment + month + treatment:month
      Value Std.Error DF   t-value p-value
(Intercept)  1.8744450  0.08820184  117  21.251767  0.0000
treatmentG    0.0287189  0.09895943  117   0.290209  0.7722
treatmentP   -0.0536165  0.10400233  117  -0.515531  0.6072
treatmentR   -0.0126386  0.11108402  117  -0.113775  0.9096
month201504    0.1103148  0.10396463  117   1.061080  0.2908
month201505    0.2319724  0.10396463  117   2.231263  0.0276
month201506    0.2286084  0.09895943  117   2.310122  0.0226
month201507    0.2500973  0.09895943  117   2.527271  0.0128
month201508    0.2923224  0.09895943  117   2.953962  0.0038
month201509    0.0559730  0.09895943  117   0.565616  0.5727
treatmentG:month201504 -0.0759009  0.14353262  117  -0.528806  0.5979
treatmentP:month201504  0.0136619  0.15020056  117   0.090958  0.9277
treatmentR:month201504  0.0466602  0.15511627  117   0.300808  0.7641
treatmentG:month201505 -0.2611496  0.14353262  117  -1.819444  0.0714
treatmentP:month201505 -0.1168095  0.15020056  117  -0.777690  0.4383
treatmentR:month201505 -0.1532734  0.15511627  117  -0.988119  0.3251
treatmentG:month201506 -0.1956743  0.13994977  117  -1.398175  0.1647
treatmentP:month201506 -0.1408425  0.14678056  117  -0.959545  0.3393
treatmentR:month201506  0.0213324  0.15688057  117   0.135978  0.8921
treatmentG:month201507 -0.1939499  0.13994977  117  -1.385854  0.1684
treatmentP:month201507 -0.0810181  0.14678056  117  -0.551967  0.5820
treatmentR:month201507  0.0197515  0.15187478  117   0.130051  0.8967
treatmentG:month201508 -0.2850358  0.13994977  117  -2.036700  0.0439
treatmentP:month201508 -0.1424495  0.14678056  117  -0.970493  0.3338
```

```
treatmentR:month201508 -0.0395419 0.15187478 117 -0.260359 0.7950
treatmentG:month201509 -0.0195579 0.13994977 117 -0.139750 0.8891
treatmentP:month201509 0.0122205 0.14678056 117 0.083257 0.9338
treatmentR:month201509 0.0643750 0.15187478 117 0.423869 0.6724
```

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.0280903	-0.6464042	0.1294265	0.6037431	2.2583802

Number of Observations: 150

Number of Groups: 6

```
> r.squaredLR(mR3ML)
[1] 0.4341577
attr(,"adj.r.squared")
[1] -1.793113
```

dRelative humidity IQR

```
> s15j<-s15[!(s15$month=="201510"),]
> s15j$trRH_iqr<-(log(s15j$RH_iqr))

> mRinull<-lme(trRH_iqr~1,random=~1|block,data=s15j,na.action = na.omit,method="ML")
> mRi3ML<-lme(trRH_iqr~treatment+month+treatment:month,random=~1|block,data=s15j,na.action = na.omit,method="ML")

> anova(mRinull,mRi3ML)
      Model df      AIC      BIC    logLik   Test  L.Ratio p-value
mRinull     1   3 243.6718 252.6836 -118.83589
mRi3ML      2  30 172.2204 262.3388 -56.11018 1 vs 2 125.4514 <.0001

> anova(mRi3ML)
      numDF denDF    F-value p-value
(Intercept)      1    116 162.90880 <.0001
treatment         3    116  14.05442 <.0001
month             6    116  16.69396 <.0001
treatment:month  18    116   1.27471 0.2173

> summary(mRi3ML)
Linear mixed-effects model fit by maximum likelihood
Data: s15j
      AIC      BIC    logLik
172.2204 262.3388 -56.11018

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:  0.07942666 0.3467637

Fixed effects: trRH_iqr ~ treatment + month + treatment:month
      Value Std.Error DF   t-value p-value
(Intercept)  0.2765379 0.1611618 116   1.715902 0.0888
treatmentG   -0.1299844 0.2221639 116  -0.585083 0.5596
treatmentP    0.1681503 0.2332754 116   0.720823 0.4725
treatmentR    0.0626326 0.2489728 116   0.251564 0.8018
month201504   0.5169709 0.2332518 116   2.216364 0.0286
month201505   0.4834596 0.2332518 116   2.072694 0.0404
month201506   1.0879371 0.2332518 116   4.664218 0.0000
month201507   1.1052913 0.2221639 116   4.975117 0.0000
month201508   1.2060156 0.2221639 116   5.428496 0.0000
month201509   0.0083710 0.2221639 116   0.037679 0.9700
treatmentG:month201504 -0.3240621 0.3221229 116  -1.006020 0.3165
treatmentP:month201504 -0.6050993 0.3370972 116  -1.795029 0.0753
treatmentR:month201504 -0.5406775 0.3480449 116  -1.553471 0.1230
treatmentG:month201505 -0.2378342 0.3221229 116  -0.738334 0.4618
treatmentP:month201505 -0.6520269 0.3370972 116  -1.934240 0.0555
treatmentR:month201505 -0.3515874 0.3480449 116  -1.010178 0.3145
treatmentG:month201506 -0.5826627 0.3221229 116  -1.808821 0.0731
treatmentP:month201506 -0.7220223 0.3370972 116  -2.141882 0.0343
treatmentR:month201506 -0.4078932 0.3589507 116  -1.136349 0.2582
treatmentG:month201507 -0.8883161 0.3141872 116  -2.827347 0.0055
treatmentP:month201507 -0.8893967 0.3295223 116  -2.699049 0.0080
treatmentR:month201507 -0.5808514 0.3408104 116  -1.704324 0.0910
treatmentG:month201508 -0.5328299 0.3141872 116  -1.695900 0.0926
treatmentP:month201508 -0.7818443 0.3295223 116  -2.372660 0.0193
treatmentR:month201508 -0.3761275 0.3408104 116  -1.103627 0.2720
```

```
treatmentG:month201509 -0.2785494 0.3141872 116 -0.886572 0.3771
treatmentP:month201509 -0.3175923 0.3295223 116 -0.963796 0.3372
treatmentR:month201509 0.2762855 0.3408104 116 0.810672 0.4192
Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-2.46723593 -0.68809234 0.07987474 0.67871937 2.33785565
```

Number of Observations: 149

Number of Groups: 6

```
> r.squaredLR(mRi3ML)
[1] 0.569133
attr(,"adj.r.squared")
[1] 0.7139917
```

dVPD mean

```
> s15j<-s15[!(s15$month=="201510"),]
> s15j$trVPD_mean<-log(s15j$VPD_mean+0.1)

> mVnull<-lme(trVPD_mean~1,random=~1|block,data=s15j,na.action = na.omit,method="ML")
> mV3ML<-lme(trVPD_mean~treatment+month+treatment:month,random=~1|block,data=s15j,na.action = na.omit,method="ML")

> anova(mVnull,mV3ML)
      Model df      AIC      BIC    logLik   Test L.Ratio p-value
mVnull      1  3 112.38528 121.4172 -53.19264
mV3ML      2 30  43.71729 134.0363   8.14135 1 vs 2 122.668  <.0001

> anova(mV3ML)
      numDF denDF F-value p-value
(Intercept)      1   117 1063.9791  <.0001
treatment        3   117   13.2782  <.0001
month            6   117   13.9286  <.0001
treatment:month  18   117    1.8528  0.0267

> summary(mV3ML)
Linear mixed-effects model fit by maximum likelihood
Data: s15j
      AIC      BIC    logLik
43.71729 134.0364  8.141354

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:   0.1369392 0.2185551

Fixed effects: trVPD_mean ~ treatment + month + treatment:month
      Value Std.Error DF   t-value p-value
(Intercept) -2.3267867 0.1167514 117 -19.929417 0.0000
treatmentG    0.0131426 0.1399156 117  0.093933 0.9253
treatmentP   -0.0290510 0.1470345 117 -0.197579 0.8437
treatmentR   -0.0395452 0.1570371 117 -0.251821 0.8016
month201504    0.0831408 0.1469847 117  0.565643 0.5727
month201505    0.3219090 0.1469847 117  2.190086 0.0305
month201506    0.6648576 0.1399156 117  4.751848 0.0000
month201507    0.8285389 0.1399156 117  5.921706 0.0000
month201508    0.6257369 0.1399156 117  4.472246 0.0000
month201509    0.0447646 0.1399156 117  0.319940 0.7496
treatmentG:month201504 -0.0731102 0.2029307 117 -0.360272 0.7193
treatmentP:month201504 -0.0316499 0.2123585 117 -0.149040 0.8818
treatmentR:month201504  0.0573222 0.2193045 117  0.261382 0.7943
treatmentG:month201505 -0.2652764 0.2029307 117 -1.307226 0.1937
treatmentP:month201505 -0.1947880 0.2123585 117 -0.917260 0.3609
treatmentR:month201505 -0.1990654 0.2193045 117 -0.907712 0.3659
treatmentG:month201506 -0.4348987 0.1978705 117 -2.197895 0.0299
treatmentP:month201506 -0.5660000 0.2075284 117 -2.727338 0.0074
treatmentR:month201506 -0.1368743 0.2217916 117 -0.617130 0.5383
treatmentG:month201507 -0.6296207 0.1978705 117 -3.181983 0.0019
treatmentP:month201507 -0.4790711 0.2075284 117 -2.308461 0.0227
treatmentR:month201507 -0.1380040 0.2147237 117 -0.642705 0.5217
treatmentG:month201508 -0.6447285 0.1978705 117 -3.258335 0.0015
treatmentP:month201508 -0.4264909 0.2075284 117 -2.055097 0.0421
treatmentR:month201508 -0.1148789 0.2147237 117 -0.535008 0.5937
```



```
treatmentG:month201509 -0.0333712 0.1978705 117 -0.168652 0.8664
treatmentP:month201509 -0.0392074 0.2075284 117 -0.188925 0.8505
treatmentR:month201509 0.0800789 0.2147237 117 0.372939 0.7099
```

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-4.37011531	-0.53005396	0.02320877	0.55143696	2.93569379

Number of Observations: 150

Number of Groups: 6

```
> r.squaredLR(mV3ML)
[1] 0.5950897
attr(,"adj.r.squared")
[1] 1.08462
```

dVPD IQR

```
> s15j<-s15[!(s15$month=="201510"),]
> s15j$strVPD_iqr<-(log(s15j$VPD_iqr))

> mVinull<-lme(VPD_iqr~1,random=~1|block,data=s15j,na.action = na.omit,method="ML")
> mVi3ML<-lme(VPD_iqr~treatment+month+treatment:month,random=~1|block,data=s15j,na.action = na.omit,method="ML")
```

```
> anova(mVinull,mVi3ML)
      Model df      AIC      BIC   logLik   Test  L.Ratio p-value
mVinull     1   3 -293.1161 -284.0842 149.5581
mVi3ML      2  30 -498.6711 -408.3520 279.3355 1 vs 2 259.5549 <.0001
```

```
> anova(mVi3ML)
      numDF  denDF    F-value  p-value
(Intercept)     1    117   141.88776 <.0001
treatment        3    117    37.27926 <.0001
month            6    117    63.43445 <.0001
treatment:month  18    117     5.49067 <.0001
```

```
> summary(mVi3ML)
Linear mixed-effects model fit by maximum likelihood
Data: s15j
      AIC      BIC   logLik
-498.6711 -408.352 279.3355
```

```
Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:  0.01326536 0.0365063
```

```
Fixed effects: VPD_iqr ~ treatment + month + treatment:month
      Value Std.Error DF  t-value  p-value
(Intercept)      0.01550000 0.01758282 117   0.881542   0.3798
treatmentG      -0.00333333 0.02337076 117  -0.142628   0.8868
treatmentP       0.00118177 0.02455117 117   0.048135   0.9617
treatmentR       0.00033363 0.02621390 117   0.012727   0.9899
month201504       0.02829163 0.02454539 117   1.152625   0.2514
month201505       0.04689163 0.02454539 117   1.910404   0.0585
month201506       0.24333333 0.02337076 117  10.411870   0.0000
month201507       0.28966667 0.02337076 117  12.394404   0.0000
month201508       0.20050000 0.02337076 117   8.579096   0.0000
month201509       0.00866667 0.02337076 117   0.370834   0.7114
treatmentG:month201504 -0.01629163 0.03389202 117  -0.480692   0.6316
treatmentP:month201504 -0.02009163 0.03546699 117  -0.566488   0.5721
treatmentR:month201504 -0.01987091 0.03662377 117  -0.542569   0.5885
treatmentG:month201505 -0.02822496 0.03389202 117  -0.832791   0.4067
treatmentP:month201505 -0.03789163 0.03546699 117  -1.068363   0.2876
treatmentR:month201505 -0.02967091 0.03662377 117  -0.810154   0.4195
treatmentG:month201506 -0.16566667 0.03305125 117  -5.012418   0.0000
treatmentP:month201506 -0.16053333 0.03466444 117  -4.631067   0.0000
treatmentR:month201506 -0.11920330 0.03703307 117  -3.218833   0.0017
treatmentG:month201507 -0.20866667 0.03305125 117  -6.313428   0.0000
treatmentP:month201507 -0.17686667 0.03466444 117  -5.102251   0.0000
treatmentR:month201507 -0.12984595 0.03586042 117  -3.620871   0.0004
treatmentG:month201508 -0.13316667 0.03305125 117  -4.029097   0.0001
treatmentP:month201508 -0.13030000 0.03466444 117  -3.758895   0.0003
treatmentR:month201508 -0.06347928 0.03586042 117  -1.770177   0.0793
```

```
treatmentG:month201509 -0.00516667 0.03305125 117 -0.156323 0.8760
treatmentP:month201509 -0.00566667 0.03466444 117 -0.163472 0.8704
treatmentR:month201509 0.00675405 0.03586042 117 0.188343 0.8509
```

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-4.33942273	-0.37049134	0.01864184	0.25755953	5.18290147

Number of Observations: 150

Number of Groups: 6

```
> r.squaredLR(mVi3ML)
```

```
[1] 0.8227805
```

```
attr(,"adj.r.squared")
```

```
[1] -0.1296607
```

dSoil temperature mean

```
> mTsnnull<-lme(Ts_mean~1,random=~1|block,data=s15,na.action = na.omit,method="ML")
> mTs3ML<-lme(Ts_mean~treatment+month+treatment:month,random=~1|block,data=s15,na.action = na.omit,method="ML")
```

```
> anova(mTsnnull,mTs3ML)
```

	Model	df	AIC	BIC	logLik	Test	L.Ratio	p-value
mTsnnull	1	3	699.7068	709.2856	-346.8534			
mTs3ML	2	34	499.7314	608.2919	-215.8657	1 vs 2	261.9754	<.0001

```
> anova(mTs3ML)
```

	numDF	denDF	F-value	p-value
(Intercept)	1	143	49.98616	<.0001
treatment	3	143	9.10663	<.0001
month	7	143	44.61046	<.0001
treatment:month	21	143	7.36807	<.0001

```
> summary(mTs3ML)
```

Linear mixed-effects model fit by maximum likelihood

Data: s15

	AIC	BIC	logLik
	499.7314	608.2919	-215.8657

Random effects:

Formula: ~1 | block

(Intercept) Residual

StdDev: 0.2596888 0.783523

Fixed effects: Ts_mean ~ treatment + month + treatment:month

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.004000	0.3716326	143	0.010763	0.9914
treatmentG	0.110833	0.4988805	143	0.222164	0.8245
treatmentP	0.058667	0.4988805	143	0.117597	0.9066
treatmentR	0.287378	0.5238576	143	0.548580	0.5841
month201504	1.120325	0.5239089	143	2.138396	0.0342
month201505	3.145125	0.5239089	143	6.003189	0.0000
month201506	3.859500	0.4988805	143	7.736322	0.0000
month201507	3.549000	0.4988805	143	7.113928	0.0000
month201508	2.191000	0.4988805	143	4.391833	0.0000
month201509	0.366667	0.4988805	143	0.734979	0.4636
month201510	-4.025675	0.5239089	143	-7.683922	0.0000
treatmentG:month201504	-0.816991	0.7234379	143	-1.129318	0.2607
treatmentP:month201504	-0.426158	0.7234379	143	-0.589073	0.5567
treatmentR:month201504	-0.753369	0.7406874	143	-1.017121	0.3108
treatmentG:month201505	-0.921291	0.7234379	143	-1.273490	0.2049
treatmentP:month201505	-1.573291	0.7234379	143	-2.174743	0.0313
treatmentR:month201505	-2.632169	0.7406874	143	-3.553684	0.0005
treatmentG:month201506	-2.629333	0.7055236	143	-3.726783	0.0003
treatmentP:month201506	-2.451000	0.7055236	143	-3.474016	0.0007
treatmentR:month201506	-1.740853	0.7410067	143	-2.349308	0.0202
treatmentG:month201507	-3.722500	0.7055236	143	-5.276223	0.0000
treatmentP:month201507	-2.429000	0.7055236	143	-3.442833	0.0008
treatmentR:month201507	-1.366378	0.7234007	143	-1.888825	0.0609
treatmentG:month201508	-2.015667	0.7055236	143	-2.856980	0.0049
treatmentP:month201508	-1.171833	0.7055236	143	-1.660941	0.0989
treatmentR:month201508	-0.646378	0.7234007	143	-0.893526	0.3731
treatmentG:month201509	-0.308333	0.7055236	143	-0.437028	0.6628
treatmentP:month201509	-0.134167	0.7055236	143	-0.190166	0.8494

```
treatmentR:month201509 -0.221211 0.7234007 143 -0.305793 0.7602
treatmentG:month201510 2.935967 0.7399594 143 3.967740 0.0001
treatmentP:month201510 3.494386 0.7654100 143 4.565379 0.0000
treatmentR:month201510 2.328223 0.8950890 143 2.601107 0.0103
```

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-2.630874444	-0.549068304	0.004556796	0.401407143	4.001882604

Number of Observations: 180

Number of Groups: 6

```
> r.squaredLR(mTs3ML)
```

```
[1] 0.7675237
```

```
attr(,"adj.r.squared")
```

```
[1] 0.7840845
```

dSoil temperature IQR

```
> s15$trTs_iqr<-(log(s15$Ts_iqr))

> mTsinull<-lme(trTs_iqr~1,random=~1|block,data=s15,na.action = na.omit,method="ML")
> mTsi3ML<-lme(trTs_iqr~treatment+month+treatment:month,random=~1|block,data=s15,na.action = na.omit,method="ML")

> anova(mTsinull,mTsi3ML)
      Model df      AIC      BIC    logLik   Test  L.Ratio p-value
mTsinull    1   3 499.7373 509.3161 -246.8686
mTsi3ML     2  34 360.2004 468.7609 -146.1002 1 vs 2 201.5369 <.0001

> anova(mTsi3ML)
      numDF denDF    F-value    p-value
(Intercept)      1    143    26.399053    <.0001
treatment         3    143    24.396929    <.0001
month             7    143    24.166186    <.0001
treatment:month  21    143     3.247725    <.0001

> summary(mTsi3ML)
Linear mixed-effects model fit by maximum likelihood
Data: s15
      AIC      BIC    logLik
360.2004 468.7609 -146.1002

Random effects:
Formula: ~1 | block
(Intercept) Residual
StdDev: 0.09696716 0.5387094

Fixed effects: trTs_iqr ~ treatment + month + treatment:month
      Value Std.Error DF t-value p-value
(Intercept) -0.1602946 0.2464383 143 -0.650445 0.5164
treatmentG -0.0743775 0.3430041 143 -0.216842 0.8286
treatmentP -0.3469192 0.3430041 143 -1.011414 0.3135
treatmentR -0.3780110 0.3600198 143 -1.049973 0.2955
month201504 1.2556458 0.3600336 143 3.487579 0.0006
month201505 1.7787582 0.3600336 143 4.940534 0.0000
month201506 1.9832717 0.3430041 143 5.782064 0.0000
month201507 2.1754973 0.3430041 143 6.342481 0.0000
month201508 1.5615194 0.3430041 143 4.552480 0.0000
month201509 0.5434793 0.3430041 143 1.584469 0.1153
month201510 -0.4140520 0.3600336 143 -1.150037 0.2520
treatmentG:month201504 -0.5734972 0.4972686 143 -1.153295 0.2507
treatmentP:month201504 -0.7528316 0.4972686 143 -1.513933 0.1322
treatmentR:month201504 -1.3022349 0.5090723 143 -2.558055 0.0116
treatmentG:month201505 -0.7902009 0.4972686 143 -1.589083 0.1143
treatmentP:month201505 -0.4379734 0.4972686 143 -0.880758 0.3799
treatmentR:month201505 -0.9873169 0.5090723 143 -1.939443 0.0544
treatmentG:month201506 -1.3077299 0.4850811 143 -2.695900 0.0079
treatmentP:month201506 -0.9708582 0.4850811 143 -2.001435 0.0472
treatmentR:month201506 -0.3408557 0.5092175 143 -0.669371 0.5043
treatmentG:month201507 -1.8956073 0.4850811 143 -3.907815 0.0001
treatmentP:month201507 -1.0830576 0.4850811 143 -2.232735 0.0271
treatmentR:month201507 -0.3833838 0.4972586 143 -0.770995 0.4420
treatmentG:month201508 -1.5247504 0.4850811 143 -3.143290 0.0020
treatmentP:month201508 -0.7742061 0.4850811 143 -1.596034 0.1127
treatmentR:month201508 -0.4515435 0.4972586 143 -0.908066 0.3654
```

```
treatmentG:month201509 -0.8324306 0.4850811 143 -1.716065 0.0883
treatmentP:month201509 -0.6575006 0.4850811 143 -1.355445 0.1774
treatmentR:month201509 -0.8698572 0.4972586 143 -1.749306 0.0824
treatmentG:month201510 -0.1027480 0.5087574 143 -0.201959 0.8402
treatmentP:month201510 0.6460326 0.5260957 143 1.227975 0.2215
treatmentR:month201510 1.6838793 0.6147685 143 2.739046 0.0069
```

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.1961987	-0.5530348	0.1274397	0.6768959	2.3858505

Number of Observations: 180

Number of Groups: 6

```
> r.squaredLR(mTsi3ML)
```

```
[1] 0.6736058
```

```
attr(,"adj.r.squared")
```

```
[1] 0.719955
```

dSoil moisture mean

```
> s15$trMs_mean<-s15$Ms_mean^(1/3)

> mMsnull<-lme(trMs_mean~1,random=~1|block,data=s15,na.action = na.omit,method="ML")
> mMs3ML<-lme(trMs_mean~treatment+month+treatment:month,random=~1|block,data=s15,na.action = na.omit,method="ML")

> anova(mMsnull,mMs3ML)
      Model df      AIC      BIC   logLik   Test  L.Ratio p-value
mMsnull     1   3 -424.6754 -415.1810 215.3377
mMs3ML      2  34 -472.6404 -365.0377 270.3202 1 vs 2 109.9651 <.0001

> anova(mMs3ML)
      numDF denDF  F-value  p-value
(Intercept)      1    138   702.3656 <.0001
treatment         3    138    29.1450 <.0001
month             7    138     2.3129 0.0292
treatment:month  21    138     1.0892 0.3666

> summary(mMs3ML)
Linear mixed-effects model fit by maximum likelihood
Data: s15
      AIC      BIC   logLik
-472.6404 -365.0377 270.3202

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:  0.03273497 0.04936078

Fixed effects: trMs_mean ~ treatment + month + treatment:month
      Value Std.Error DF t-value p-value
(Intercept)  0.3981226 0.02674910 138 14.883589 0.0000
treatmentG    0.0369144 0.03152626 138  1.170911 0.2437
treatmentP   -0.0234475 0.03152626 138 -0.743744 0.4583
treatmentR    0.0018673 0.03311372 138  0.056390 0.9551
month201504    0.0018850 0.03312060 138  0.056913 0.9547
month201505    0.0046381 0.03312060 138  0.140036 0.8888
month201506    0.0339577 0.03152626 138  1.077124 0.2833
month201507    0.0472754 0.03311708 138  1.427522 0.1557
month201508   -0.0006945 0.03152626 138 -0.022030 0.9825
month201509    0.0233149 0.03152626 138  0.739538 0.4608
month201510   -0.0111664 0.03312060 138 -0.337143 0.7365
treatmentG:month201504 -0.0059122 0.04572613 138 -0.129295 0.8973
treatmentP:month201504 -0.0156096 0.04572613 138 -0.341371 0.7333
treatmentR:month201504 -0.0271980 0.04681920 138 -0.580916 0.5622
treatmentG:month201505  0.0092789 0.04572613 138  0.202924 0.8395
treatmentP:month201505 -0.0040018 0.04572613 138 -0.087516 0.9304
treatmentR:month201505 -0.0237664 0.04681920 138 -0.507620 0.6125
treatmentG:month201506  0.0538512 0.04458486 138  1.207836 0.2292
treatmentP:month201506  0.0147502 0.04458486 138  0.330835 0.7413
treatmentR:month201506 -0.0654297 0.04684145 138 -1.396833 0.1647
treatmentG:month201507  0.0543614 0.04676100 138  1.162538 0.2470
treatmentP:month201507 -0.0484026 0.04676100 138 -1.035106 0.3024
treatmentR:month201507 -0.1027897 0.04784563 138 -2.148361 0.0334
treatmentG:month201508  0.0145425 0.04458486 138  0.326175 0.7448
treatmentP:month201508 -0.0000801 0.04458486 138 -0.001796 0.9986
treatmentR:month201508 -0.0551709 0.04572115 138 -1.206681 0.2296
```



```
treatmentG:month201509  0.0220550 0.04458486 138  0.494675  0.6216
treatmentP:month201509 -0.0234509 0.04572613 138 -0.512856  0.6089
treatmentR:month201509 -0.0712710 0.04572115 138 -1.558819  0.1213
treatmentG:month201510  0.0048231 0.04676100 138  0.103143  0.9180
treatmentP:month201510 -0.0063309 0.04837859 138 -0.130861  0.8961
treatmentR:month201510  0.0144303 0.05660629 138  0.254923  0.7992
```

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-4.28134790	-0.48896785	0.07519849	0.57668886	3.30091687

Number of Observations: 175

Number of Groups: 6

```
> r.squaredLR(mMs3ML)
```

```
[1] 0.5342961
```

```
attr(,"adj.r.squared")
```

```
[1] -0.05789692
```

dLitter pH

```
> soil15$trdLitter_pH<-log(soil15$dLitter_pH+0.5)

> mLitterpHnull<-lme(trdLitter_pH~1,random=~1|block,data=soil15,na.action =
  na.omit,method="ML")
> mLitterpH3ML<-lme(trdLitter_pH~treatment+season+treatment:season,random=~
  1|block,data=soil15,na.action = na.omit,method="ML")

> anova(mLitterpHnull,mLitterpH3ML)
      Model df      AIC      BIC    logLik    Test  L.Ratio p-value
mLitterpHnull      1   3  91.94765  97.56125 -42.97382
mLitterpH3ML       2  10  70.55729  89.26930 -25.27865 1 vs 2 35.39035 <.0001

> anova(mLitterpH3ML)
      numDF denDF    F-value    p-value
(Intercept)      1     35    25.946828    <.0001
treatment         3     35     8.888053    0.0002
season            1     35     8.685361    0.0057
treatment:season  3     35     3.645544    0.0218

> summary(mLitterpH3ML)
Linear mixed-effects model fit by maximum likelihood
Data: soil15
      AIC      BIC    logLik
70.55729 89.2693 -25.27865

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:   0.1922667 0.3823417

Fixed effects: trdLitter_pH ~ treatment + season + treatment:season
      Value Std.Error DF   t-value p-value
(Intercept)   0.0332295 0.1913905 35   0.173621  0.8632
treatmentG     0.2046331 0.2418141 35   0.846241  0.4032
treatmentP    -0.7785433 0.2418141 35  -3.219594  0.0028
treatmentR    -0.9879794 0.2418141 35  -4.085698  0.0002
seasonT       -0.5370359 0.2418141 35  -2.220862  0.0329
treatmentG:seasonT -0.3640041 0.3419768 35  -1.064412  0.2944
treatmentP:seasonT  0.3901027 0.3419768 35   1.140728  0.2617
treatmentR:seasonT  0.6967473 0.3419768 35   2.037411  0.0492

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-2.33614151 -0.39507720  0.04123653  0.74830688  2.42802361

Number of Observations: 48
Number of Groups: 6

> r.squaredLR(mLitterpH3ML)
[1] 0.5235332
attr(,"adj.r.squared")
[1] 0.6278794
```

*d*Litter mass

```
> soil15$trdLitter_mass<-sqrt(soil15$dLitter_mass+550)

> mLitterMnull<-lme(trdLitter_mass~1,random=~1|block,data=soil15,na.action
= na.omit,method="ML")
> mLitterM3ML<-lme(trdLitter_mass~treatment+season+treatment:season,random=
~1|block,data=soil15,na.action = na.omit,method="ML")

> anova(mLitterMnull,mLitterM3ML)
      Model df      AIC      BIC    logLik   Test  L.Ratio p-value
mLitterMnull    1   3 332.2222 337.8358 -163.1111
mLitterM3ML     2 10 324.8847 343.5967 -152.4424 1 vs 2 21.33748 0.0033

> anova(mLitterM3ML)
      numDF denDF    F-value    p-value
(Intercept)      1     35  134.58077 <.0001
treatment         3     35   2.16425 0.1097
season            1     35  10.81187 0.0023
treatment:season  3     35   1.95539 0.1387

> summary(mLitterM3ML)
Linear mixed-effects model fit by maximum likelihood
Data: soil15
      AIC      BIC    logLik
 324.8847 343.5967 -152.4424

Random effects:
Formula: ~1 | block
      (Intercept) Residual
StdDev:      3.93488 5.204792

Fixed effects: trdLitter_mass ~ treatment + season + treatment:season
      Value Std.Error DF   t-value p-value
(Intercept)  16.166313  2.917984 35   5.540234 0.0000
treatmentG    2.276430  3.291800 35   0.691546 0.4938
treatmentP    1.817937  3.291800 35   0.552262 0.5843
treatmentR   10.562571  3.291800 35   3.208753 0.0029
seasonT       8.433373  3.291800 35   2.561934 0.0149
treatmentG:seasonT -1.244553  4.655308 35  -0.267341 0.7908
treatmentP:seasonT -0.961449  4.655308 35  -0.206528 0.8376
treatmentR:seasonT -9.879693  4.655308 35  -2.122243 0.0410

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-2.89563623 -0.53537118 -0.05857455  0.61833623  1.92266526

Number of Observations: 48
Number of Groups: 6

> r.squaredLR(mLitterM3ML)
[1] 0.423697
attr(,"adj.r.squared")
[1] 0.4241231
```

*d*Litter moisture

```
> soil15$trdLitter_moist<-sqrt(soil15$dLitter_moist+11)

> mLitterMCnull<-lme(trdLitter_moist~1,random=~1|block,data=soil15,na.action = na.omit,method="ML")
> mLitterMC3ML<-lme(trdLitter_moist~treatment+season+treatment:season,random=~1|block,data=soil15,na.action = na.omit,method="ML")

> anova(mLitterMCnull,mLitterMC3ML)
      Model df      AIC      BIC    logLik   Test  L.Ratio p-value
mLitterMCnull    1   3 167.3907 173.0043 -80.69534
mLitterMC3ML     2 10 134.3879 153.1000 -57.19397 1 vs 2 47.00274 <.0001

> anova(mLitterMC3ML)
      numDF denDF    F-value    p-value
(Intercept)      1     35  1008.2659    <.0001
treatment         3     35    9.3178    1e-04
season            1     35   16.4776    3e-04
treatment:season  3     35    7.3548    6e-04

> summary(mLitterMC3ML)
Linear mixed-effects model fit by maximum likelihood
Data: soil15
      AIC      BIC    logLik
134.3879 153.1 -57.19397

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev: 2.747633e-05 0.7966041

Fixed effects: trdLitter_moist ~ treatment + season + treatment:season
      Value Std.Error DF   t-value p-value
(Intercept)  5.317266 0.3562522 35 14.925568 0.0000
treatmentG   0.443921 0.5038167 35  0.881116 0.3843
treatmentP  -0.838824 0.5038167 35 -1.664938 0.1049
treatmentR  -2.831247 0.5038167 35 -5.619598 0.0000
seasonT     -1.815308 0.5038167 35 -3.603112 0.0010
treatmentG:seasonT -0.410319 0.7125044 35 -0.575883 0.5684
treatmentP:seasonT  0.915097 0.7125044 35  1.284339 0.2075
treatmentR:seasonT  2.666211 0.7125044 35  3.742027 0.0007

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-2.82715424 -0.53343318  0.02819601  0.47678081  3.45947286

Number of Observations: 48
Number of Groups: 6

> r.squaredLR(mLitterMC3ML)
[1] 0.6243975
attr(,"adj.r.squared")
[1] 0.6468129
```

dSoil pH

```
> mdpHnull<-lme(dpH~1,random=~1|block,data=soil15,na.action = na.omit,method="ML")
> mdpH3ML<-lme(dpH~treatment+season+treatment*season,random=~1|block,data=soil15,na.action = na.omit,method="ML")
```

```
> anova(mdpHnull,mdpH3ML)
```

	Model	df	AIC	BIC	logLik	Test	L.Ratio	p-value
mdpHnull	1	3	-22.85075	-17.23714	14.42537			
mdpH3ML	2	10	-32.70727	-13.99526	26.35363	1 vs 2	23.85652	0.0012

```
> anova(mdpH3ML)
```

	numDF	denDF	F-value	p-value
(Intercept)	1	35	2.028731	0.1632
treatment	3	35	3.634596	0.0221
season	1	35	15.740617	0.0003
treatment:season	3	35	0.040684	0.9889

```
> summary(mdpH3ML)
```

Linear mixed-effects model fit by maximum likelihood

Data: soil15

	AIC	BIC	logLik
	-32.70727	-13.99526	26.35363

Random effects:

Formula: ~1 | block

	(Intercept)	Residual
--	-------------	----------

StdDev:	0.1371361	0.1199902
---------	-----------	-----------

Fixed effects: dpH ~ treatment + season + treatment * season

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.14733333	0.08149107	35	1.8079690	0.0792
treatmentG	-0.02366667	0.07588848	35	-0.3118611	0.7570
treatmentP	-0.02066667	0.07588848	35	-0.2723294	0.7870
treatmentR	0.12183333	0.07588848	35	1.6054260	0.1174
seasonT	-0.16316667	0.07588848	35	-2.1500849	0.0385
treatmentG:seasonT	0.02833333	0.10732251	35	0.2640018	0.7933
treatmentP:seasonT	-0.00100000	0.10732251	35	-0.0093177	0.9926
treatmentR:seasonT	0.02316667	0.10732251	35	0.2158603	0.8303

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-2.50497974	-0.55501504	-0.01743328	0.45780107	2.74961529

Number of Observations: 48

Number of Groups: 6

```
> r.squaredLR(mdpH3ML)
```

```
[1] 0.5441644
```

```
attr(,"adj.r.squared")
```

```
[1] -1.483696
```

dhy

```
> mdhynull<-lme(dhy~1,random=~1|block,data=soil15,na.action = na.omit,method="ML")
> mdhy3ML<-lme(dhy~treatment+season+treatment:season,random=~1|block,data=soil15,na.action = na.omit,method="ML")
```

```
> anova(mdhynull,mdhy3ML)
```

	Model	df	AIC	BIC	logLik	Test	L.Ratio	p-value
mdhynull	1	3	47.52722	53.14083	-20.76361			
mdhy3ML	2	10	51.09904	69.81105	-15.54952	1 vs 2	10.42818	0.1656

```
> anova(mdhy3ML)
```

	numDF	denDF	F-value	p-value
(Intercept)	1	35	0.0351563	0.8524
treatment	3	35	2.8241929	0.0528
season	1	35	0.1146569	0.7369
treatment:season	3	35	0.4256336	0.7358

```
> summary(mdhy3ML)
```

Linear mixed-effects model fit by maximum likelihood

Data: soil15

	AIC	BIC	logLik
	51.09904	69.81105	-15.54952

Random effects:

Formula: ~1 | block

	(Intercept)	Residual
--	-------------	----------

StdDev:	0.1381251	0.3156743
---------	-----------	-----------

Fixed effects: dhy ~ treatment + season + treatment:season

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-0.0576714	0.1540966	35	-0.3742550	0.7105
treatmentG	-0.1603560	0.1996499	35	-0.8031860	0.4273
treatmentP	0.0384743	0.1996499	35	0.1927087	0.8483
treatmentR	0.3445262	0.1996499	35	1.7256516	0.0932
seasonT	-0.0002703	0.1996499	35	-0.0013540	0.9989
treatmentG:seasonT	0.2268021	0.2823477	35	0.8032724	0.4272
treatmentP:seasonT	-0.0436020	0.2823477	35	-0.1544266	0.8782
treatmentR:seasonT	-0.0469117	0.2823477	35	-0.1661487	0.8690

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-2.29336826	-0.44202863	-0.06855167	0.43475237	2.96161113

Number of Observations: 48

Number of Groups: 6

```
> r.squaredLR(mdhy3ML)
```

```
[1] 0.219002
```

```
attr(,"adj.r.squared")
```

```
[1] 0.3702955
```

dSOC content

```
> soil15$trdSOC<-log(soil15$dSOC+1.5)

> mdSOCnull<-lme(trdSOC~1,random=~1|block,data=soil15,na.action = na.omit,method="ML")
> mdSOC3ML<-lme(trdSOC~treatment+season+treatment:season,random=~1|block,data=soil15,na.action = na.omit,method="ML")

> anova(mdSOCnull,mdSOC3ML)
      Model df      AIC      BIC    logLik   Test  L.Ratio p-value
mdSOCnull    1   3 78.89660  84.5102 -36.44830
mdSOC3ML     2  10 87.88855 106.6006 -33.94428 1 vs 2 5.008045   0.659

> anova(mdSOC3ML)
              numDF denDF  F-value  p-value
(Intercept)         1    35   7.308574  0.0105
treatment            3    35   1.201850  0.3234
season              1    35   0.158484  0.6930
treatment:season     3    35   0.222781  0.8799

> summary(mdSOC3ML)
Linear mixed-effects model fit by maximum likelihood
Data: soil15
      AIC      BIC    logLik
 87.88855 106.6006 -33.94428

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:   0.4069811 0.4304601

Fixed effects: trdSOC ~ treatment + season + treatment:season
              Value Std.Error   DF   t-value  p-value
(Intercept)   0.4818693 0.2649262  35   1.8188810   0.0775
treatmentG     0.1351994 0.2722469  35   0.4966058   0.6226
treatmentP    -0.1786870 0.2722469  35  -0.6563418   0.5159
treatmentR     0.3256883 0.2722469  35   1.1962978   0.2396
seasonT        0.0011581 0.2722469  35   0.0042537   0.9966
treatmentG:seasonT -0.1043581 0.3850152  35  -0.2710494   0.7879
treatmentP:seasonT  0.0898911 0.3850152  35   0.2334742   0.8168
treatmentR:seasonT -0.2069286 0.3850152  35  -0.5374555   0.5944

Standardized Within-Group Residuals:
      Min          Q1          Med          Q3          Max
-2.126563001 -0.406879918  0.004750577  0.537757755  1.868282465

Number of Observations: 48
Number of Groups: 6

> r.squaredLR(mdSOC3ML)
[1] 0.3515845
attr(,"adj.r.squared")
[1] 0.4173705
```

dN content

```
> soil15$trdN<-log(soil15$dN+0.1)

> mdNnull<-lme(trdN~1,random=~1|block,data=soil15,na.action = na.omit,method="ML")
> mdN3ML<-lme(trdN~treatment+season+treatment:season,random=~1|block,data=soil15,na.action = na.omit,method="ML")

> anova(mdNnull,mdN3ML)
      Model df      AIC      BIC    logLik  Test  L.Ratio p-value
mdNnull     1  3 28.78135 34.39495 -11.390674
mdN3ML      2 10 39.36641 58.07842  -9.683206 1 vs 2  3.414936  0.8442

> anova(mdN3ML)
      numDF denDF  F-value  p-value
(Intercept)      1    35   327.8920  <.0001
treatment         3    35    0.9121  0.4451
season            1    35    0.0075  0.9316
treatment:season  3    35    0.0736  0.9738

> summary(mdN3ML)
Linear mixed-effects model fit by maximum likelihood
Data: soil15
      AIC      BIC    logLik
39.36641 58.07842 -9.683206

Random effects:
Formula: ~1 | block
      (Intercept)  Residual
StdDev:   0.2537805 0.2586079

Fixed effects: trdN ~ treatment + season + treatment:season
      Value Std.Error DF   t-value p-value
(Intercept) -2.2557817 0.1620386 35 -13.921260  0.0000
treatmentG   0.1534898 0.1635580 35  0.938443  0.3544
treatmentP  -0.0314319 0.1635580 35 -0.192176  0.8487
treatmentR   0.1491802 0.1635580 35  0.912093  0.3680
seasonT      0.0431960 0.1635580 35  0.264102  0.7933
treatmentG:seasonT -0.0944611 0.2313059 35 -0.408382  0.6855
treatmentP:seasonT -0.0032141 0.2313059 35 -0.013895  0.9890
treatmentR:seasonT -0.0468295 0.2313059 35 -0.202457  0.8407

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-3.14078132 -0.42943497 -0.06162177  0.51605364  2.39122843

Number of Observations: 48
Number of Groups: 6

> r.squaredLR(mdN3ML)
[1] 0.3566512
attr(,"adj.r.squared")
[1] 0.6254373
```


dP content

```
> soil15$trdALP<-log(soil15$dALP+2)

> mdALPnull<-lme(trdALP~1,random=~1|block,data=soil15,na.action = na.omit,method="ML")
> mdALP3ML<-lme(trdALP~treatment+season+treatment:season,random=~1|block,data=soil15,na.action = na.omit,method="ML")

> anova(mdALPnull,mdALP3ML)
      Model df      AIC      BIC    logLik   Test  L.Ratio p-value
mdALPnull    1   3 80.59801  86.21161 -37.29901
mdALP3ML     2 10 84.28975 103.00176 -32.14487 1 vs 2 10.30826  0.1718

> anova(mdALP3ML)
      numDF denDF    F-value  p-value
(Intercept)      1     35  26.524124  <.0001
treatment         3     35   1.935567  0.1418
season            1     35   1.033453  0.3163
treatment:season  3     35   0.965346  0.4200

> summary(mdALP3ML)
Linear mixed-effects model fit by maximum likelihood
Data: soil15
      AIC      BIC    logLik
 84.28975 103.0018 -32.14487

Random effects:
Formula: ~1 | block
(Intercept) Residual
StdDev:    0.3885489 0.415074

Fixed effects: trdALP ~ treatment + season + treatment:season
      Value Std.Error DF   t-value p-value
(Intercept)  0.8127562 0.2542663 35   3.196476  0.0029
treatmentG   0.4648970 0.2625159 35   1.770929  0.0853
treatmentP   0.1487647 0.2625159 35   0.566688  0.5745
treatmentR   0.2286490 0.2625159 35   0.870991  0.3897
seasonT      -0.2439890 0.2625159 35  -0.929426  0.3590
treatmentG:seasonT -0.1453025 0.3712535 35  -0.391384  0.6979
treatmentP:seasonT  0.4592378 0.3712535 35   1.236993  0.2243
treatmentR:seasonT  0.1282791 0.3712535 35   0.345530  0.7318

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-2.2485420 -0.4842965 -0.1627035  0.6725320  1.8500067

Number of Observations: 48
Number of Groups: 6

> r.squaredLR(mdALP3ML)
[1] 0.3880933
attr(,"adj.r.squared")
[1] 0.4621953
```

dK content

```
> mdALKnull<-lme(dALK~1,random=~1|block,data=soil15,na.action = na.omit,met  
hod="ML")  
> mdALK3ML<-lme(dALK~treatment+season+treatment:season,random=~1|block,data  
=soil15,na.action = na.omit,method="ML")
```

```
> anova(mdALKnull,mdALK3ML)
```

	Model	df	AIC	BIC	logLik	Test	L.Ratio	p-value
mdALKnull	1	3	227.0341	232.6477	-110.5170			
mdALK3ML	2	10	228.2991	247.0111	-104.1495	1 vs 2	12.73502	0.0788

```
> anova(mdALK3ML)
```

	numDF	denDF	F-value	p-value
(Intercept)	1	35	5.899471	0.0204
treatment	3	35	1.641195	0.1975
season	1	35	6.956095	0.0124
treatment:season	3	35	0.172503	0.9143

```
> summary(mdALK3ML)
```

Linear mixed-effects model fit by maximum likelihood

Data: soil15

	AIC	BIC	logLik
	228.2991	247.0111	-104.1495

Random effects:

Formula: ~1 | block

(Intercept) Residual

StdDev: 1.216952 1.938375

Fixed effects: dALK ~ treatment + season + treatment:season

	Value	Std.Error	DF	t-value	p-value
(Intercept)	1.5283333	1.023550	35	1.4931698	0.1444
treatmentG	1.3483333	1.225936	35	1.0998401	0.2789
treatmentP	-0.0800000	1.225936	35	-0.0652563	0.9483
treatmentR	1.9200000	1.225936	35	1.5661505	0.1263
seasonT	-1.5833333	1.225936	35	-1.2915304	0.2050
treatmentG:seasonT	-0.2783333	1.733735	35	-0.1605397	0.8734
treatmentP:seasonT	0.6616667	1.733735	35	0.3816423	0.7050
treatmentR:seasonT	-0.5166667	1.733735	35	-0.2980079	0.7675

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-2.27578350	-0.54363817	-0.09740638	0.62594394	2.44180174

Number of Observations: 48

Number of Groups: 6

```
> r.squaredLR(mdALK3ML)
```

```
[1] 0.298857
```

```
attr(,"adj.r.squared")
```

```
[1] 0.3016151
```