

A glance at Reynolds data on node survival
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In an initial analysis, the experimental unit can be taken as replication. The response measured on such a replication is the total number of nodes that survive out of 30 (15 stolons, each with 2 nodes, per rep.) An equivalent response is the proportion surviving, and the arcsin square root transformation can be used in an attempt to stabilize the variance of this response. The model used for this analysis is that for a 6×4 fixed effects factorial design with $n = 4$ replications per treatment combination.

The table below shows the mean survivorships for the 24 treatment combinations. Each entry is the average of $n = 4$ replications. Each replication involves the calculation of a sum of surviving nodes out of 30:

Cultivar	Temperature			
	1	2	3	4
Tifsport	0.7666667	0.6250000	0.6166667	0
Tifway	0.8333333	0.6500000	0.2916667	0
GN1	0.7416667	0.3666667	0.3000000	0
QS	0.6666667	0.6500000	0.4416667	0
NB	0.7083333	0.7083333	0.3583333	0
Tifton	0.6750000	0.6250000	0.3833333	0

A model for the mean (on the transformed scale) of survivorship using this analysis is then

$$\mu_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} \quad \text{for } i = 1, 2, \dots, 6, \quad j = 1, 2, 3, \quad k = 1, 2, 3, 4$$

where $(\alpha\beta)_{ij}$ denote possible cultivar by temperature interaction effects and α_i and β_j denote cultivar and temperature main effects, respectively.

There was complete mortality at temperature 4, and no transformation can overcome the resulting inhomogeneity of variance. It is apparent that level four of the temperature factor results in more mortality than any other level. Subsequent analyses are therefore only conducted using the 6×3 treatment combinations where variability was observed in the data.

The ANOVA table below indicates no interaction effect. There is certainly evidence that mortality increases with temperature, even across the restricted range (1-3), but there is no evidence that the temperature dependence varies across cultivars. There is also no evidence of variation in mortality across cultivars, after averaging over the 3 temperature levels.

CAVEAT: a more efficient analysis may be possible using stolon as the experimental unit, rather than the average of 15 stolons. The response would have support 0, 1, 2, so the probabilities $\Pr(Y_{ij} = 0)$ and $\Pr(Y_{ij} = 1)$ would have to be modelled using a generalized linear model. These models can be fit using PROC GENMOD or PROC NLMIXED in SAS.

The SAS System

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The GLM Procedure

Class Level Information

Class	Levels	Values
Temp	3	1 2 3
cultivar	6	GN1 NB QS Tifsport Tifton Tifway

Number of observations 72

Dependent Variable: y (arcsin sqrt transform)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	2.56533339	0.15090196	4.00	<.0001
Error	54	2.03489645	0.03768327		
Corrected Total	71	4.60022984			

R-Square	Coeff Var	Root MSE	y Mean
0.557653	22.48171	0.194122	0.863466

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Temp	2	1.72478635	0.86239317	22.89	<.0001
cultivar	5	0.29058470	0.05811694	1.54	0.1923
Temp*cultivar	10	0.54996235	0.05499623	1.46	0.1804

Level of Temp	Level of cultivar	N	propn	Mean	Std Dev	y	Mean	Std Dev
1	GN1	4	0.74166667	0.09574271	1.04342079	0.11430462		
1	NB	4	0.70833333	0.10671874	1.00700049	0.12773621		
1	QS	4	0.66666667	0.06085806	0.95643887	0.06480991		
1	Tifsport	4	0.76666667	0.18658728	1.08811195	0.21979904		
1	Tifton	4	0.67500000	0.05692750	0.96517689	0.06054052		
1	Tifway	4	0.83333333	0.06666667	1.15479242	0.08442346		
2	GN1	4	0.36666667	0.16329932	0.64341546	0.17643899		
2	NB	4	0.70833333	0.07391186	1.00274678	0.08282895		
2	QS	4	0.65000000	0.16666667	0.94760950	0.18644992		
2	Tifsport	4	0.62500000	0.17924740	0.91807228	0.18854972		
2	Tifton	4	0.62500000	0.07391186	0.91314386	0.07831486		
2	Tifway	4	0.65000000	0.07934920	0.93979627	0.08611056		
3	GN1	4	0.30000000	0.11863420	0.57486437	0.12752327		
3	NB	4	0.35833333	0.22339966	0.62711499	0.24379804		
3	QS	4	0.44166667	0.34251250	0.69768926	0.40639089		
3	Tifsport	4	0.61666667	0.18559215	0.90870355	0.19441816		
3	Tifton	4	0.38333333	0.13743685	0.66431438	0.14302625		
3	Tifway	4	0.29166667	0.28722813	0.48996694	0.40577086		

Least Squares Means

Temp	propn LSMEAN	Standard Error	Pr > t
1	0.73194444	0.03359912	<.0001
2	0.60416667	0.03359912	<.0001
3	0.39861111	0.03359912	<.0001

Temp	y LSMEAN	Standard Error	Pr > t
1	1.03582357	0.03962494	<.0001
2	0.89413069	0.03962494	<.0001
3	0.66044225	0.03962494	<.0001

The GLM Procedure
Least Squares Means

cultivar	propn LSMEAN	Standard Error	Pr > t
GN1	0.46944444	0.04751633	<.0001
NB	0.59166667	0.04751633	<.0001
QS	0.58611111	0.04751633	<.0001
Tifsport	0.66944444	0.04751633	<.0001
Tifton	0.56111111	0.04751633	<.0001
Tifway	0.59166667	0.04751633	<.0001

cultivar	y LSMEAN	Standard Error	Pr > t
GN1	0.75390021	0.05603813	<.0001
NB	0.87895409	0.05603813	<.0001
QS	0.86724588	0.05603813	<.0001
Tifsport	0.97162926	0.05603813	<.0001
Tifton	0.84754504	0.05603813	<.0001
Tifway	0.86151855	0.05603813	<.0001