

2020 Sunflower referee data analysis by Dr. Riad Baalbaki

Table 1. Analysis of variance of percentage germination results over all samples, labs and temperature regimes.

SV	df	MS	F	p-value	Sig.
Sample (S)	5	3899.8	316.7	9.2×10^{-15}	yes
Lab (L)	7	365.7	29.7	9.3×10^{-31}	yes
Temperature (T)	1	41.3	3.4	0.07	no
S x L	35	150.0	12.2	4.1×10^{-39}	yes
S x T	5	339.6	27.6	8.4×10^{-23}	yes
L x T	7	194.3	15.8	1.6×10^{-17}	yes
S x L x T	35	47.4	3.8	1.1×10^{-10}	yes
Error	288	12.3			
Total	383	93.0			

Table 2. Analysis of variance (mean squares) of percentage germination results per sample, over all labs and temperature regimes.

SV	df	MS					
		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Temperature	1	16.0 NS	1216.3 **	5.1 NS	0.4 NS	0.8 NS	500.6 **
Labs	7	32.1 **	145.8 **	86.4 **	19.2 **	13.9 **	818.5 **
T x L	7	15.5 *	99.0 **	45.9 NS	20.8 **	11.9 **	238.1 **
Error	48	6.2	15.0	21.8	4.6	3.7	22.6
Total	63	10.3	57.9	31.4	8.0	5.7	142.5

NS, *, ** Not significant, significant at p = 5%, and significant at p ≤ 1%, respectively.

Table 3. Average percentage germination (G) and variance (V) at each temperature regime (T1 and T2), for each tested sample.

Temp. regime	Sample											
	1		2		3		4		5		6	
	G	V	G	V	G	V	G	V	G	V	G	V
T1	93.7	7.3	84.0	30.4	85.6	30.1	95.9	8.5	97.5	1.7	77.6	84.6
T2	92.7	13.2	75.3	48.2	86.2	33.6	95.8	7.7	97.3	9.8	83.2	188.9
Sig. diff.	N		Y		N		N		N		Y	

T1 = 20-30 °C; T2 = 20 °C.

Explanation of results:

Analysis of variance (Table 1), combining all sample, lab and temperature results, indicated that, overall, use of either temperature regime will not lead to significant differences in final percentage germination (the 'no' associated with Temperature sig. effect in the table). However, the same analysis indicated that, when the variation due to temperature regimes and samples was excluded, labs significantly varied in their results (i.e., lab performance was non-uniform). As expected, sample differences, when other factors were accounted for, were significant (i.e., samples had a range of germination, as they should).

When each sample was analyzed separately (Table 2), most results indicated no difference in final germination between the two temperature regimes. However, use of two temperature regimes produced significantly different results for samples 2 and 6 (Tables 2 and 3). For sample 2, higher average germination over all labs was observed at 20-30 C compared to 20 C. While this trend was also observed for other samples, the effect was much larger for sample 2 (**note: this result is not surprising, as the overall average of the two temperatures is 89.1 for T1 and 88.4 for T2, but the extent of difference is larger**). In contrast, sample 6 results significantly differed, but in this case, 20 C resulted in the higher germination (**note: this is the only sample in which there is a sig. increase after using T2; this might need an explanation based on your observations; it is not unusual for lower temperatures to lead to higher germination if the sample had a high rate of infections that manifest at higher temperatures; from a statistical point of view, the 8 lab results showed a very high magnitude of variation when testing sample 6 at 20 C, so hypothetically you can end up with different results if the tests were to be repeated**). It should be noted that the magnitude of variation (V in Table 3) was always lower at T1 compared to T2, implying that variation among labs was always lower when testing at 20-30 C, compared to a constant temperature of 20 C (**note: not sure why this is the case, but this is an important consideration, especially if you plan on eliminating one of the two temperature regimes**).