

A Few Comments To Those Brave Few Who Wrote A Lab Report

I was very happy with the lab reports I received, given that you had to guess what was expected, you all did a fine job.

The fast plants reach their maximum height in about 3-4 weeks (Figure 1), by which time all of the flowers have been produced (Figure 2). The aberrant value for 5 weeks growth on nutrient solution would not be obtained if one started with seeds. Obviously, plants cannot shrink and then re-grow. But the value should be included, because this is the experiment being analyzed.

There is quite a lot of variation in height, and some overlap between Ortho™ and nutrient mix standard errors. But **most** science fair judges would not argue with the conclusion that the Ortho™ plants grew taller. The result was due to our small sample size (4), where a single plant that grows poorly can have a major influence on the mean. If the height of plants on weeks 4,6, and 7 were the sample (12) analyzed the result would be Ortho™ (30.1 ± 2.4) and nutrient solution (25.8 ± 1.6). Here there is no overlap between the lowest Ortho™ ($30.1 - 2.4$) and the highest nutrient solution ($25.8 + 1.6$). Let me stress that it is not legitimate to average plants grown for different periods, rather I am trying to illustrate that if our sample size had been 8 or 12 there probably would not have been any overlap.

The comparison of the total reproductive structures and the number of fruits containing seeds was problematic, because we were not all singing from the same hymnal. For example, on week 5 (May 17) the total reproductive structures on Ortho™ was 0, 10, 0, and 19, whereas the number of fruits containing seeds was 17, 19, 13, and 2. Figure 2. does illustrate that the plants feed Ortho™ produced almost twice as many reproductive structures. The reason is that the plants produced lateral branches with flowers. One result is that is that height is not the best measure of growth. A better measure is to take the 7-week-old plants that have dried out and weigh them. The dry weight of the Ortho™ plants would be 50-100% more than the nutrient solution grown plants, because the former have lateral branches and the leaves are significantly larger.

The explanation of why the Ortho™ plants did so well is that it contains about twice as much nitrogen according to my calculations.

Comments And Answers To Questions About The Lab Reports

In the present experiment, the control group would be those fertilized with the nutrient solution and those fertilized with Ortho™ would be the experimental group. The hypothesis to be tested could be:

Plants fertilized with Ortho™ will not grow as well and produce as many fruits as those fertilized with nutrient solution, because Ortho™ contains urea as a nitrogen source whereas the nutrient solution contains nitrate, which is the form of nitrogen usually available to plants.

This hypothesis was not supported, and the reason is bad experimental design. The Ortho™ contains twice as much nitrogen as urea than the nutrient solution does as nitrate. There are therefore two variables the form of nitrogen and the amount of nitrogen.

In a Science Fair context, if you recognize at the end that the experiment was poorly designed, acknowledge this, and **most** judges will give the student credit, if he or she suggests how the design could be improved.

There are also a lot of other differences in the composition of the two solutions, so even if the nitrogen was adjusted to be the same in both cases, the difference in other components may explain the result.

In a research situation two identical solutions would be prepared that contained the same concentration of all ions and urea would be added to one and nitrate to the other.

In a Science Fair context, the safest way to avoid these problems is to use Ortho™ at 2 or 3 dilutions and hypothesize that the addition of more NPK will increase growth and the production of reproductive structures. The control group would be the recommended dilution and the experimental groups would be modifications of this.

Science experiments are like old style dances, you go home with the person you came with. The decline in height between week 4 and 5 must be included and then explained away, it cannot be omitted.

It is best not to use average, because it is an ambiguous term, use mean, median, or mode.

The mean is the sum of measurements divided by the number of samples.

The median is the value that divides the data in half, where 50% of the measurements are higher and 50% of the measurements are lower.

The mode is the measurement that is represented most times.

The statistics book I mentioned is **How to lie with statistics** by Darrell Huff, published by W.W. Norton. It was originally published in 1954, so most of the numbers are out of date, e.g., \$3,000 per year is considered a good salary. It does not really deal with statistics, but rather the way that graphs and opinion polls can be deceptive and the use of average can be meaningless.

Odds and Ends

For those teachers who have students calculate standard errors for Science Fair projects without a scientific calculator that does it for you, things can be simplified by having the mean be a whole number. For example, the sum of 39, 45, 30, and 33 is 147, so the mean is 36.75. This makes the calculation of the difference of samples from the mean and squaring them complicated. If one just adds 1 to the smallest number then the sum is 148, the mean is 37 and the difference between the number and the mean is +2, +8, -6, and -4. These can easily be squared, added together and the variance determined by dividing by 3. Most calculators have a button to calculate square roots.

Superscripts and subscripts

It is very easy to forget where these are if you do not use them often.

In Microsoft Word

On the tool bar click on **Format**

click on **Font**

Under effects click in **superscript** or **subscript**, a tick appears, then click **OK**. (Remember after you have inserted the subscript, go back to Format, Font, and remove the tick otherwise everything will be a subscript).

The ammonium ion is NH_4^+ , using subscripts and superscripts this appears as NH_4^+ . Superscripts and subscripts are always smaller than letters. I prefer to increase their size for neatness. So I type NH in Arial12, but increase the sub and supers to Arial 14 so that it looks like this NH_4^+ .

Ortho is a trade mark or possibly registered.

On the tool bar click on **Insert**

select **Symbol**

click on **special characters**, then select [™] or ® etc. If you anticipate using it several times click **copy** on the tool bar and **paste** whenever you need it.

On the tool bar click on **Insert**

select **Symbol**

on **Font** also select **Symbol** by scrolling down. This is where you find such oldies but goodies as \pm , \bullet , \geq , α , β , etc.

Latin names of plants and animals are traditionally written in italics *Brassica rapa*.

In reports Tables have a legend at the top and figures have a legend at the bottom.

The tradition on numbers is that 10 and below are written out, but above ten numerals are used. The exception is that where a number starts a sentence it and any units are written in full, e.g., Twenty five milliliters--within a sentence this would be written as 25 ml.