Chapter 6

A "Good" Sample Student Laboratory Report

The laboratory report in this chapter was written by Lynne Waldman during her first year at Bucknell University, in an introductory course for biology majors. Lynne and her lab partners designed and carried out an original project in which they investigated the effect of a fungus on the growth of bean, pea, and corn plants.

Lynne's report has many of the characteristics of a well-written scientific paper. When you look over her presentation, notice the style and tone of her writing, as well as the format of the paper. The comments and annotations alert you to important points to keep in mind when you write your laboratory report.

The presentation here has been typeset to fit this book and to accommodate the annotations. Your report should be formatted to fit standard 8½ × 11 inch paper. Unless you are instructed otherwise, use a serif type (Times Roman is standard), double space, and leave *at least* 1 inch of margin all around.

For details on how to format documents in Microsoft Word, see "Formatting a Document" in Appendix 1.

Informative title

The Effects of the Fungus *Phytophthora infestans* on Bean, Pea, and Corn Plants

Author's name first, followed by lab partners' names in alphabetical order

Lynne Waldman, Partner One, Partner Two

Sections of report are clearly labeled.

Abstract

Background information is present.

Phytophthora infestans is a fast-spreading, parasitic fungus that caused the infamous potato blight by devastating Ireland's crops in the 1840s. *P. infestans* also causes late blight in tomato plants, a relative of the potato. In this experiment, the effects of *P. infestans* on *Phaseolus* variety long bush bean, *Zea mays* (corn), and *Pisum sativum* (pea) were studied. The soil surrounding the roots of 18-day old plants was injected with *P. infestans* cultured in an L-broth medium. Plant height, number of leaves, and leaf angle were measured for each plant during the next 8 days. Chlorophyll assays were performed prior to exposure, and on the eighth day after exposure to the fungus. The plants were also examined for black or brown leaf spots characteristic of late blight infections. The results showed that *P. infestans* had no apparent effect on the bean, corn, and pea plants. One reason for this may be that there were no fungus zoospores in the L-broth medium. More probably, however, *P. infestans* may be a species-specific pathogen that cannot infect bean, corn, or pea plants.

No references are used in Abstract.

Purpose of current experiment is given.

Short description of methods

Results are given.

No references are made to figures.

Short explanation of results is given.

Abstract is a maximum of 250 words long.

Introduction

Background information

Originating in Peruvian-Bolivian Andes, the potato *(Solanum tuberosum)* is one of the world's four most important food crops (along with wheat, rice, and corn). Cultivation of potatoes began in South America over 1,800 years ago, and through the Spanish conquistadors, the tuber was introduced into Europe in the second half of the 1600s. By the beginning of the 18th century, the potato was widely grown in Ireland, and the country's economy heavily relied on the potato crop. In the middle of the 19th century, Ireland's potato crop suffered widespread late blight disease caused by *Phytophthora infestans,* a species of pathogenic plant fungus. Failure of the potato crop because of late blight resulted in the Irish potato famine. The famine led to widespread starvation and the death of about a million Irish.

Latin names are italicized.

The potato continues to be one of the world's main food crops. However, *P. infestans* has reemerged in a chemical-resistant form in the United States, Canada, Mexico, and Europe (McElreath, 1994). Late blight caused by the new strains is costing growers worldwide about $3 billion annually. The need to apply chemical fungicides eight to ten times a season further increases the cost to the grower (Stanley, 1994 and Stanley, 1997). *P. infestans* is thus an economically important pathogen.

Proper citation format is used (Name-Year system).

P. infestans, which can destroy a potato crop in the field or in storage, thrives in warm, damp weather. The parasitic fungus causes black or purple lesions on a potato plant's stem and leaves. As a result of infection by this fungus, the plant is unable to photosynthesize, develops a slimy rot, and dies. *P. infestans* similarly infects the tomato plant *(Lycopersicon esculentum)* (Anonymous, 1994).

No direct quotations are used. Citations are paraphrased and the source is given in parentheses.

"Anonymous" is used when no author is given in newspaper or magazine articles.

The purpose of the present experiment was to determine the effects of *P. infestans* on plant height, number of leaves, leaf angle, and chlorophyll content of three agriculturally important plants: *Phaseolus* variety long bush beans, *Zea mays* (corn), and *Pisum sativum* (peas). Symptoms of fungal infection were assumed to be similar to that in potatoes.

Purpose of experiment is clearly stated.

Materials and Methods

Phaseolus variety long bush bean, *Zea mays* (corn) and *Pisum sativum* (pea) seeds were soaked overnight in tap water. Fifteen randomly chosen seeds of each species were planted 1 cm beneath the surface in three separate trays containing 10 cm of potting soil. Another set of trays, which was to be the control group, was prepared in the same fashion.

M&M are always written in past tense.

Sufficient detail is given to allow the reader to repeat the experiment.

All the experimental plants were placed in one fume hood, and all the control plants were placed in relative positions in another fume hood in the same room. The plants were exposed to the ambient light intensity in the hood (153 fc) and air current 24 hrs a day, and were watered lightly daily. The plants were allowed to germinate and grow for 18 days.

Phytophthora infestans on potato dextrose agar was obtained from Carolina Biological Supply House. At day 10 of the plant growth regime, pieces of agar on which the fungus was growing were transferred to L-broth. L-broth consisted of 5 g yeast extract, 10 g tryptone, 1 g dextrose, and 10 g NaCl dissolved in distilled water, and adjusted to pH 7.1, to make 1 L of medium. The medium was sterilized before adding the fungal culture. After 4 days in L-broth, 6 mL of the fungal culture were injected into the soil around the roots of each 18-day old plant. 6 mL of L-broth without *P. infestans* was injected into the soil of the control plants. All plants were then allowed to grow for another 8 days.

Every other day after treatment with *P. infestans*, plant height and number of leaves were measured for both the control and the experimental plants. Plant height was measured from the soil to the apical meristem of the plant. Leaf angle (as shown in Figure 1) of the largest, lowest leaf on each plant was measured three times, once prior to injection, once 4 days after injection, and once 8 days after injection. Leaf angle was measured in order to

Figures that explain the methodology may be included in M&M section.

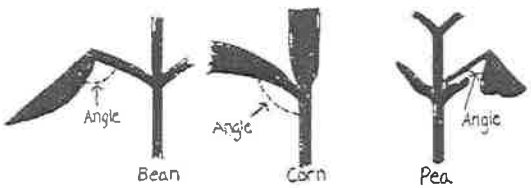

Figure 1 Leaf angle as measured in bean, corn, and pea plants

determine if *P. infestans* causes wilting in the three plant species. In addition, the plant was examined visually for the presence of any leaf spots.

Chlorophyll assays were performed on one plant from each tray prior to injection and on the eighth day after injection. For each chlorophyll assay, the leaves of the plant were removed from the stem. For each 0.1 g of leaves, 6.0 mL of 100% methanol were used. The leaves were thoroughly ground in half of the methanol with a pestle in a mortar. The leaves were ground again after the rest of the methanol was added. Extraction of the chlorophyll was allowed to proceed for 45 min at room temperature. Then the suspension was gravity filtered through filter paper to remove the leaf parts. The absorbance of the filtrate was measured with a Spectronic 20 spectrophotometer at 652 nm and 665.2 nm. The absorbance values were converted to relative chlorophyll units using the following equation derived by Porra and colleagues (1989):

Total chlorophyll (a and b) = Dilution factor × [22.12 $A_{652\ nm}$ + 2.71$A_{665.2\ nm}$ (mg/L)] × Volume of solvent (L) / Weight of leaves (mg)

Subscripts are made properly.

Results

P. infestans-treated plants and the control plants had similar growth patterns (Figure 2). Both the experimental and control pea and corn plants grew at a

Results section must contain a text in which the author presents each figure and table to the reader.

Reference is made to the next figure in the sequence, and the important results are described.

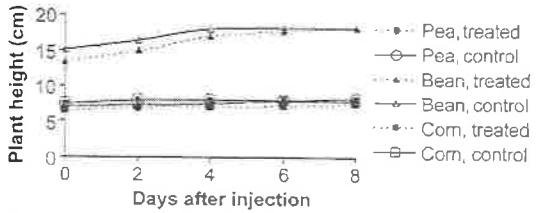

Figure 2 Average height of control and experimental plants in the period after injection with *P. infestans*

Figure is large enough to read key and axes easily.

Axes have proper spacing.

Points and lines on curve are dark and can be easily distinguished from each other.

Units are given in parentheses after the axis label (where applicable).

Figure caption is located below figure.

Figure title is not simply a repeat of "*y*-axis label vs. *x*-axis label."

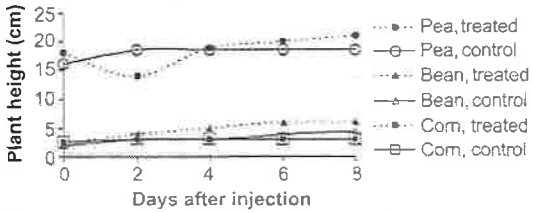

Figure 3 Average number of leaves of control and experimental plants in the period after injection with *P. infestans*

constant, but very slow rate over the eight day test period. The control bean plants were taller on average than the experimental bean plants throughout most of the experiment. Both groups showed the same growth pattern, however, with rapid growth occurring from day 18 to 24 (0 to 4 days after injection), followed by slower growth to the end of the experiment.

Figure number sequence is correct.

As plant height increased, the average number of leaves on all of the plants also increased over the measurement period (Figure 3). There is an uncharacteristic decrease in the number of leaves of pea plants treated with *P. infestans* from day 18 to 20 (0 to 2 days after injection), but this is probably due to counting error.

Reference is made to the next figure and the important information is described.

Symbols (such as °) are typed using word processing software.

There was a general decline in average leaf angle of all the plants over the first four days after injection with *P. infestans* (Figure 4). The plants did not follow this pattern over the second half of the experiment, however. The leaf angle of the experimental bean group increased by 28°, while that of the control bean group only increased by about 3°. The leaf angle of the control pea plants increased significantly (33°), while that of the experimental pea plants decreased 4°. The leaf angle of the corn control group decreased 0.5°, while that of the corn experimental group showed a much sharper decline of 24°.

There was also no difference between the experimental and control groups with regard to chloro-

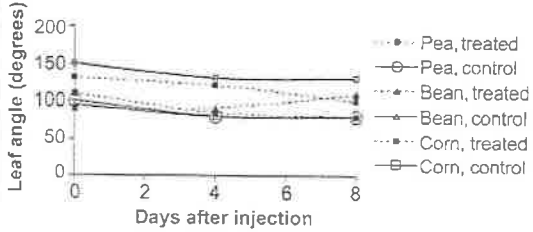

Figure 4 Average leaf angle of control and experimental plants in the period after injection with *P. infestans*

phyll content. There was a slight increase in chlorophyll content from day 18 to 26 (0 to 8 days after injection) in the corn plants (Table 1). For the bean group, there was a large decrease in chlorophyll content, 0.1 relative chlorophyll units, which did not seem to agree with the general appearance of the plants. There may have been some error when this assay was carried out. There was little change in chlorophyll content for the pea group.

Table is numbered properly.

Finally, there was no evidence of any brown or black leaf spots symptomatic of *P. infestans* infection.

Table caption is placed above the table.

Table 1 Chlorophyll content of corn, bean, and pea plants prior to infection and 8 days after infection

Plant	Relative chlorophyll units		Change in chlorophyll content (relative units)
Plant	Day 0	Day 8	
Corn, treated	9.036×10^{-4}	9.383×10^{-4}	$+3.45 \times 10^{-5}$
Corn, control	9.270×10^{-4}	8.963×10^{-4}	$+3.34 \times 10^{-5}$
Bean, treated	1.034×10^{-1}	1.2×10^{-3}	-1.022×10^{-1}
Bean, control	1.7×10^{-3}	1.6×10^{-3}	-1×10^{-4}
Pea, treated	1.3×10^{-3}	1.7×10^{-3}	$+4 \times 10^{-4}$
Pea, control	1.2×10^{-3}	1.2×10^{-3}	0.0000

Scientific notation is used correctly.

It is preferable to leave extra space at the bottom of the page, rather than to split a table across a page.

Discussion

Results are summarized or briefly restated in the Discussion section.

P. infestans did not affect the plant height, leaf angle, number of leaves, and chlorophyll content of *Zea mays, Pisum sativum,* or *Phaseolus*. Symptoms of infection are the presence of brown or black spots (areas of dead tissue) on leaves and stems, and, as the infection spreads, the entire plant becomes covered with a cottony film (Stanley, 1994). None of the experimental plants exhibited these symptoms.

Explanations for results are given.

There may be several reasons why *P. infestans* did not affect the plants in this study. One reason is that the L-broth culture of *P. infestans* may not have contained zoospores of the fungus. Zoospores are motile spores that can penetrate the host plant through the leaves and soft shoots, or through the roots (Stanley, 1994). Zoospores are usually produced in wet, warm weather conditions (Ingold and Hudson, 1993). If the L-broth culture did not contain any zoospores, or if the soil around the plants was not sufficiently saturated to stimulate production of zoospores, then these conditions may have prevented *P. infestans* from attacking the roots and shoots of the plants.

References are used to support explanations.

Ways to test explanations may be offered.

In order to determine if the problem was lack of zoospores, first the L-broth culture could be examined microscopically for presence of zoospores. Second, the *P. infestans* plants could be watered with different quantities of water to determine if the fungus requires wetter soil for zoospore production and motility.

Frequent use of references is made to support explanations. Whenever possible, use primary references (journal articles, conference proceedings, collections of primary articles in a book). Avoid textbooks (secondary references) and Internet sources (may be unreliable).

Another reason why *P. infestans* may not have affected the plants is that this species of fungus may be specific to potato *(Solanum tuberosum)* and tomato *(Lycopersicon esculentum)* plants (Stanley, 1994), which both belong to the nightshade family (Solanaceae). In contrast, corn belongs to the grass family (Gramineae), and peas and beans are legumes (Leguminosae). It may be that these plant families are not susceptible to *P. infestans*, which has a very limited host range (Stanley, 1994). Non-susceptible plants have been shown to have defense mechanisms that prevent *P. infestans* from infecting them (Gallegly, 1995).

Further research is required to determine if *P. infestans* really cannot infect corn, pea, and bean plants. Goth and Keane (1997) developed a test to measure resistance of potato and tomato varieties to original and new strains of *P. infestans*. Their experiments involved exposing the experimental plants' leaves directly to the fungus, and this method could perhaps be tested on corn, pea, and bean leaves as well.

References

[Anonymous]. 1994. Brave New Potato. Discover 15(10): 18–20.

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Stanley D. 1994. What was around comes around. Agricultural Research 42(5): 4–8.

Stanley D. 1997. Potatoes. Agricultural Research 45(5): 10–14.

When Name-Year citation format is used, authors are listed alphabetically in the References section.

Most references should be primary journal articles or articles in books. Textbooks and articles in newspapers and magazines are secondary references (less preferable).

List all authors (up to 10; then list first 10 followed by "et al." or "and others.")

See the tabbed pages in Chapter 4 for examples of how to reference journal articles, articles in books, and books.

List the starting and ending pages of the article, not just the page(s) you extracted information from.

All citations must have a corresponding reference.

All references must be cited in the text.

* References + citation will be different and discussed in class