* A **hypothesis** is a proposed explanation for a natural phenomenon. A **prediction** is a statement of what one expects to observe in a specific situation. A **null hypothesis** specifies what we should observe when the hypothesis being tested is wrong.
* There are several types of **variables**. Factors that are kept the same in experimental and control treatments—and which might affect the result—are called **controlled variables**. The variable that you manipulate—the one that differs between experimental and control groups—is the **independent** (or explanatory) variable. The independent variable is the factor that you think is driving change in a **dependent** (or response) variable.

1. You are given the data from Experiment #1 shown below. Each test group included 10 poppies of the same species, germinated in the same type of soil in a greenhouse. Plants were grown under controlled temperature conditions. The experiment was repeated three times with equivalent results.

**Experiment #1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Test Group 1 | Test Group 2 | Test Group 3 | Test Group 4 |
| Water | 10 ml | 10 ml | 5 ml | 5 ml |
| Sunlight | 8 hours | 12 hours | 8 hours | 16 hours |
| Fertilizer | 10 grams | 20 grams | 20 grams | 20 grams |

Results of Experiment:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Average growth of poppies per day | 0.5 cm | 1 cm | 1 cm | 1 cm |

* How many poppies were included in each test group in Experiment #1? \_\_*10 plants*\_\_\_\_\_\_\_\_ (this is **the sample size**)
* Why is sample size important? *The experiment should be performed with a large enough sample size to minimize effects due to natural variability from one poppy to another.*
* What variable was being measured in Experiment #1? \_\_\_\_\_\_*growth rate*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* How was this variable measured? \_\_\_\_\_\_\_\_\_\_\_\_*cm growth per day*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* How many times was the experiment repeated? \_\_\_\_\_\_\_\_\_*3\_*\_\_
* Why do you think the experiment was repeated? *Consistent results indicate that the finding is repeatable and not due to any unforeseen variables that were not controlled e.g. time of day seeds were planted*
* Aside from the variables listed in the table, what additional variables were controlled? *Temperature, species, soil conditions*
* Why was it important to control these other variables? *These variables represent viable alternative hypotheses i.e. differences in soil may also influence poppy growth rate.*
* Can Experiment #1 be used to test the statement “the amount of sunlight poppies are exposed to influences their growth rate”? (circle one) **YES** NO

|  |  |
| --- | --- |
| **If YES**,  1) State which test groups should be compared to test this statement : Test group # \_\_*3*\_\_\_ and Test group # \_\_\_*4*\_\_\_  2) For the test groups you compared, list the following:  Independent variable: \_\_\_\_\_\_*hours of sunlight\_*\_\_\_\_\_  Dependent variable: \_\_\_\_\_*growth rate*\_\_\_\_\_\_\_\_\_\_\_\_\_  3) Explain whether the results support or refute the statement and why  *The results refute the statement because there was no observed change in poppy growth rate when water and fertilizer were held constant, while hours of sunlight were increased* | **If NO**, explain why not, and describe the experiment you would need to perform in order to test this statement. |

* Are there any other conclusions about poppies that can be made based on the data shown in the table? Explain.

*No. No conclusions can be made about the influence of fertilizer or water on poppy growth rate because there are no test groups which can be compared which hold other variables constant and only alter either fertilizer or water levels.*

2. You are given the data from Experiment #2 shown below. Each test group included 10 poppies of the same species, germinated in the same type of soil in a greenhouse. Plants were grown under controlled temperature conditions. The experiment was repeated three times with equivalent results.

**Experiment #2**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Test Group 1 | Test Group 2 | Test Group 3 |
| Water | 5 ml | 5 ml | 10 ml |
| Sunlight | 8h | 16h | 16h |
| Fertilizer | 10 grams | 20 grams | 10 grams |

Results of Experiment:

|  |  |  |  |
| --- | --- | --- | --- |
| Average growth of poppies per day | 0.5 cm | 1 cm | 1 cm |

Can Experiment #2 be used to test the statement “the amount of sunlight poppies are exposed to influences their growth rate”? (Circle one) YES **NO**

|  |  |
| --- | --- |
| **If YES**,  1) State which test groups should be compared to test this statement : Test Group # \_\_\_\_\_ and Test Group # \_\_\_\_\_  2) For the test groups you compared, list the following:  Independent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*\_\_*\_\_\_\_  Dependent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  3) Explain whether the results support or refute the statement and why | **If NO**, explain why not, and describe the experiment you would need to perform in order to test this statement.  *There are no test groups in which water levels and fertilizer are kept constant while sunlight is varied.*  *You should repeat test group 1, but increase the fertilizer to 20g.*  *You could then compare poppy growth rate between test groups 1 and 2 to determine whether sunlight influences poppy growth rate.* |

* Are there any other conclusions that can be made based on the data shown? Explain.

*No. No conclusions can be made about the influence of fertilizer or water on poppy growth rate because there are no test groups which can be compared which hold other variables constant and only alter either fertilizer or water levels*