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Comparison of Pea Seed Germination Due to Manipulation of Soil Conditions

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ABSTRACT

This experiment was done with the intent to understand optimal soil conditions for pea seed germination. We investigated this using three soil conditions – 100% potting soil, 50% potting soil/50% sand, and 100% sand. Seemingly healthy pea seeds were planted and observed over five weeks. We measured both the total number of sprouts per week and the combined weight of the plants and seeds per condition before planting and after uprooting. We expected to find that the 100% potting soil condition would germinate the best, resulting in the most sprouts and heaviest weight of the condition's seeds and plants. This is the result that we found. This study contributes to prior soil manipulation research by reinforcing the same results as other studies have achieved.

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Plants are able to grow in various kinds of soils, under various environmental conditions. However, all cells, including plant cells, have optimal conditions for growing. To discover the optimal conditions, an experiment must be done (Campbell, et al., 2011). Any plant experiment must begin with seed germination. Germination is the process of a seed extending its roots and extending its shoots to become a plant (Whyte, 2016).

Some seeds will not germinate, meaning that they are truly dormant embryos. This could be due to the seed itself or to its environment, i.e. the soil type, the water and light conditions, temperature, pH, and macronutrient concentration (Koning, 1994). Other seeds will successfully germinate, becoming plants. After germination, scientists can take their own route to studying their specific scientific questions and hypotheses.

Other studies have looked at pH levels as well as nitrogen, phosphorous, and potassium levels. By using potting soil, local soil, sand, and gravel as her four conditions, Meghna Soni investigated the optimal pH and nitrogen, phosphorous, and potassium concentration for plant growth. She discovered that potting soil, followed by local soil, gravel, and sand, gave the best growth outcome due to optimal pH and macronutrient concentration (Soni, 2006).

The purpose of this experiment was to discover the optimal soil condition for pea plant growth. This experiment involved planting sixty pea seeds in three different soil conditions to test how well they would grow, i.e. how many seeds would germinate per condition and thus how much each condition's plants would weigh at the end of the experiment. We expected that the seeds in the 100% potting soil condition would germinate and grow the best, followed by the 50% potting soil/50% sand condition, and finally the 100% sand condition.

Method

Sixty pea seeds were randomly placed into three conditions, twenty seeds per condition. We began with six bags of Pea Shelling, Progress #9 seeds and weighed them to verify the 18 gram weight on the bag. We then found the weight of each individual pea seed and planted sixty random seeds out of the conglomeration that we had. All seeds were green and wrinkled, appearing to be healthy pea seeds.

Materials

We performed the experiment in the Boyer Greenhouse. We utilized three flats and three seed trays, using twenty cells from each of the three trays. The potting soil came from the stock that is kept in the Greenhouse. The sand came from Primex in Glenside (AP Sand 5lb). The pea seeds also came from Primex in Glenside (Botanical Interests, Pea Shelling, Progress #9).

Procedure

Three conditions were used: 100% sand, 100% potting soil, and 50% sand/50% potting soil. The 100% potting soil condition functioned as the control. Twenty seemingly healthy seeds were placed into each condition, each seed in a separate cell in a seed tray. The conditions were kept at the same temperature, water regiment, sunlight, and oxygen and carbon dioxide exposure. Ceteris paribus, the independent variable was the soil type that the seeds were planted in, including the inherent pH and macronutrient concentration differences between soil types. The first set of data for the plants came from the number of seeds germinating per week as well as the total number of germinating seeds at the five week mark. The second set of data came from the weight of the seeds before planting and the weight of the plants in each condition after removal from soil at the end of five weeks. We drew our conclusion of optimal soil type from this data. The plants and water level in the flats were checked three times a week. The seeds were weighed

before planting to establish that all the seeds should be equal at the beginning of the experiment. The rate of germination was also observed once every week over five weeks.

Results

The results of the seed germination experiment (Table 1, Figure 1, Table 2, Figure 2) suggest that the 100% soil condition is the optimal condition for pea plant growth.

	Week 1	Week 2	Week 3	Week 4	Week 5	Total
100% Sand	0	0	0	0	0	0
50%/50%	1	1	1	1	2	2
100% Soil	1	8	8	9	9	9

Table 1. Week-by-week total germination numbers of the plants in each respective condition.

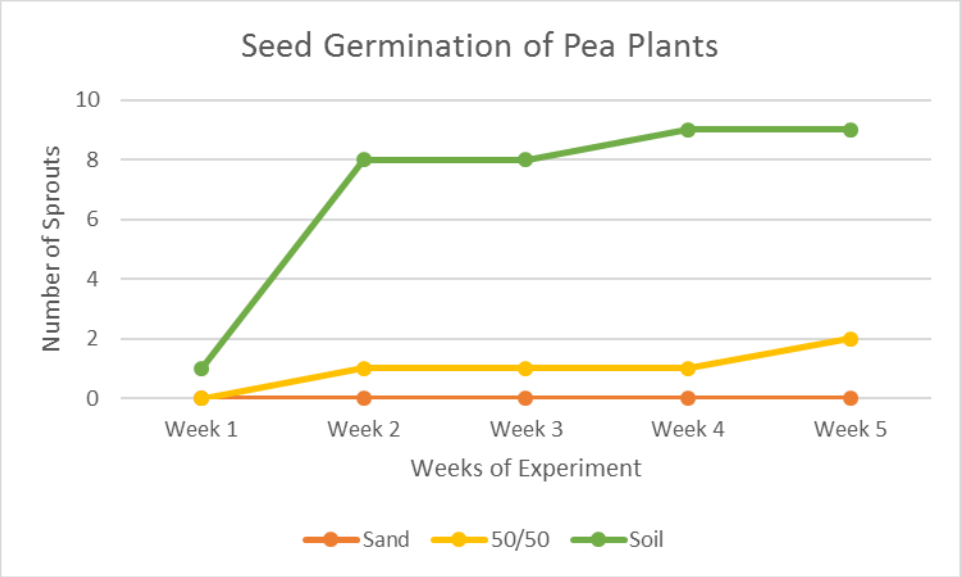

Figure 1. Week-by-week total germination numbers of the plants in each respective condition.

The 100% soil condition had a 45% germination rate. The 50% sand/50% soil condition had a 10% germination rate while the 100% sand condition had a 0% germination rate. The control condition had the best outcome over the two experimental sand conditions. This is also seen in Table and Figure 2.

	Before Planting (20 seeds)	End of Five Weeks (Germinated seeds)	Δ Weight
100% Sand	0 g	0 g	- 6 g
50%/50%	6 g	8.3 g	+ 2.3 g
100% Soil	6 g	19.7 g	+ 13.7 g

Table 2. Comparison of pea seed and plant weight at the beginning and end of the experiment.

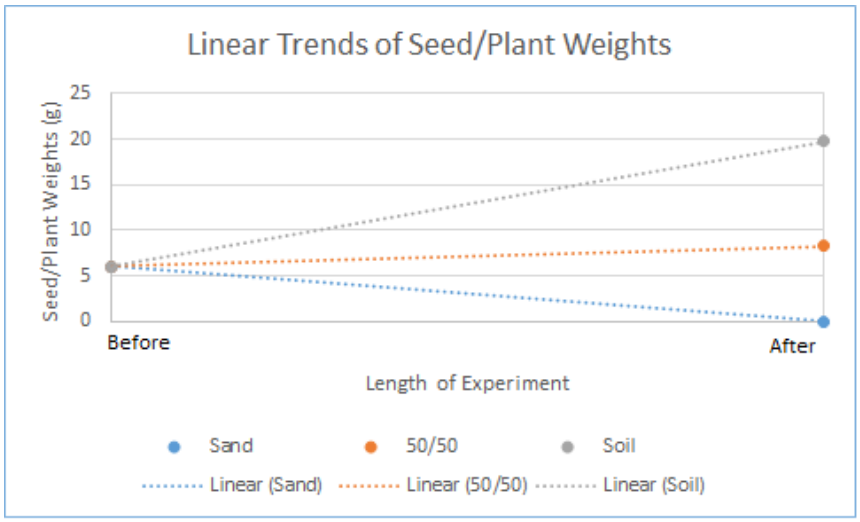

Figure 2. Comparison of pea seed and plant weight before and after the five weeks of experiment.

Table 2 is another example of how the 100% Potting Soil condition was the optimal condition for pea plant growth, based on how the condition weighed more than the other two conditions. Figure 2 displays the linear change of weight in each condition, moving from before the experiment when the seeds were weighed, to after the five weeks of the experiment, when the plants were weighed.

Discussion

The poor germination of the sand conditions relative to the control (soil) condition (Table 1, Figure 1, Table 2, and Figure 2) suggests that the sand was unable to keep the water and nutrients in and in turn was unable to metabolize the seed so that it would germinate (DuPont, 2012). This result supports the result that Meghna Soni recorded for her soil manipulation

experiment (Soni, 2006). They also support the hypothesis of this experiment, which was founded on the basis of the leaching of sand and the moisture and nutrient retention capabilities of potting soil (Campbell, 2011). Seeds that did not germinate disintegrated, so there were no seeds to weigh at the end of five weeks, resulting in a negative outcome for the 100% sand condition (Table 2, Figure 2).

These results also point to a deeper understanding of the make-up of the different soils – the potting soil, being the optimal condition for pea seed germination, has the optimal amount of macronutrients and the optimal pH, while the 50%/50% condition, since it includes some of the soil, is next in line for optimal germination, and the sand is last (DuPont, 2012, Soni, 2006, Whyte, 2016).

A flaw in the experiment would be that there is no way to test if the embryo of the seed itself did not contain the adequate amount of food preserves, etc. or if the lack of growth was truly due to the individual soil conditions. The random assignment of seeds should have made this equal across conditions, although that is not always the case. Additionally, the soils were supposed to be under the same environmental conditions, although they were in a corner of the greenhouse so depending on where the sun was, they may have received unequal amounts of sun and shade.

A supporting experiment should utilize smaller amounts of sand as well as the large amounts and include other soil types, for instance gravel and clay. This would allow a more conclusive result of the optimal soil type for pea plants. Additionally, testing the pH of the different soil types as well as looking for the macronutrient quantities in each type would allow for a more in-depth discussion of why the soils did better or worse with germinating seeds than other soils did with germination.

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