If someone behind you tapped you on the shoulder, your first response would probably be to turn around. All living organisms respond to stimuli, and plants are no exception to this rule. Since they cannot turn around, though, how would they respond to a light contact with neighboring plants? Are plants in touch with their neighbors? We searched for the answer to this question.

We applied a light touch to potato plants and measured changes in their trichomes (plant’s hair), biomass distribution, and the volatile compounds they released. We also analyzed changes in plant structure, physiology, and interactions with insects.

Our results showed that plants do respond to light touch by their neighboring plants. This affects their structure in a way that makes them shorter and stockier compared to the untouched plants. Curiously, insects do not find the smell of touched plants very attractive and prefer their untouched counterparts.

Introduction

Just like humans, living with others can be hard for plants. Unlike humans though, plants cannot pack up and move to another place. To survive, they sense and respond to the cues from their neighbors. Changes in the amount of sunlight or the chemicals in the soil give plants cues about their neighbors. Plant leaf tips may also touch with neighboring plants due to wind or lack of space. This mechanical stimuli may be another way plants gain information about their neighbors.

Plants respond to mechanical stimuli in various ways. For example, a very small group of plants, including Mimosa pudica and Venus fly traps, respond very rapidly. A Venus fly trap shuts its traps, whereas the Mimosa pudica folds inward when touched. Most plants, however, change their structure or physiology over longer periods of time.

Plants are the basis of all food webs. A change in plants can impact their interaction with other organisms. For example, herbivorous insects are very sensitive to the changes in plants. A change in a host plant’s status may result in an increase or decrease in the population of herbivorous insects. This may have consequences for agricultural crop production.

In this study, we used potato plants to investigate the effects of touching by neighboring plants. We studied the following changes in touched vs. untouched (control) plants:

1. Biomass distribution
2. Amount of trichome (plant’s hair)
3. Released volatile chemical compounds
4. Their effect on odor preference of herbivorous insects (Fig. 1)

Figure 1: A winged peach-potato aphid (Myzus persicae). It is hazardous for plants because it acts as a vector for the transport of plant viruses, such as potato virus Y and potato leafroll virus to members of the nightshade/potato family Solanaceae. (Source: Wikipedia)
Methods

We used an important vegetable crop for human nutrition - the potato (*Solanum tuberosum*) - as our model plant (Fig. 2). The two most harmful pests to the potato are potato aphid and green peach aphid. We used these two species of aphids as the herbivorous insects of our study.

To simulate contact with a neighboring plant, we used a soft brush to touch the ends of the leaves of each potato branch for 1 min per day (we call these plants “treated”) (Fig. 3). After the 8th day, we collected air samples with the volatile compounds released by the plants and identified the gases.

We used another group of plants to study plant-aphid interaction. We placed the aphids in a special chamber where they could smell both touched and untouched plants. To determine aphids’ smell preferences, we counted the number of visits by each aphid to the treated and untreated plants.

We started structural analyses after the 17th day of the touching treatment. We picked the plants and measured stem, branch, and leaf mass of each of them. We calculated the mass ratio of each part (e.g. What fraction of the entire mass does the stem constitute?)

We collected the touched terminal leaves and primary leaves of the same branch. We analyzed the structural changes on leaf surfaces by determining amount of trichomes.

Results

Our data showed that touching resulted in a decrease in plant height and stem mass fraction but an increase in branch and leaf mass fraction. As a result of these changes, touched plants were shorter with more compact appearances compared to the control group.

Regarding the trichomes, we found that treated terminal leaves did not show a significant change. However, the
primary leaves on the same branches showed a significant increase in number of trichomes.

We detected 16 different volatile compounds released by potato plants. The total amount of compounds released by touched and control plants was equal but the exact amount of each of the compounds was different.

Both aphid species showed a significantly lower preference for the smell of touched potato plants compared to untreated plants (Fig. 4).

Discussion

Plants are clearly in touch with their neighbors. They reprogram themselves in many ways when they sense their existence by a light touch, but why?

Let's analyze structural modifications first. Touched plants changed their biomass distribution and became more compact than others. This is a common response to mechanical stimuli among plant species and makes them more resistant to potential damage. For example, plants that live in very windy environments tend to have shorter and stockier trunks than the plants of the same species that grow in less windy environments. Furthermore, compact plants may have a better chance of survival when they need to compete for space with neighboring plants.

Regarding physiological modifications, an increase in leaf surface and number of trichomes helps plants use sunlight and water more efficiently. This may be quite helpful when resources are scarce and gives plants a competitive advantage over their rivals.

What about plant-insect interactions? Aphids and other herbivorous insects use their sense of smell to locate host plants. In our study, changes in the blend of volatile compounds altered the smell of touched plants and made them less attractive to aphids.

Conclusion

Scientists use cause and effect analysis to understand complex relationships between organisms. As we have seen in our results, a light touch between plants can induce (cause) changes in their structure and physiology. Furthermore, by making plants less attractive, these changes may extend to organisms at higher trophic levels.

Could plant responses to mechanical stimuli have ecological and evolutionary significance? Possibly but answering this would need further research. Now the big question is: Could a stimulus, as subtle as touch, lead to evolutionary changes in plants and organisms higher up on the food chain? Did the evolution of potato plants just unfold in front of our eyes?
Glossary of Key Terms

Control group – A control group in a scientific experiment is a group separated from the rest of the experiment where the independent variable being tested (in this case - being touched) cannot influence the results. This isolates the independent variables’ effects on the experiment and can help rule out alternate explanations of the experimental results. In this case, the control group were the untouched plants.

Biomass – The mass amount of living matter.

Stimulus (plural, stimuli) – Something that causes a change or a reaction. Heat and light are physical stimuli. The dog responded to the stimulus of the ringing bell.

Physiology – The way in which a living organism or bodily part functions. “the physiology of the brain”.

Primary leaf – The first pair of leaves that emerge after the germination of seed.

Terminal leaf – Leaf at the top of a stem or branch.

Trichome – An epidermal hair structure on a plant. Some of these structures contain volatile oils and other secretions that are produced by the plants.

Volatile compounds – Organic compounds that easily become vapors or gases.

Check your understanding

1. Plant response to the mechanical stimuli of touch by neighboring plants is analyzed in this study. Can you think of other stimuli that causes plants to respond in certain ways?

2. What are the effects of touch on plant structure and physiology? How do these effects help plants compete with their neighbors?

3. Why was it important for the scientist to study the effects on plant-insect relationships?

4. How can we use this information in regards to growing crops?

REFERENCES

