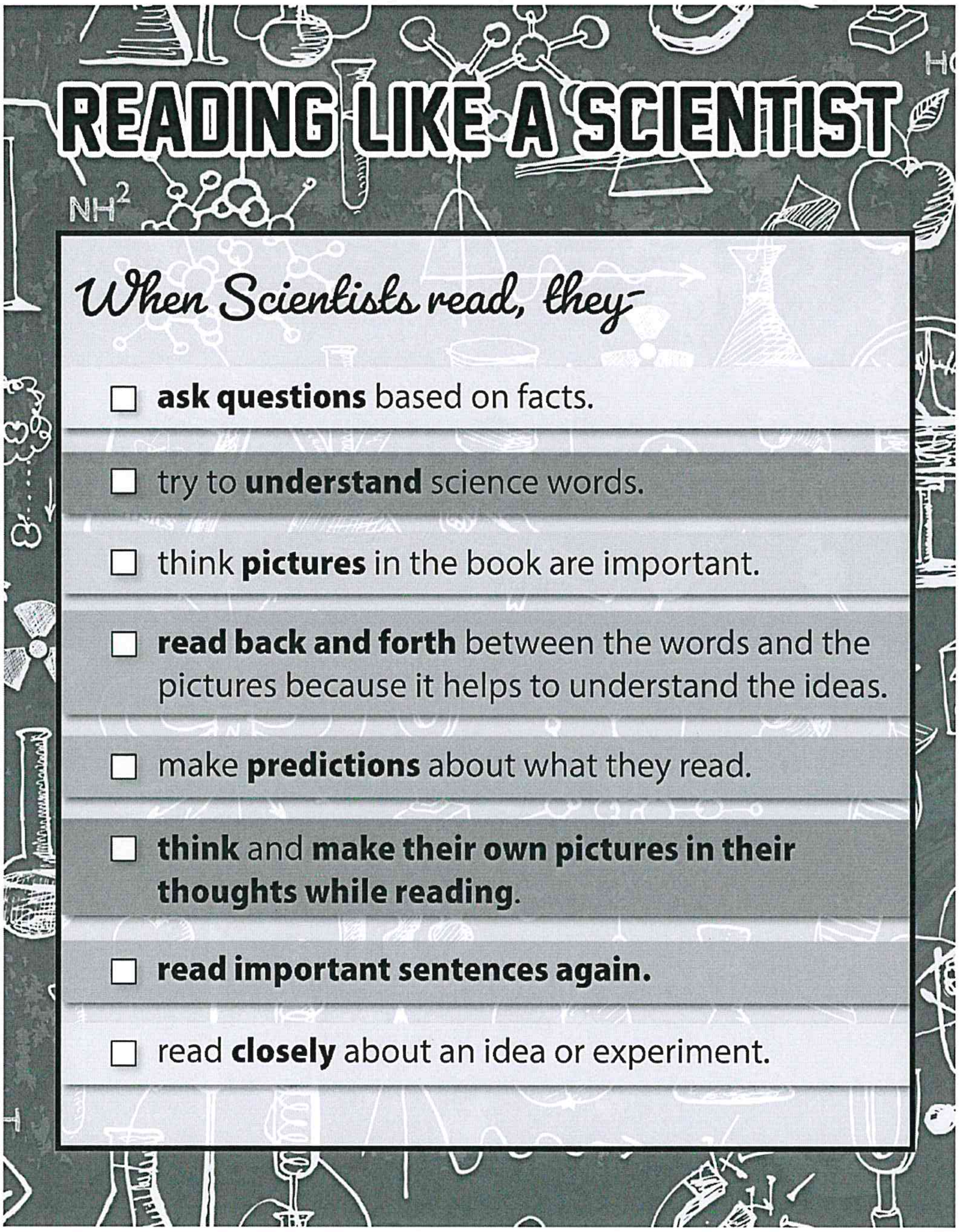
KS3 READING BOOK



Lent 2 Higher LEVEL

- You can use the information on the next 2 pages to help you enhance and practice your skills of how to read like a scientist.
- We have carefully selected these real scientific journals to help you develop key scientific skills.

You can and are encouraged to:

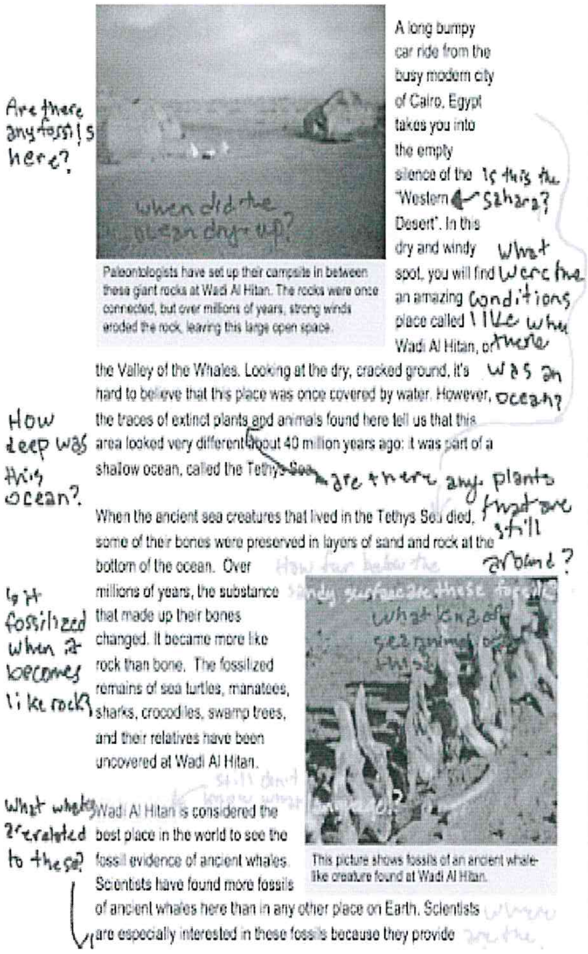
1. Annotate the articles like you do in English.
2. Write questions around the article and ask more questions
3. Go to the website found at the bottoms of the article pages to watch the video's that help you on this.
4. Type up your answers/write them up neatly as this is showing you to be 'Be like Bede'
5. Have fun as you read, read with a parent/carer/adult/sibling and then further research what you read about.

Date W/C	Article	Completed Yes or No	Score

Different outlook
about the goal of reading

How do scientists view reading?

- As an act of inquiry
  - They annotate (makes notes around), the text.
  - Ask further questions
  - Pick out key parts



A long bumpy car ride from the busy modern city of Cairo, Egypt takes you into the empty silence of the "Western Desert". In this dry and windy spot, you will find an amazing place called Wadi Al Hitan, or the Valley of the Whales. Looking at the dry, cracked ground, it's hard to believe that this place was once covered by water. However, the traces of extinct plants and animals found here tell us that this area looked very different about 40 million years ago: it was part of a shallow ocean, called the Tethys Sea.

Paleontologists have set up their campsite in between these giant rocks at Wadi Al Hitan. The rocks were once connected, but over millions of years, strong winds eroded the rock, leaving this large open space.

When the ancient sea creatures that lived in the Tethys Sea died, some of their bones were preserved in layers of sand and rock at the bottom of the ocean. Over millions of years, the substance that made up their bones changed. It became more like rock than bone. The fossilized remains of sea turtles, manatees, sharks, crocodiles, swamp trees, and their relatives have been uncovered at Wadi Al Hitan.

Wadi Al Hitan is considered the best place in the world to see the fossil evidence of ancient whales. Scientists have found more fossils of ancient whales here than in any other place on Earth. Scientists are especially interested in these fossils because they provide

This picture shows fossils of an ancient whale-like creature found at Wadi Al Hitan.

Different purposes for reading

Why do students read?

- Because the teacher assigned a reading
- To learn information

Why do scientists read?

- To situate their research
- To interpret others' data and critique their findings
- To find specific information to support their own investigations
- To learn about others' procedures and experiments
- To learn what other scientists are learning

Different approaches to reading

How do students read?

- From beginning to end

How do scientists read?

- Skip around
- Use headings
- Read captions
- Compare text descriptions to visual representations
- Check their understanding

ENVIRONMENTAL SCIENCE JOURNAL FOR TEENS

JANUARY 2024

What are the benefits of growing multiple crop species together?

Researchers:
Chunjie Li, Tjeerd-Jan Stomph, David Makowski, Wopke van der Werf and others

Associate Editors:
Allison Gamzon and Alexandra Appleton

Abstract

UPPER READING LEVEL

Did you know there are different ways to grow food? One way is sole cropping, which occurs when a field only has one species of crop. Another method is intercropping, which is when many species are grown together in the same field. We wanted to compare sole cropping and intercropping. We found that intercropping produces less of each type of crop on a field than sole cropping. But intercropping produces more diverse food choices. It also can save land space and reduce the amount of nitrogen fertilizer needed to grow food. That is why intercropping is an important agricultural technique to consider for the future.

Introduction

The goal of the current agricultural system is to meet the demand of an increasing world population in a **sustainable** way. How do farmers get high **yields** sustainably? There are different options, including **sole cropping** and **intercropping**. Sole cropping occurs when only one plant species grows in a field at a given time. Intercropping occurs when two or more plant species are grown in the same field at a given time. A common combination of species used in intercropping include grains and **legumes**.

Intercropping increases crop **diversity**, which can make crop production more stable. That is because when there is only one crop type, the field is **susceptible** to pests, diseases, and weeds. If one plant becomes infected with a pest or disease, this can spread to plants of the same species. With intercropping, the mixture of plants prevents the pests and diseases from spreading. Intercropping can also affect the amount of fertilizer used by a farm. Reducing fertilizer use is important because it can lessen costs for the farmer. It also reduces the amount of nitrogen reaching water systems through **runoff**.

Even though scientists and farmers know the benefits of intercropping, it is not a widespread practice. We wanted to do a comparison between sole cropping and intercropping to provide more information to farmers and policy makers. We used the results of field experiments to compare these two techniques.

Corn (maize) is the most widely cultivated grain in the world. People can eat it directly, but also use it for animal feed, corn starch, corn syrup, and biofuels.
Photo: Frank Meriño on Pexels.

Methods

We analyzed a global set of data. It included the results of over two hundred experiments. These experiments investigated intercrops that included a grain and another crop type, either a legume or **oilseed** crop. We focused on experiments that used the same or similar practices to grow the intercrop and the sole crop.

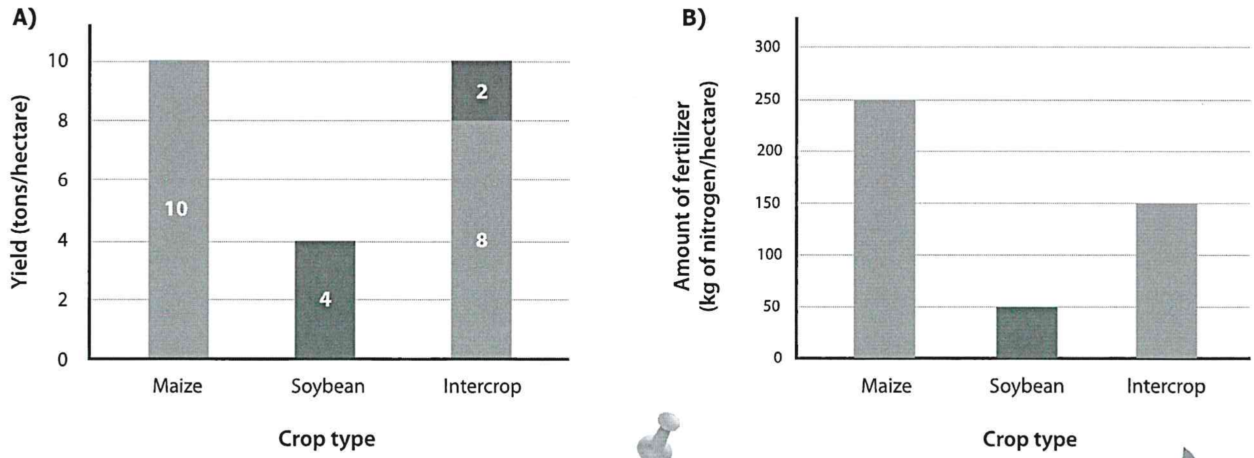
We used the results of these experiments to determine the amount of each crop that could grow on a piece of land together. Then we determined how much of each crop could grow on that same piece of land alone. We also figured out how much nitrogen fertilizer these crops needed if grown together and separately. Finally, we calculated different productivity measures. These included land use efficiency and protein content.

Results

Intercropping produces less grain compared to sole cropping (Fig. 1A). For example, if a farmer plants only corn (**maize**) on one **hectare** of land, they get 10 tons. If a farmer plants one hectare of land half with corn and half with soybeans, only 8 tons of corn grows.

However, intercropping is more land efficient because it produces a greater total output of food compared to sole cropping. For example, to grow corn and soybeans with sole cropping, a farmer needs two hectares of land. One hectare produces 10 tons of corn and the other produces 4 tons of soybeans, which is a total food output of 14 tons. If the farmer plants both hectares with half corn and half soybeans, they will produce 16 tons of corn and 4 tons of soybeans, which is a total output of 20 tons.

We also found that intercropping requires less nitrogen fertilizer (Fig. 1B). It also produces either the same amount or a higher amount of protein than the most protein-rich crop.



How does the amount of corn (maize) grown as a sole crop compare to the amount grown with intercropping?

Figure 1:
A) The yields of corn (maize), soybeans, and an intercrop of corn and soybeans
B) The amount of fertilizer needed to grow corn, soybeans, and an intercrop of corn and soybeans

How does the total amount of fertilizer needed to grow corn and soybeans separately compare to the amount of fertilizer needed to grow them as intercrops?

Discussion

The success of intercropping is dependent on the goal of the agricultural system. If the goal is to produce the largest crop yield of a single crop, then sole cropping is the better technique. If the goal of an agricultural system is a diversity of foods, then intercropping is the better technique. With intercropping, farmers cannot grow as much of each individual crop. But by growing two crops together, the land produces multiple food types.

Intercropping can also increase land **productivity**. If one hectare of land contains half corn and half soybeans, we expect half as much of each crop to grow compared to sole cropping. Based on the example above, that means 5 tons of corn and 2 tons of soybeans should grow. But 8 tons of corn and 2 tons of soybeans grew. Why? The corn and soybeans grow in alternating rows. Each species grows better because they compete less with individuals of a different species than from the same species. That is because they have different needs.

We also learned that intercropping often decreases nitrogen fertilizer use. That means intercropping is a more sustainable practice because it reduces the amount of resources needed to grow food. It also helps reduce the impact of farming on the environment. Nitrogen fertilizer is a common water pollutant that can negatively impact river systems and the ocean.

Our research showed that intercropping is a good alternative to sole cropping. We found that there are many benefits to intercropping, in addition to making areas more resistant to diseases, pests, and extreme weather. That is why this technique is an important consideration for the future.

Conclusion

Intercropping is an example of how important diversity is to an ecosystem. The more diverse an area, the more able it is to survive disease, pests, and extreme weather events. You can help keep your local ecosystem stable by planting a diverse set of plants in your yard or garden. This diversity can maintain the health of the soil and provide habitats to many organisms, such as insects and birds. Which plants are best to grow in your area? Do some research on native species or ask for guidance when purchasing plants to grow in your yard or garden.

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Glossary of Key Terms

Diversity - the state of having variety or more than one type of something.

Hectare - a measurement of land area that is equal to 10,000 square meters or about 2.5 acres.

Intercropping - the agricultural practice of growing two or more crop species in a field at the same time.

Legumes - family of flowering plants that comprises species that produce protein-rich edible seeds. Legumes typically have a root relationship with bacteria that enables them to fix nitrogen from the atmosphere. Crop species include lentils, peas, broad beans, chickpeas, soybeans, common beans, lima beans, and peanuts.

Maize - the agricultural term used for corn.

Oilseed crop - a crop grown to produce oil. Examples include soybeans, cottonseed, sunflower seed, canola, rapeseed, and peanuts.

Runoff - when the water from heavy rainfall or excess irrigation doesn't sink into the soil, but instead washes into nearby streams, lakes, and other bodies of water.

Productivity - the ability of the land to grow crops.

Sole cropping - the agricultural practice of growing only one crop species in a field at the same time.

Susceptible - liable to be influenced or harmed by a particular thing.

Sustainable - avoiding an overuse of natural resources so that a practice can continue into the future.

Yield - a term in agriculture used to describe the amount of crop produced by a farm or piece of land.

Check your understanding

1. How does the amount of grain grown on a single field using sole cropping compare to the amount of grain grown using intercropping?

2. What are three benefits of intercropping?

3. How could this research impact the use of intercropping worldwide?

4. Intercropping requires farmers to select two or more crops that can grow together. With a partner, brainstorm at least two characteristics of crops that farmers need to consider when determining which plants to intercrop.

5. The increase in stability provided by intercropping is known as an ecosystem service. An ecosystem service is a benefit that humans obtain from an ecosystem. Make a list of other examples of ecosystem services you can think of.

ASTRO SCIENCE JOURNAL FOR TEENS
JANUARY 2024

How does dark energy affect galaxies?

Authors:
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Associate Editors:
Saskia Hagan-Fellowes and Tanya Dimitrova

Abstract

Scientists have known for a while that the universe is expanding, and it's doing so faster and faster. This strange phenomenon is caused by something we call dark energy. To understand this better, we need to think about a special number called the Cosmological Constant. It helps us describe how things move in space.

In our research, we aimed to uncover how dark energy causes objects like stars and galaxies to interact. As an example, we've been studying our neighbor galaxy – Andromeda. By looking at how it moves and at its mass, we can see how dark energy affects it.

Introduction

Imagine the universe as a gigantic balloon that just keeps growing and growing. You know how the air inside a balloon makes it get bigger? Well, our universe has something called **dark energy**, and it's a bit like that invisible air inside the balloon.

Think of dark energy as the opposite of gravity, or "anti-gravity". This is because while gravity normally works to pull things together, dark energy pushes them apart. Dark energy makes our universe expand, but we can't see or touch it because it's "dark" and very tricky to understand. We think up to 2/3 of the universe may be made up of this type of energy.

Our solar system is part of the **Milky Way Galaxy**. The Milky Way and its neighbor the Andromeda Galaxy are both part of a larger group of galaxies in space (Fig. 1). In this **Local Group**, dark energy is like an invisible force gently influencing how galaxies move.

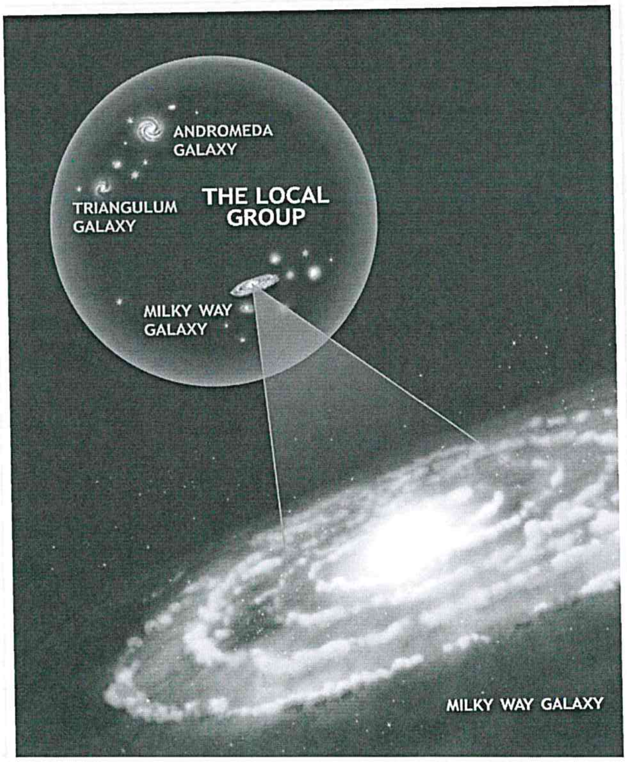

Figure 1: :The Milky Way is not an island universe, but a member of a small cluster of galaxies called the Local Group. The Local Group contains about three dozen known galaxies, clumped in two subgroups around two massive spiral galaxies: the Milky Way and the Andromeda Galaxy. In several billion years it is possible that the Milky Way and Andromeda will collide and merge to form one huge elliptical galaxy. (Image: NASA/Chandra X-Ray Observatory/M.Weiss)

Other galaxies are moving away from us due to the universe's expansion. But Andromeda is actually coming closer to us. We're on a collision course with Andromeda, but don't worry; it won't happen for billions of years! By studying Andromeda's mass and how it moves, we hope to see the effect dark energy is having on it.

One big clue in solving the mystery of dark energy comes from Albert Einstein. He came up with an idea called the Cosmological Constant. It is a vital clue in the dark energy mystery. It can help us understand how strong this mysterious force is and why the universe is expanding.

Methods

We focused on the Local Group of galaxies. These galaxies are pulled together by gravity. But they are also pushed apart by dark energy in our expanding universe. As a result, they have complex close orbits. We used mathematical models and simulations to see how dark energy and the Cosmological Constant affect their orbits.

Results

We calculated the maximal value on the Cosmological Constant only based on Andromeda's motion. It is 5 times greater than the value we measure from faraway galaxies. The result agrees with our known value of the Cosmological Constant. But it also opens new possibilities to test the Cosmological Constant in nearby galaxies.

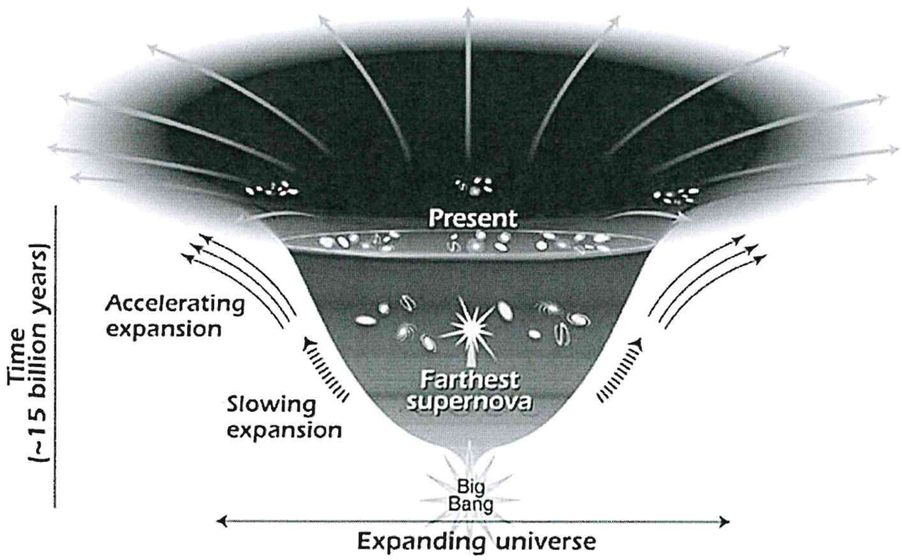

Figure 2:
We can see how fast the universe is expanding as it ages by using estimates of how much dark energy was in the universe at each time. We can see the universe got a lot bigger about 7.5 billion years ago. Dark energy may be speeding up this expansion. (Image: NASA/STSci/Ann Feild)

Discussion

We found that dark energy plays a major role in the galaxies' movement in our Local Group. Dark energy has a big impact on how objects move in space. Our method opens new directions to test the impact of dark energy, even from nearby galaxies in our local universe (Fig. 2). These findings provide us with valuable insights into how the entire universe operates and how it changes over time.

Conclusion

The universe's accelerating expansion and the role of dark energy are intriguing puzzles. It is truly amazing that we even have the capacity to think about these questions. After all, we are inhabitants of just a single planet in just one of the star systems in just one of the galaxies! A scientist's job is to ask interesting questions and design tests that can help answer them. What are you curious about? How can you learn more about it?

Glossary of Key Terms

Albert Einstein - a famous physicist who helped develop the theoretical physics behind our expanding universe.

Cosmological Constant (aka Λ, the Greek letter lambda) - a special number used to describe the value of dark energy in mathematical terms. Albert Einstein came up with this term. He thought it described a universe that does not expand. Later, when scientists discovered the universe was getting bigger, Einstein called it his "biggest blunder."

Dark energy - an invisible force that makes up approximately 68% of our universe. We can't see it, but we know that it's there because of measurements showing the universe started expanding faster about 7.5 billion years ago.

Expansion of the universe - our universe is getting bigger, and the space between galaxies is actually growing!

Galaxy - a large group of stars, planets, gas, and dust bound together by gravity. Galaxies come in various ages, shapes, and sizes.

Local Group - a group of nearby galaxies including the Andromeda Galaxy, the Milky Way, and the Triangulum Galaxy.

Mass - a measure of how much matter (that is, the total number of atoms) that are in an object. It is a fundamental property that does not change regardless of what forces are acting on it. It is different from "weight", which depends on gravity and other forces.

Mathematical models - a set of equations and rules that show how things in our universe (like stars and galaxies) move and behave. We can use models to make predictions about the universe and understand the physics behind certain astronomical events.

Milky Way - the galaxy we live in. It includes our solar system and hundreds of billions of other stars.

Orbit - the path of celestial objects moving in space

Acknowledgment: This article's adaptation was supported by the Goggio Family Foundation.
Goggio Family Foundation

Check your understanding

1. What is dark energy and how is it different from gravity?

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2. What were the key findings about the impact of dark energy on nearby galaxies like Andromeda?

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3. What causes galaxies to have complex orbits?

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4. How did Albert Einstein's concept of the Cosmological Constant contribute to understanding dark energy?

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5. How do you think studying dark energy and its influence on galaxies could benefit our understanding of the universe's evolution? Discuss potential advancements.

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NOVEMBER 2022

ENVIRONMENTAL SCIENCE JOURNAL FOR TEENS

Can a spray make our crops better?

Authors:
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Yoko Horii, and others

Associate Editors:
Elitsa Panayotova
and Rachel Watson

Abstract

UPPER READING LEVEL

Did you know that the first genetically modified crop was a tomato with delayed ripening? Genetically modified organisms (GMOs) have been around for decades now. And they offer a lot of benefits, such as an increased food supply, resistance to diseases, and more. Yet there are a few downsides as well. Producing them takes a lot of time and is often expensive. Plus, many people have concerns about their safety, since they include foreign DNA in their genome. But what if we can alter the crops without changing their genome? We tried using bioactive molecules which can change cell activity. To insert them into the plant cells we tested sprays with nanocarriers. It turned out to be a success! Many nanocarriers were able to penetrate the plant cells. We also successfully inserted bioactive molecules in the cells through spraying. In this way the cell could express a new gene or silence an existing one.

Introduction

You have probably heard of **genetically modified organisms** (GMOs). But do you know how scientists make them? It usually takes 4 steps:

1. They look for a trait that can improve the organism. For example, a desirable plant trait could be disease or drought resistance. Then they find another organism that already has that trait and locate the **DNA** responsible.

2. They copy the desired DNA. Often scientists use bacterial cells to produce a lot of DNA copies.

3. They insert the DNA into the organism they wish to modify. Sometimes they use bacteria to infect the cells. Other times, they use metal particles coated with DNA. The result is that the desired DNA integrates into the **genome** of the GMO. This modified genome then **expresses** different **genes**, leading to the desired effects. The modified genome also carries on to future generations.

4. Finally they grow the new plants that are resistant to diseases, drought, insects, etc.

We can't deny that GMOs can be very helpful. But there are some downsides. For instance, GMOs take a long time to make and the production can be quite expensive. Another issue is that many people consider them harmful to our bodies and the environment.

So, what if we can modify the plant to have the desired traits without altering its genome? So that it won't take so much time to produce and it would be cheaper? And much easier to do? This is what we wanted to achieve.

Methods

Bioactive molecules (for example, hormones, DNA, or RNA) can interact with cells and adjust their activity. So, instead of changing the plant's genome, we can insert such molecules to control the cells. It sounds simple enough, but achieving it is no easy task. Plus, we wanted an easy application method that people can use in agriculture. We decided to try delivery through sprays.

We considered different **nanocarriers** that can insert the bioactive molecules into the cells. We settled on **cell-penetrating peptides (CPPs)**, since they can target specific **organelles** inside the cell.

We performed three separate experiments.

Experiment 1: We wanted to figure out which CPP would be the best at entering plant cells via spraying. For this purpose we tagged various CPPs with fluorescent yellow dye. Next we sprayed this complex (CPP plus dye) on the plants' leaves. We then measured the fluorescence with a special microscope.

Experiment 2: We wanted to test if these nanocarriers could insert DNA and **RNA** into the cells. So, we combined CPPs with a **reporter gene system** and sprayed another group of plants (Figure 1). If the DNA penetrated the plants' cells, they would express its genes and we would see blue spots.

Experiment 3: We wanted to see if we could **silence** some genes, because this can be as important as inserting new ones. As a test subject we used a genetically modified plant that expresses yellow fluorescence (glows yellow!). We sprayed this plant with a nanocarrier combined with a small RNA molecule that should interfere with the expression of fluorescence – without changing the modified genome. Success would mean no or decreased fluorescence.

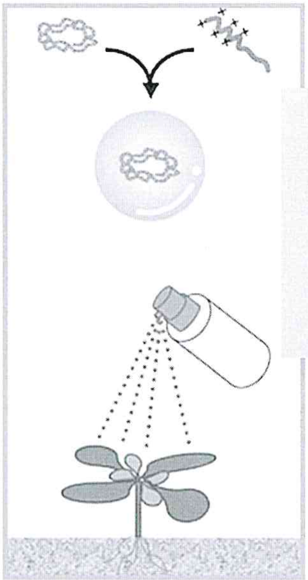

Figure 1:
Spraying the leaves with a nanocarrier with bioactive molecules (DNA or RNA).

Results

Our experiments showed us that:

1. Various CPPs showed different fluorescence intensities after we sprayed them on the plants' leaves.

2. There were blue spots after we sprayed plants with the combination of nanocarriers with DNA.

3. Spraying the genetically modified plant with the nanocarrier/RNA combination resulted in reduced fluorescence. In contrast, spraying it only with the nanocarrier or the RNA didn't reduce the fluorescence. (See Figure 2.)

Fluorescence of yellow fluorescent protein

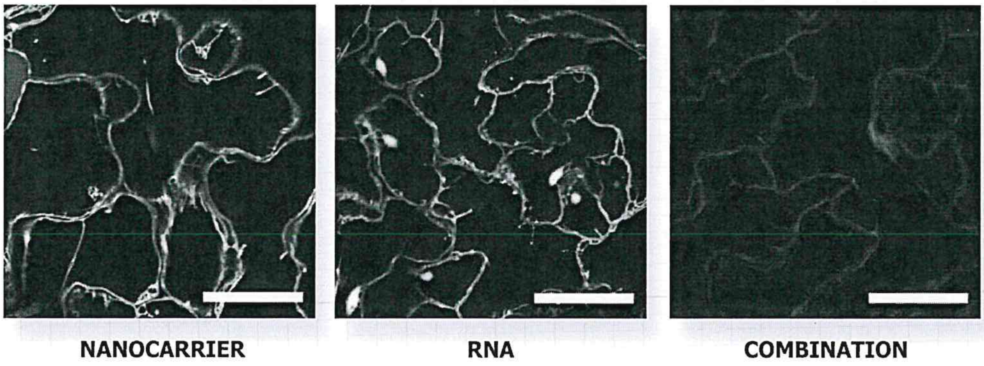

Figure 2:
Microscopic images of the yellow protein's fluorescence after spraying the genetically modified plant's leaves with
1) a nanocarrier
2) a bioactive molecule (interfering RNA)
3) a combination of both of these.

Why is there fluorescence in the first two microscopic images? And why is there hardly any fluorescence on the third image?

Discussion

Our results are quite promising! Spraying bioactive molecules on the plants' leaves is an efficient delivery method. Many natural CPPs were able to enter the leaves' outer layer. The nanocarriers were also successful at delivering DNA molecules into the cells. Observing the fluorescence after this delivery means the cells express the new genes.

Moreover, we were able to silence other genes. This means that the bioactive molecule (RNA) blocks a gene. In our case, the RNA blocked the gene expressing the fluorescent protein. Thus, the genetically modified plant, which usually glows, emitted a lot less fluorescence.

Conclusion

We developed a way to modify plants without changing their genome that is both safe and very easy to apply! Plus, it takes a lot less time and money! This doesn't mean we should ignore GMOs, though. Do some research to find out what genetically modified crops are grown in your country. What are their benefits? What about their drawbacks?

Glossary of Key Terms

Bioactive molecules – various molecules, like hormones, growth factors, DNA, and (small) RNA, which can interact with a cell and change its activity. For example, tannins can have antioxidant effects.

Cell-penetrating peptide (CPP) – a type of nanocarrier that is a short peptide (chain of amino acids). They facilitate the intake of molecules inside the cells.

DNA (DeoxyriboNucleic Acid) – a molecule that carries the genetic information used in the growth, development, function, and reproduction of all known living organisms, including humans.

Expression (genetic) – the process when a gene gets turned on to make RNA (and then proteins).

Gene – a small section of DNA with the instructions for characteristics of the organism.

Genetically modified organism (GMO) – an organism whose genome has been changed intentionally (in the lab).

Genome – all genetic material in a cell or organism. The genome consists of DNA.

Nanocarrier – a very tiny (1-100nm) material that can transport other substances, such as bioactive molecules, and drugs.

Organelle – a special subunit within the cell that has a specific function. For example, the nucleus in eukaryotic cells contains the DNA and controls all activities in the cell.

Reporter gene system – a technique that shows if a gene is expressed. In our case we used a gene that codes for fluorescent proteins.

RNA – short for RiboNucleic Acid, a nucleic acid present in all living cells. It can act as a messenger carrying instructions from DNA for the synthesis of proteins. RNA molecules can also switch on and off the expression of other genes. This is called RNA interference (RNAi).

Silencing (gene silencing) – regulation inside the cell that prevents (switches off) a gene's expression. It can occur during either transcription or translation.

Check your understanding

1. What is the difference between genetically modified organisms and altering cell activity through bioactive molecules?

2. What did the reduced fluorescence in the third part of our experiment show us?

3. In our experiment, we silenced the gene expressing fluorescence, not a very important trait. Can you think how gene silencing can be useful?

4. Resistance to drought and diseases are two examples we gave for positive traits desired in crops. Can you think of any others?

5. Do you support GM crops? Why or why not? Consider how they have helped to address global hunger as well as the risks they present to humans and the environment. Discuss this in small groups in class, or do some research online!

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