You Worked Together with an Astronaut in a Space Experiment

Space Seeds for Asian Future 2013

Kibo-ABC
an initiative to promote Asian beneficial collaboration through Kibo utilization under Asia-Pacific Space Agency Forum

Contents

Introduction

Can plants grow in space similarly to plants on Earth?

Growing food in space helps solve various issues associated with space travel. Moreover, growing plants in space may give us many hints for improving farm production on Earth. Space farming is a theme not only for a handful of researchers, but also for anyone who is interested in the biological and agricultural sciences. Today, you can collaborate with astronauts working in space to observe how plants grow in conditions that are different from conditions on the earth's surface.

The Program

Space agencies and educational institutions in the Asia-Pacific region jointly started an initiative, The Asian Beneficial Collaboration through Kibo Utilization

(Kibo-ABC), to realize benefits in the region from contributions of the Japanese Experiment Module (Kibo) aboard the International Space Station (ISS).

The Space Seeds for Asian Future (SSAF) program is one of the activities of Kibo-ABC. The program promotes understanding and gives regional space agencies experience in the utilization of Kibo. It also provides young people in the Asia-Pacific region with opportunities to learn about leading scientific discoveries through their participation in experiments under peculiar space conditions including microgravity. Students from Indonesia, Malaysia, Thailand, and Vietnam participated in the SSAF2010–2011 program. As part of this program, seeds from each of these nations were flown to the ISS and kept in the Kibo module. These seeds were then returned to Earth, where they germinated; then, they were compared to control seeds not flown in space. This experiment involved researchers, students, and the general public.

In the SSAF2013 program, there are plans to cultivate seeds indigenous to Asia in the Kibo/ISS facilities. The plan is to send Azuki beans (*Vigna angularis*) to Kibo and observe the growth of their seedlings under dark conditions. Members of the Kibo-ABC initiative are collaborating in the preparation of seed germination testing procedures, and many people—children, students, and researchers—are expected to participate in the program.

Through the program, a batch of Azuki beans will be grown for seven days onboard the Japanese module of the ISS, also known as Kibo. Astronauts will film the sprouting of Azuki beans in space and transmit the images back to Earth. This experiment will provide important information regarding the differences between plants grown in space and the same plant species grown on earth.

Determination of Experimental Conditions

Determination of growth conditions and development of methodology for measuring physical strength of Azuki bean stems for the SSAF2013 program

Biology Club (Osaka City University), Sachiko Yano (JAXA), Kouichi Soga (Graduate School of Science, Osaka City University)

Introduction

Plants utilize gravity, which is present in a constant direction and magnitude on Earth, as the most reliable environmental signal for growth and morphology. Thus, growth and morphology of plants grown under microgravity conditions in space will be different from those grown at 1 G condition on Earth. In the SSAF2013 program, participants of the program observed changes in growth and morphology of Azuki bean seedlings grown in space. Additionally, the physical strength of epicotyls (stems) was measured. In the present study, our aims were to determine desirable growth conditions for the Azuki bean and to develop suitable methods for measuring the physical strength of their stems for the SSAF2013 space experiment.

Surface sterilization of seeds

In the SSAF2013 space experiment, dry seeds of Azuki beans were transported to the International Space Station (ISS); then, the seeds were watered for germination. Generally, mold growth occurred around the cotyledons of the Azuki beans when non-sterilized seeds were used for experimental purposes. Thus, we selected suitable methods for surface sterilization of seeds. Sterilization with a sodium hypochlorite solution and ethanol was the most effective method for preventing mold growth (Fig. 1). The germination rate of sterilized seeds was almost the same as that of non-sterilized seeds.

Reduction of seedling size variations

In typical experiments on the ground, seeds of Azuki beans are soaked and allowed to germinate in running tap water. Additionally, seedlings are selected for uniformity in length and diameter of stems for growth experiments. However, in the SSAF2013 experiment, dry seeds of Azuki beans were transported to the ISS; then, they were watered directly and used for growth experiments. Therefore, we selected seeds with fewer variations in seedling size. Most frequently, seeds weighed 110–120 mg, according to our examination of the distribution of dry weight (Fig. 2). Thus, we selected seeds in this range for the present experiment. Further, we removed seeds with inferior color or abnormal shapes. Fewer variations in seedling size were noted for selected seeds than for unselected seeds (Fig. 3).

In germination of the Azuki bean, initial water absorption is conducted through the strophiole. Efficiency of water absorption may be enhanced by cutting off the strophiole. Further, we examined variations in the seedling size by using such cutting seeds (Fig. 4). The results showed that variations in the seedling sizes of cutting seeds were smaller than that of intact seeds (Fig. 3). Additionally, the germination rate of cut seeds that were stored for two months at room temperature was almost the same as that of cut seeds that were allowed to germinate immediately.

Physical strength of stems

Developing resistance to gravitational force is a critical response for terrestrial plants if they are to survive under 1 G conditions. We refer to this reaction as "gravity resistance," and we have analyzed its nature and mechanisms using hypergravity conditions produced by centrifugation (Hoson and Soga 2003; Soga 2010, 2013). Our results indicate that the cell wall rigidity in plants increases to resist gravitational force. To measure the cell wall rigidity of Azuki bean stems in the ISS, we searched for an available instrument, and we identified a spring balance as a candidate. Then, we compared the breaking load of stems grown under hypergravity conditions with that of controls. The stem was hooked to the spring balance and pulled until it broke. Cultivation at 300 *g* clearly increased the breaking load of stems (Fig. 5), which was similar to the result obtained with a tensile tester. These results indicate that the spring balance was useful for measurement of cell wall rigidity in the SSAF2013 space experiment. We also verified that the measurement could be conducted smoothly under microgravity conditions by parabolic flight.

Conclusions

In the present experiment, we identified suitable growth conditions for the Azuki bean in SSAF2013. The Azuki beans were selected based on dry weight, color, and shape. Then, seed surfaces were sterilized with a sodium hypochlorite solution and ethanol. Finally, strophioles of seeds were cut off to enhance water absorption. Results indicated that the spring balance is useful for measuring cell wall rigidity. Utilizing the growth conditions and method for measuring physical strength of stems identified from investigations in the present study, the SSAF2013 space experiment was carried out successfully from September 6 through August 30, 2013.

References

Hoson T, Soga K (2003) New aspects of gravity responses in plant cells. Int Rev

Cytol 229: 209-244.
Soga K (2010) Gravity resistance in plants. Biol Sci Space 24: 129-134.
Soga K (2013) Resistance of plants to gravitational force. J Plant Res 126: 589-596.

Figures

1) Put ca. 25 seeds (ca. 3 g) into a 50 ml conical centrifuge tube.
2) Add 30 ml of sodium hypochlorite solution (dilute original solution to 4 times; Wako, 194-02216, Japanese Food Additives); then, close the cap of the tube.
3) Vortex the seeds at high speed for 1 min.
4) Decant the sodium hypochlorite solution.
5) Repeat steps 2–4 twice.
6) Add 30 ml of ethanol (99.5%); then, close the cap of the tube.
7) Vortex the seeds at high speed for 1 min.
8) Decant ethanol.
9) Repeat steps 6–8.
10) Remove the seeds and blot ethanol with paper.
11) Dry the seeds on a clean bench.

Fig. 1 Method for surface sterilization of Azuki beans

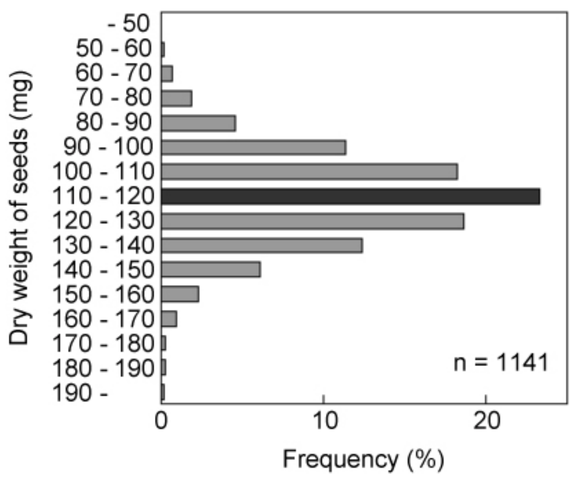
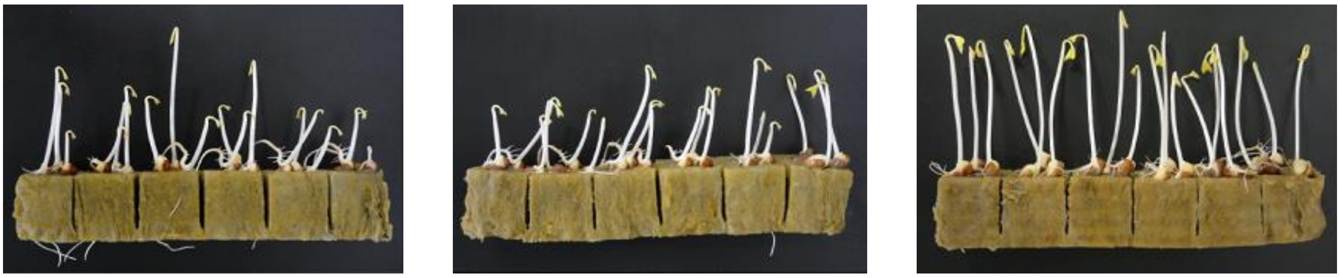


Fig. 2 Distribution of the dry weight of Azuki beans



Unselected

Selected by dry weight

Selected and their strophiole cut off

Fig. 3 Azuki bean seedlings

Intact Seed

Strophiole – cut seed

Fig. 4 Azuki beans

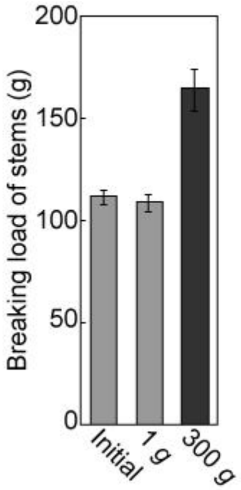


Fig. 5 Effects of hypergravity on breaking load of stems

SSAF2013 Space Experiment

Report No. 1: Ground Preparation

To conduct an experiment in the ISS, necessary experimental equipment should be prepared carefully before launching. For SSAF2013, we prepared containers in which Azuki beans can grow.

This article explains how the containers for the SSAF2013 flight experiment were prepared; it will be a reference when you carry out your ground experiments, but you do not have to follow the specific method described herein.

Preparation Procedure

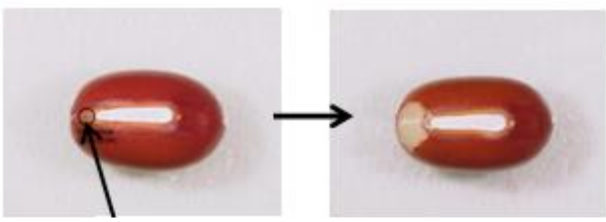
On July 5, 2013, preparations for SSAF2013 were undertaken at JAXA's Tsukuba Space Center with the support of Osaka City University.

Materials

- Azuki beans *Vigna angularis* 'Erimoshozu' (18 beans per box)
- Plastic containers with clear lids (External: 21 cm × 15 cm × 5 cm, Internal: 18 cm × 12 cm × 4 cm)
- Rock wool
- Cutter

Method

1. Fit watering and ventilation ports to each plastic container.
2. Disinfect Azuki seeds with sodium hypochlorite and ethanol.
3. Cut off strophioles to enhance water absorption and germination, taking care not to damage the embryos.



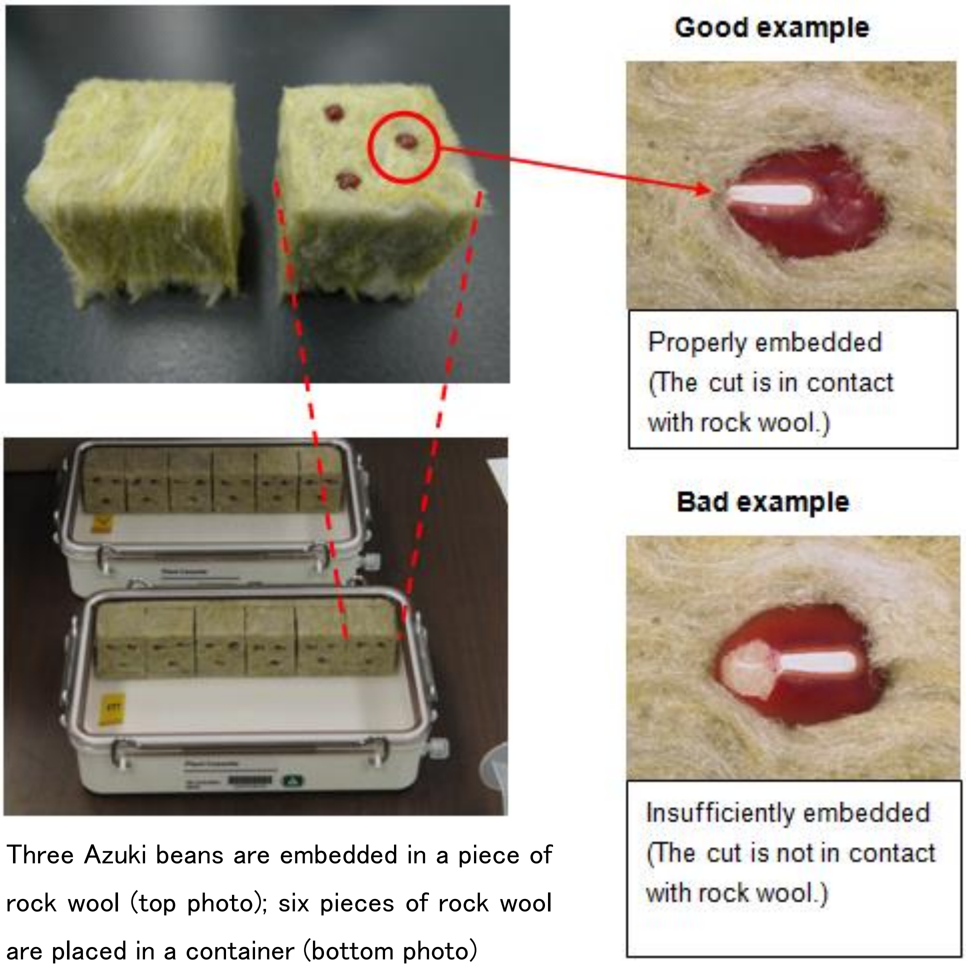
Bean with strophiole **Bean with strophiole cut off**

Examples of inferior cuts:

Too extensive

Insufficient

4. Cut rock wool to fit in the container and crate small incisions to embed Azuki beans.



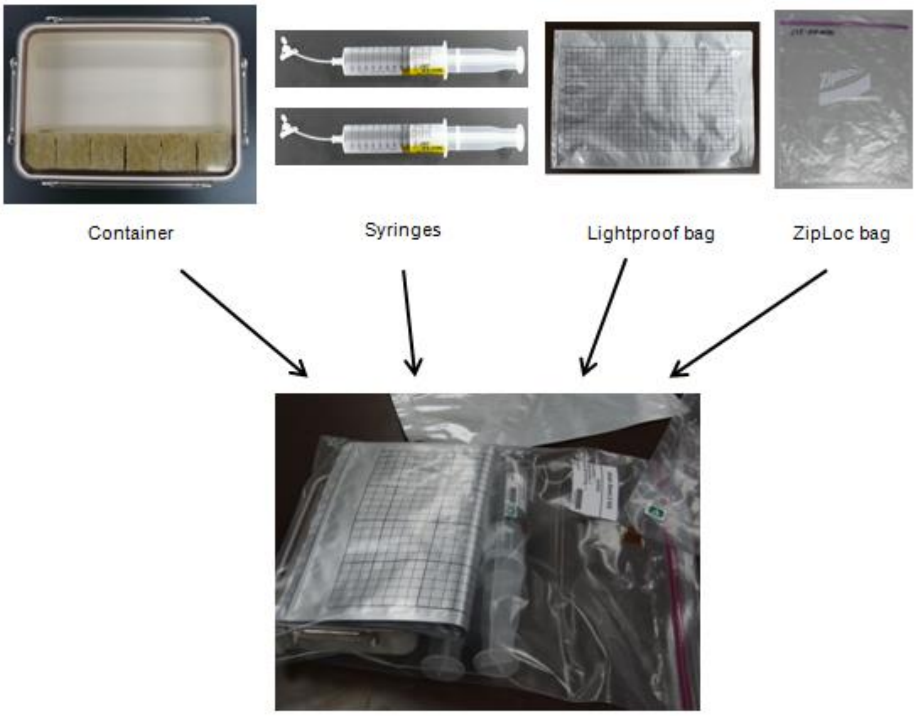
Three Azuki beans are embedded in a piece of rock wool (top photo); six pieces of rock wool are placed in a container (bottom photo)

5. Embed Azuki beans into the slits as shown above.

6. Place six pieces of rock wool with Azuki beans into a container with a clear lid.

During the actual procedure, five containers were prepared.

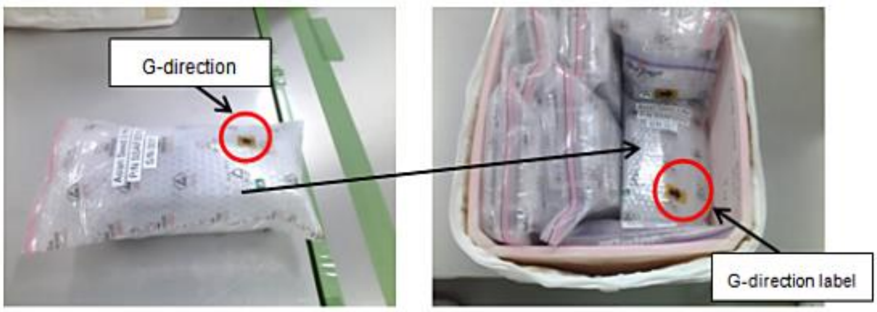
The five containers, along with other experimental materials, were put into Ziploc bags as flight kits. Each kit consisted of a container, two watering syringes, and a lightproof bag with a grid of 1 cm on one of its sides.



Flight Kit

One kit was selected for flight; the others were designated for ground controls or as backup.

On July 8, 2013, the integrated flight kits were enveloped with bubble wrap and put into clear bags. The bags were labeled to indicate the direction of gravity (i.e., G-direction); then, they were placed in a Cargo Transfer Bag (CTB).



Flight Kit　　Flight Kit in CTB

*The label indicating the direction of gravity has been placed on the bag (above) to ensure that the same direction is maintained during a vibration test.

The CTB was transferred to JAXA's Tanegashima Space Center for placement in HTV4 to be launched by an H-IIB launch vehicle. On July 15, 2013, the CTB was opened, and it was confirmed that the onboard flight kit was in good condition.

An experimental method utilized in orbit is provided in the next article.

All times represent Japan Standard Time (JST)

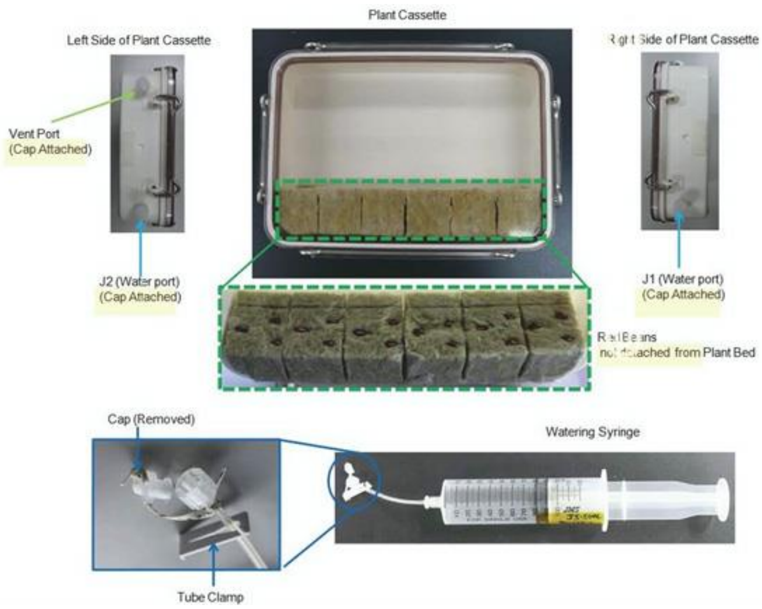
Report No. 2: Launch and Onboard Operation Procedure

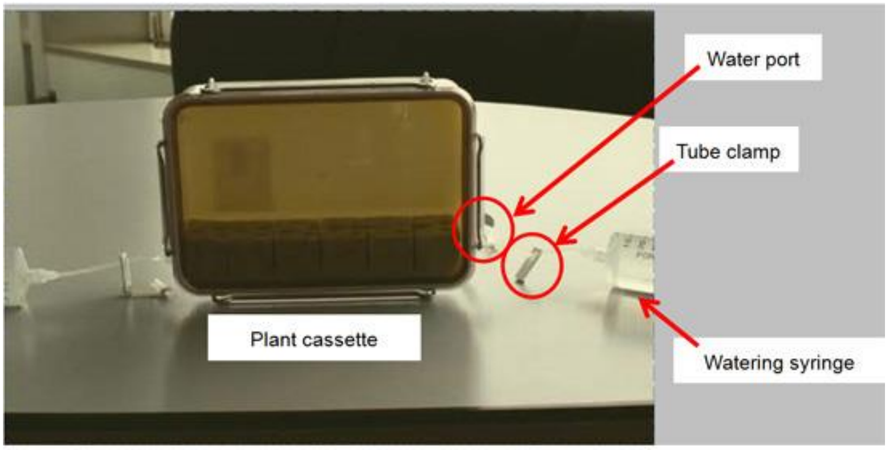
The fourth H-II Transfer Vehicle, or HTV4 (also known as KOUNOTORI4), was launched successfully aboard an H-IIB launch vehicle from JAXA's Tanegashima Space Center at 4:48 am on August 4, 2013. KOUNOTORI4, which delivers supplies to the International Space Station (ISS), docked on August 10. (All times appear in Japan Standard Time, UTC + 9 hrs.)

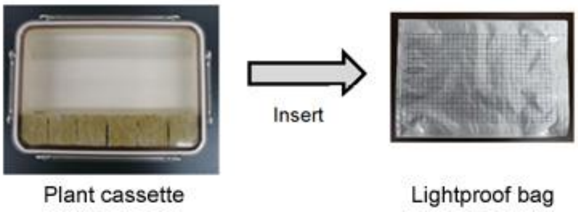
Our SSAF2013 experiment materials, of course, are among the payloads of KOUNOTORI4. The operation is expected to start in early September 2013, following the planned operational procedure given below. These space operation procedures do not have to be followed on the ground because of the unavailability of certain materials. You can modify the procedure by using accessible materials.

First day: Watering

Take out the SSAF plant cassette. Connect water syringes to watering ports and slowly inject to wet rock wool. Put the seeds into a lightproof bag and store at room temperature.





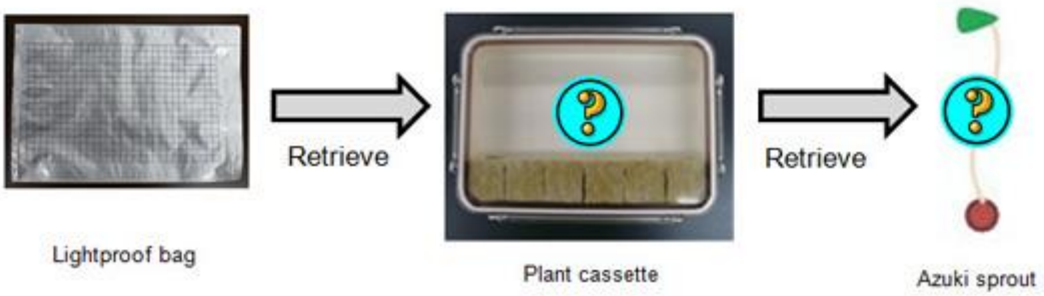


Fifth day: Growth check

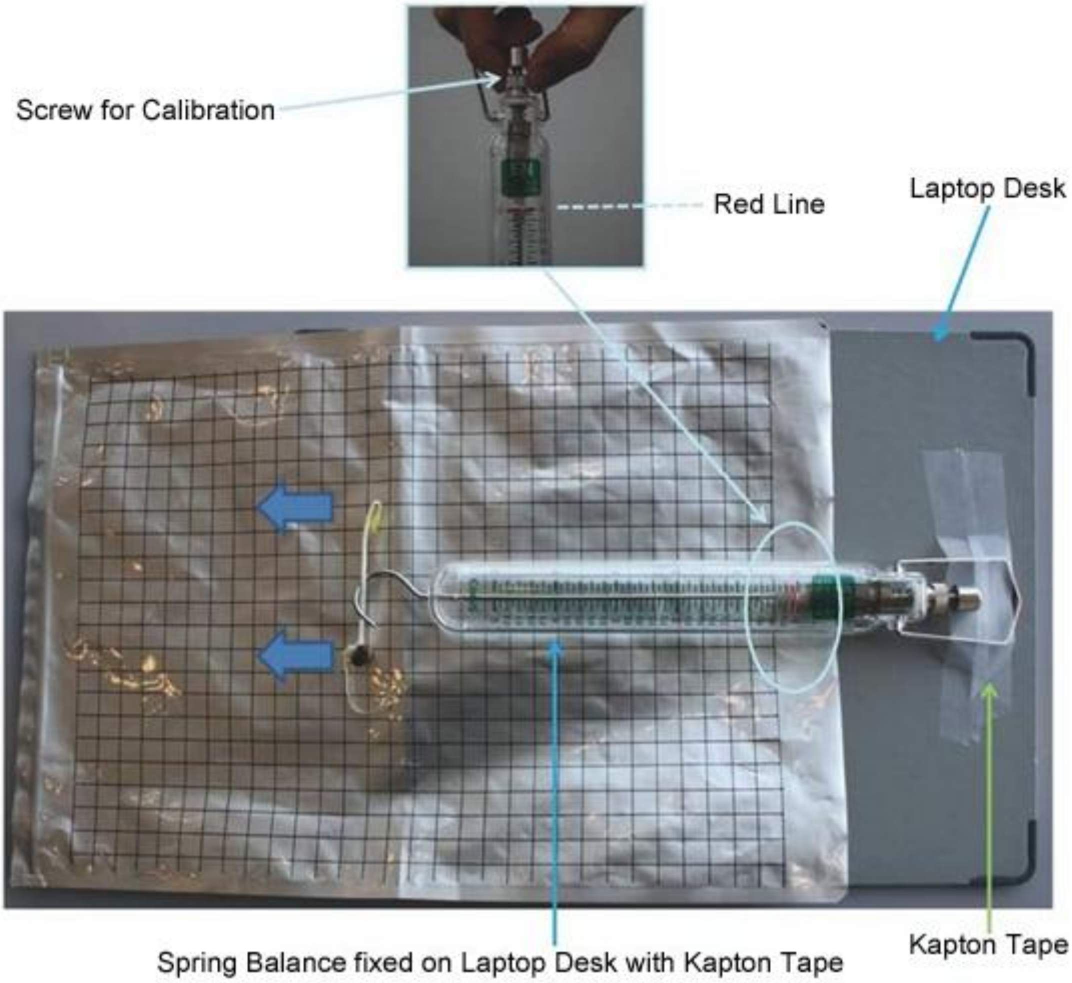
i. Retrieve the plant cassette from the lightproof bag.
ii. Observe the growth of Azuki beans. (Record with video camera.)
iii. Insert the plant cassette back into the lightproof bag.

Seventh day: Final observations

On the final day of this experiment, conduct detailed observations to determine how Azuki beans grow in space under the condition of microgravity. After observing the plant cassette in all directions, take some Azuki sprouts and drag, swing, and bend them.



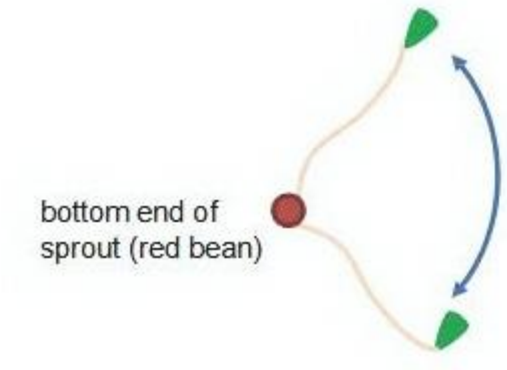
① **Dragging**



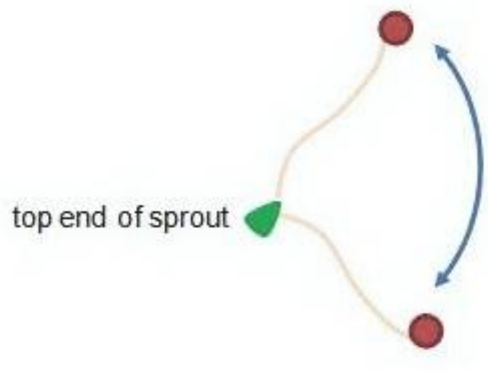
i. Pick one sprout from the plant cassette.
ii. Hold both ends of the sprout using both hands, and hook it to the spring balance.
iii. Slowly pull on both ends of the sprout until it breaks.

② **Swinging**

i. Holding the bottom end of sprout (bean), swing the sprout several times.

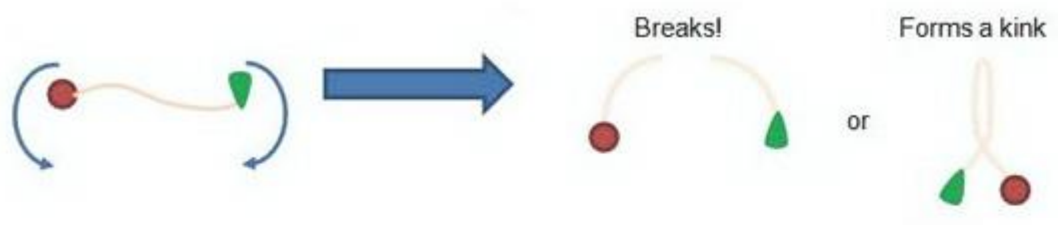


ii. Holding the top end of sprout, swing the sprout several times.



③ **Bending**

i. Holding the bottom end of sprout (bean), swing the sprout several times.



Report No. 3: Watering to Begin Cultivation

Astronaut Karen Nyberg initiated the SSAF2013 experiment by watering the seeds on board Kibo. At 10:15 pm on August 30, 2013 (Japan time), she completed all procedures and placed the seeds in storage.

Although the seed container used in space may appear to be tightly sealed to prevent water leakage, measures are taken so that gases will permeate. On the ground, there is no need to use a watertight container.

There are two temperature probes in Kibo. The readings before starting the procedure were 22.2°C and 23.1°C.

http://iss.jaxa.jp/en/kuoa/news/ssaf2013_report3.html

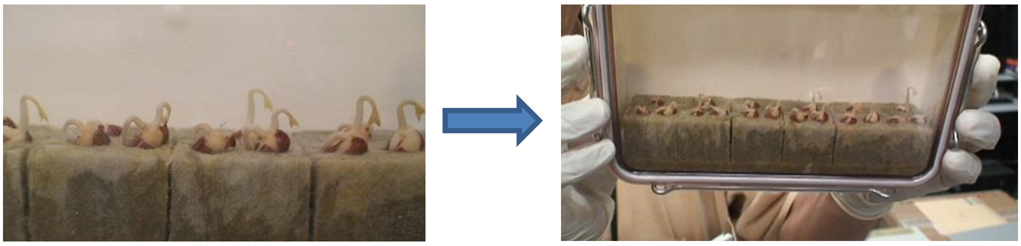
Four hours prior to the operation on board Kibo, a set of seeds on the ground were given water at Tsukuba Space Center using hardware identical to hardware used in space. Then, the seeds were cultivated at 22.5°C.

Report No. 4: Growth Check

On September 3, 2013 at 6:53 pm (Japan Standard Time), Astronaut Karen Nyberg let us glance at the growth of Azuki beans in Kibo. The observation was completed very quickly to minimize the effect of light on the seedlings.

http://iss.jaxa.jp/en/kuoa/news/ssaf2013_report4.html

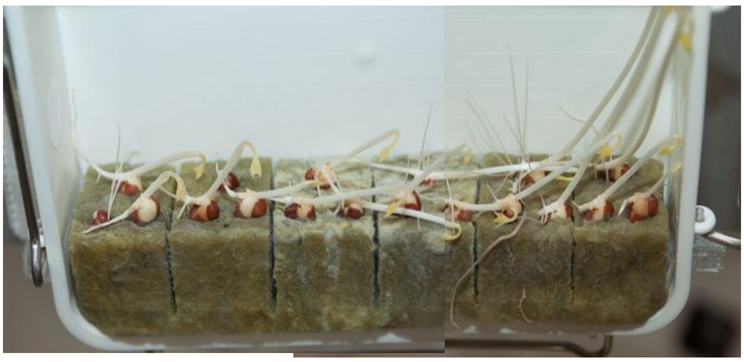
Ground staff at the Tsukuba Space Center also took a brief look at the seedlings under the condition of normal gravity.



Please compare the photographs with the seedlings at your home or in your classroom. Carefully observe if there is any variation, and be prepared to describe differences in appearance.

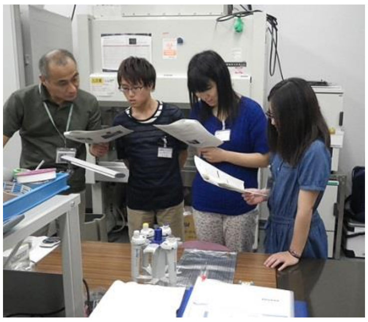
Report No. 5: Final Observations

On September 6, 2013 at 1:21 am, final observations began. To identify the differences between seedlings grown in space and seedlings grown on the ground, astronaut Karen Nyberg recorded still and video images from various angles. To estimate their physical strength, Nyberg removed some seedlings from the container and tested them by dragging, swinging, and bending.



http://iss.jaxa.jp/en/kuoa/news/ssaf2013_report5.html

At the Tsukuba Space Center, students from Osaka City University performed similar procedures.



The observation in space is only a part of the SSAF2013 program. Observations made by students on the ground are essential for a fully successful experiment. Please compare your results with those from space. If you find any differences, determine why they might have occurred and form your hypothesis. Then, make plans for further experimentation to verify your hypothesis. Please describe your ideas for next steps in space experiments if you deem them necessary.

Ground Experiments in the Asia-Pacific Region

Australia

Mt Stromlo and Siding Spring Observatories
The Australian National University (ANU)

Australia greatly appreciates opportunity to participate in the 2013 Space Seeds for Asian Future (SSAF). Even though Australian students are inspired by space, and often dream of being an astronaut, they assume that they will need to leave Australia if they want to work in the space industry.

Australia is not a member of the International Space Station (ISS) so there is no direct opportunity to expose students to space research using this platform. Through the Kibo-ABC, Australian students are not only able to participate in space research; they are also encouraged to collaborate with schools in the Asia-Pacific region.

The SSAF announcement was circulated through a national network of teachers with an interest in space science and experience in using the context of space to teach mathematics and science. The information was also broadly circulated through the Victorian Space Science Education Centre (VSSEC) and the Education and Training Directorate in the Australian Capital Territory to capture broader interest.

Growing seeds is a common activity for Australian students, so no special training was required. The ability to compare the shoots grown in the classroom with shoots grown on the ISS enriched the activity and provided an opportunity to discuss physics concepts such as gravity.

To enhance the experience, JAXA offered each of the participating countries some Azuki beans from the batch being sent to the ISS. This was a wonderful opportunity for students to make a direct comparison between the beans on the ground and the beans in space. Australian Customs was consulted and it quickly became apparent that it would be impractical to import the beans. This sad news was communicated to JAXA and we were amused to discover that they imported the beans from Australia.

Lessons learned: It is unknown how many students participated in this activity. The information was broadly distributed and there was no requirement to register. This made it impossible to measure the level of participation.

Future activity: The video taken aboard the ISS has been loaded on the JAXA website. This makes it possible for schools to conduct this activity at any time. Australia will continue to promote this activity as an effective way to introduce students to conducting science research in the space environment.

We would like to thank JAXA for supporting this excellent education activity and Bean Growers Australia for providing the Azuki beans.

Indonesia

National Institute of Aeronautics and Space (LAPAN)
Bandung Institute of Technology (ITB)

Purpose of participation

We have been using Azuki beans for scientific purposes. The scientific experiments by using clinostat and other treatments are being conducted by ITB graduate students.

Educational impact and spreading effect

By conducting the experiment on the ground and then comparing results with the "in space" experiment, students have learned why and how gravitation plays a role in their lives. Consequently, students were triggered to study space in a further in-depth manner. We also delivered beans to high school students at the Space Science Festival, so that they could plant them following the event and compare their findings with Kibo experimental results. Their scientific investigation is expected to broaden their knowledge about space.

Agency valuations and next steps

The scientific experiment is being conducted by the ITB team, and more time is needed to conclude the research. Further, we delivered Azuki beans to students from nine schools that agreed to participate when approached at the Space Science Festival, last October. Therefore, we are waiting for the results from these schools. The ITB team has been supervising students in their related activities.

Results

Quantitative results: Participating schools and students

Nine high school students participated.

Scientific results

Findings will be published by the ITB team.

Photos

Azuki beans from Japan (left) and the clinostat (right)


Activities in the ITB laboratory


Presentation about the effect of microgravity on plants (left)

Distributing Azuki beans to the schools (right)

Japan

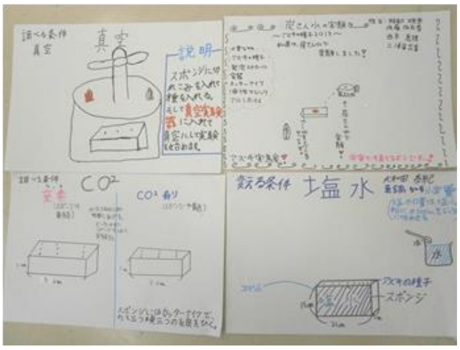
Japan Aerospace Exploration Agency (JAXA)

The Japan Aerospace Exploration Agency (JAXA) conducted a local program to promote science education for young people as well as an understanding of space environment utilization. JAXA has developed an Azuki growth observation kit consisting of Azuki beans and an instruction booklet; thus far, the agency has distributed about 3,500 kits to children and teachers at venues such as open house events, seminars for science teachers, and so on. .

Nagaya Primary School, Yokohama City, Kanagawa Prefecture

Science teacher Dr. Tomoe Saruwatari instructed fifth grade pupils to observe the germination and growth of Azuki beans under various conditions in addition to gravity. The class of 31 pupils learned about Japan's space development activity and the general nature of space, in addition to plant biology.

Children seemed excited to find that the things they learn in their daily classroom may apply to outer space. They made their own hypothesis considering the conditions aboard the space station. Some children employed critical thinking skills to ask questions such as "How will it be in space...?" for other subjects of this program, such as medaka fish or humans.



Saibi High School, Matsuyama City, Ehime Prefecture

Students of the Biology Club (below) observed the Azuki growth as an extracurricular activity under the guidance of Ms. Tomomi Oka-Kobayashi. They presented information about the program and instructions for growing Azuki beans at their annual school festival; additionally, they invited junior high school students to join the club.

Malaysia

National Space Agency of Malaysia (ANGKASA)

Purpose of participation (objective)

- Fostering a culture of science and technology among students and the community through increasing knowledge of the agricultural and microgravity sciences
- Supporting the teaching and learning of space science in schools
- Comparing and analyzing the hypothesis about growth of seeds (i.e., microgravity-exposed seeds compared to Earth-grown seeds)

In conjunction with Space Seeds for Asian Future 2013 (SSAF2013), a special program was conducted by ANGKASA as follows:

TITLE: Malaysia Space Seeds 2013 (MASS2013)

INTRODUCTION

MASS2013 was a local program held in conjunction with the international program "Space Seeds for Asian Future 2013 (SSAF2013)." MASS2013 was organized by the National Space Agency of Malaysia (ANGKASA) in cooperation with the Ministry of Education (MOE), Malaysian Agricultural Research and Development Institute (MARDI), and the National Seeds Association of Malaysia (NSAM). This international cooperative effort was promoted by the Asian Beneficial Collaboration through "Kibo" Utilization (Kibo-ABC) and the Japan Aerospace Exploration Agency (JAXA).

NATURE OF COMPETITION

MASS2013 was a competitive program open to students of primary and secondary schools throughout Malaysia; the competition was conducted online (http://mass2013.angkasa.gov.my).

Students studied the response properties for different growth orientations of red beans or Azuki seeds (*Vigna angularis*) sent to the International Space Station (ISS). Growth of seeds in the condition of microgravity was compared to growth of seeds on the ground (normal gravity); seeds germinated in the dark for seven days.

Comparisons were made by viewing the video sent from the ISS after the seventh day of germination; the astronaut conducted demonstrations and physical observations of the space seeds.

Students were required to conduct a research project to evaluate germination behavior of Azuki beans and upload daily ground germination data for comparison with space germination data obtained from the ISS on the seventh day of the experiment. Further, students were required to provide a full report of the experiment on the seventh day and conduct additional experiments related to the Azuki beans.

ANGKASA has conducted a survey to measure the effectiveness of the program. All students were asked to respond to an entry survey (during registration) and an exit survey (after submission of the full report).

ELIGIBILITY

Each school was allowed to send only one team comprised of five students supervised by a teacher.

COMPETITION ENTRY

All entries to the competition had to be submitted by the schools and received by the Organizer online no later than the deadline fixed by ANGKASA. Submission was made through the MASS2013 web site at URL http://mass2013.angkasa.gov.my

Educational impact and spreading effect

- Integration of ICT applications in space science teaching and learning through ISS data access and uploaded online reporting were noted.
- Students participated in international programs and microgravity science experiments.
- Cooperation among participating students, teachers, and communities was strengthened.
- Teachers and students in space science indicated their continued support.
- Besides the educational activity module, a local educational web site was developed for use by students in data mining and reporting; it indirectly exposed students to Information Technology (IT) applications.

Agency valuations, outcomes, and next steps

- SSAF2013 and MASS2013 increased local expertise (capital development) and students' knowledge of microgravity sciences, particularly in the field of space agriculture.
- The program is expected to contribute to the scientific mission of the 2nd National Astronaut Program (NAP-2) through the highly valued scientific merits of the microgravity program.
- Participation in APRSAF and the Kibo-ABC program earned national recognition.
- The national educational level was upgraded based on schools' involvement in international and space science activities.
- Continuation of the ground-based microgravity program using clinostat has been recommended for future scientific investigations.

Mediareports (newspaper, TV, web, and others)

BH 6 SEPTEMBER 2013 JUMAAT PENDIDIKAN 5

57 pasukan sekolah rendah, menengah sertai MASS2013

Banting: Peserta Pertandingan Malaysia Space Seeds 2013 (MASS 2013) perlu mula menanam biji benih *Vigna angularis* yang telah dibekalkan kepada mereka pada 2 September 2013 dan terus membuat pemantauan selama tujuh hari sehingga hari terakhir pertandingan iaitu 8 September ini bagi mengkaji pertumbuhannya.

Pemerhatian, pemantauan

Ketua Unit Penyelidikan Sains Angkasa, Agensi Angkasa Negara (ANGKASA), Mhd Fairos Asillam, berkata pelajar perlu membuat pemerhatian dan pemantauan mengenai pertumbuhan biji benih itu serta menghantarnya ke laman web MASS2013 di http://mass2013.angkasa.gov.my setiap hari sebelum jam 12 tengah malam.

Pada masa sama, katanya, biji benih berkenaan akan turut ditanam di Japan Experiment Module (KIBO), Stesen Angkasa Antarabangsa (ISS) untuk diuji percambahannya dalam suasana graviti hampir sifar atau mikrograviti.

"Data imej dan video biji benih dari ISS akan dimuat turun ke dalam laman web pada 9 September dan pelajar perlu membuat kajian serta membandingkan pertumbuhan biji benih yang mereka tanam dengan yang ditanam di angkasa lepas.

"Laporan serta hasil kajian pelajar mengenai faktor yang boleh mempengaruhi pertumbuhan biji benih perlu dihantar menerusi laman web selewat-lewatnya pada 20 September ini," katanya.

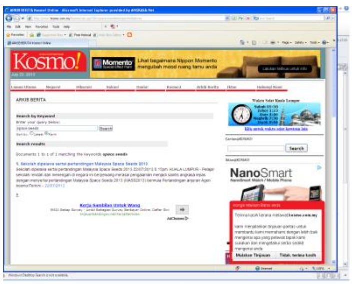
Sebanyak 57 pasukan terdiri daripada 20 sekolah rendah dan 37 sekolah menengah dari seluruh negara menyertai MASS2013.

Pemenang kategori sekolah rendah akan menerima wang tunai RM3,000 diikuti kedua RM1,500 dan ketiga RM500.

Hadiah wang tunai RM5,000 pula menanti juara kategori sekolah menengah diikuti RM3,000 kedua dan RM2,000 ketiga.

*"Data imej dan video biji benih dari ISS **akan dimuat turun ke dalam laman web pada 9 September**"*

Mhd Fairos Asillam,
Ketua Unit Penyelidikan Sains Angkasa (ANGKASA)



Obstructions/Challenges

Malaysia has sought to import the same Azuki seeds from JAXA (i.e., same locale and variety) as seeds sent to the ISS.

- Seed imports into Malaysia have remained status quo because of Japan's strict phytosanitary requirements.
- Azuki seeds for domestic usage were used to overcome obstacles.

Results

Quantitative results: Participating schools and students

- 395 students (young researchers) were involved directly through 25 primary schools and 54 secondary schools; about 39,500 pupils were involved indirectly (79 schools multiplied by 500 students per school).
- 79 teachers were directly involved directly in conducting and supervising the science experiment.

MASS2013 Competition Winners

- <u>Category 1: Primary School</u>
  1st Place: SJK (C) Pulai, Johor Bahru, Johor
  2nd Place: SK (P) Methodist, Ipoh, Perak
  3rd Place: SK Manjoi Dua, Ipoh, Perak
- <u>Category 2: Secondary School</u>
  1st Place: SMK Convent Bukit Nanas, Kuala Lumpur
  2nd Place: SMK (P) Sultan Ibrahim, Johor Bahru, Johor
  3rd Place: MRSM Gemencheh, Negeri Sembilan

Photos







New Zealand

KiwiSpace Foundation

Space Seeds 2013 overview

In late August or early September, astronauts aboard the International Space Station (ISS) will be undertaking a growth experiment by using Azuki beans. The Japan Aerospace Exploration Agency (JAXA) sent us seeds from the same batch as those being flown into space, to encourage the performance of experiments on Earth.

Grow your own "space seeds" and compare the differences.

- How do seeds grow in space?
- How does gravity affect seeds grown on Earth?

Follow along as the astronauts tend to seeds on the ISS and spot the differences and similarities with the growth of your seeds.

Results

Quantitative results: Participating schools and students

The project Seed in Space was very successful in New Zealand.
45 school groups participated in total.
Out of those we are expecting reports from around five to ten schools.

- Wellington East Girls' College in Wellington, New Zealand
- Palmerston North Intermediate Normal School in Palmerston North, New Zealand

The Seed in Space project was excellent for integrating with the New Zealand curriculum and we are looking forward to more projects from JAXA.
They are very useful as they assist the New Zealand space education efforts to produce school resources that have New Zealand participation and flavor.

Photos


Day 1


Day 2


Day 3


Day 4

Thailand

National Science and Technology Development Agency (NSTDA)

Purpose of participation

NSTDA promoted the specific program to increase understanding of space biology. Thai students were offered the opportunity to join the activities during the same period that Kibo astronauts were conducting investigations. Students were encouraged to download the linked video in which an astronaut on the Kibo module of the ISS was explaining the in-space experimental process. It was an excellent opportunity for students to experience and learn about differences in experiments conducted on the ground and in space.

Educational impact and spreading effect

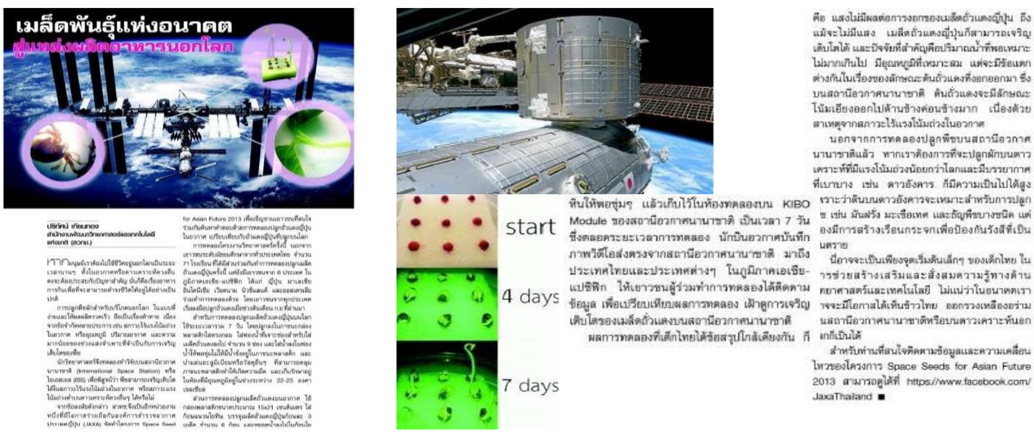
The aim of this experiment was to discover the relationship between gravity and plant growth. The experiment involved comparing two batches of Azuki beans in different gravitational conditions—microgravity in the ISS and normal gravity on Earth. Of course, the condition for student experimentation was Earth's gravity. Participating students studied other factors that evolve during plant germination and development, including light and cuttings on sprouts. Furthermore, the experiments provided students with new ideas and knowledge for conducting scientific research and inquiry.

Agency valuations and next steps

SSAF2013 has been accomplished successfully; many schools throughout the country participated, and students performed well. NSTDA hopes to have the opportunity to run the SSAF2014 project.

Mediareports (newspaper, TV, web, and others)

Newspaper : National paper (Post today http://www.posttoday.com)

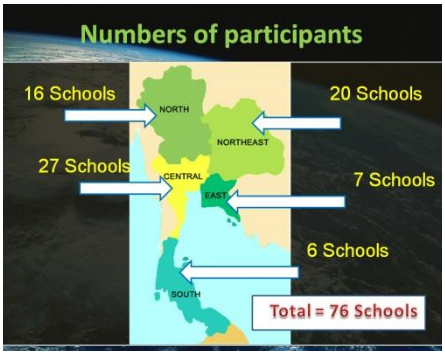


Results

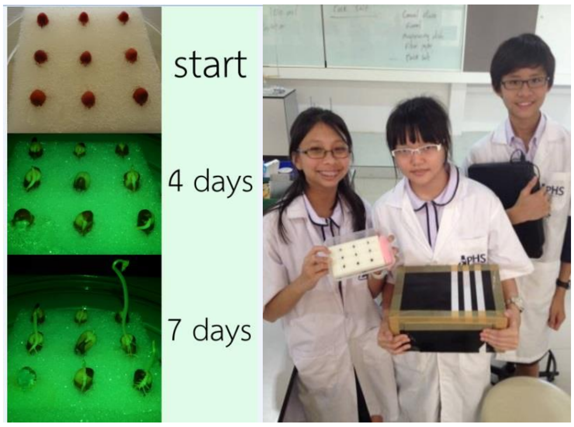
Quantitative results: Participating schools and students

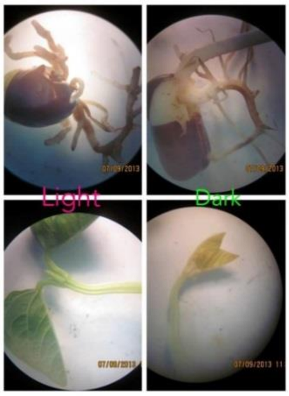
Secondary schools: 17 schools, 68 students, and 17 teachers participated

High Schools: 59 schools, 236 students, and 59 teachers participated



Photos





Taking a photo under a stereo microscope

Vietnam

Vietnam Academy of Science and Technology (VAST)

Space Technology Institute (STI)

General information

- Participating school: Secondary school Nguyen Tat Thanh
- Coordinating lecturer: Ms. Nguyen Thi Thanh Hien

Main objectives

- Raising awareness for education in space science/technology and interdisciplinary studies
- Observing and assessing differences in growth for ground and space seeds, and evaluating the impact of gravity and microgravity
- Building a bridge between professions and education
- Conveying new insight and vision in Biology for secondary school students and teachers
- Introducing and advertising to the public community the SSAF and Kibo-ABC programs

Number of participants: 275 secondary school pupils

Results and effectiveness

- The program has attracted a number of secondary school pupils who are conducting their own experiments.
- Pupils have been very excited about the SSAF program. It provides students and teachers with opportunities to observe experimental operations during the condition of zero gravity.
- Information regarding the Kibo laboratory (International Space Station) and its use for scientific research and Asian benefits (Kibo-ABC program) has been disseminated.
- The program was successful in stimulating the interest and attention of pupils and teachers in space science and technology—necessary precursors for the buildup of human resources for the space sciences.
- Through the SSAF program and experiment, pupils practiced teamwork, gained scientific research skills and experience, and improved their presentation and reporting skills. Students were able to apply the statistical and comparison knowledge obtained in the classroom to conduct their experiments and report and propose scientific conclusions.
- This program provided teachers with the opportunity to expand their understanding, improve lectures and teaching content, encourage collaboration between schools and research institutes, promote pupils' interest in science and technology, and apply knowledge obtained to their current jobs.

Follow-up activities

- Plant, observe, and compare the growth of ground and space seeds for longer periods to investigate the importance of gravity, as well as the auto formation and orientation of plants.
- Extend the experiment to other seeds.
- Develop guidelines and proposals for alternative materials.
- Encourage teachers and pupils to continue investigations annually with more diverse experiments.
- Enlist support from JAXA for the Kibo-ABC program and a collaborative network among participating groups.

Reflections from the public and community

- Pupils were excited and delighted with the program.
- The school administrator and teachers described the program as interesting and attractive, with the potential for long-term collaborations.
- Pupils' parents indicated that they were happy with the training program and collaboration developed through experimentation; it strengthened their belief in teachers and the school.

Photos






The Australian National University
http://www.anu.edu.au/

National Institute of Aeronautics and Space
http://www.lapan.go.id/

Japan Aerospace Exploration Agency
http://iss.jaxa.jp/en/kuoa/

Malaysian National Space Agency
http://mass2013.angkasa.gov.my/

KiwiSpace Foundation
http://www.kiwispace.org.nz/

National Science and Technology Development Agency
http://www.nstda.or.th/eng/

Vietnam Academy of Science and Technology
http://sti.vast.ac.vn/en/

KIBO-ABC
Asian Beneficial Collaboration through Kibo Utilization