Asian Herbs in Space (AHiS)

Kibo-ABC Meeting
APRSAF-22
29th Nov 2015
Bali, Indonesia

CONTENTS

1. AHiS mission Objectives

General Objective

- To promote microgravity sciences via utilization KIBO platform to the region
- To develop regional human capital development conducting microgravity sciences and space experiment

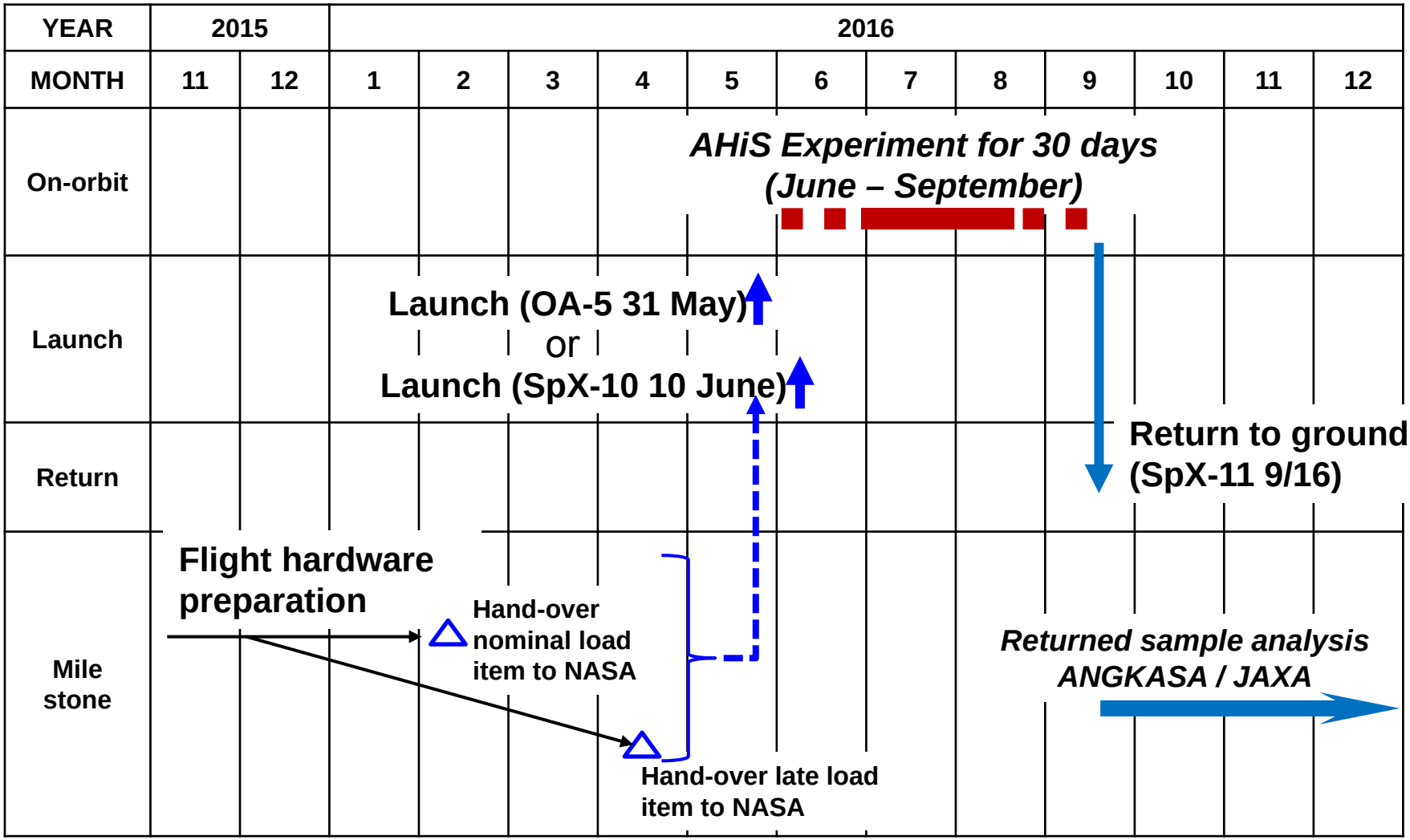
Specific Objective

- To learn the herb’s ability to sense and respond to gravity

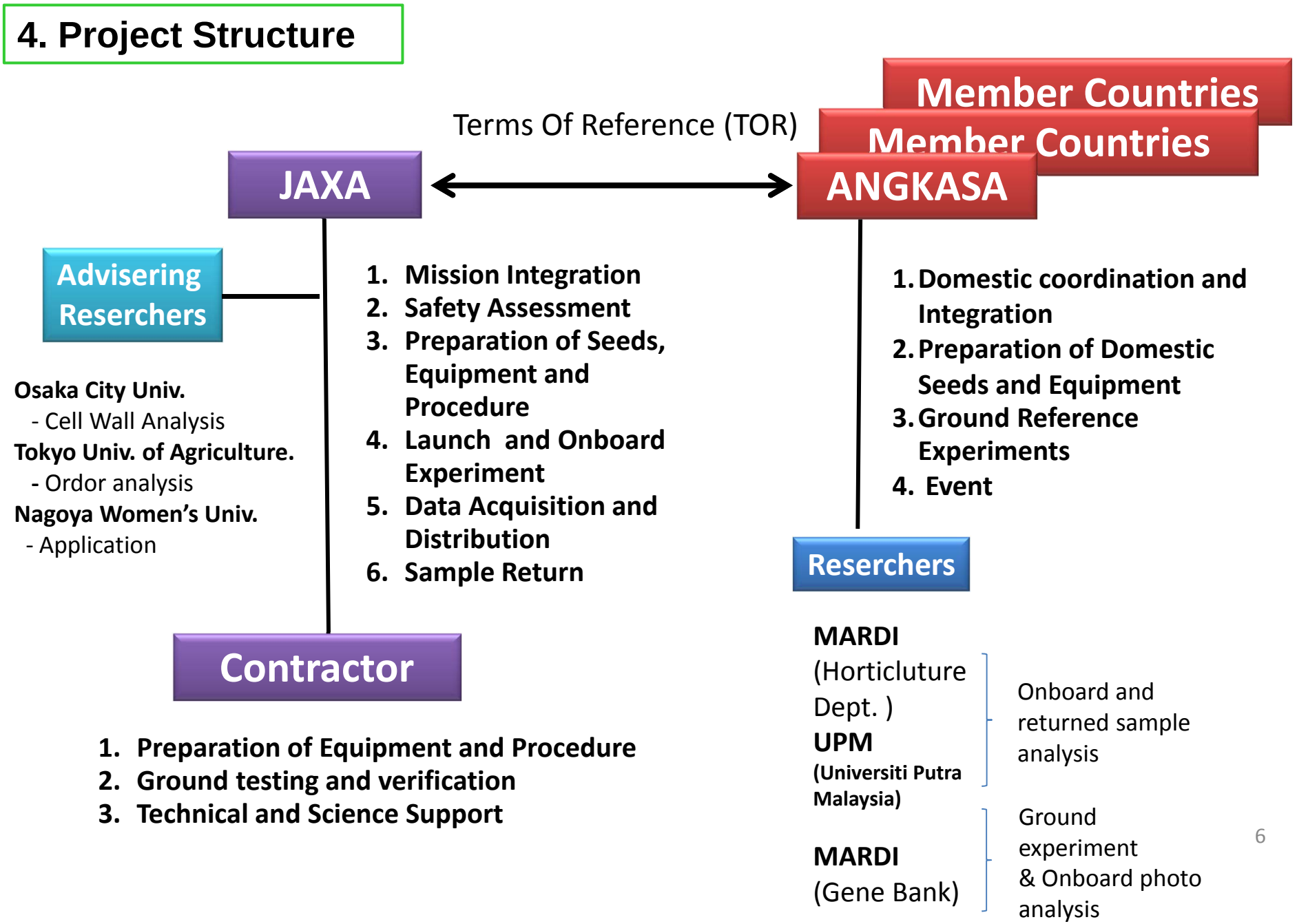
2. SSAF2013 and AHiS

Exp. Mission	SSAF2013	AHiS
Seeds	Azuki bean	Herb (Malaysian and Japanese)
Purpose	To compare plant growth and cell wall	To compare plant growth and odor
Exp. Term	7 days	30 days
Light	Dark conditions	Fluorescent light
Sample return	No return	Sample return

3. Mission schedule



4. Project Structure



5. Roles And Responsibilities

JAXA

1. Mission Design and Integration of Participants
2. Pre-Experiments (Procedure Development, Hardware Development, Clarification of Issues toward Space Experiments and Ground Reference Experiments)
3. Safety Assessment of plants and hardware
4. Ops Prep
5. Launch coordination and Onboard Experiment
6. Imagery, Experiment Data Acquisition and Distribution to Participants
7. Environmental Data Acquisition and Distribution to Participants (Including Analysis)

ANGKASA

1. Development of Domestic Mission Plan (Including Verification Plan, Ground Reference Experiments Plan, Event Plan)
2. Pre-Verification (Preparation of Seeds and Equipment)
3. Pre-Experiments (Procedure Development, Hardware Development, Clarification of Issues toward Space Experiments and Ground Reference Experiments)
4. Domestic Coordination (Event Announcement, Preparation and distribution of materials and procedures)
5. Integration of Domestic Ground Reference Experiments
6. Execution of Event

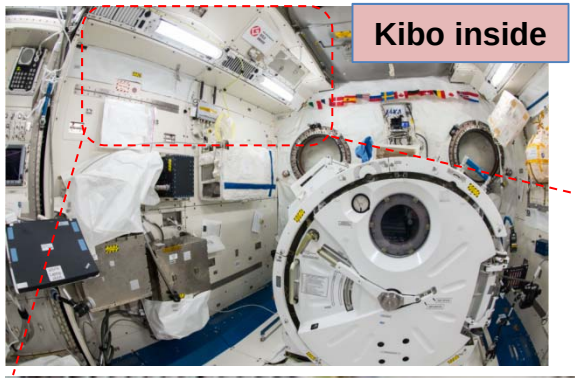
Member Countries

We welcome on your participation and contribution

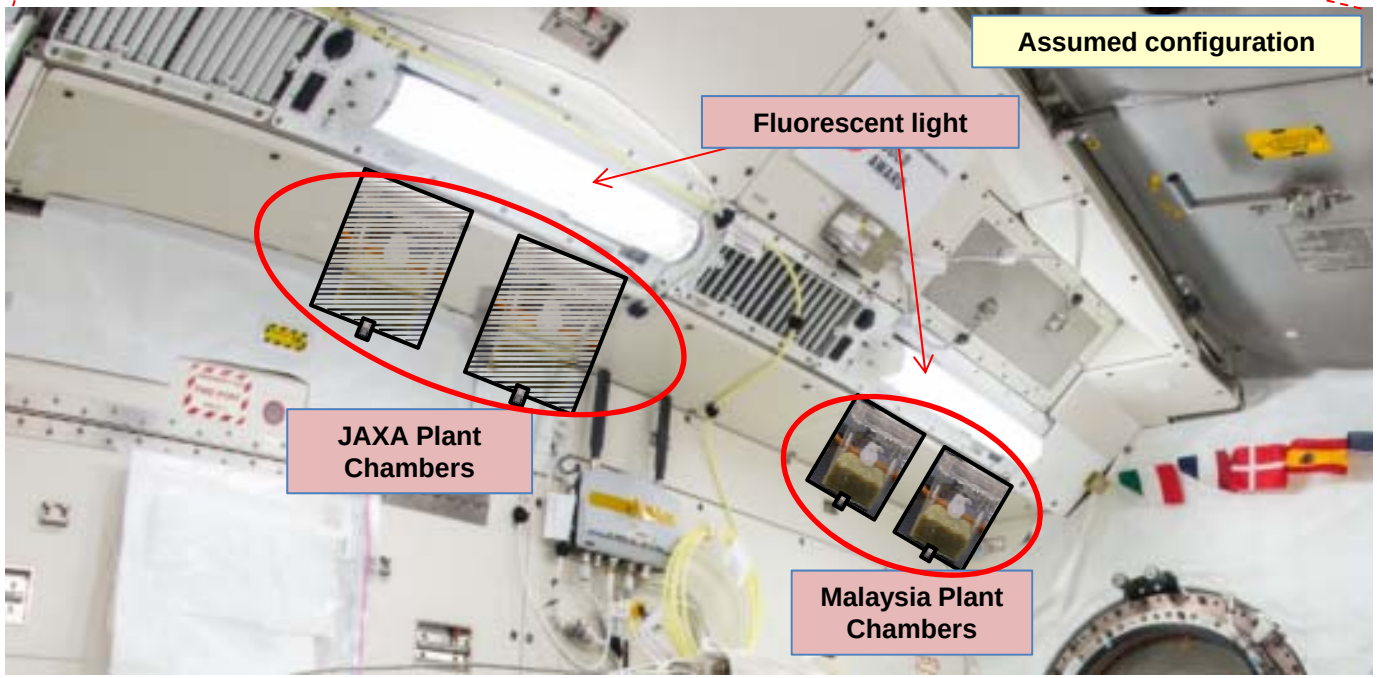
Space Experiment Plan

1. On-orbit configuration

All plant will be cultivated in Plant Chambers under fluorescent light to get sufficient illumination (photon) for herbs to grow.



Cabin Temp	almost 23-25 deg C
Cabin Light	24 hrs always-on Light intensity: 40μmol/m^2/sec ? Under investigating
Term of cultivating	30 days (Current status)



2. Kibo cabin conditions

Herb seeds should be selected with following conditions.

(1) Lighting intensity

- Herb seeds should grow at minimum lighting intensity (at least 40 μmol/m^2/sec)

(2) temperature

- Herb should grow at low temperature 23-25 deg C

(3) Ventilation in plant chamber

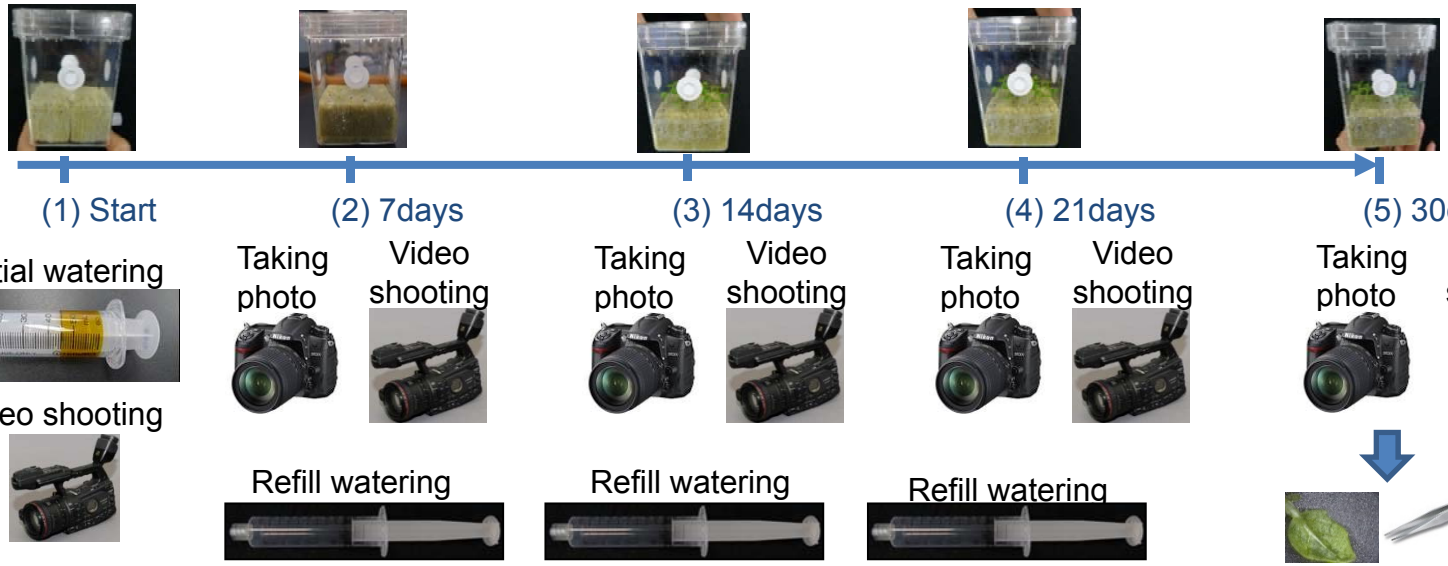
- Herb should grow in less air circulation.

Amount of return samples are needed

- Depending on the research purposes

- and crops producing

3. On-orbit experiment plan



(0)	MELFI retrieval	Retrieving all Plant Chambers from MELFI +2 degree C
(1)	Initial watering	Watering 100ml to each Plant Chamber. Attaching near fluorescent light in Kibo
	Video shooting	Video shooting of crew operation.
(2)	Refill watering	Refilling 10ml water.
(3)	Taking photo	Taking several photos of herb overview every seven days.
(4)	Video shooting	Video shooting of crew operation.
(5)	Taking photo	Taking several photos of herb overview and Glandular Development on back side of leaf. Pick one leaf of herb then taking photo of back side of the leaf.
	Video shooting	Video shooting of crew operation.
(6)	Frozen for return*	After six days, stowed in refrigerator at -96 degree C.

* Still under review

*MELFI is a Freezer/Refrigerator available for science in ISS

4. Post-Flight Analysis

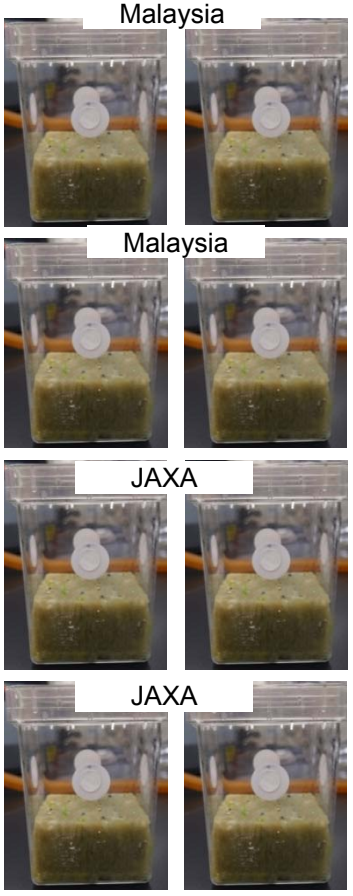
- Plant growth and Glandular hair Development analysis by on board photo

- Odor analysis, Cell wall, gene expression and metabolic analysis by returned samples

- Returned samples will be transported to the researchers for analysis.

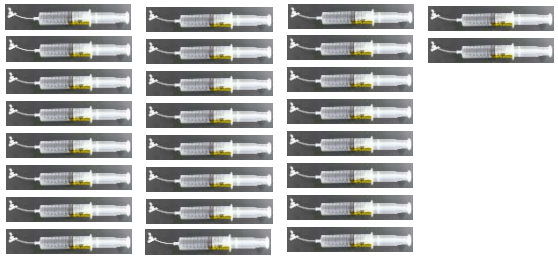
5. Launch hardware

Plant Chamber (8)



Starter Syringe (9)

Refill Syringe (26)



Forceps (2)

Ground experiments for Herbs selection

1. Consideration of selecting herbs

We tried to cultivate five kind of herbs; Sweet basil and Peppermint (Herbs proposed by Japan); Hempedu Bumi, Dukung Anak and Holy Basil (Herbs proposed by Malaysia) at following conditions in a small plant chamber.

Temperature: 23 - 25 deg C

Humidity: Vent port (Milli seal attached, no control)

Some water drop were found on chamber walls.

Light: 40 μmol/m^2/sec, 24hrs always-on

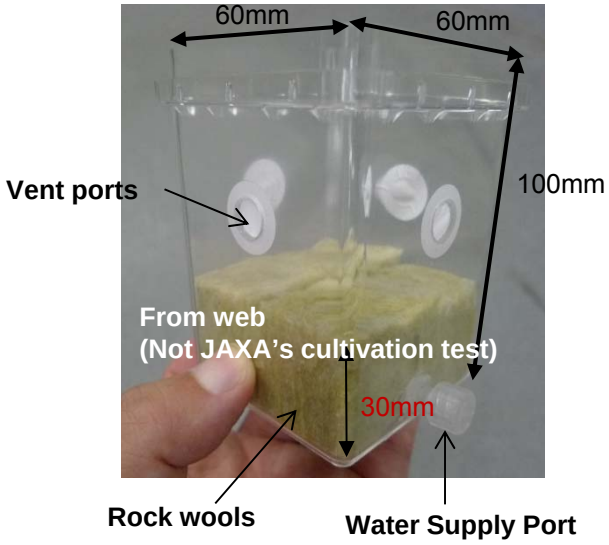
<u>Targeting Results:</u>

(1)We try to figure out at least 30 days are needed for developing real leaf.

Watering day	Leaf state
3-5	Germinated
7	Cotyledon developed
12	Leaf developed
15	Grew leaf larger
30	Enough for analysis

What kind of herbs will be selected?
Need to be Determined

JAXA		ANGKASA/Malaysia
Herb	**Sweet Basil** or **Peppermint**	**Dukung Anak or Hempedu Bumi or Holy Basil**
Plant Chamber	Plant Chambers x2 L60mm x W60mm x H100 mm Vent ports in each side.	Same configuration as per recommended
Medium	Rock wool L60mm x W60mm x H30 mm	
Seed quantity	Sweet basil : 36 seeds (TBD) Peppermint : 50 seeds (TBD)	
Nutrition	Hyponex 100 mg	No nutrition



Plant Chamber

Same as the Kibo/ISS condition (but, gravity applied):

Temperature: 23 - 25 deg C

Light: 40 μmol/m^2/sec, 24hrs

ANGKASA SELECTION OF HERBS

GROUND EXPERIMENT TECHNICAL REVIEW

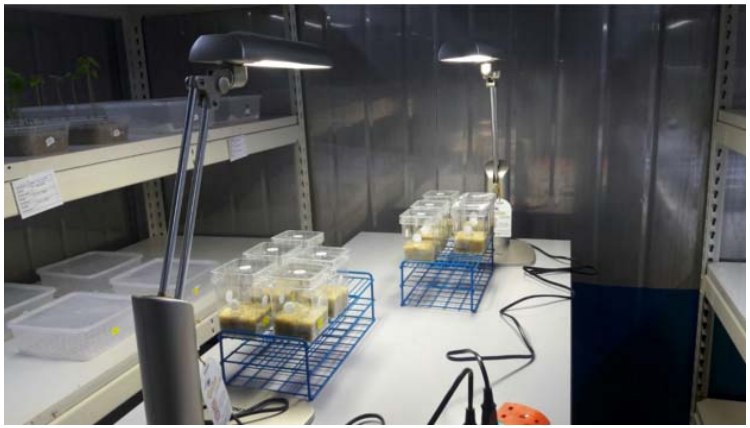
1. ANGKASA Herb candidates

Initially, ANGKASA selected two kind of herbs, Dukung Anak and Hempedu Bumi

Dukung Anak

and

Hempedu Bumi



We are trying to cultivate two kind of herbs; Dukung Anak and Hempedu Bumi with ventilation filter.

Temperature: 23 - 25 deg C

Humidity: 75%; Vent port (Milli seal attached, no control), no water drop were found on chamber walls.

Light: 40 µmol/m^2/sec, 24hrs

Set up date: 23rd Oct 2015, No seeds treatment were made

Results (1/2):

(1) We are trying to figure out at least 30 days growing process until developing real leaf.

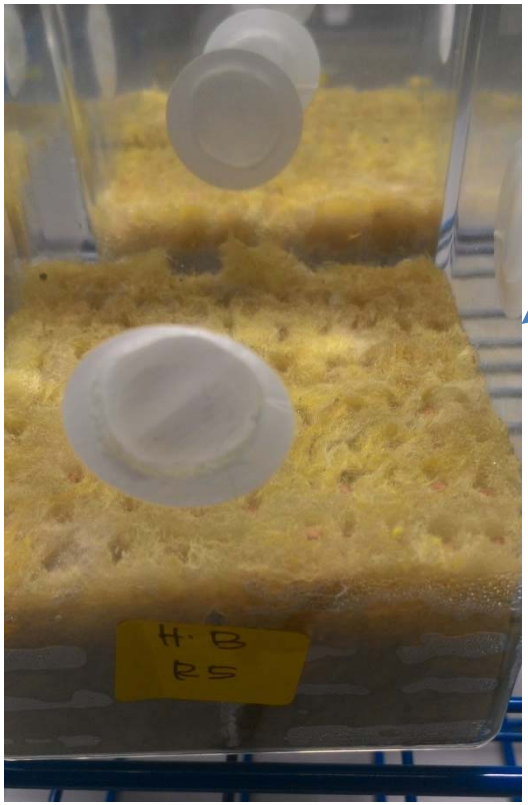
Hempedu Bumi (HB)	
Watering day	Leaf state
3	Germinated
8	Cotyledon developed
11	Leaf developed
TBO	Grew leaf larger
TBO	Harvested

Dukung Anak (DK)	
Watering day	Leaf state
Not yet	Germinated
Not yet	Cotyledon developed
Not yet	Leaf developed
Not yet	Grew leaf larger
Terminated	Harvested

Refference schedule for an ideal case recommended by JAXA

Watering day	Leaf state
3	Germinated
5	Cotyledon developed
12	Leaf developed
15	Grew leaf larger
30	Harvested

Dukung Anak (DA)



Hempedu Bumi (HB)

Results (2/2):

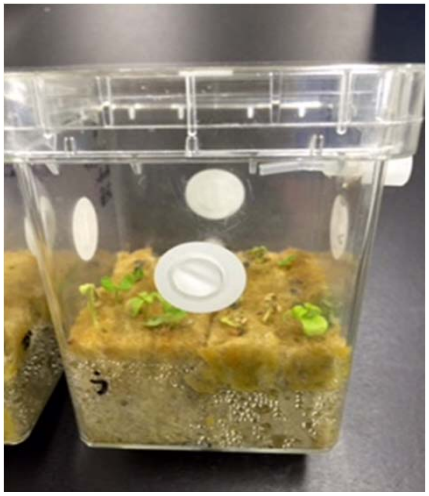
(2) Only HB started to germinate (as per observation on 28 October 2015).

(3) DK no germination observed (as per observation on 28 October 2015).

2. Issues

- JAXA is also conducting ground experimenf for Malaysian Herbs in Japan (thank you JAXA!!!)

Kibo inside temperature:23-25 degrees Celsius（℃）
Kibo insside humidity：50% the
Kibo illumination：40μmol/m2/sec
Duration: 24 Sep to 13 Oct.



Andrographis paniculata

(Hempedu Bumi)

Results:

- ❑ Growth for 8-10mm in 30 days! (Low grow rate)
- ❑ Mold!!

Phyllanthus niruri
(Dukung Anak)

Results:

- ❑ Germination rate was 1/30 in 30 days ! (Very Low grow rate)

3. Decision for solution (1/2)

After meeting with JAXA and AHiS Malaysian Team (ANGKASA, MARDI and UPM researchers) on 28th October 2015 (Wednesday), we came out with solution:

Selection of herbs

In view of very low germination and grow rate of **DA** that proposed before, we proposed new species of herbs – ***Osmium Sanctum, OS*** (or the Holy Basil; the common name).

We continue to observe the **HB and terminate the DA herbs experiment.**

We take note JAXA's ground experiment result on Hempedu Bumi (HB) on mold. In that case, the HB must be treated (soak) with Chemical Benlate before set up the germination process to avoid the mold.

The OS was sent to Japan on 5th Nov 2015 and reached JAXA on 9th Nov 2015.

Ground experiment for OS was started in Malaysia on 5th Nov 2015.

4. ANGKASA's consideration for selecting herbs (revised)

We have been trying to cultivate two kind of herbs; Hempedu Bumi (HB) and Holy Basil (OS) with ventilation filter.

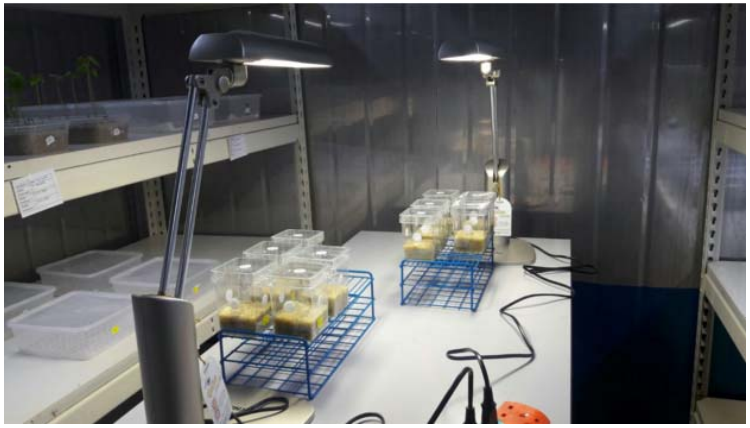
Temperature: 23 - 25 deg C

Humidity: 75%; Vent port (Milli seal attached, no control

Light: 40 µmol/m^2/sec, 24hrs

Set up date (HB): 23rd Oct 2015

Set up date (OS): 5th Nov 2015



Results (1/2):

(1) We are trying to figure out at least 30 days growing process until developing real leaf.

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Hempedu Bumi (HB)	
Watering day	Leaf state
3	Germinated
8	Cotyledon developed
11	Leaf developed
TBO	Grew leaf larger
TBO	Harvested

Osiumum Sanctum (OS)	
Watering day	Leaf state
2	Germinated
4	Cotyledon developed
6	Leaf developed
14	Grew leaf larger
TBO	Harvested

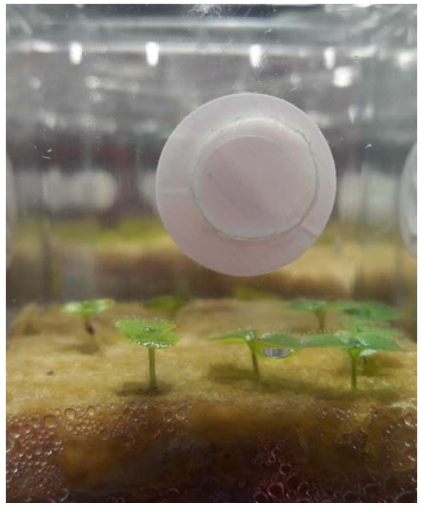
Refference schedule for an ideal case recommended by JAXA

Watering day	Leaf state
3	Germinated
5	Cotyledon developed
12	Leaf developed
15	Grew leaf larger
30	Harvested

Length of stem:
0.2 to 1.0cm

Average total germination:
74%

Holy Basil *(Oscimum Sanctum)*
15-days-old
(On going test)



0.3 to 0.7cm length of stem.

Total germination is around 13%.

Hempedu Bumi (Andrographis paniculata)
24-days-old
(On going Test)

JAXA SELECTION OF HERBS

GROUND EXPERIMENT TECHNICAL REVIEW

1. Cultivation test in JAXA lab

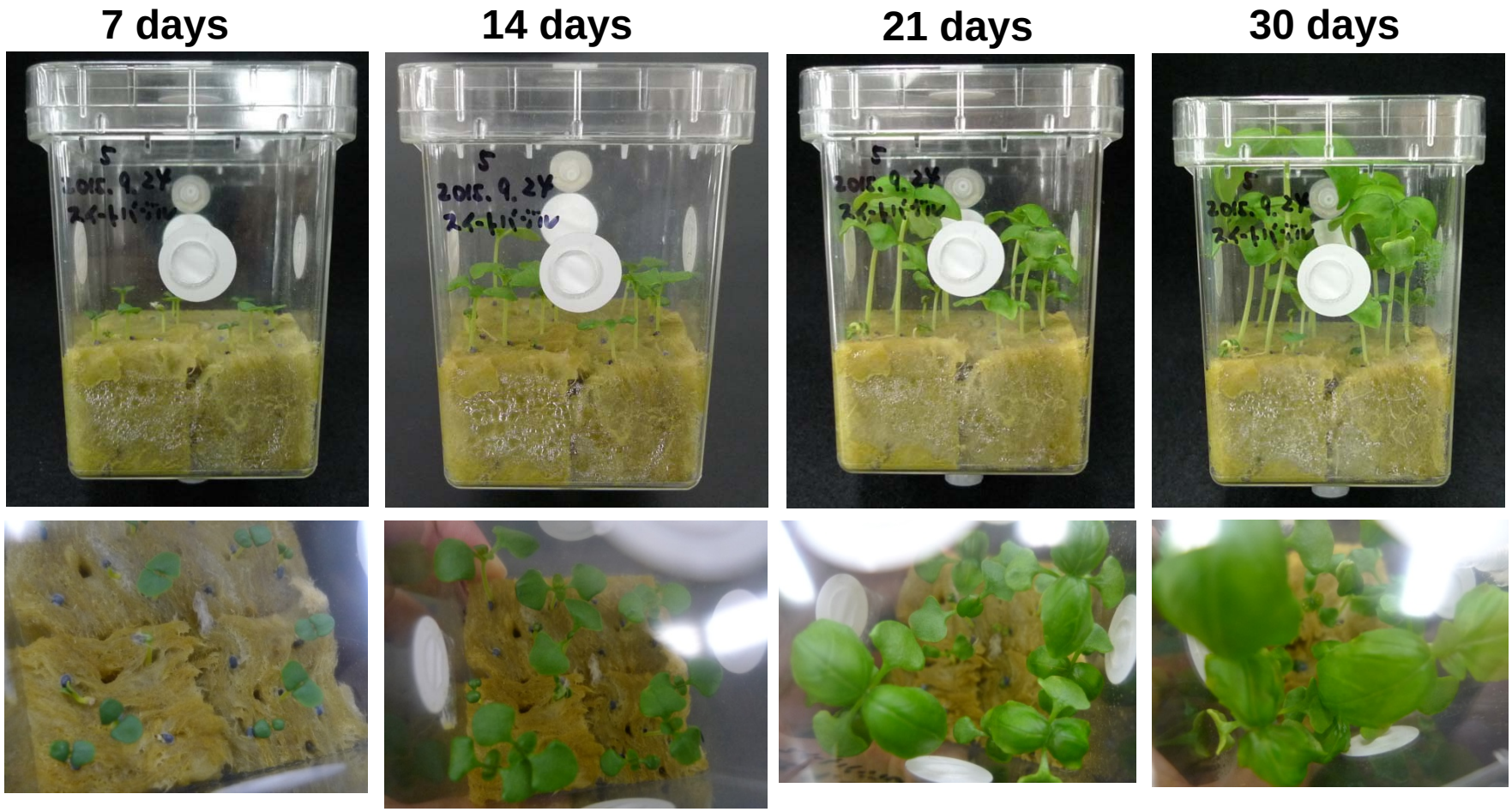
Desktop
Fluorescent light

Plant Chambers

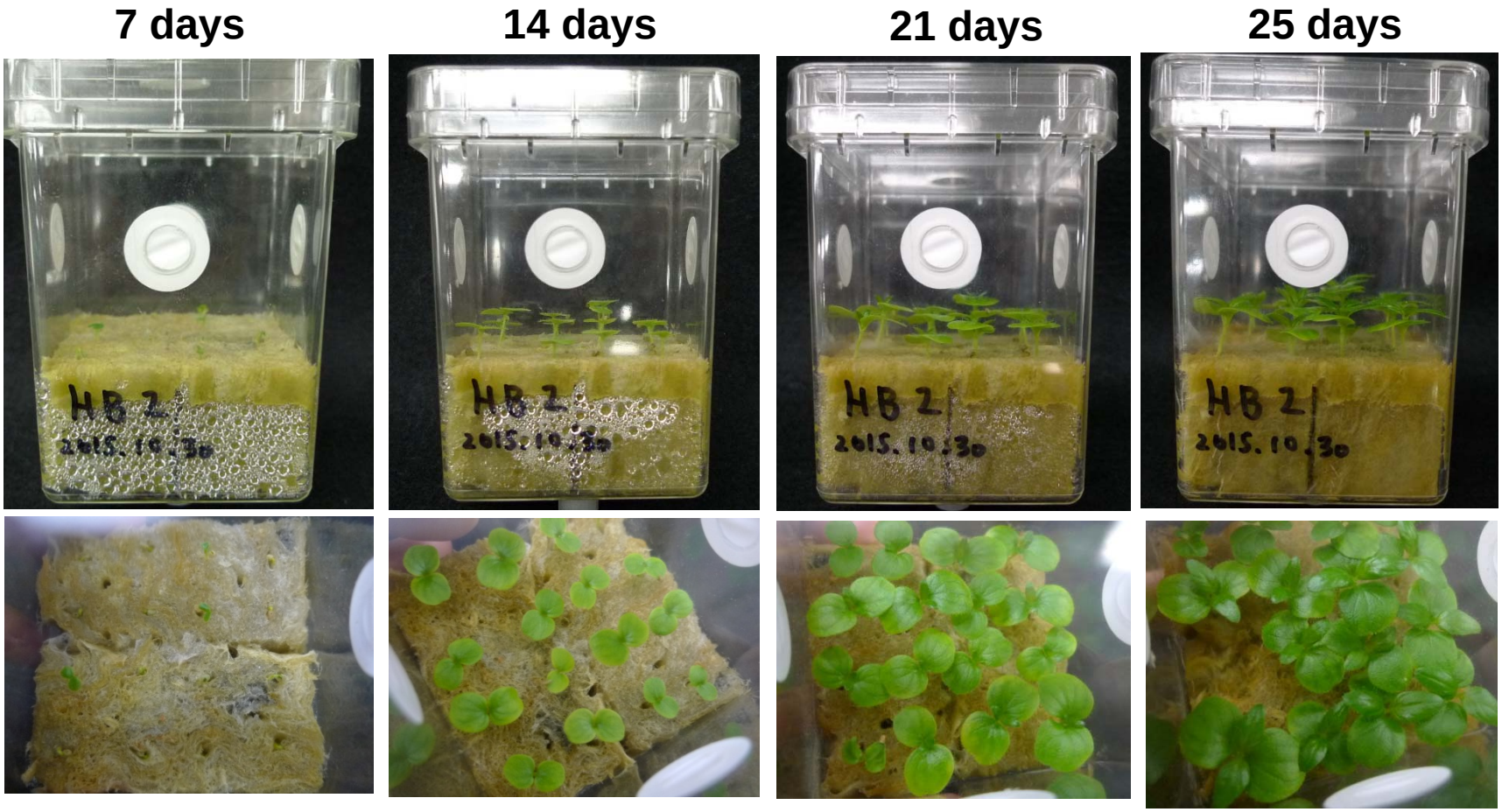
JAXA is trying to cultivate Sweet basil and Malaysian candidete herbs in almost similar condition of Kibo inside environment.

Condition:

- **Desktop Fluorescent light: 24hrs always-on**
- **Light intensity: 40 μmol/m^2/sec**
- **Nutrition: Hyponex 1:1000 dilution**
- **Cultivating term: 30 days**



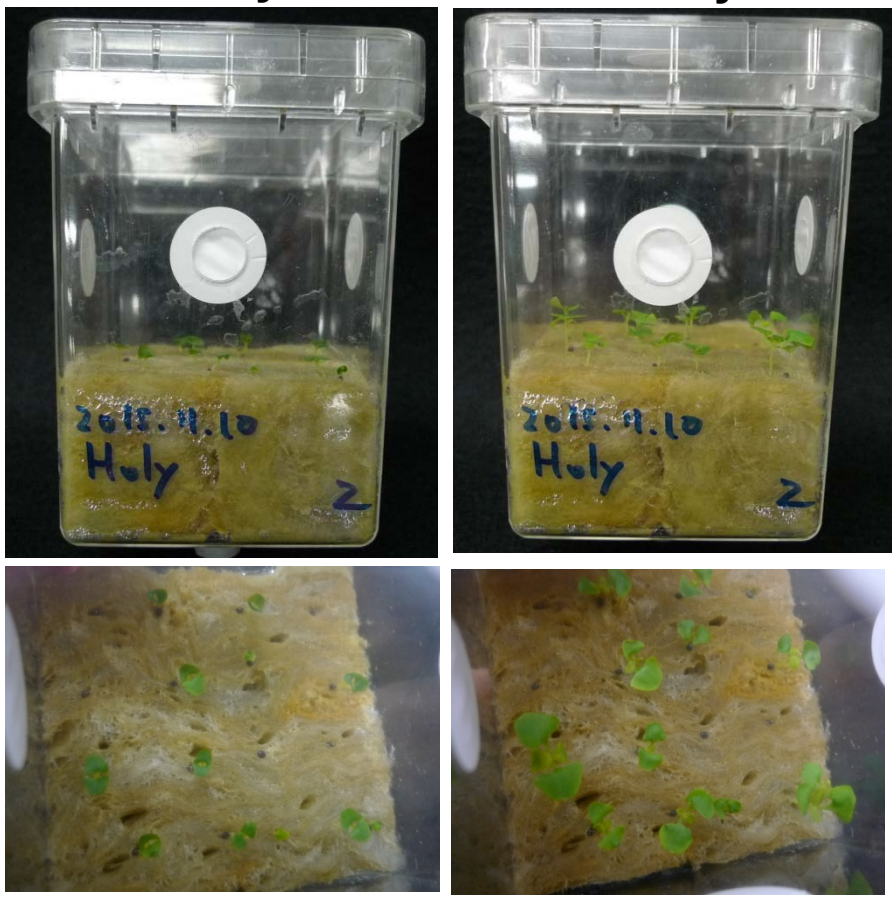
Sweet basil (SB) plants after initial watering



Malaysian candidete herbs `Hempedu Bumi (HB)` plants after initial watering (ongoing test)

7 days

14 days



Malaysian candidete herbs `Holy Basil (HB)` plants after initial watering (ongoing test)

DISCUSSION

ITEM OPEN FOR DICUSSION

Experiment Conditions

- ✓ Type of Herbs (HB, OS and OB)
- ✓ Grow from seeds to plant

Observation

- ✓ Colour of plant
- ✓ Smell/ Odour
- ✓ Size of leaf
- ✓ Strength of stems
- ✓ Strength of root
- ✓ Root direction
- ✓ Cell wall analysis
- ✓ Length of stem

Kibo-ABC country participation?

- ✓ Sharing onboard data/ images
- ✓ Seeds distribution? Or seeds originated from respective country
- ✓ Human Capital development
    - Packing
    - Sample preparation
    - Sample retreival
    - Hardware

THANK YOU