2026

Seeds in Space, Germination Report

1ST ROCKINGHAM SCOUT GROUP

DANIEL CLARK

Contents

Introduction 2

Objective 2

Methodology 2

Experimental Design and Variables 2

Materials 2

Risk Management & Safety 3

Preparing the Seeds 3

Planting & Placement 3

Data Collection 3

Results 3

Observation Log – Table 1 3

Germination & Growth Data Comparison – Table 2 11

Data Interpretation & Key Findings 11

Discussion 11

Evaluation of Variables 11

Conclusion 12

Seeds in Space Germination Report

Introduction

In 2020, One Giant Leap Australia Foundation in collaboration with the Australia Space Agency and the Japan Aerospace Exploration Agency sent Golden Wattle seeds to the International Space Station (ISS). The seeds spent roughly six months orbiting Earth inside the Japanese Experiment Module 'Kibo', where they experienced persistent microgravity and elevated cosmic radiation. Exposing seeds to space environments induces physical and physiological stresses that can alter cellular structures and DNA integrity. Understanding how orbital conditions influence seed dormancy and early viability provides critical insights for long future long-duration space habitation and space agriculture.

Once back on Earth the Space flown seeds, along with their Earth control were distributed to schools and community groups to carry out a unique citizen science project, gathering data for space science/agriculture.

Objective

To measure and compare the germination rates, time to germination and early vigour of space flown Golden Wattle seeds against Earth control samples under identical environmental conditions.

Methodology

Experiment conducted by Daniel Clark – Cub leader and a selection of Joey and Cub Scouts, representing 1st Rockingham Scouts, Rockingham, Western Australia.

Experiment ran from 2nd June 2026 to 22nd August 2026

Experimental Design and Variables

This study follows a controlled, comparative design.

> ***Independent Variables*** – The seed treatment environment - Space flown versus Earth control.
>
> ***Dependant Variables*** - Germination rate, time taken to germinate and seedling vigour.
>
> ***Controlled Variables-*** Soil type, volume of water, amount of sunlight, temperature of the growing environment and scarification technique.

Materials

Seeds In Space germination kit

- Seedling starter tray
- A clip lock bag that has wattle seeds that stayed on earth – labelled 'E'
- Clip lock bag that has wattle seeds that went to space – labelled with a 'S' sticker
- 2 small containers with lids – labelled 'E' and 'S'.
- Sandpaper for scarification
- 20ml syringe
- Plastic spoon
- Laminated instructions for seed placement

Risk Management & Safety

Special care taken during the use of boiling water to prepare the seeds after scarification – stable surface, away from young Scouts, temperature allowed to cool a little before placing lids. When handling the potting mix, gloves and safety glasses were worn.

Preparing the Seeds

The provided video link, explaining the scarification process was viewed. 'E' labelled seeds were gently sanded; boiling water was placed in the tub labelled' E' – put aside to soak for 24 hrs. The same method was repeated for the 'S' labelled seeds.

Planting & Placement

After 24 hours of soaking the seeds, the greenhouse was prepared. With safety glasses and gloves on, potting mix was carefully placed into each cell of the tray, using the spoon provided. To ensure equal measurements between the cells, the spoon has a line drawn on the end – allowing for a 1cm gap between the top of the soil and the cell.

Once all 12 cells were evenly filled with soil, it was time to plant the seeds. A laminated planner was provided, to ensure correct labelling of seeds. Each seed was planted using tweezers as per the plan. Using the syringe, each cell was given 5 millilitres of water. Lids were placed on the seedling greenhouse and placed in front of the window, in indirect sunlight - where they were kept moist, but not flooded.

Data Collection

It was requested that observations be taken on day zero, day 10, day 20, day 30 and so on. The basic characteristics to be recorded were:

- Germination rate – the number of seeds that sprout, date it appeared - how many germinated withing the first 14 days.
- Plant height - measure and record in millimetres
- The number of leaves
- Environment – record temperature

Journal entries and photos were used to record observations. Data will be collated and presented in a results table and key findings highlighted and discussed.

Results

Observation Log – Table 1

Day 10 Observations – 12th June 2026			
Seed	**Date of/ days since germination**	**Height**	**Leaves**
S1			
S2			
S3			

S4			
S5			
S6			
E1			
E2			
E3			
E4			
E5			
E6			

Notes
Temperature 22 degrees at 12noon
Lots of condensation in the lid of the humidity control zone
No signs of germination

Day 20 Observations – 22nd June 2026

Seed	Date of/ days since germination	Height	Leaves
S1			
S2			
S3			
S4			
S5			
S6			
E1			
E2			
E3			
E4			
E5			
E6			

Notes
Temperature 16 degrees at 12noon
Lots of condensation in the lid of the humidity control zone
Removing humidity dome lid – condensation causing mould
No signs of germination

Day 30 Observations – 2nd July 2026

	Date of/ days since germination	Height	Leaves
S1			
S2			
S3	01/07/26	0.5cm	Seed cap still intact
S4			
S5			
S6			
E1			
E2			
E3			
E4			
E5			
E6			

Notes
Temperature 20 degrees at 12noon
First sign of life – a *Space Seed*

Day 35 Observations - 7th July 2026

	Date of/ days since germination	Height	Leaves
S1			
S2			
S3	6	1cm	1 leaf
S4			
S5			
S6			
E1	06/07/26	0.8cm	Lost its seed cap
E2			
E3			
E4			
E5	07/07/26	0.8cm	Lost its seed cap
E6	07/07/26	0.8cm	Seed cap still in tact

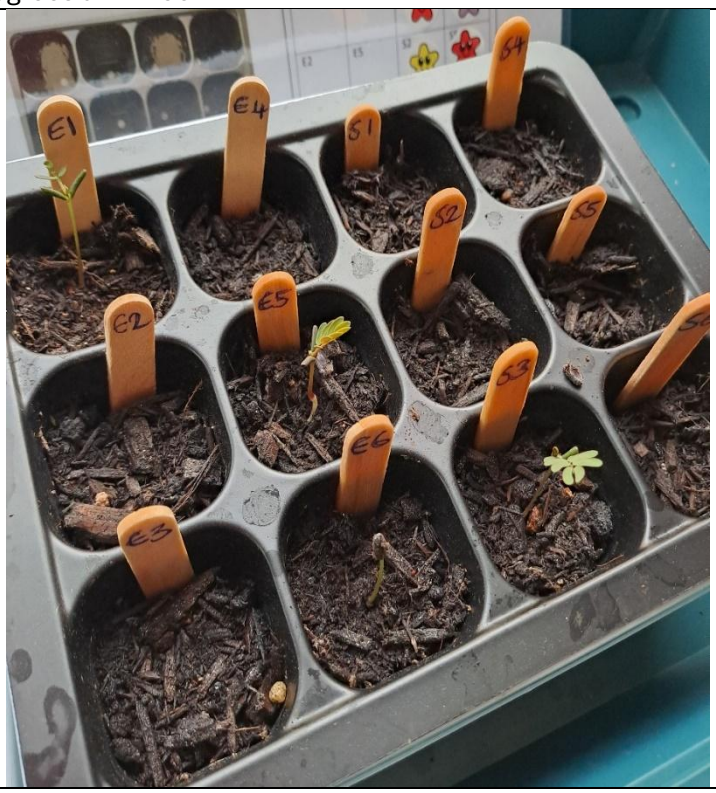
Notes
Temperature 22 degrees at 12noon
3 *Earth seeds* have emerged – at emergence they are longer than S3 - 2/3 have already lost their seed caps

Day 40 Observations -12th July 2026

	Date of/ days since germination	Height	Leaves
S1			
S2			
S3	12	2.5cm	1 leaf
S4			
S5			
S6			
E1	6	1.7cm	Leaf starting to form
E2			

E3			
E4			
E5	5	2cm	1 leaf
E6	5	1.8cm	Seed cap still intact

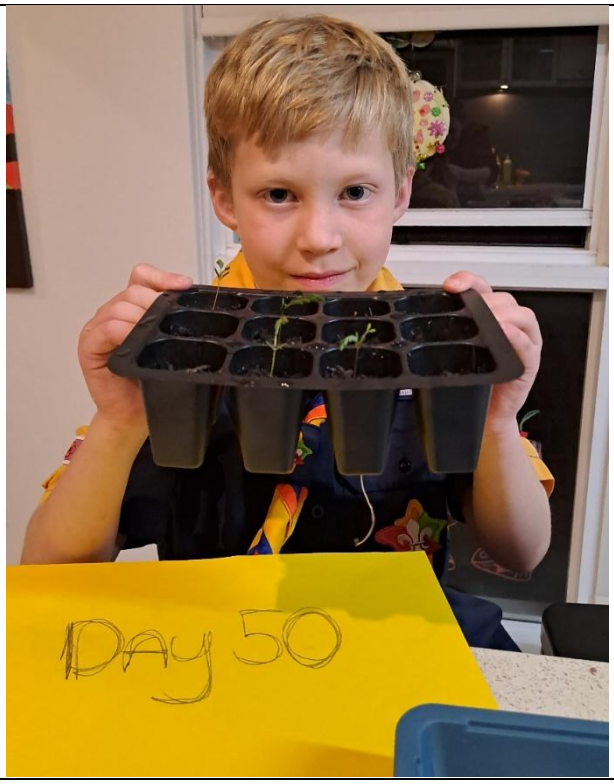
Notes
Temperature 21 degrees at 12noon



Day 50 Observations - 22nd July 2026

	Date of/ days since germination	**Height**	**Leaves/ Roots**
S1			
S2			
S3	22	3cm	2 leaves – tap appeared through tube hole – 6cm
S4			
S5			
S6			
E1	16	3cm	Leaves still developing
E2			
E3			
E4			
E5	15	2.8cm	1 leaf
E6	15	3cm	2 leaves

Notes
Temperature 19 degrees at 12noon
Still no sign of any more *Space Seeds* germinating – too cold?
S3 is the only seedling so far to have roots show through tube hole. Too fragile to report.



Day 60 Observations - 2nd August 2026

	Date of/ days since germination	**Height**	**Leaves**
S1	30/07/2026	0.5cm	2 leaves – very small
S2			
S3	32	3.5cm	3 leaves
S4	01/08/26	1.5cm	Seed cap still intact
S5			
S6			
E1	26	3.8cm	2 leaves
E2	01/08/26	1.5cm	Seed cap still in tact
E3			
E4			
E5	25	4cm	2 leaves
E6	25	3.8cm	2 leaves

Notes

Temperature 22 degrees at 12noon

3 new seedlings 2 *Space* 1 *Earth*

The 2 *Space seeds* are very different – S1has developed leaves almost instantly but has no height. S4 has gained height rapidly – 1cm taller than S3 on emergence

E2 also emerged with greater height that its counterparts E1, E5 and E6

Day 70 Observations - 12th August 2026

	Date of/ days since germination	**Height**	**Leaves**
S1	13	0.5cm	2 leaves, very small
S2			
S3	42	4cm	4th leaf forming
S4	13	2cm	1 leaf, still has seed cap
S5			
S6			
E1	36	4cm	3 leaves
E2	12	1.8cm	1 leaf and seed cap
E3			
E4			
E5	35	4.2cm	3 leaves
E6	35	4.3cm	3 leaves

Notes
Temperature 23 degrees at 12noon
S1 - no growth – survival questionable
Growth slowing in all seedlings

Day 80 Observations - 22nd August 2026

	Date of/ days since germination	**Height**	**Leaves**
S1	23	0.3cm	2 leaves - shrinking back
S2			
S3	52	4.5cm	4 leaves
S4	23	2.5cm	2nd leaf forming
S5			
S6			
E1	46	4.5cm	3 leaves
E2	22	1.8cm	2nd leaf forming
E3			
E4			
E5	45	4.5cm	4th leaf forming
E6	45	4.6cm	5 leaves

Notes

Temperature 21 degrees at 12noon

S1 – shrinking back – not thriving

All seedlings – height growth has slowed, all spindly, not thickening out – compared with how Golden Wattle seedlings should be behaving.

Relocate to plant nursery for more consistent conditions

Germination & Growth Data Comparison – Table 2

		Days Since Germination									
	How many days before germination	Emerging		11-20		21-30		31-40		41-50	
		Height cm's	Leaf count	Height cm's	Leaf count	Height cm's	Leaf count	Height cm's	Leaf count	Height cm's	Leaf count
S1	58	0.5	2	0.5	2	0.3	2				
S3	30	0.5	0	2.5	1	3	3	3.5	3	4	4
S4	59	1.5	0	2	1	2.5	2				
E1	34	0.8	0	3	0	3.8	2	4	3	4.5	3
E2	59	1.5	0	1.8	1	2.8	2				
E5	35	2	1	2.8	1	4	2	4.2	3	4.5	4
E6	35	1.8	0	3	2	3.8	2	4.3	3	4.6	5

Data Interpretation & Key Findings

Our key findings were as follows:

- None of our seedlings emerged in the 14-day window, typical of Golden Wattles.
- Seven out of the 12 seeds sprouted. They sprouted between days 30 and 35 and 58 and 59.
- A Space seed was the first to germinate.
- When sprouting, the Space seeds had the smallest heights recorded, when compared with the Earth seeds.
- One Space seed (S1) emerged with 2 leaves - although small, they were fully formed and the seed cap detached- this was observed in no other seedling.
- One Space seed (S3) was the only seedling to have a visible tap root (6cm by day 20 since germination).
- Earth seeds had the most height.
- Space seeds were not uniform in growth measurements.
- Earth seeds had the most uniform growth measurements.

Discussion

Evaluation of Variables

Independent variables – the Space flown seeds showed non uniform growth development – height, leaf formation and number of leaves different in all 3. Microgravity exposure effects can alter physiology, the absence of gravity can alter cellular structure, that said, the tap roots visible would suggest once back on Earth the seeds were able to respond to gravity and roots grow in the right direction. Germination could have been stalled by the impacts of microgravity, however, we can not draw conclusions on this, as our Earth seed controls also showed delayed germination, therefore, this is more likely due to dependant and controlled variables, discussed below.

Cosmic radiation can alter cellular DNA, causing mutations, could this be the reason why one of Space seeds emerged with fully formed leaves, albeit in miniature, and why each Space seedling emerged with no uniformity in growth development?

Dependant variables – none of our seedlings emerged within or even close to the expected 14-day window. Several factors could impact this, seed viability – it has been 5 years since the seeds went to space, how many years do Golden Wattles remain viable? What were the storage conditions of the seeds, were they optimal for the Golden Wattle? Another factor is, we started this experiment in late autumn – daytime recorded

temperatures ranged from 16 – 23 degrees Celsius. Spring / early autumn temperatures hovering around 25 degrees Celsius is considered optimal.

Controlled variables- the environment was kept moist; however, it was too moist in the beginning – with mould starting to appear – did this impact results? The humidity dome lid was removed to minimise impact. The temperatures likely to low for optimal germination. Both sets of seeds were subjected to the same conditions. From day 80, the seeds were relocated to a local garden nursery to provided more constant conditions, to encourage stronger growth.

Conclusion

The results demonstrated that the Earth control seeds outperformed the space flown seeds in both germination rates and overall height. This indicates that prolonged exposure to cosmic radiation and microgravity on the ISS likely caused subtle cellular damage, altering their development. However, dependant variables, namely the storage and age of the seeds, and controlled variables such as temperature could have impacted viability and skewed results. Furthermore, it must be stressed the sample of seeds is small, and not fully representative. That said the results of our small sample, when collated with the results across Australia, will contribute to the overall project and provide valuable insight for space agricultural science.