Effect of the addition of human urine-based struvite on the growth of green bean on Mars and moon soil simulants.

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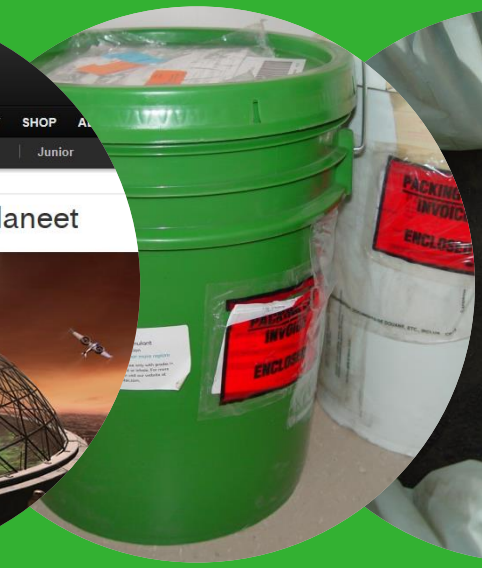

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100years
1918 — 2018

Living on Mars

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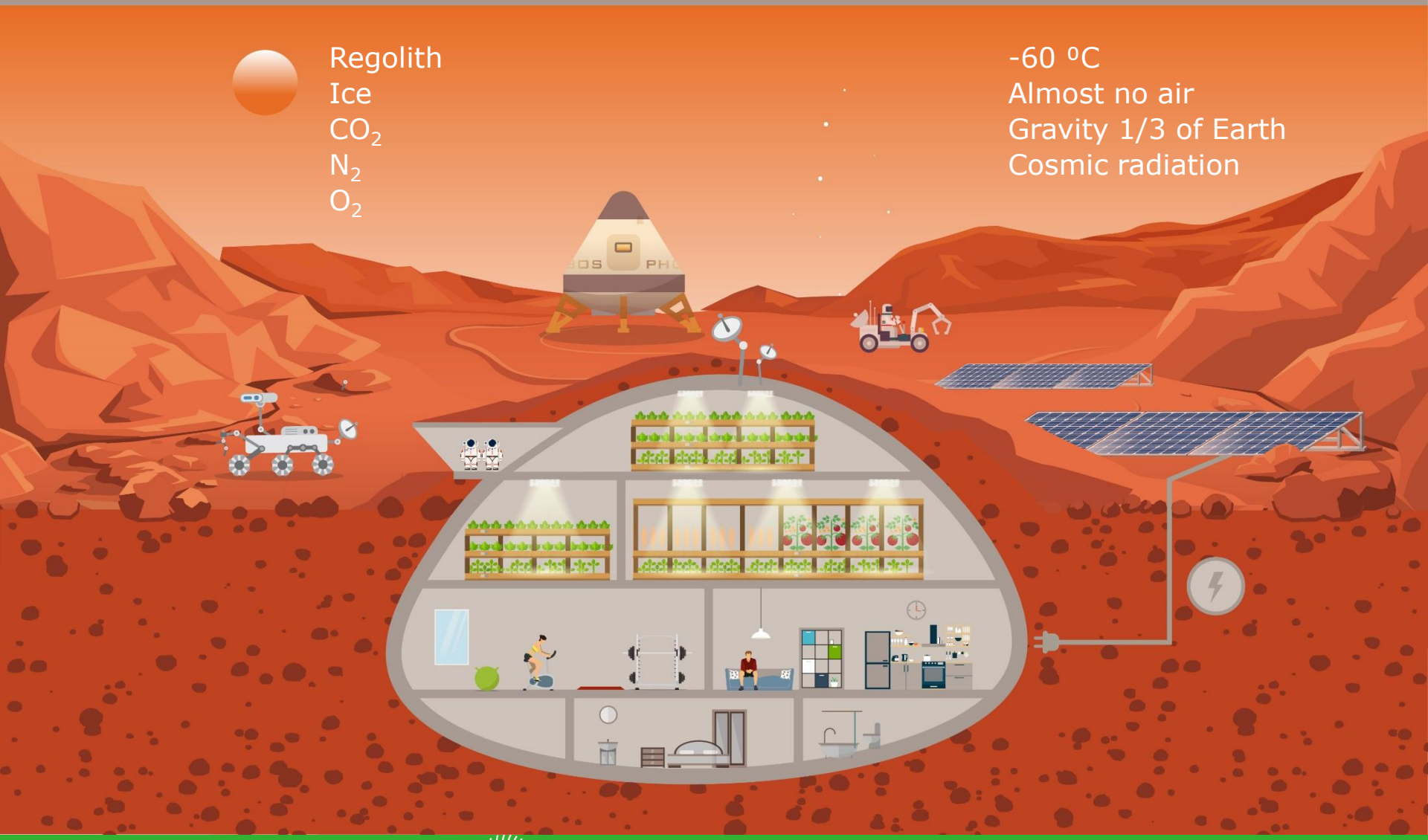
Regolith
Ice
CO_2
N_2
O_2

-60 ºC
Almost no air
Gravity 1/3 of Earth
Cosmic radiation



A sustainable agricultural ecosystem for Mars

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Content of Moon regolith

Major element composition	wt. %
Silicon Dioxide (SiO_2)	46–49
Titanium Dioxide (TiO_2)	1–2
Aluminum Oxide (Al_2O_3)	14.5–15.5
Ferric Oxide (Fe_2O_3)	3–4
Iron Oxide (FeO)	7–7.5
Magnesium Oxide (MgO)	8.5–9.5
Calcium Oxide (CaO)	10–11
Sodium Oxide (Na_2O)	2.5–3
Potassium Oxide (K_2O)	0.75–0.85
Manganese Oxide (MnO)	0.15–0.20
Chromium III Oxide (Cr_2O_3)	0.02–0.06
Diphosphorus Pentoxide (P_2O_5)	0.6–0.7

Licheri et al. Acta Astronautica 201: 164-171

Content of Mars regolith

Oxide	Rocknest bulk, wt%	JSC Mars-1[a]	MGS-1[b]	MMS[c]
SiO_2	42.97	43.5	47.2	49.8
TiO_2	1.19	3.8	0.4	1.1
Al_2O_3	9.37	23.3	11.6	17.2
FeO_T	19.18	15.6	17.5	11.0
MnO	0.42	0.3	0.1	0.2
MgO	8.69	3.4	9.9	6.1
CaO	7.26	6.2	5.6	10.5
Na_2O	2.70	2.4	2.8	3.3
K_2O	0.49	0.6	0.5	0.5
P_2O_5	0.95	0.9	0.1	0.2
Cr_2O_3	0.49	–	0.1	0.1
Cl	0.69	–	–	–
$\%SO_3$	5.47	–	4.3	0.1
Total	99.87	100.0	100	100

Clark et al. Icarus 351: 113936

Struvite

$MgNH_4PO_4$

From Dixies on Festivals in Amsterdam and water treatment plants

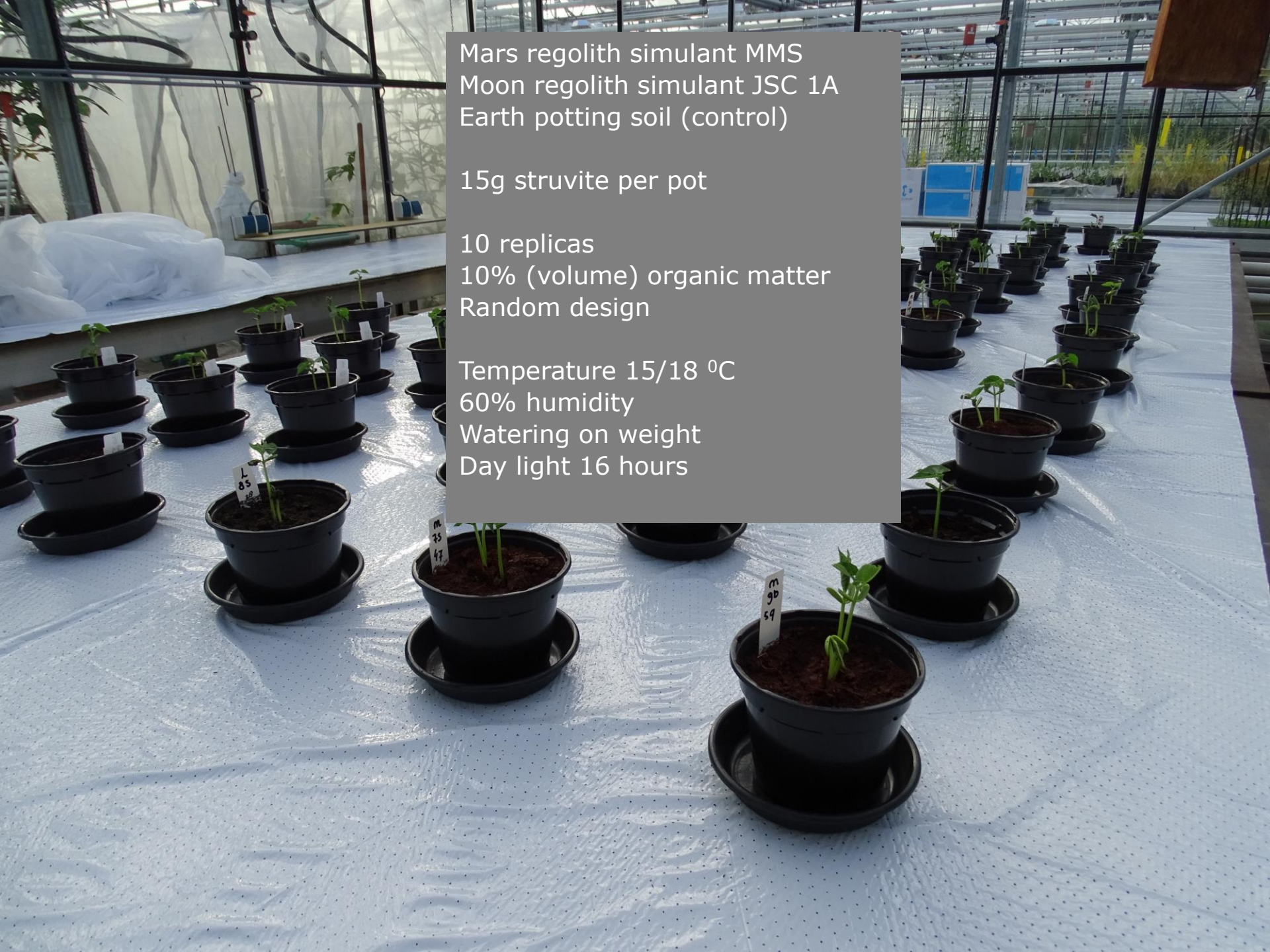
Medicine remnants (and other stuff)

weight%	Pure struvite	Land van Cuijk	A'dam West	Den Bosch	Avareage	Stdev
N	6	5	6	5	5.5	0.6
Mg	10	9	7	10	9.0	1.4
P	13	12	10	12	11.8	1.3
P2O5	29	26	23	28	26.5	2.6

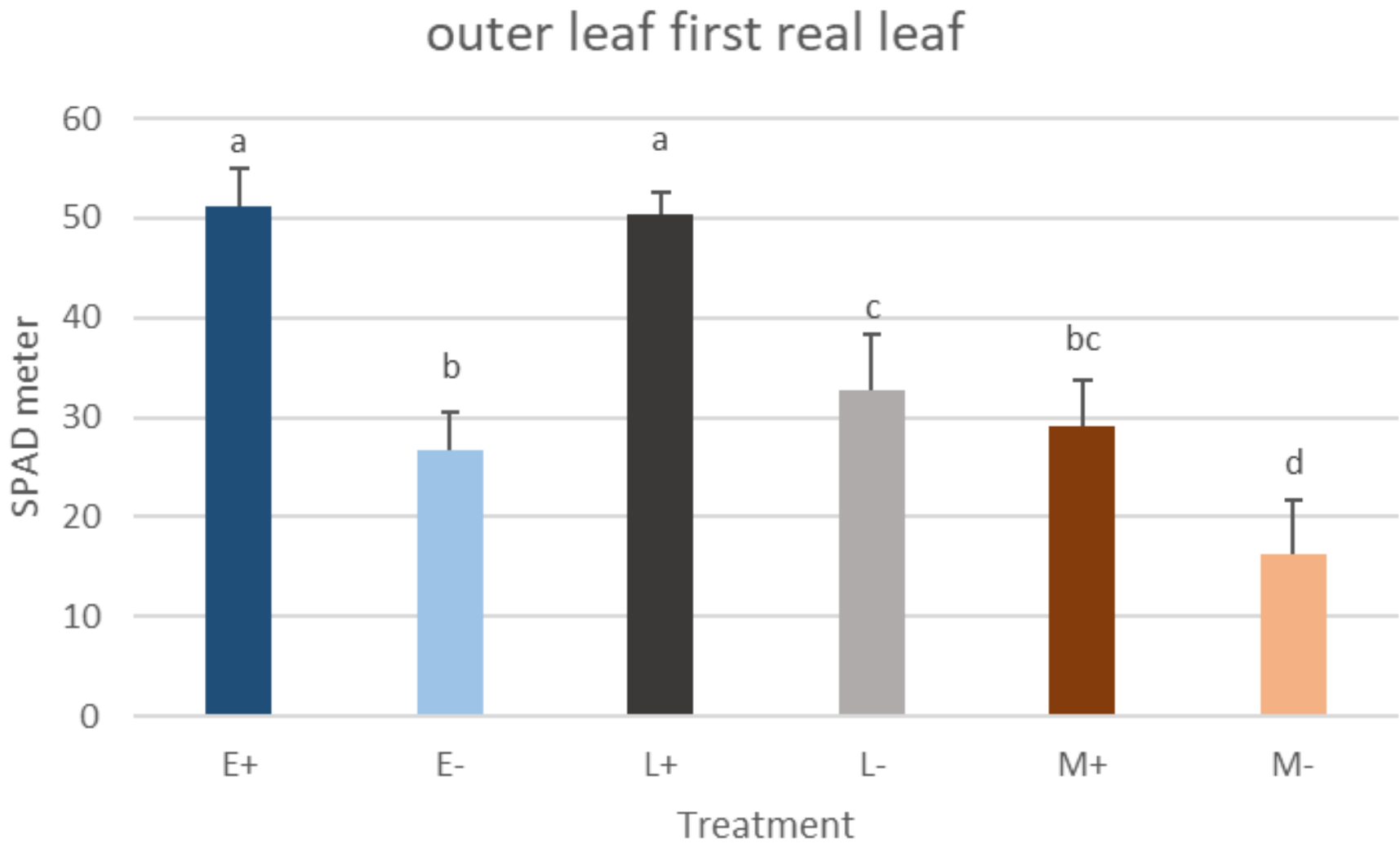
Trace elements of Fe and Ca

Slow releaser

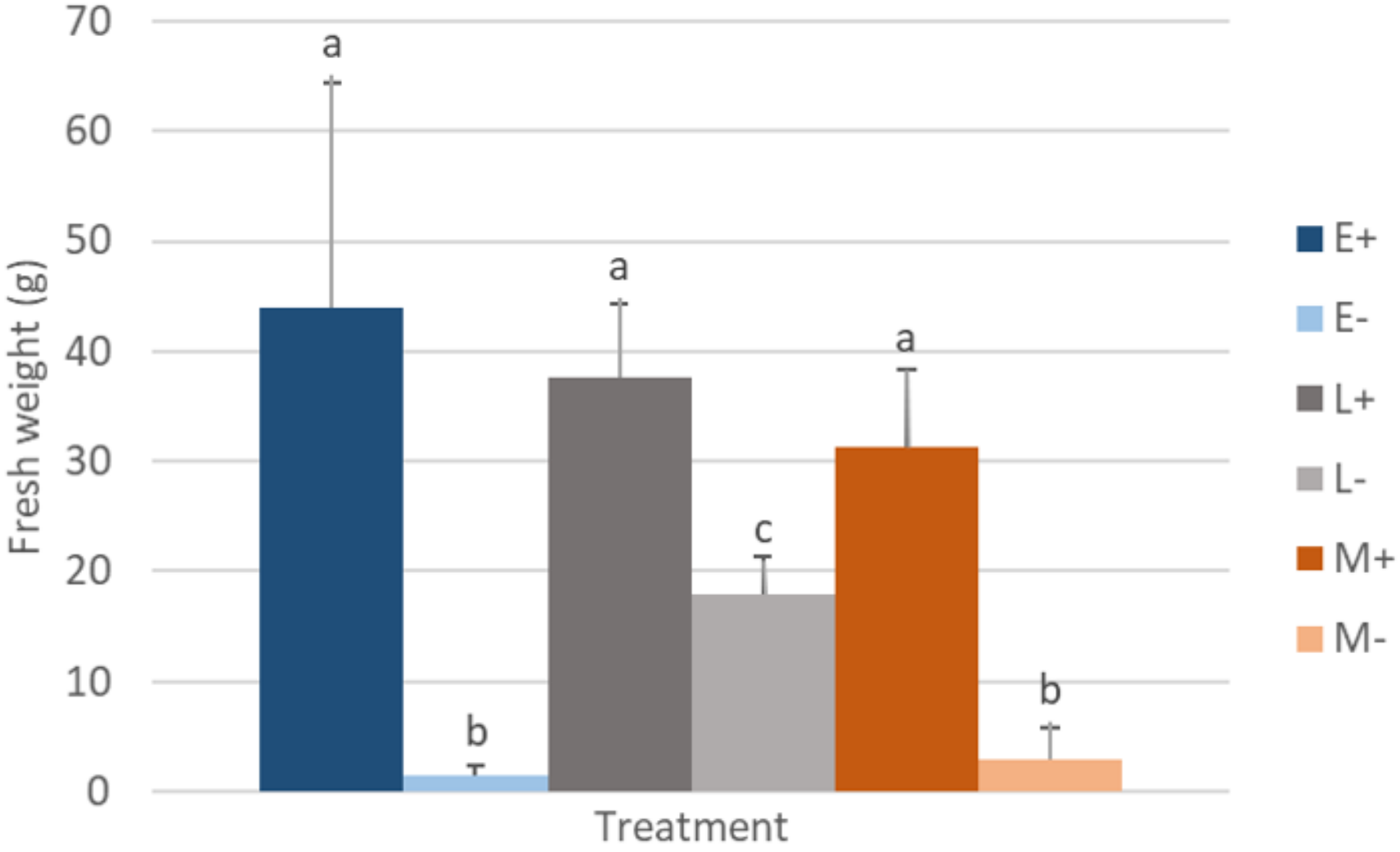
Struvite donated by Aqua Minerals


Mars regolith simulant MMS
Moon regolith simulant JSC 1A
Earth potting soil (control)
15g struvite per pot
10 replicas
10% (volume) organic matter
Random design
Temperature 15/18 ^{0}C
60% humidity
Watering on weight
Day light 16 hours

SPAD meter


outer leaf first real leaf
SPAD meter
60
50
40
30
20
10
0
a
b
a
c
bc
d
E+
E-
L+
L-
M+
M-
Treatment

Fresh weight harvest of green beans



Conclusions and Discussion

- Clear positive effect of Struvite on the biomass production
- Moon regolith simulant comparable to Earth potting soil
- Mars regolith simulant performed less well
- Finding an optimum supply
- Human faeces
-

The lesser mealworm as protein source living on plant waste products

Lotte Bohlander

Mealworms provided by Ynsect

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- wieger.wamelink@wur.nl
- https://www.youtube.com/channel/UC0kJ7aUpt3SKkIFFdmOI-7g?
- https://www.wur.nl/nl/Onderzoek-Resultaten/Projecten/Food-for-Mars-and-moon.htm
- https://www.facebook.com/Food.for.Mars.and.moon/ for pictures of the experiment
- Twitter: Wamelink_wieger
- Instagram: foodformarsandmoon
- Crowdfunding https://crowdfunding.wur.nl/project/food-for-mars-urine?locale=nl