

LIVINGAGRO Project

Technology Dissemination Workshop

Using a hypoxia workstation to select species that will produce more forage



After a short introduction to the LIVINGAGRO project, Dr. Panagiotis Kalaitzis explained what the Oxford Optronix HypoxyLab Hypoxia Workstation rented by the LIVINGAGRO project is, and what it can do: it allows users to easily and precisely control oxygen, carbon dioxide, temperature, and humidity with controlled conditions inside it. It is the only system that makes it possible to gradually decrease the amount of oxygen inside it (“gradient oxygen concentration”). So, for example, it allows experiments to be carried out under low oxygen conditions (hypoxia). In the past, this workstation (photo) has been used mainly for cancer research, stem cell investigations, and molecular physiology studies involving flooding and the response of plants to a complete lack of oxygen (anoxia). It has the advantage of enabling long-term exposure to low oxygen conditions at a low cost of consumables, in order to see the growth rate of any species under various conditions.



The current experiment built on work published in 2022 in Nature, “An oxygen-sensing mechanism for angiosperm adaptation to altitude,” which included evidence that plants at a very high altitude grow based on their sensing of the low oxygen concentration.

The current work carried out under the LIVINGAGRO project aimed to identify species that produce more forage for grazing animals in Lebanon and Jordan through a combination of germplasm testing and selection. The

hypothesis was that forage species that typically grow at 1000 meters or higher could produce more forage for grazing animals when grown at lower altitudes.

In the experiment, rice was used as a positive control, since it is a model system for hypoxia research: it grows underwater, with low oxygen. The experimental subjects include species that typically grow at a high

altitude (in the mountains), and other related species that tend to grow at a low altitude, near sea level. Seeds were provided by LIVINGAGRO partners at the Lebanese Agricultural Research Institute (LARI).

Experimental Subjects

Altitude	Poaceae	Fabaceae	Fabaceae
High altitude	Poaceae <i>Avena barbata</i> (1385m)	Fabaceae <i>Lathyrus hirsutus</i> (1593m)	Fabaceae <i>Medicago monspeliaca</i> (1426m)
Low altitude	Poaceae <i>Taeniatherum caput-medusae</i> (15m)	Fabaceae <i>Medicago Maxima</i> (17m)	Fabaceae <i>Lathyrus gorgoni</i> (127m)

The experimental subjects and rice seeds were first grown in normal environmental conditions (normoxia, approximately 20% oxygen), with the high altitude species appearing to do better that way.

They were also grown under hypoxic conditions (1.5% oxygen).

As expected, the control (rice) grew better under hypoxic conditions, indicating that the experiment worked well. On the other hand, all the other plants grew better under normal oxygen conditions (normoxia), with the species adapted to high altitude exhibiting the greatest difference between plant growth in normal vs. hypoxic conditions.

As hypothesized, this suggests that plants adapted to high altitude conditions could produce more forage for grazing if grown near sea level instead of at their usual high altitude locations. However, more experiments are required to confirm this, and to ascertain if the differential growth is related to long-term low oxygen adaptation.

The presentation is available here: https://livingagrolab.eu/wp-content/uploads/2023/09/hypoxia-lab_workshop-presentation-final.pdf

Results- Observations

Control plant rice demonstrated increased plant growth in hypoxia conditions as would be expected.

Both high and low altitude adapted, Fabaceae and Poaceae species, demonstrated increased plant growth in normoxia than in hypoxia conditions.

High altitude adapted, Fabaceae and Poaceae species, demonstrated increased plant growth in normoxia than the low altitude adapted species. It remains to be investigated whether this differential growth is related to long term low oxygen adaptation

Bar Chart Data:

Species	Environment Average plant height	Hypoxia Average plant height
Fabaceae High altitude	~11	~1.5
Fabaceae Low altitude	~2.5	~1.5
Rice	~7	~10.5
Poaceae high altitude	~14	~5
Poaceae low altitude	~10	~6.5