Impact of Air Nanobubbles on Lettuce Growth

Case Study: IIT Ropar, Punjab

Location:

IIT Ropar, Punjab

Application:

Hydroponic Lettuce Cultivation

Unit installed:

NanoCloud N10

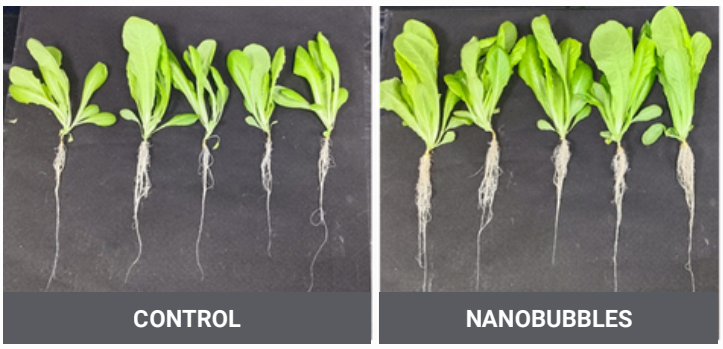
Results:

- 21.4% wider leaves and 11.4% taller shoots, demonstrating enhanced vegetative growth.
- 25.7% longer roots, indicating stronger root development.
- Dry biomass increased from 1.01 g to 2.06 g (104% increase)
- Fresh biomass increased from 2.67 g to 4.76 g (78% increase)

Background

To investigate the influence of air nanobubbles on leafy vegetable production, Nanokriti conducted a controlled hydroponic trial at IIT Ropar using romaine lettuce. Plants were grown in identical hydroponic systems under the same nutrient solution, irrigation schedule, temperature, humidity, and lighting conditions. The treatment system received continuous air nanobubble enrichment through the NanoCloud Air Nanobubble Generator, while the control system operated without nanobubbles. The study focused on evaluating changes in biomass production and overall plant growth.

Nanokriti NanoCloud air Nanobubble Generator was used to generate nanobubble water from Deionised/Milli-Q water. Nanobubble size distribution (<200 nm) and number concentration (>1 × 10^8 nanobubbles/mL) were validated using Nanoparticle Tracking Analysis (NTA).

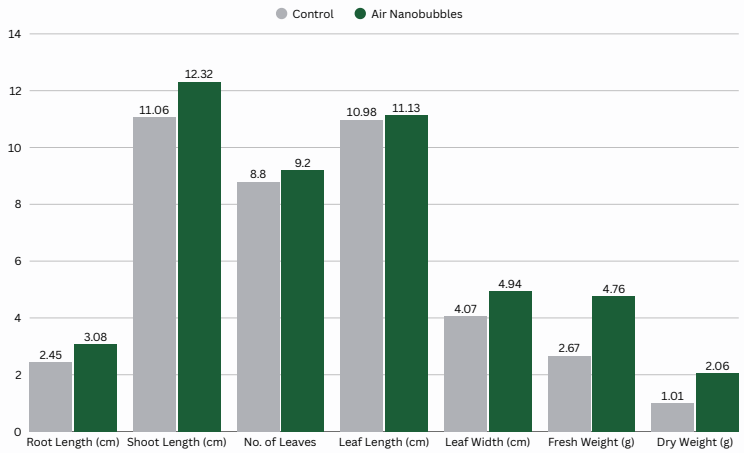


CONTROL | NANOBUBBLES

Air nanobubbles remain dispersed in water for extended periods, enhancing gas–liquid interaction within the nutrient solution. The improved root-zone environment supports more efficient root respiration, nutrient uptake, and water absorption, enabling the plant to allocate more resources toward leaf development and biomass production.

Results & Key Findings

Nanobubble-treated lettuce produced noticeably greater biomass than the control plants while also showing improvements in root and shoot growth. Root length improved by 25.7%, leaf width by 21.4%, and shoot length by 11.4%, while leaf count increased by 4.5%. Collectively, these improvements demonstrate a stronger and more productive vegetative response under nanobubble irrigation. Most notably, fresh biomass increased from 2.67 g to 4.76 g (78.3%), while dry biomass increased from 1.01 g to 2.06 g (104.0%), indicating substantially greater biomass accumulation.



Conclusion

The IIT Ropar trial demonstrates that integrating air nanobubbles into irrigation can significantly improve lettuce productivity without altering nutrient composition or cultivation practices. The improvements in biomass and plant growth indicate that the unique physicochemical properties of nanobubbles enhance oxygen availability and nutrient transport, making them a promising technology for improving crop productivity in controlled-environment agriculture.

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