# Near-Null Magnetic Fields in Lunar Plant Biology: The First 5 Days of Growth

## 1. LUNAR MAGNETIC REALITY

- Moon lacks global core dynamo
- Artemis South Pole: 0.40–0.82 nT (Crustal proxy at 30 km altitude)
- Deep near-null magnetic void (<1 nT)

**Payload Field Architecture:**

$B_{total} = B_{crust} + B_{ext} + B_{lander}$

Spacecraft DC (2–48 μT) vs
AC Ripple (15–50 nT_RMS)
Swamps Ambient Lunar Void
⟶ 3-Axis In Situ Logging Mandatory

**Planetary Environment:**
**Deep Near-Null Void (<1 nT)**

## 2. FIRST 5 DAYS OF GROWTH

- Phase I (0–72 h): Heterotrophic peroxisome & lipid catabolism
- Phase II (72–120 h): Greening photomorphogenic transition

**Empirical Phenotypes in NNMF:**

- Viability: -10 to -30% (Table 3)
- Velocity: $\Delta t50$ = +16 h Lag
- Dry Biomass: -28.5% Penalty
- Pigments: HEMA1, CHLH, POR & HY5 Repressed (-1.8 to -2.5x)
- Mitigated by Fe-EDTA & Sucrose

**Developmental Penalty:**
**Viability, Speed, Pigments**

## 3. SCIENCE & FLIGHT RIGOR

- Multi-Stressor Disambiguation: NNMF (<1 nT) vs Lunar g (0.166 g) vs Chronic GCR (60–100 mGy/yr)
- Distinct bioenergetic targets

**Operational Flight Standards:**

- Ground: 3-Chamber & Bifilar Sham Controls (net $B_{coil} \approx 0$)
- Flight: In Situ 3-Axis Canopy Magnetometry & Deconvolution
- Verification: 45 μT Active Rescue

**Operational Standards:**
**Ground Rigor & Flight Logging**