

Effects of Fertiliser Placement on Soil Osmotic Suction and Growth of *Pseudostellaria heterophylla* [HS8.3.4]

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Introduction

- Pseudostellaria heterophylla* is a traditional medicinal plant cultivated for its bioactive tubers.
- Optimising growth requires control of soil and root-zone conditions.
- Fertiliser placement influences plant performance, but mechanisms remain unclear.
- Fertiliser placement alters root-zone osmotic suction, affecting water availability and plant response.

Objective

To investigate the effects of fertiliser placements on soil osmotic suction and the growth of *Pseudostellaria heterophylla*.

Methodology

A. Experimental Design

- Conducted under laboratory conditions over a 6-week period
- Materials: soil (S), potting mix (PM), and chemical fertiliser (NPK)
- Pseudostellaria heterophylla* tubers planted at 1 cm depth
- Root-zone conditions modified by:
 - NPK placement [8 tubers per pot]
 - PM distribution at different depths [3 tubers per pot]

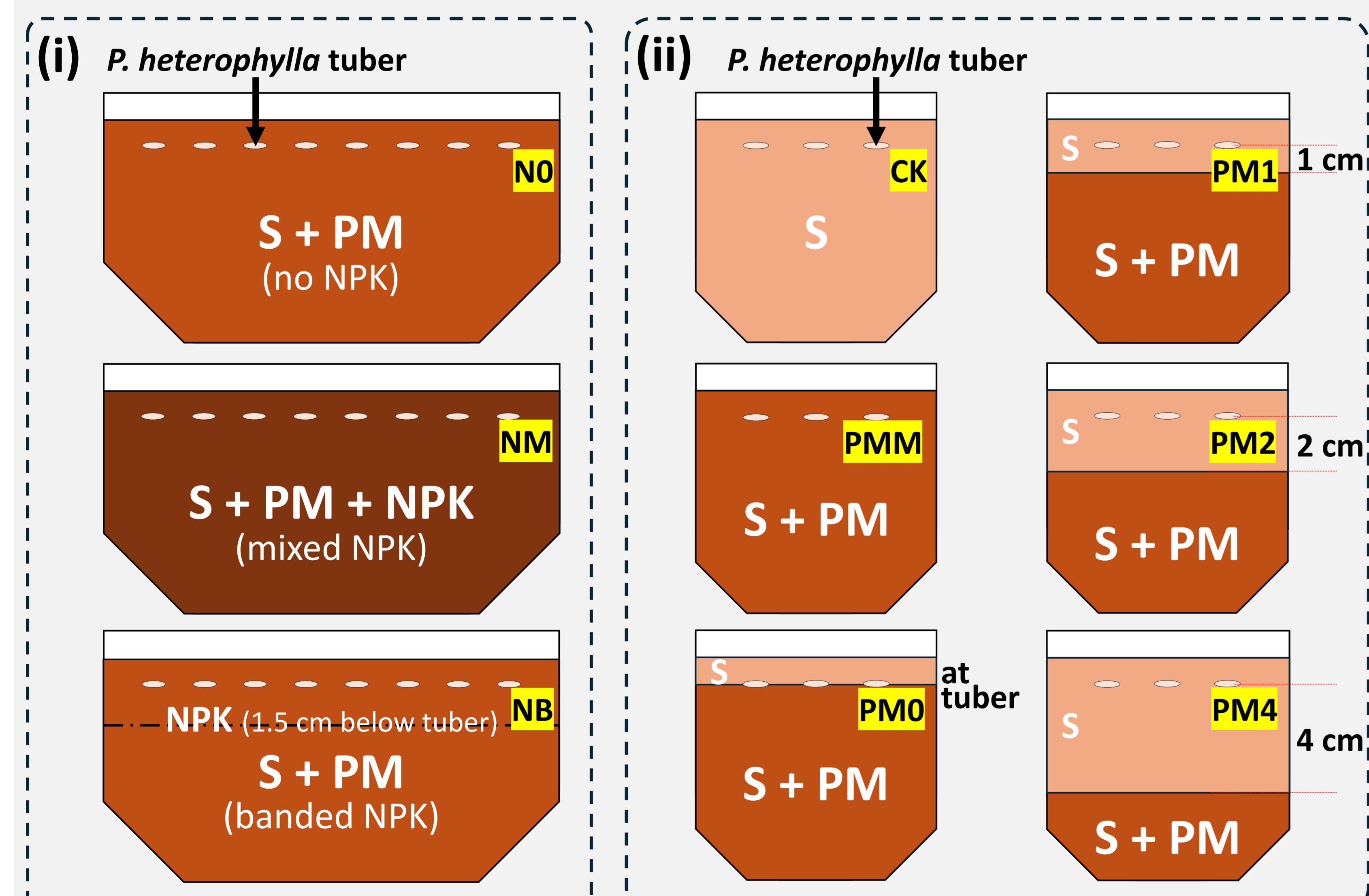


Figure 1. Experimental design showing (i) NPK placement and (ii) PM distribution at different depths [not to scale]

B. Measurements

- Soil electrical conductivity
- Plant germination rate
- Plant responses: stomatal conductance and plant height

C. Analysis

Soil osmotic suction was estimated from electrical conductivity using an empirical relationship based on van't Hoff's law.

$$\pi = 36 EC_{meas} \left(\frac{\omega_{ref}}{\omega_{act}} \right) [1, 2]$$

Where:

- π = soil osmotic suction (kPa)
- EC_{meas} = measured electrical conductivity (dS/m)
- ω_{ref} = reference gravimetric water content (%)
- ω_{act} = actual gravimetric water content (%)

Key Findings

- PM approximately doubled soil osmotic suction, while NPK increased it by about four times.

Treatment	Osmotic suction (kPa)
S	55
S + PM	120
S + PM + NPK	228

- Germination rate (GR) in NPK placement was highest in NO and lowest in NM. In PM distribution, PM1 showed more uniform germination, while PM4 had the lowest.

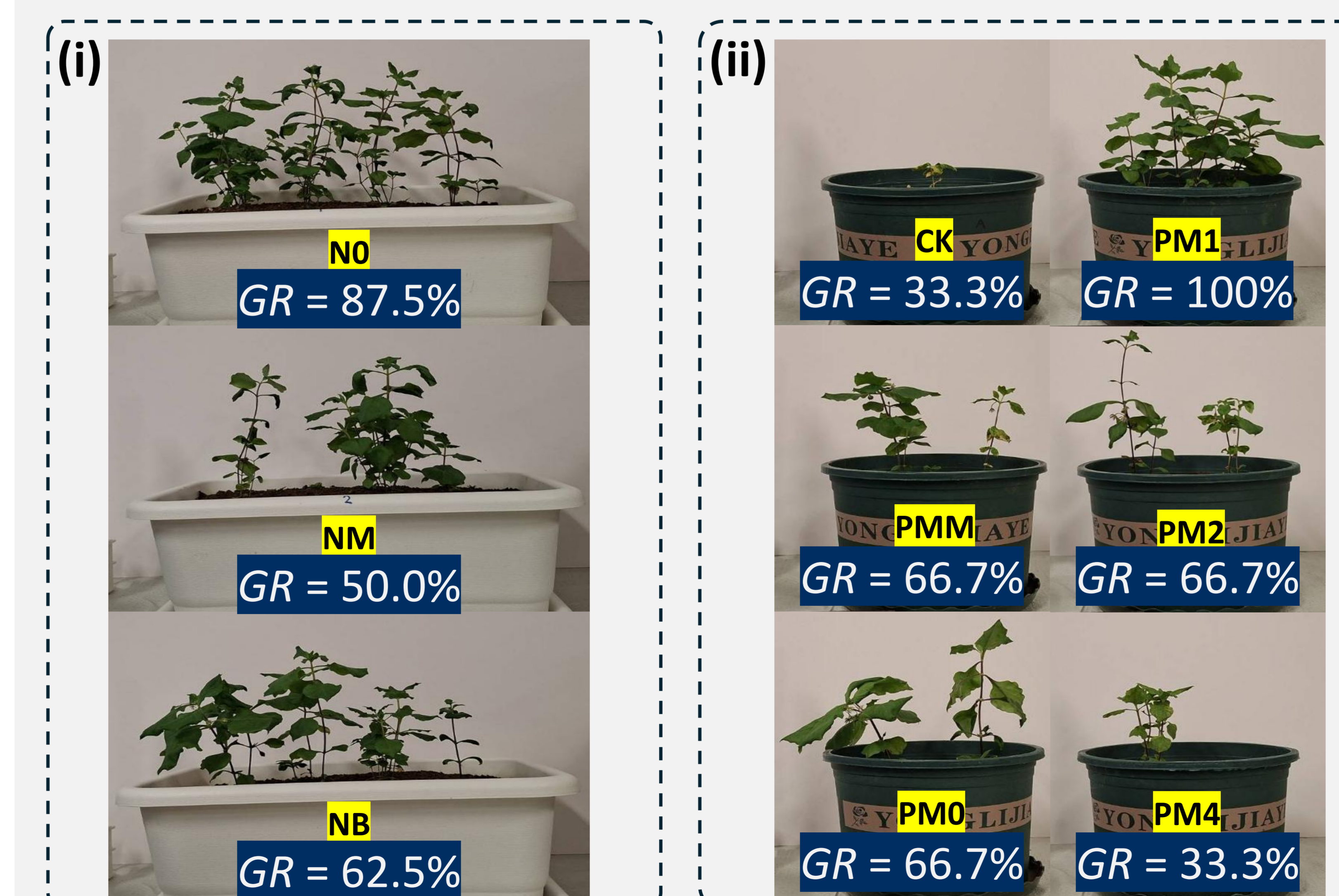


Figure 2. Germination rate of *Pseudostellaria heterophylla* at Week 6 under (i) NPK placement and (ii) PM distribution at different depths

- NM consistently showed the lowest stomatal conductance, suggesting reduced gas exchange under higher osmotic suction.
- PM4 had the lowest stomatal conductance among PM treatments, suggesting that higher osmotic effects at depth may affect gas exchange.

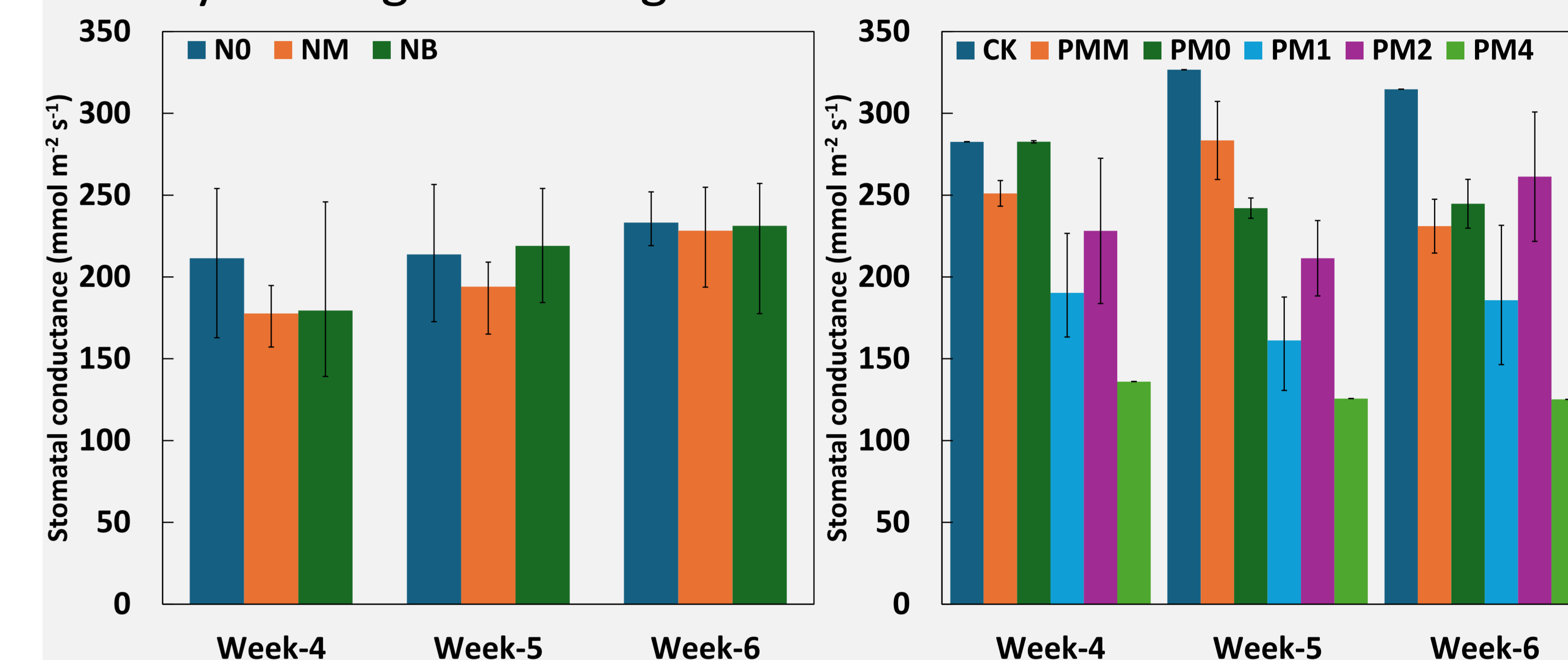


Figure 3. Stomatal conductance ($\text{mmol m}^{-2} \text{s}^{-1}$) of *Pseudostellaria heterophylla* over a 6-week period

- NM had generally lower plant height, consistent with lower stomatal conductance and higher osmotic suction.
- CK had the lowest plant height despite the highest stomatal conductance. PM0 and PM2 had the highest plant height, while PM4 became lower at later weeks, suggesting the effect of higher osmotic suction at depth on plant growth.

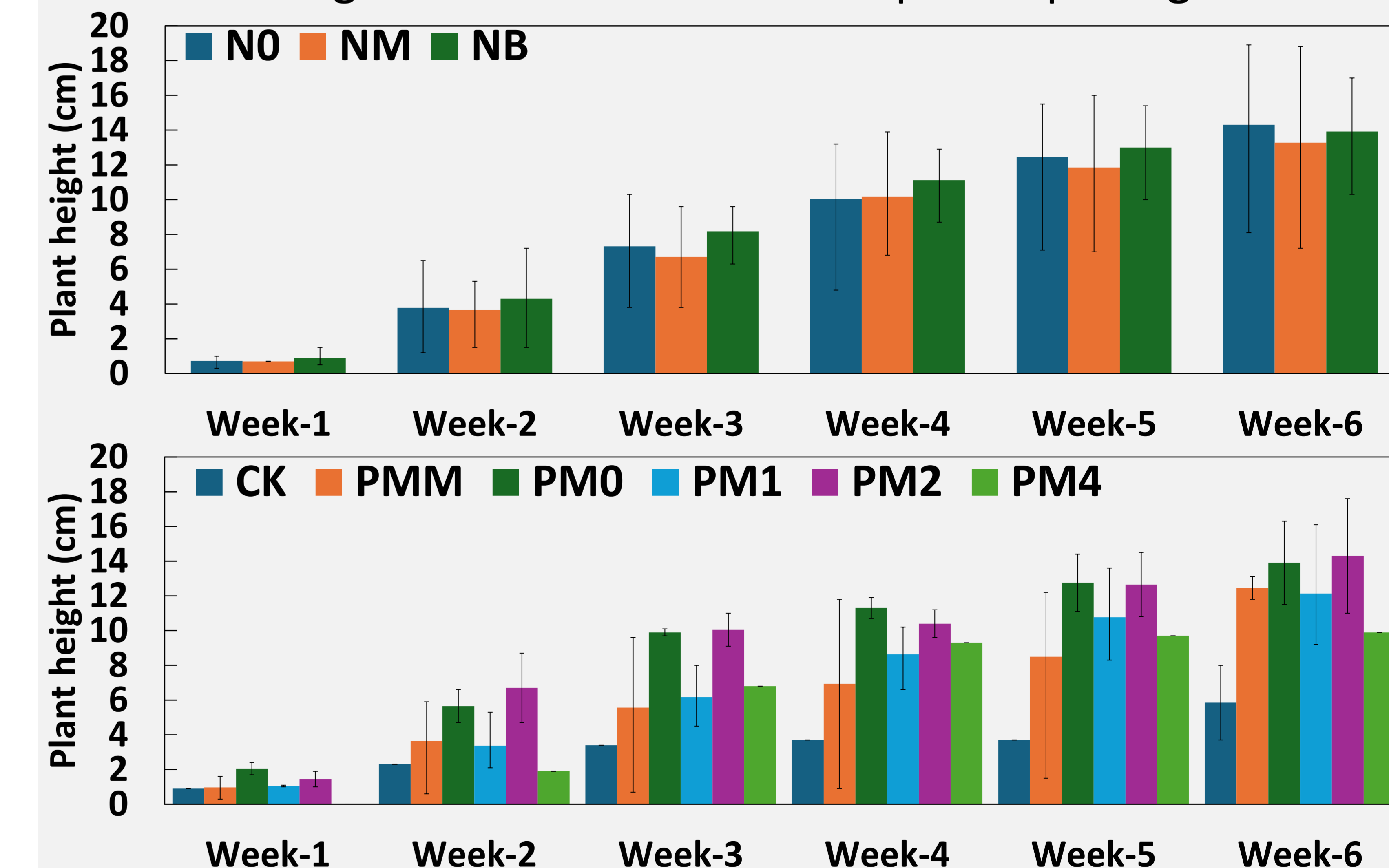


Figure 4. Plant height (cm) of *Pseudostellaria heterophylla* over a 6-week period

These results indicate that higher osmotic suction from NPK treatments limited *Pseudostellaria heterophylla* germination and growth, while higher osmotic suction at depth associated with PM placement improved plant performance.

Reference:

- [1] Ng, C. W. W., Wang, Y. C., Ni, J. J., et al. (2022). Effects of phosphorus-modified biochar as a soil amendment on the growth and quality of *Pseudostellaria heterophylla*. *Scientific Reports*, 12, 7268.
- [2] Richards, L. A. (ed.) (1954). *Diagnosis and improvement of saline and alkali soils*. USDA Agriculture Handbook No. 60. U.S. Department of Agriculture.

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