Module Presentation

Phosphorous Uptake

Ecosystem Modeling | Spring 2025
Monika Kelley

Goal:

Depict phosphorus uptake within a system

Goal: Depict phosphorus uptake within a system

Inputs

- Root length average of area

- NPP (g C m-2 y-1) of:
  - Leaves
  - Stems
  - Roots

- CP ratios
  - Of the individual organs

- Climate modifier of P availability
  - Represented in %, ideally considers how wet/ hot the year was

- P pools
  - Inorganic P (Pi) soluble
  - Organic P (Po) soluble
  - Inorganic P (Pi) insoluble

Output

- P uptake capability of the system

- P pools available after P uptake

General Module Overview

Broken up into 3 submodules

P demand
- The amount of P required for the amount of C in biomass per organ

P availability
- Pool availability is modified by pH of the soil
- Root length modifies the availability of P

P uptake
- **P uptake:** P pool caps the P demand
- **P pool remaining after uptake:** Starting P pool availability – P uptake
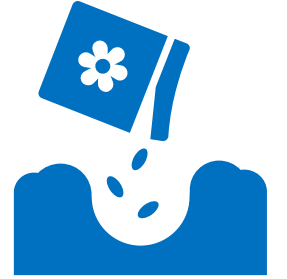
P Demand: NPP / C:P

Explanation

Amount of P required to build C being produced in the organ's biomass
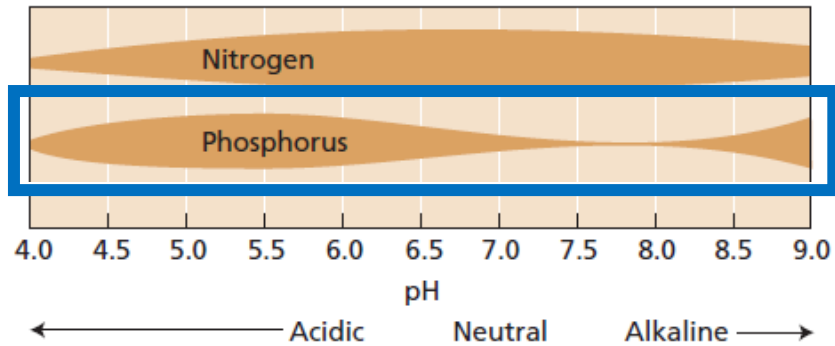
Formula

```
p_demand[organ] = npp[organ] / cp_ratio[organ]

P_demand_total =
  sum(pdemand_leaf, pdemand_stem, pdemand_root)
```

P availability: pH

Explanation

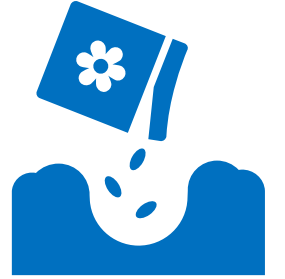

P less available at extreme pH values

1:5 = P pool * 0.5
6:7 = P pool * 1
9:14 = P pool * 0.5

Taiz et al., 2015

Formula

```
ph_mod <-
ifelse(soil_ph >= 6 & soil_ph <= 8, 1, 0.5)


p_pool_total_ph_mod = (p_pool_total) * ph_mod
```

P availability: root length

Explanation

Longer roots = able to acquire more P

Shorter roots = less P acquired

Formula

```
explore_depth <- 1.0 # meters

root_length_mod <- pmin(root_length_average /
explore_depth, 1) # units cancel


p_annual_availablity_root_mod <-
p_annual_availablity * root_length_mod
```

P uptake: P uptake

Explanation

If the demand is less than the pool the P uptake = P pool

If the demand is greater than the P pool the P uptake = P demand

Formula

```
If
(p_demand_total < p_pool_total){
        p_uptake <- p_demand_total
 }else{
        p_uptake <- p_pool_total
 }
```

P uptake: P pool remaining

Explanation
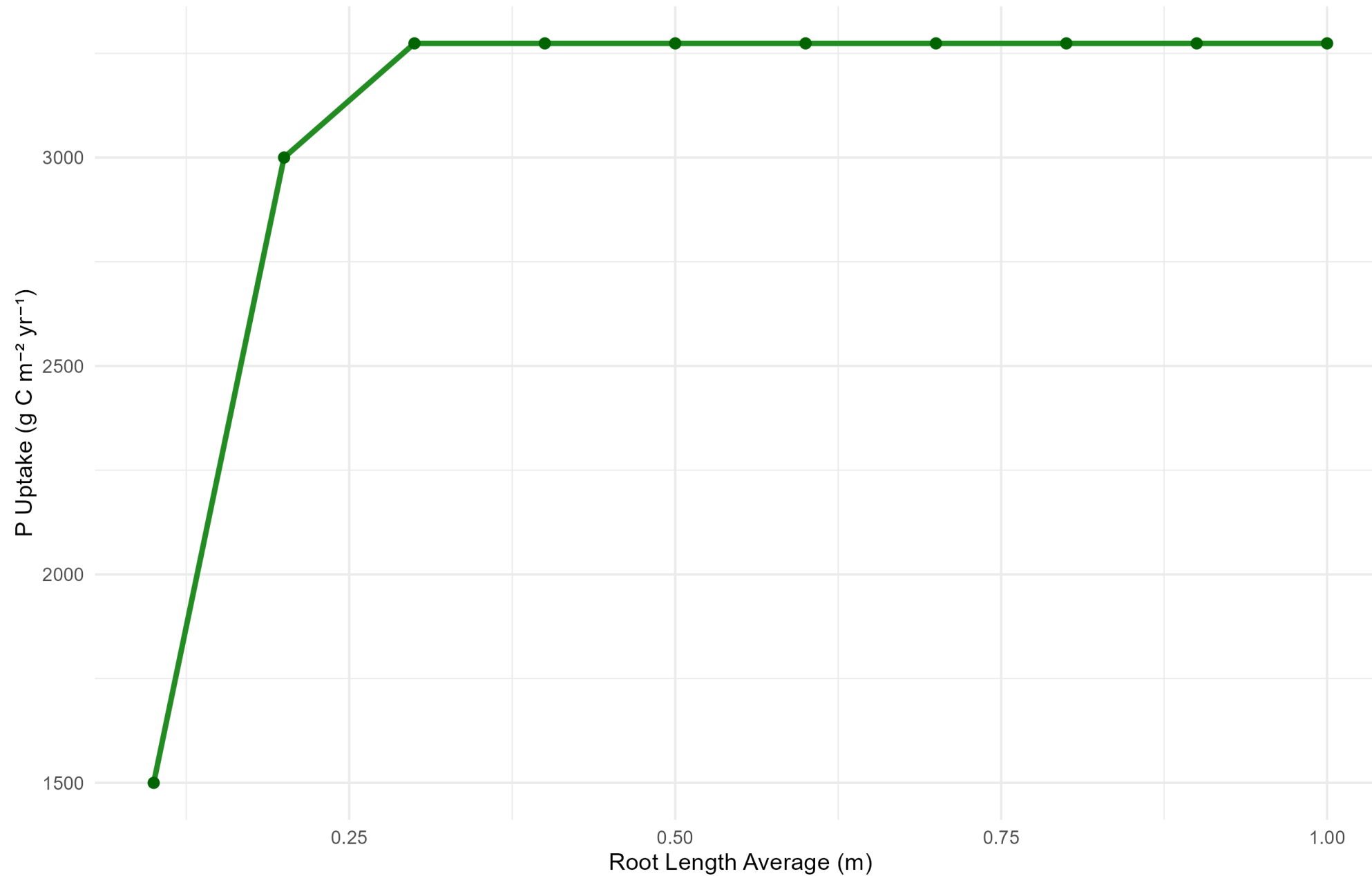
P pool (after P modifications) – P uptake

Formula

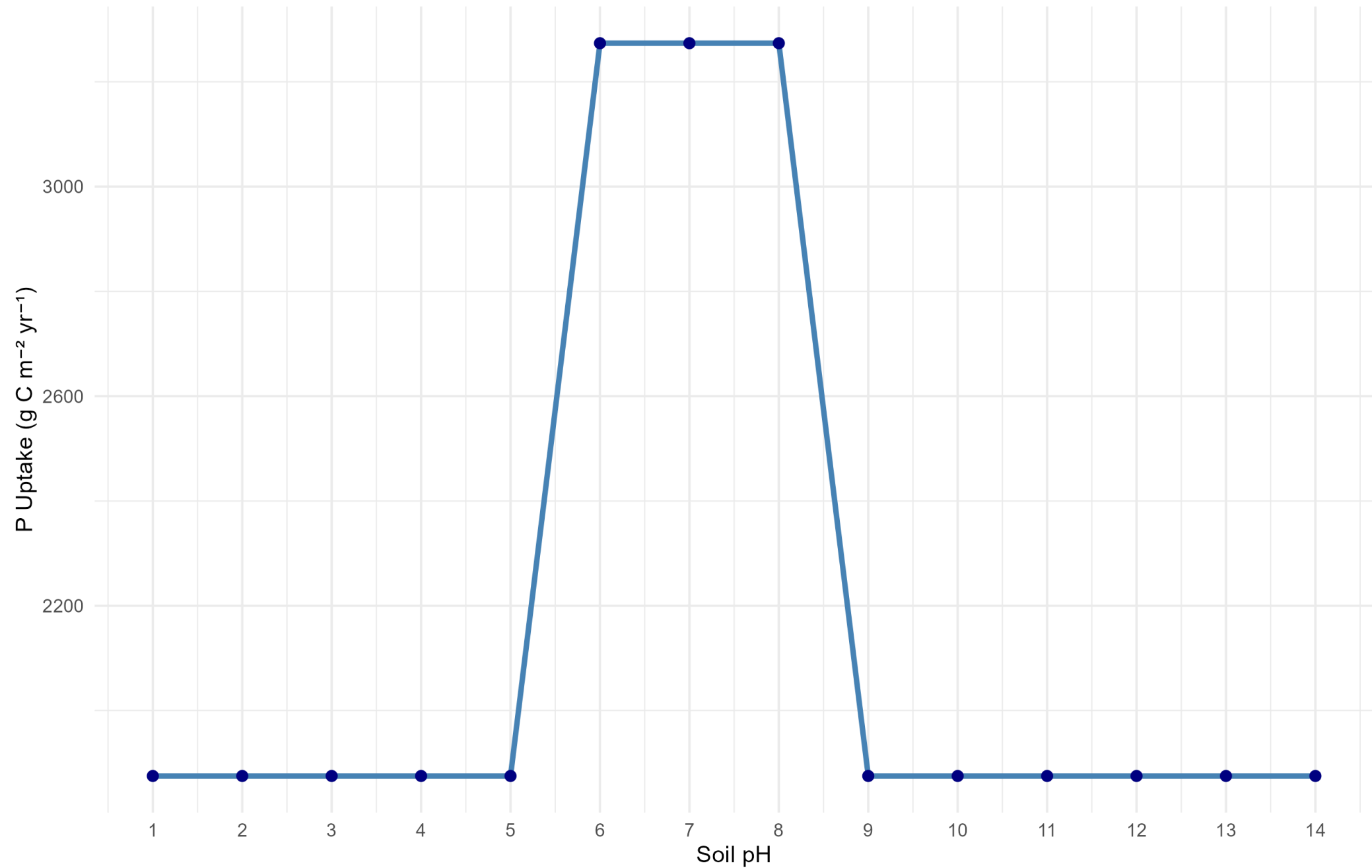`P_pool_modified - p_uptake = p_pool_leftover`

Goal:

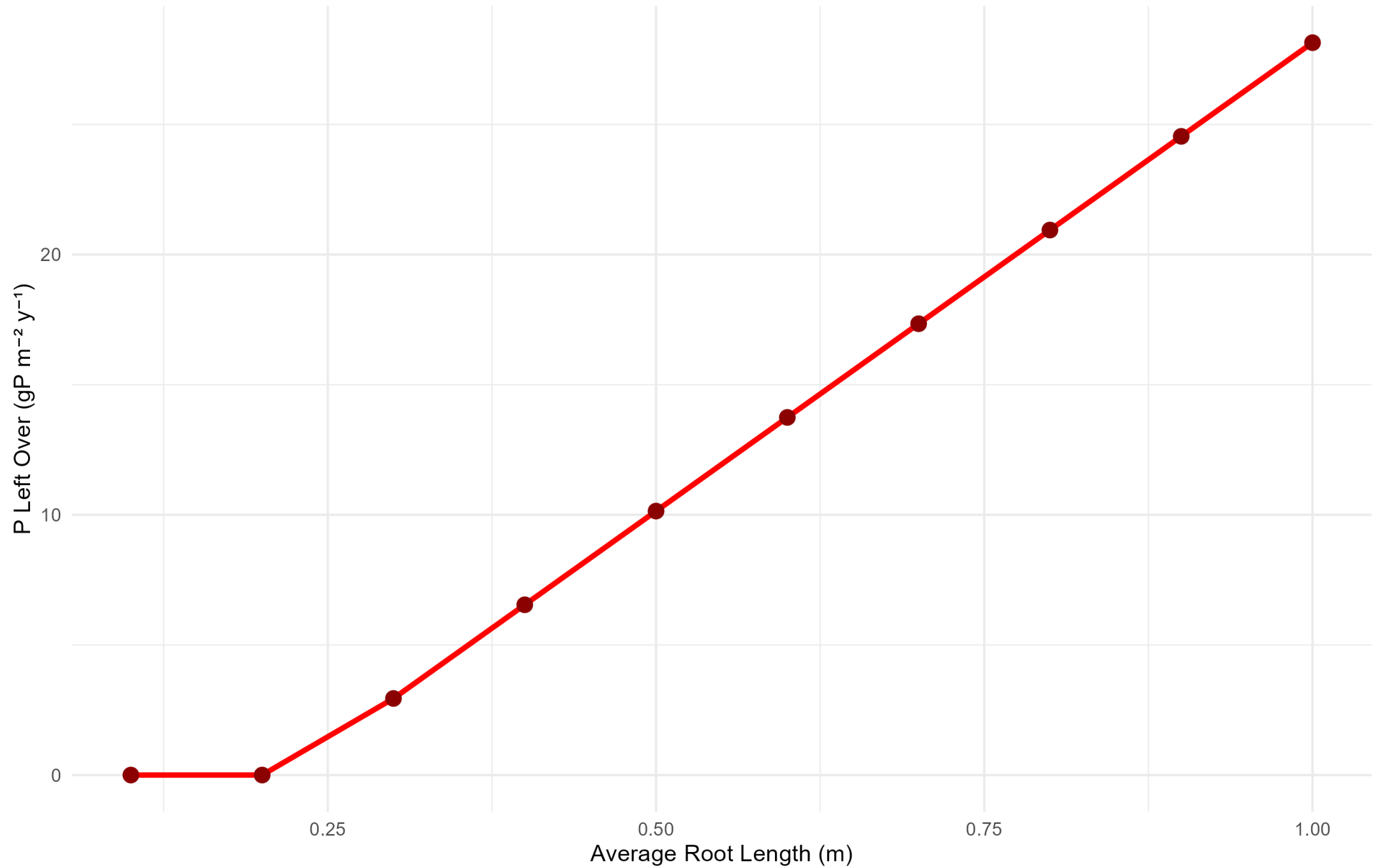Depict phosphorus uptake within a system

Effect of Root Length on Phosphorus Uptake

Effect of Soil pH on Phosphorus Uptake

P Left Over vs. Root Length

P Left Over vs. Root Length

Average Root Length (m)

P Left Over (gP m⁻² y⁻¹)