

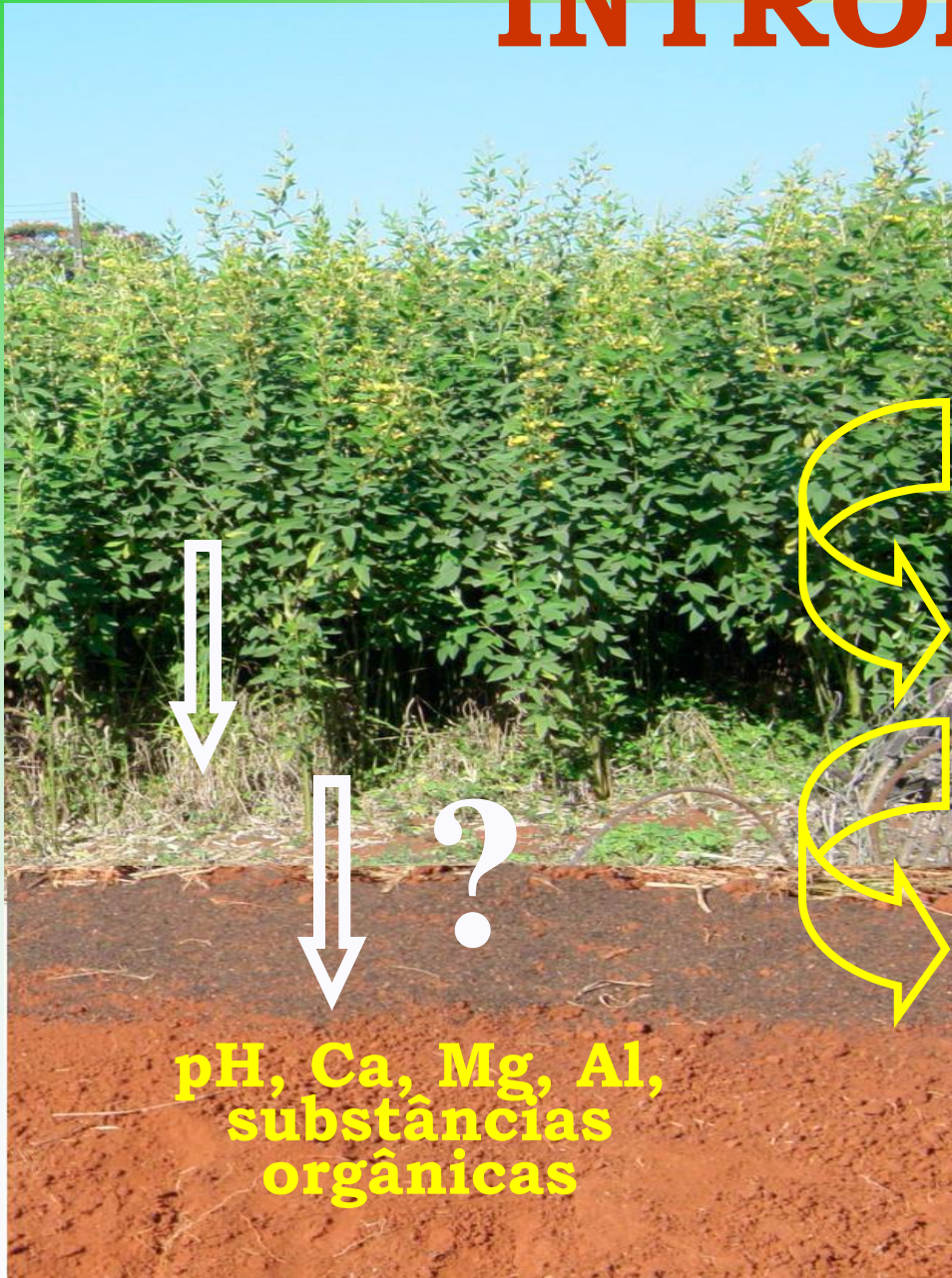


# ***NEUTRALIZAÇÃO DA ACIDEZ DO PERFIL DO SOLO POR MATERIAL VEGETAL***

**MARIO MIYAZAWA  
MARCOS A. PAVAN  
JÚLIO C. FRANCHINI  
julho/2003**

**Instituto Agronômico do Paraná**

# INTRODUÇÃO



Guandu, nabo, aveia

⇐ **ADUBOS VERDES**

reciclagem de nutrientes,  
fixação de  $N_2$

⇐ **MATERIAL ORGÂNICO**

água da chuva, temperatura

⇐ **MATÉRIA ORGÂNICA -  
substâncias húmicas**

CTC, adsorção de  $Mn^+$ ,  
porosidade



# OBJETIVO

**APRESENTAR  
ALTERAÇÕES  
QUÍMICAS DOS  
SOLOS ÁCIDOS POR  
COMPOSTOS  
ORGÂNICOS  
SOLÚVEIS DO  
MATERIAL VEGETAL**



**pH, Ca, Mg, Al,  
substâncias  
orgânicas**

# ALTERAÇÕES QUÍMICAS DO SOLO

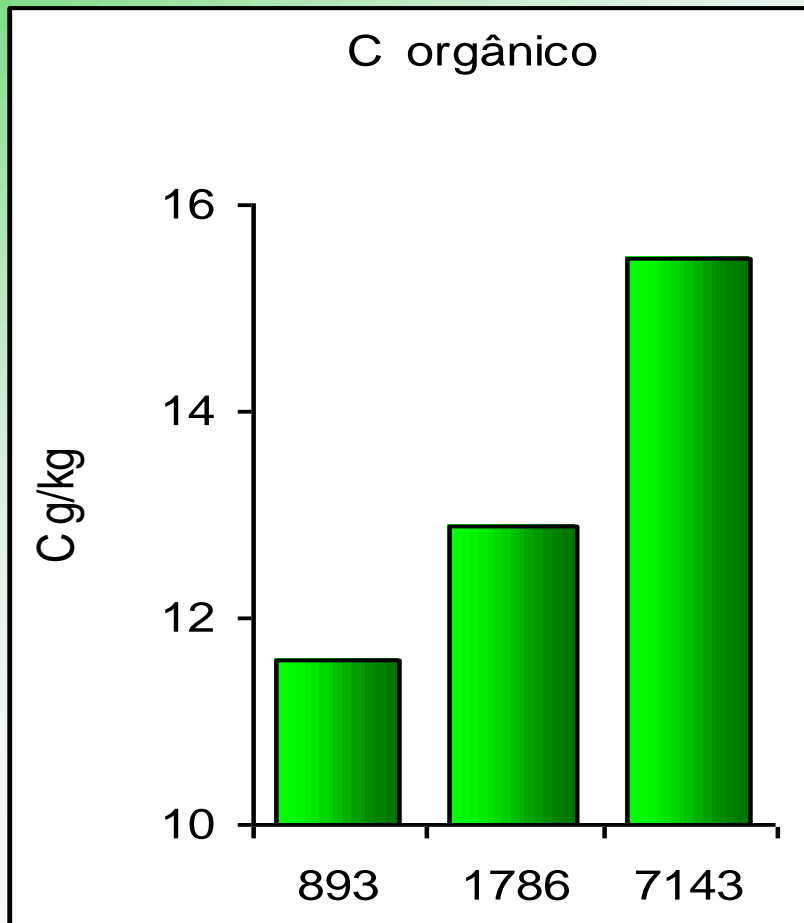
- **pH:** Neutralização da acidez
- **Al:** Hidrólise, complexação
- **Transporte de cátions:**  $K^+$ ,  
 $Ca^{2+}$ ,  $Mg^{2+}$ ,  $Al^{3+}$



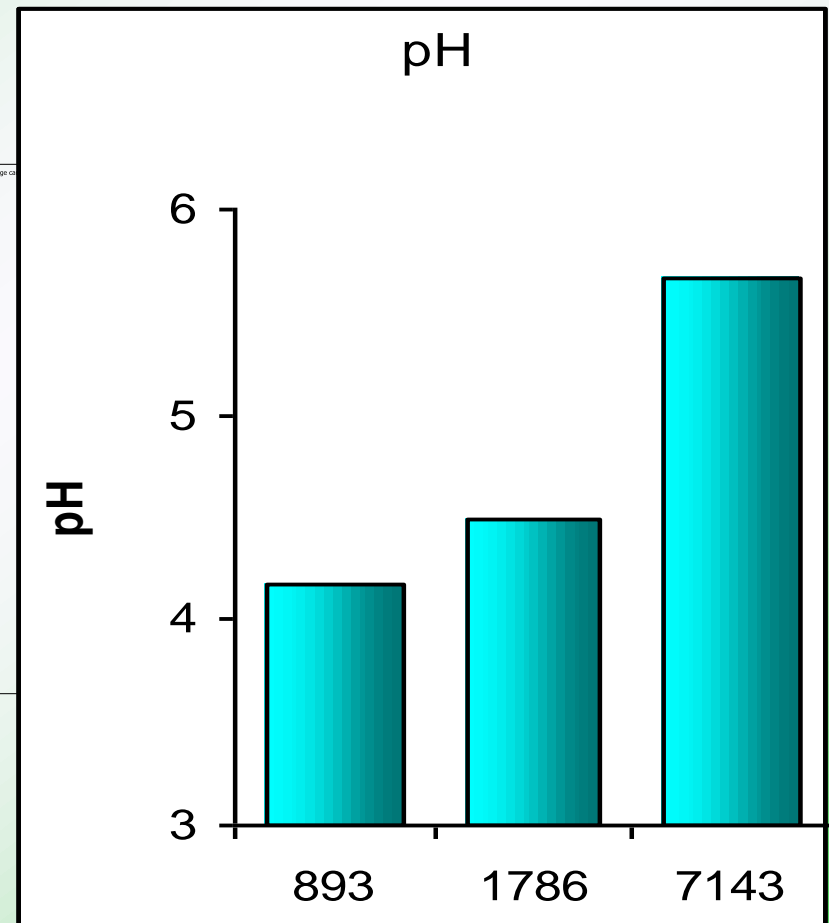
# **I) NEUTRALIZAÇÃO DA ACIDEZ DO SOLO POR RESÍDUOS VEGETAIS**

# Densidade do Cafeeiro

Pavan et al., 1994



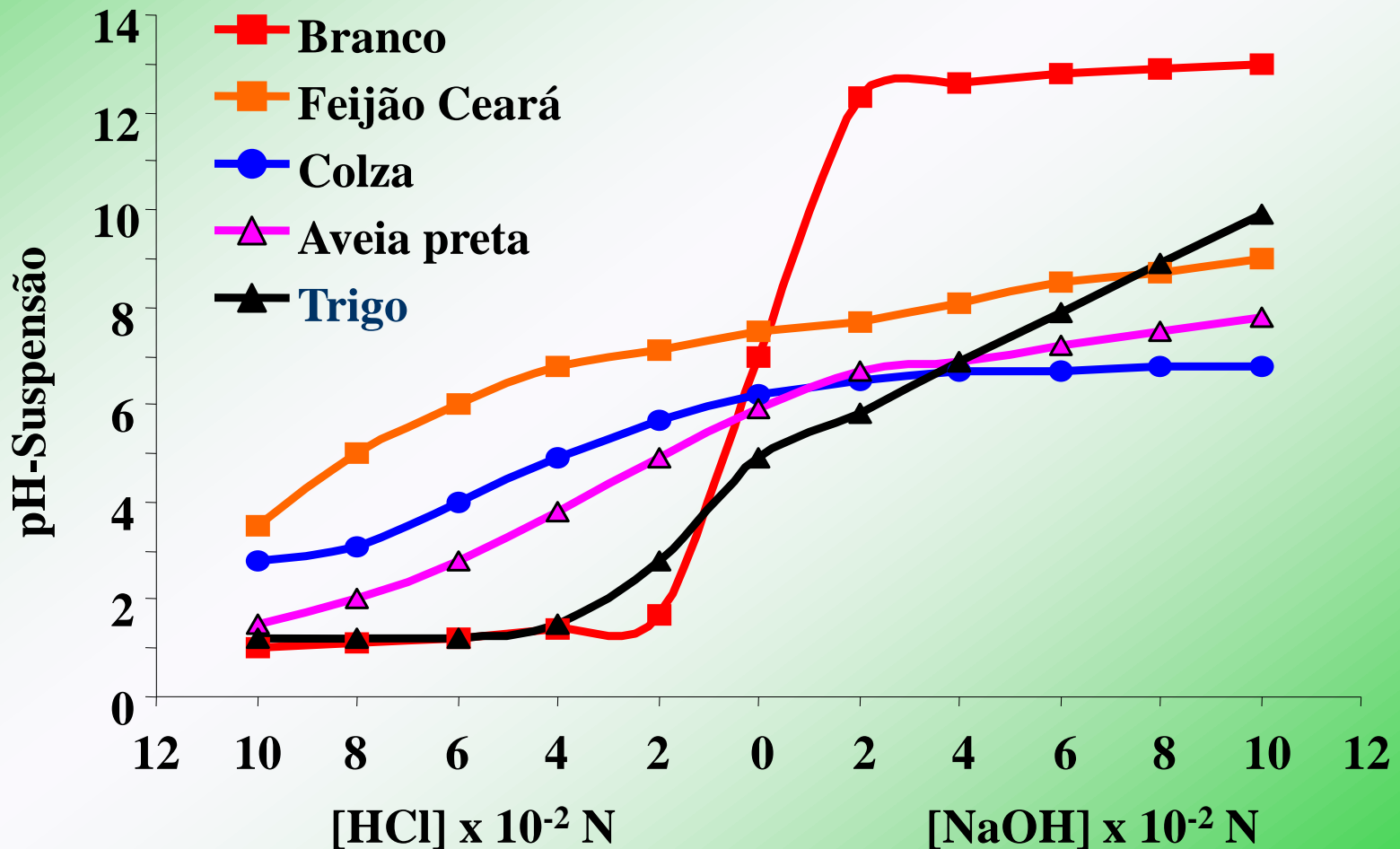
plantas por ha



plantas por ha

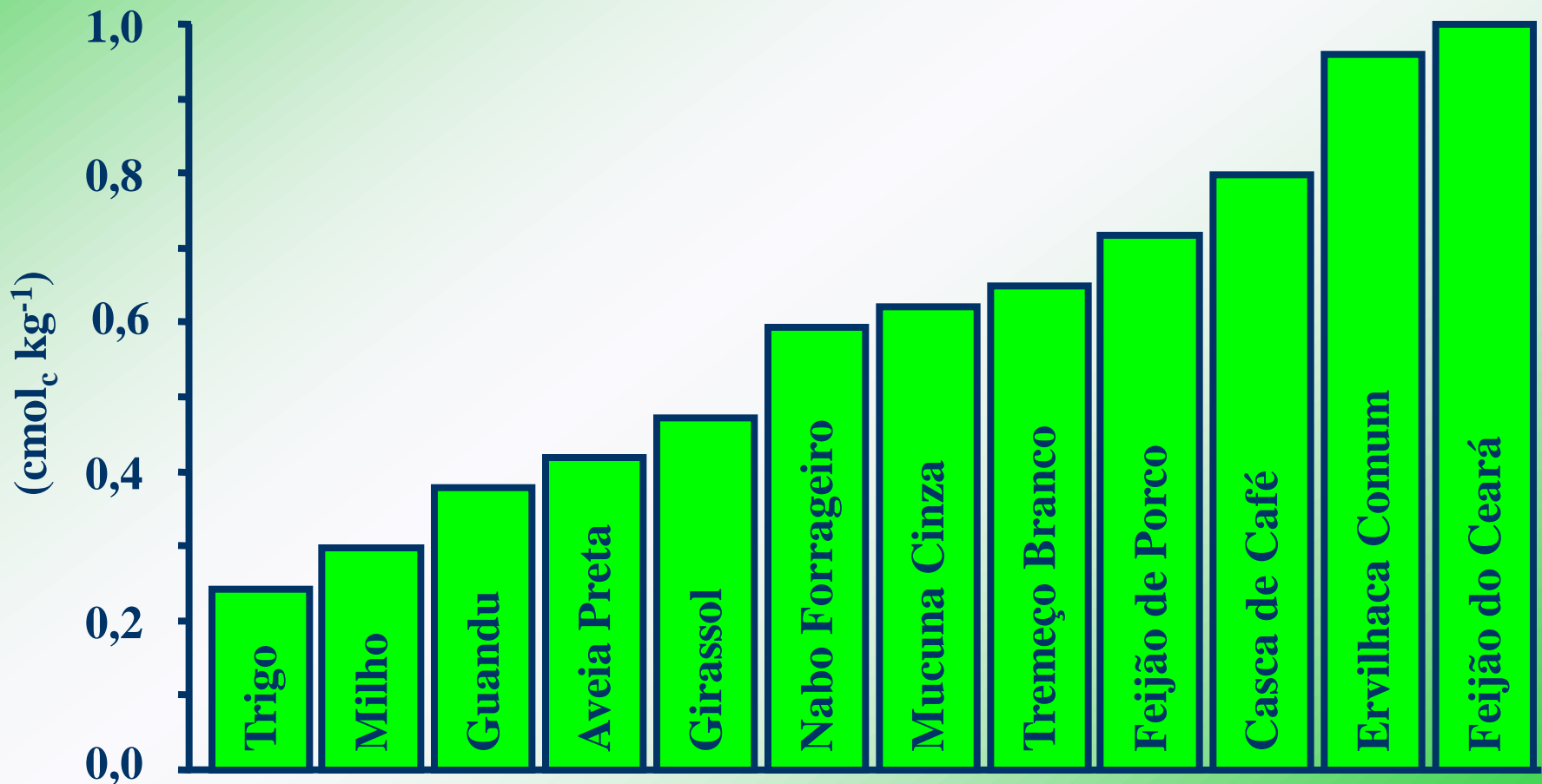
# Neutralização de $H^+$ e $OH^-$ dos resíduos vegetais

Miyazawa et al. (1993)



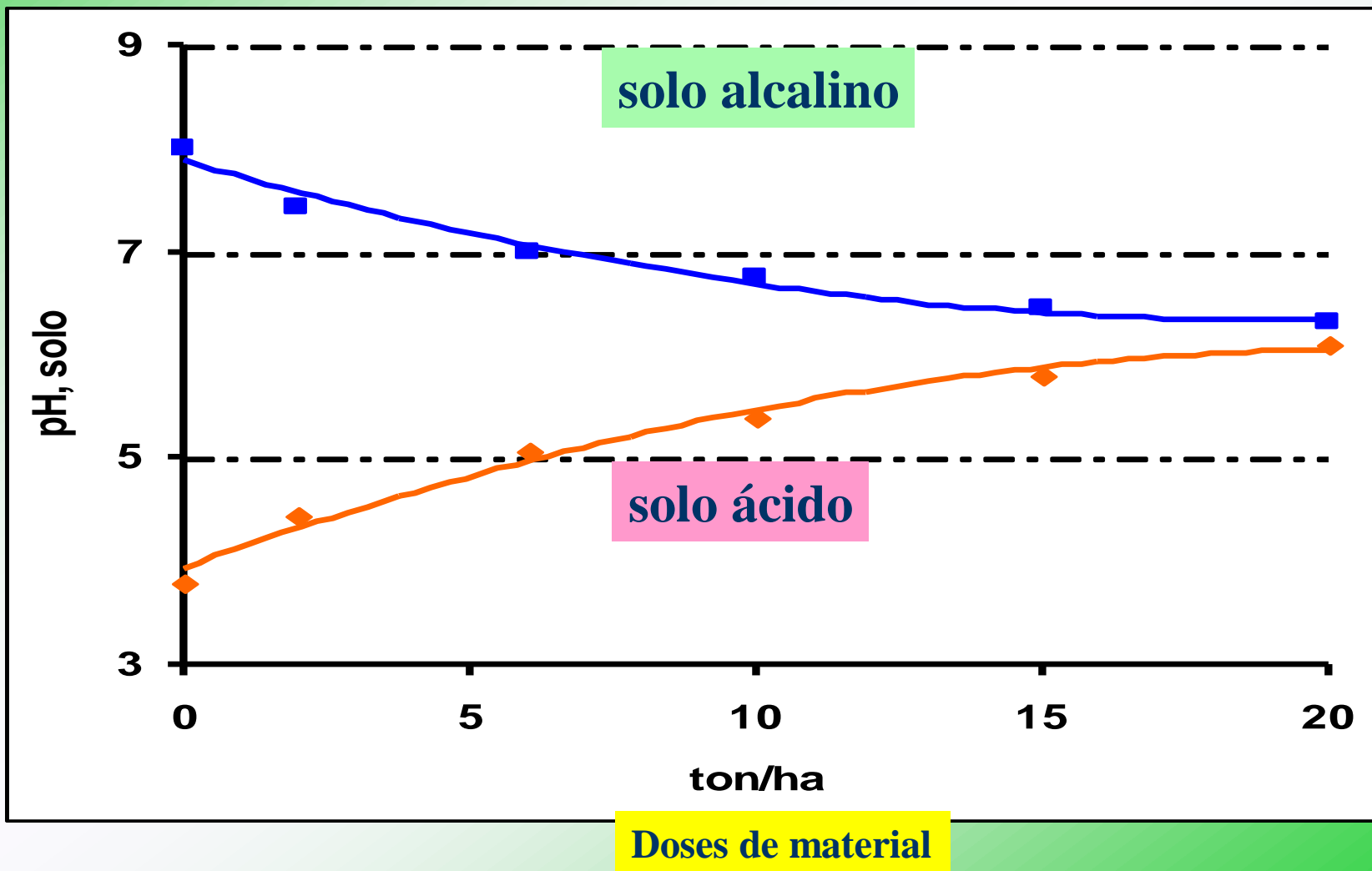
# Capacidade de Neutralização de $H^+$ dos Resíduos Vegetais

Miyazawa et al. (1993)





# Influência do Material Vegetal sobre o pH do Solo

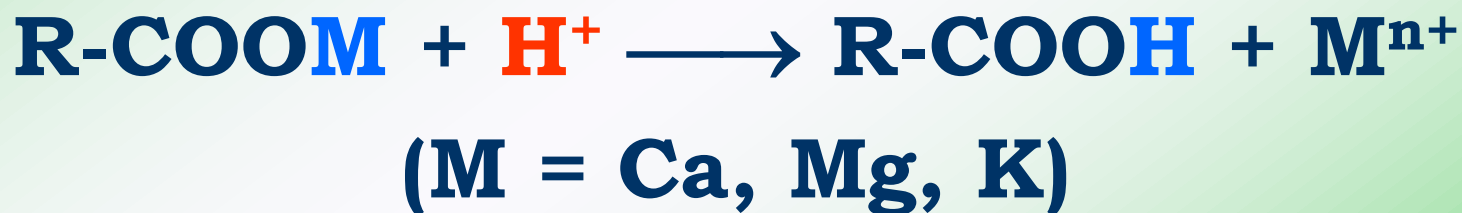




# Neutralização do pH

## Caráter anfótero da MO

- **Solo ácido** (aumento de pH)

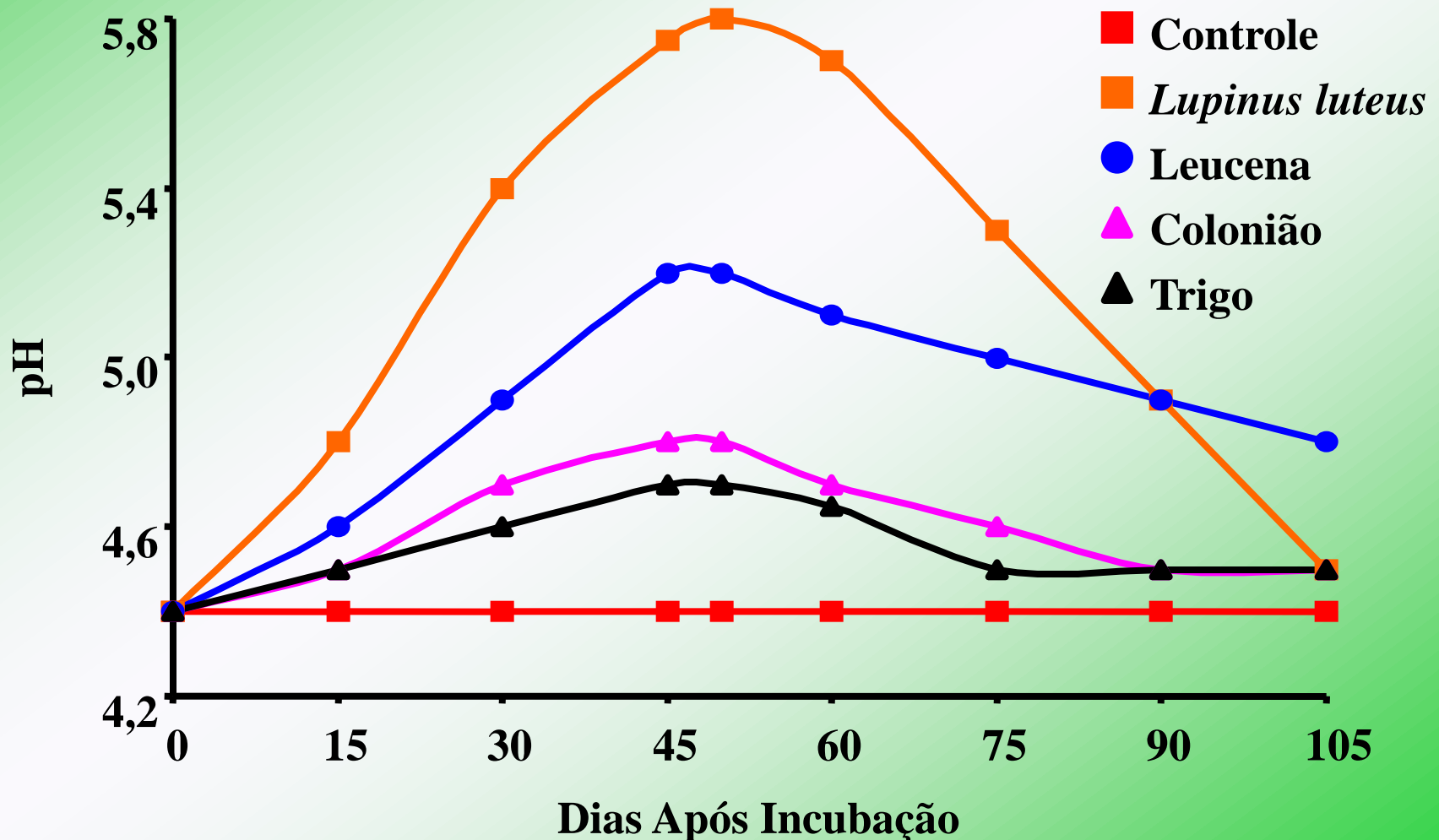


- **Solo alcalino** (diminuição de pH)



# Alteração do pH do solo pelos resíduos vegetais

Miyazawa et al. (1993)





**II) NEUTRALIZAÇÃO  
DA TOXIDEZ DE  
 $Al^{3+}$  POR  
RESÍDUOS ORGÂNICOS**



# Diagrama das espécies de Al

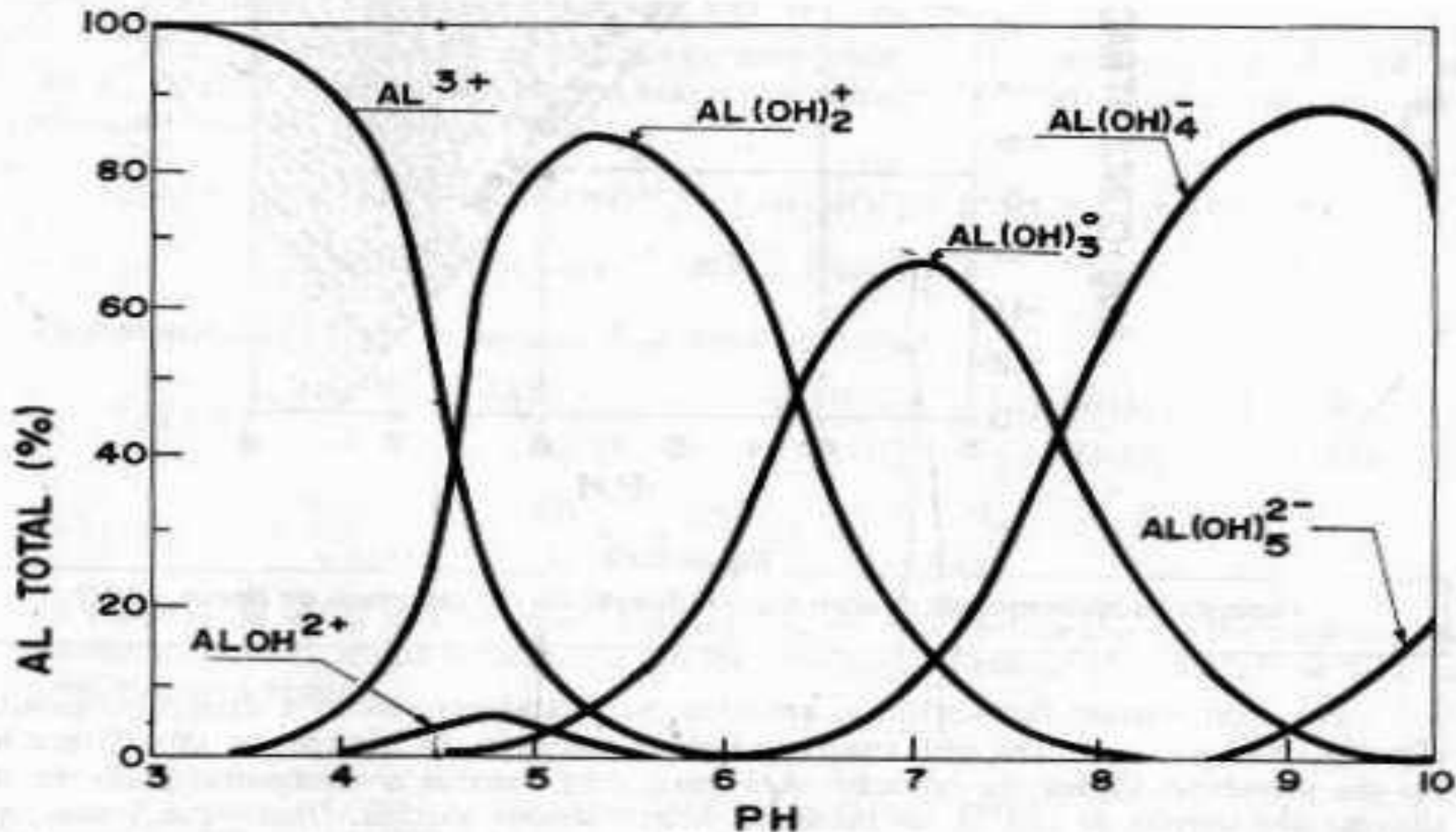
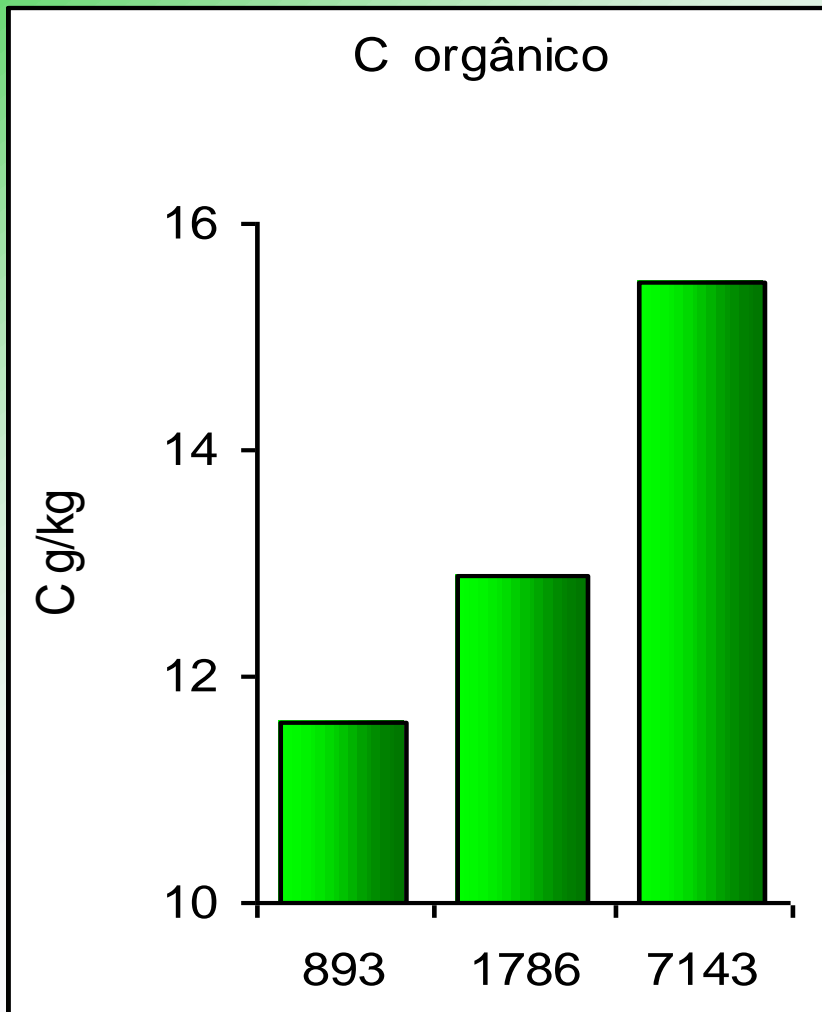


Figura 9.9

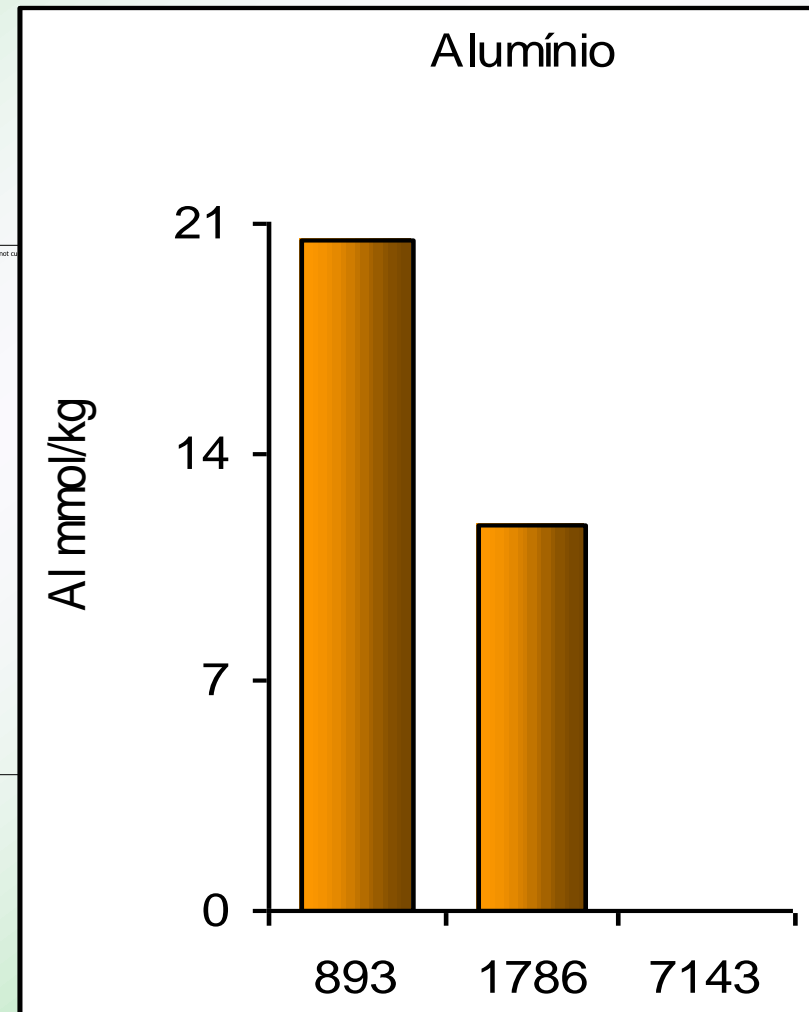
Relação entre várias formas de alumínio e pH (adaptada de Marion et al., 1976).

# Densidade do Cafeeiro

Pavan et al., 1994

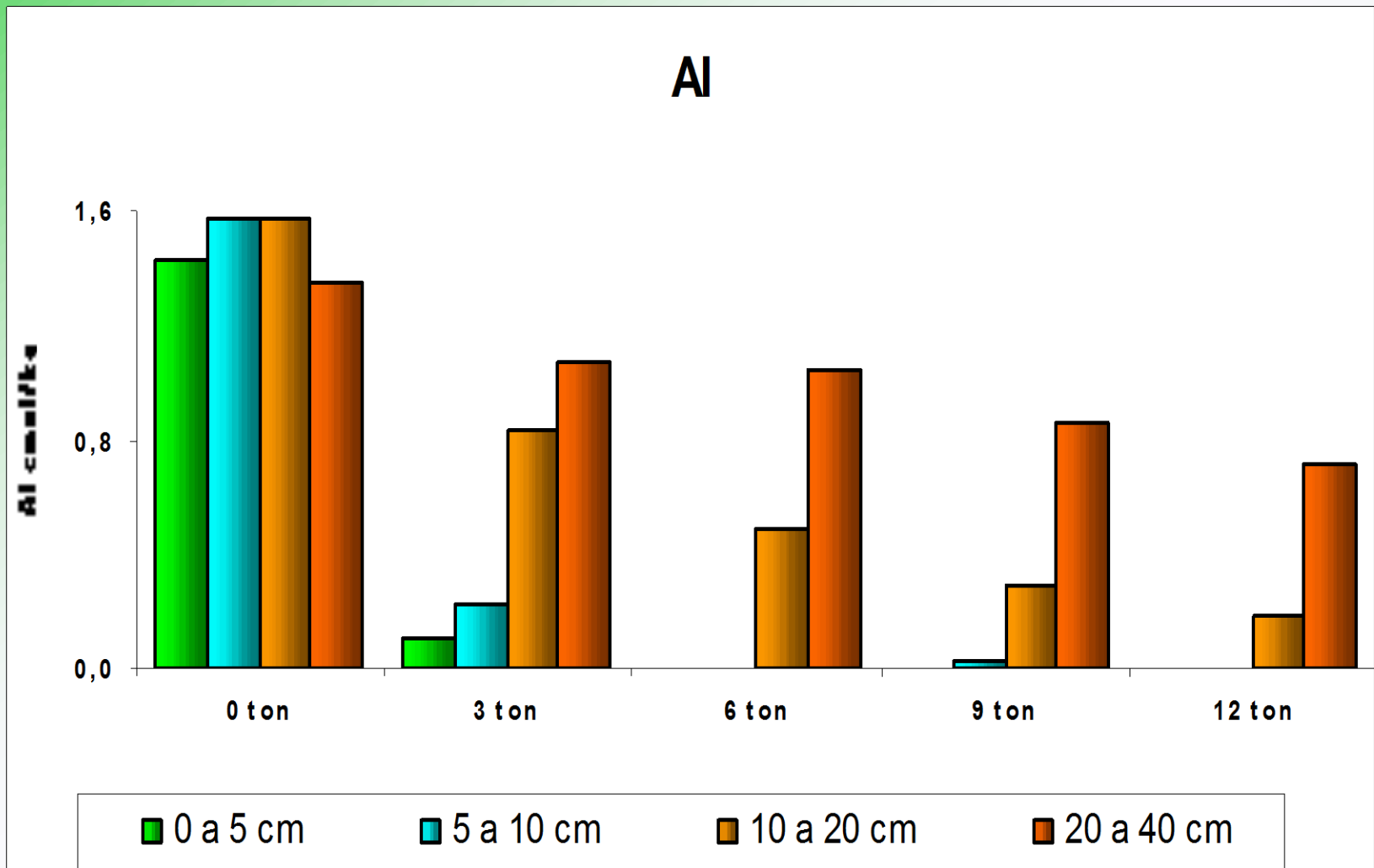


plantas/ha



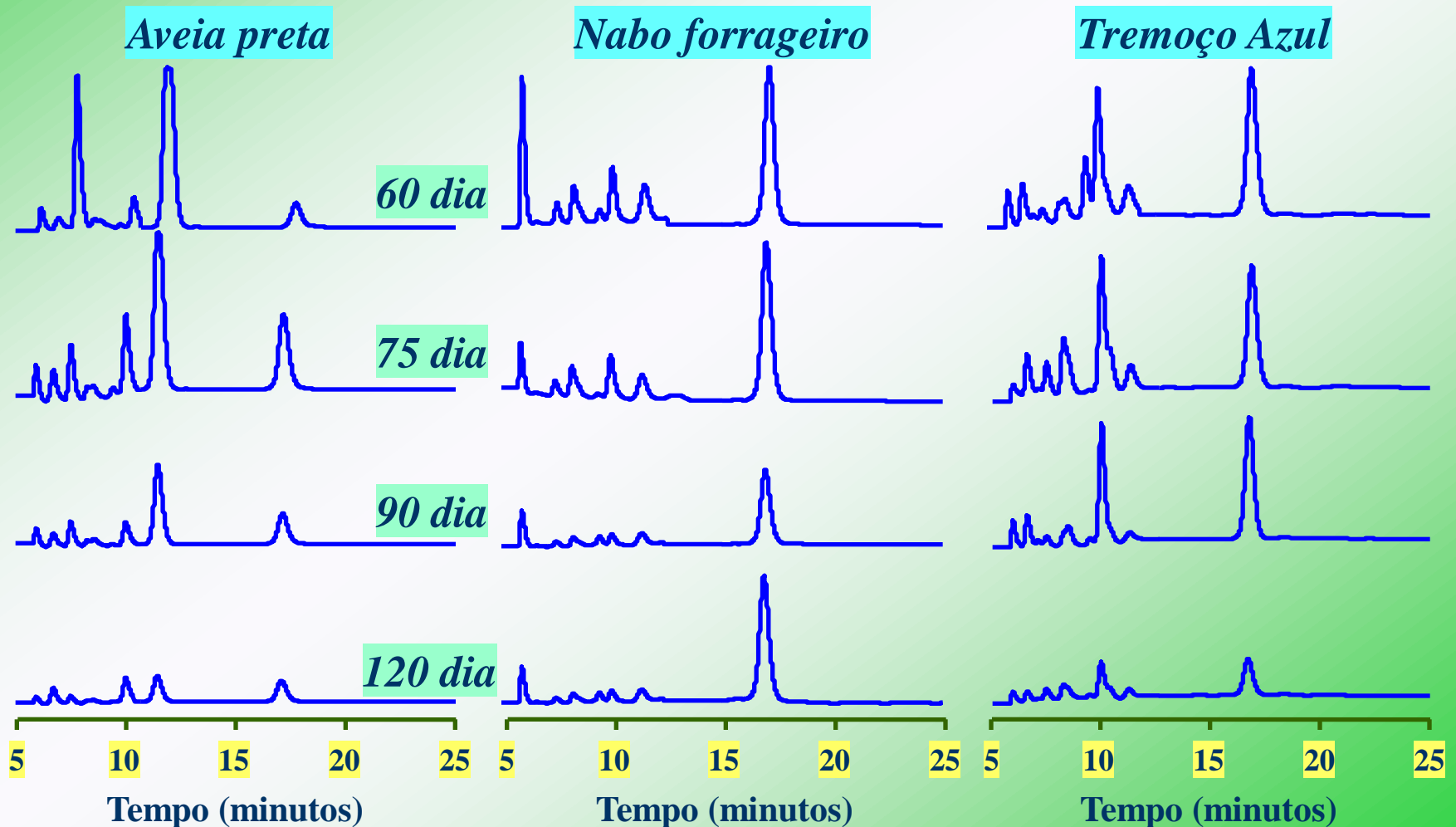
plantas/ha

# Calcário na Superfície do Solo



# Ácidos alifáticos dos adubos verdes - tempo de maturação

Franchini et al. (2000)





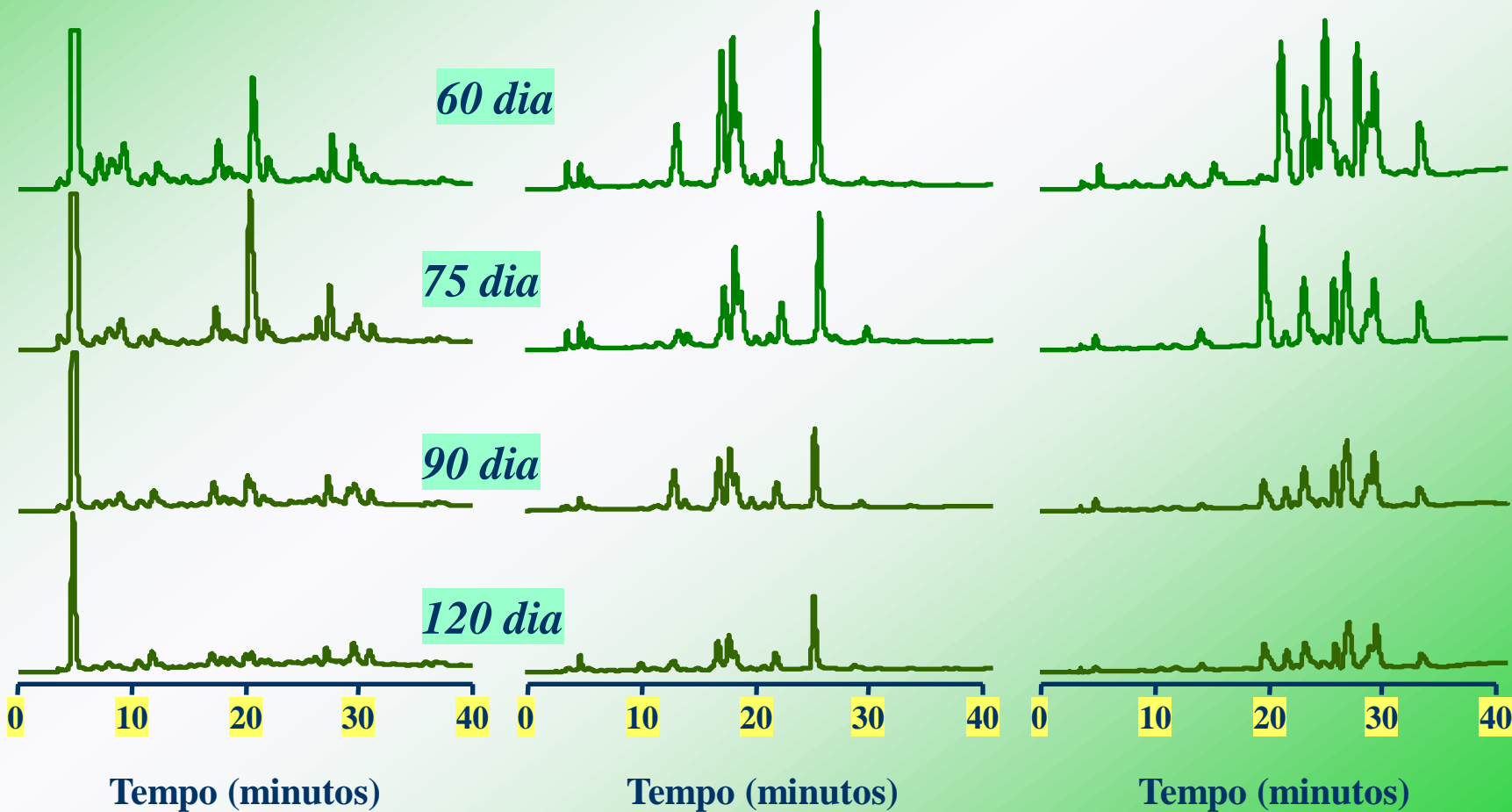
# Ácidos fenólicos dos adubos verdes - tempo de maturação

Franchini et al. (2000)

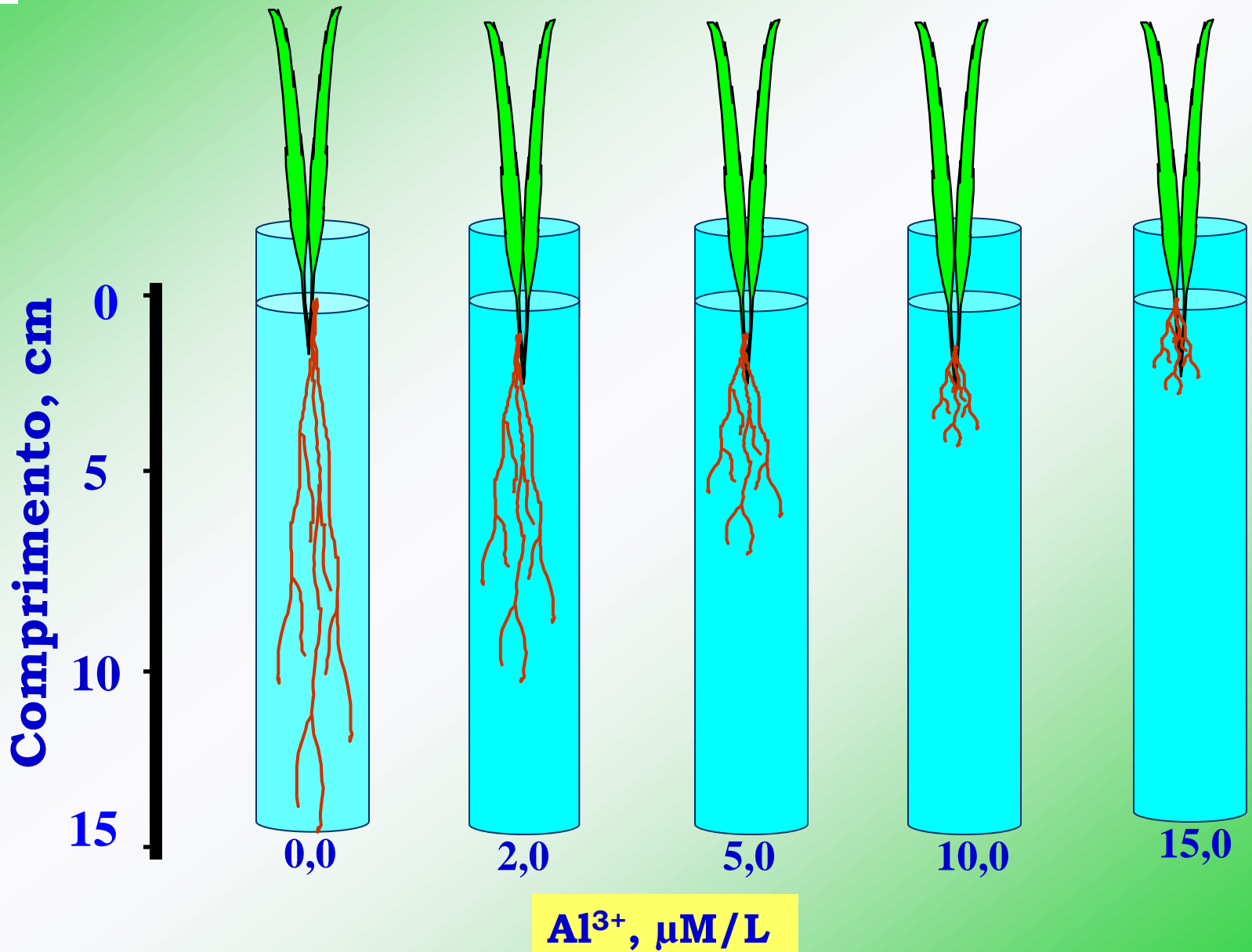
*Aveia preta*

*Nabo forrageiro*

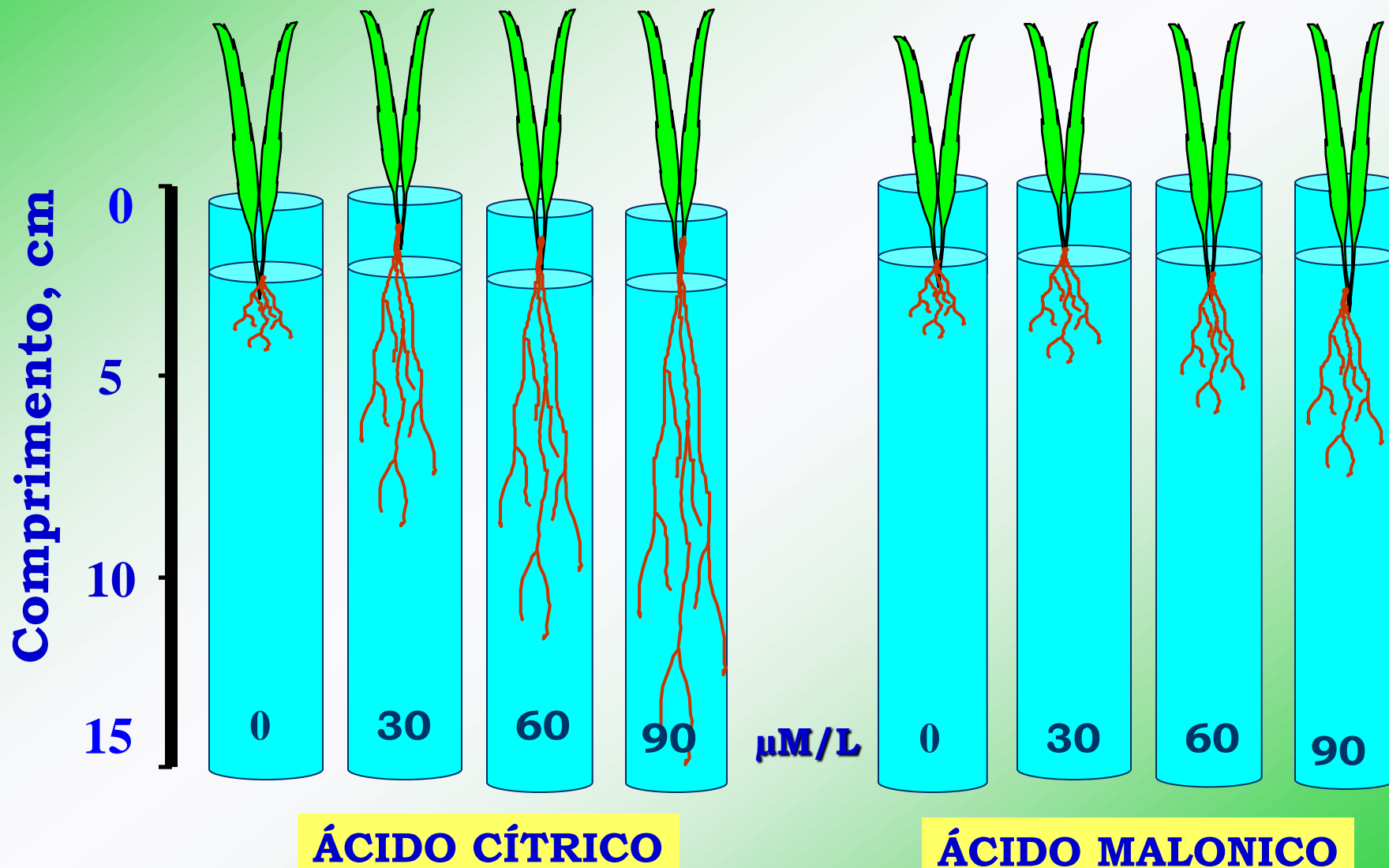
*Tremoço Azul*



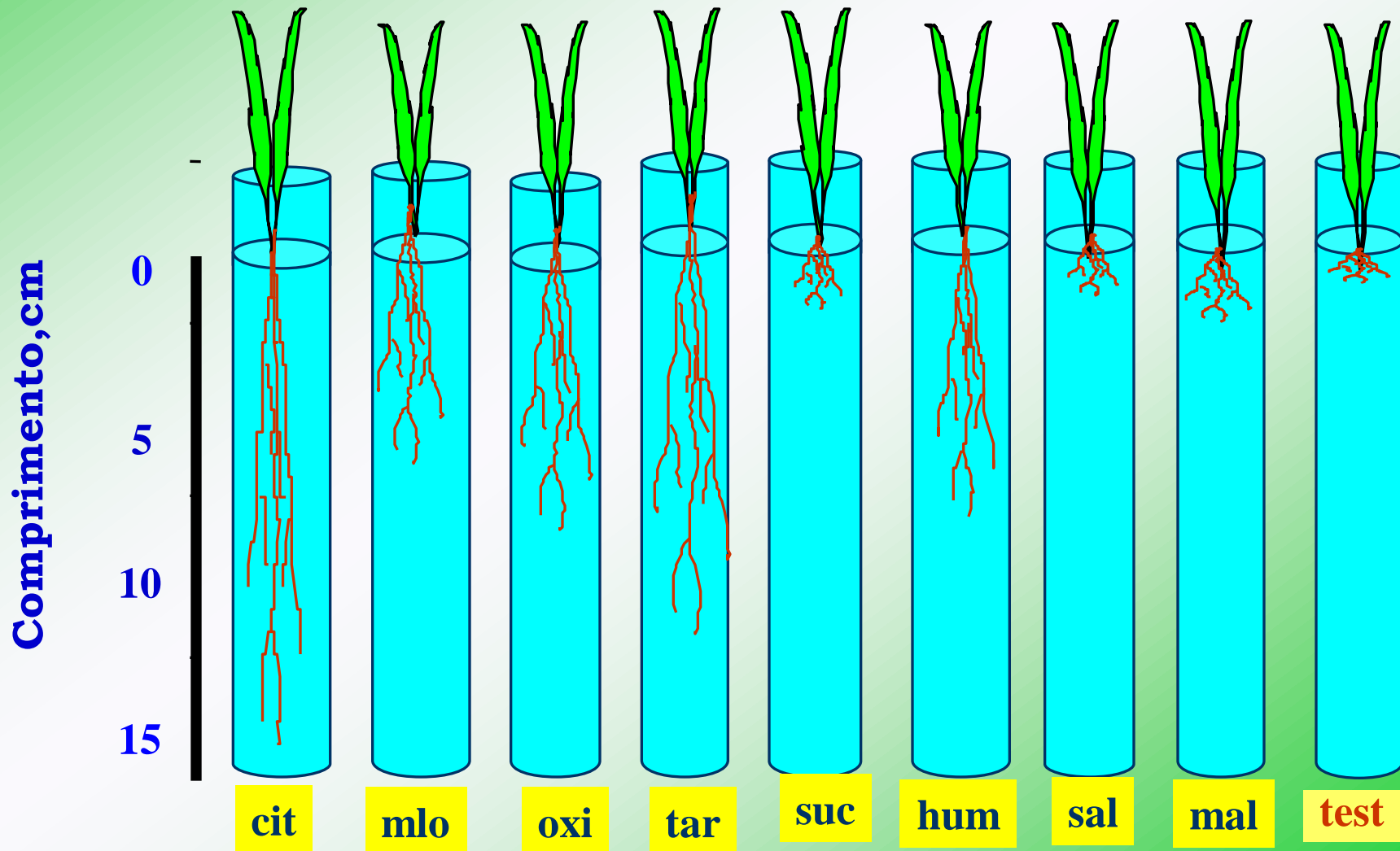
# TOXIDEZ DE $\text{Al}^{3+}$ , $\mu\text{M}$



# REDUÇÃO DE 20 $\mu\text{M}$ $\text{Al}^{3+}$ COM ÁCIDOS ORGÂNICOS

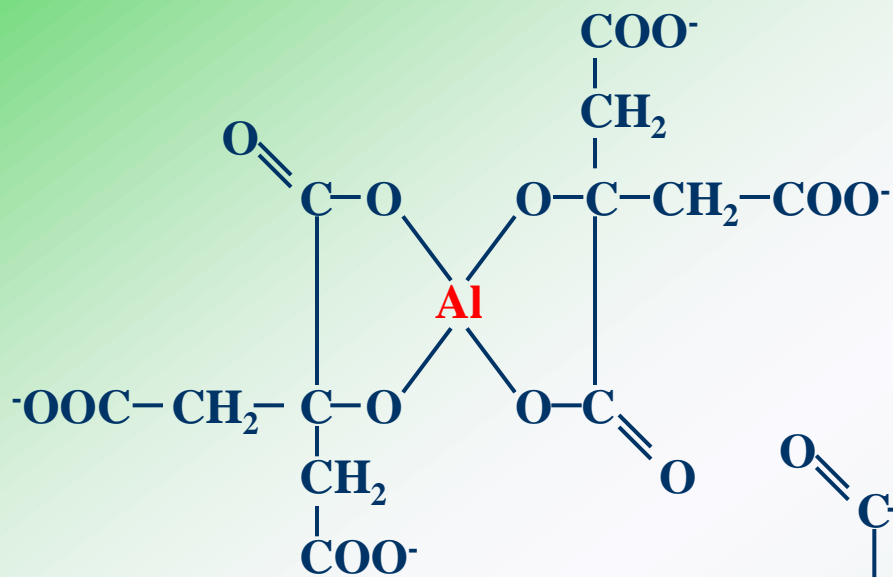


# NEUTRALIZAÇÃO DA TOXIDEZ DE $Al^{3+}$ POR ÁCIDOS ORGÂNICOS

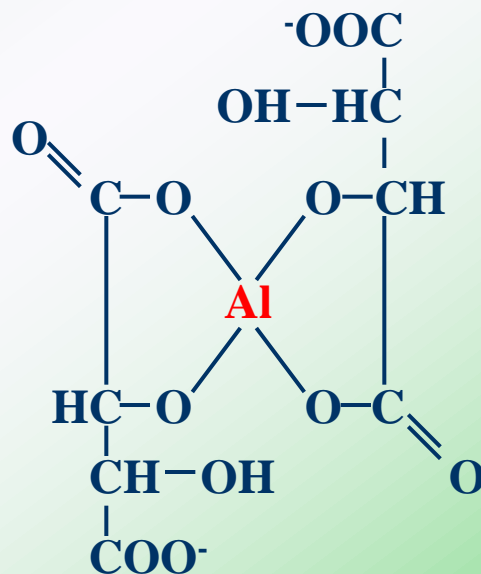




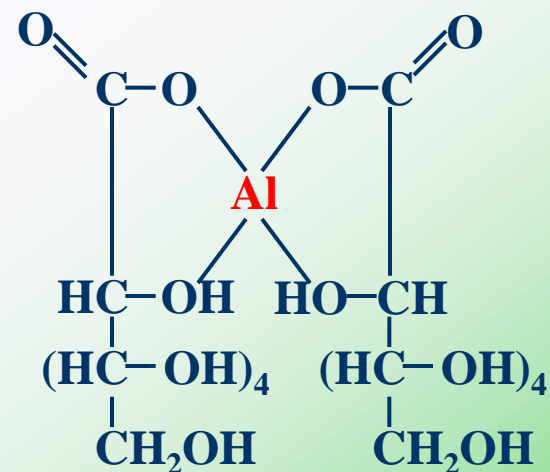
# Estrutura molecular de complexos Al-orgânico



CITRATO



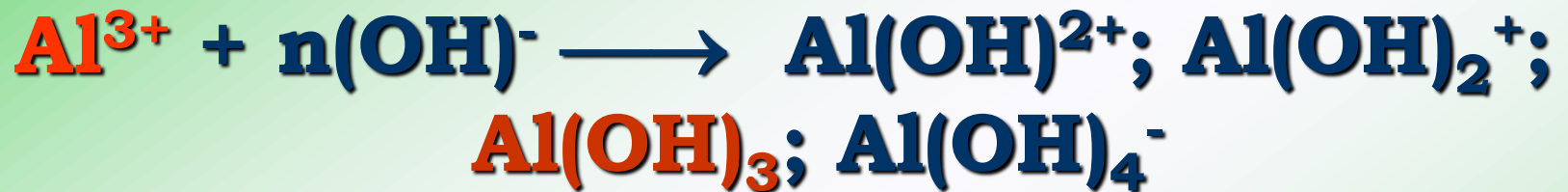
TARTARATO



GLUCONATO

# Neutralização do Al do Solo

- **Hidrólise do Al**



(calcário, resíduos vegetais)

- **Complexação por ligantes orgânicos**

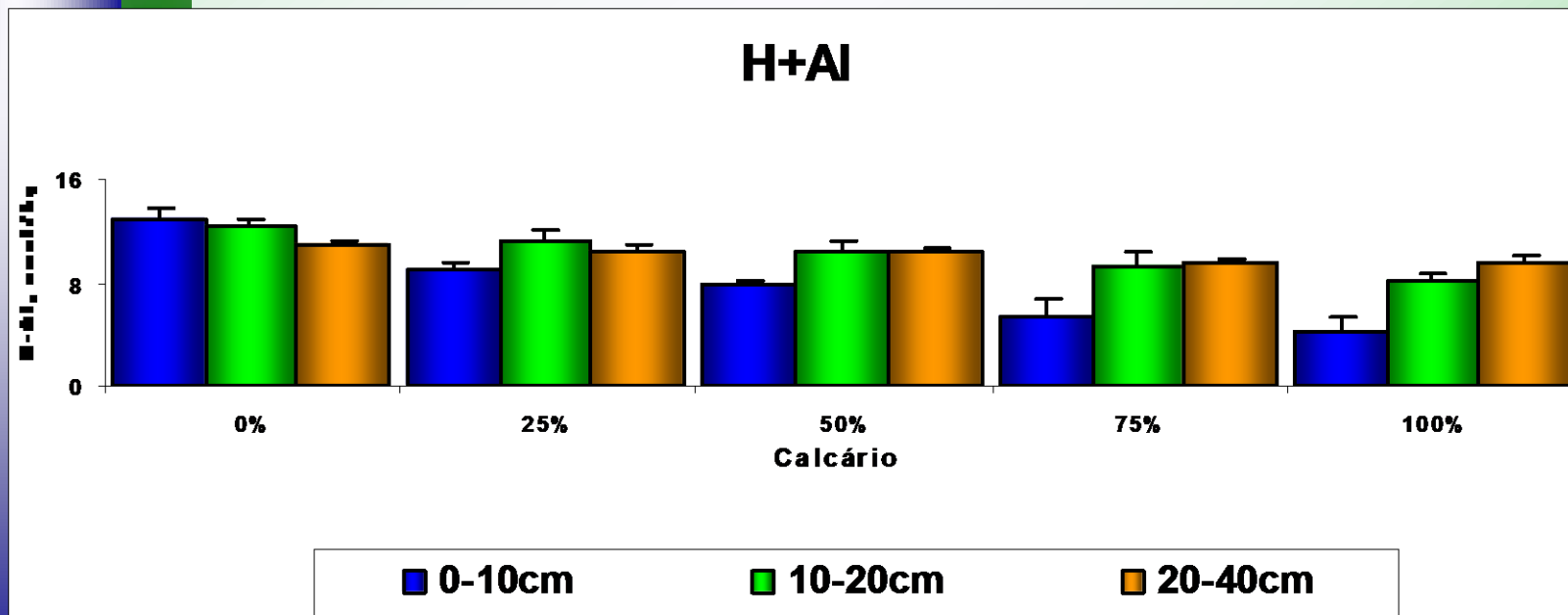
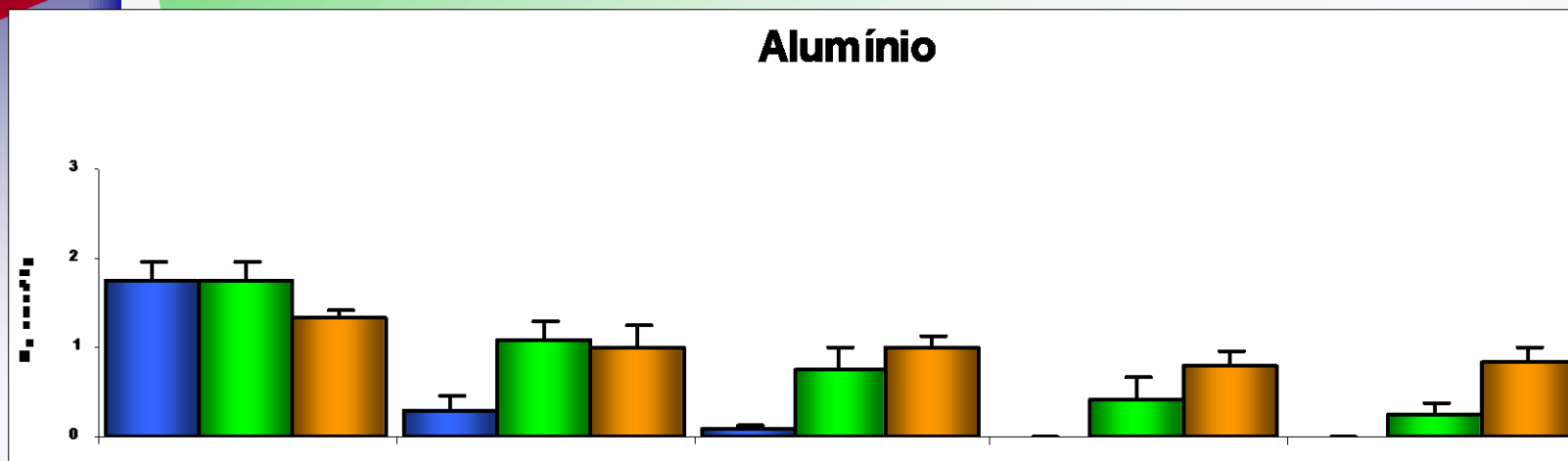


(L = ligante orgânico)

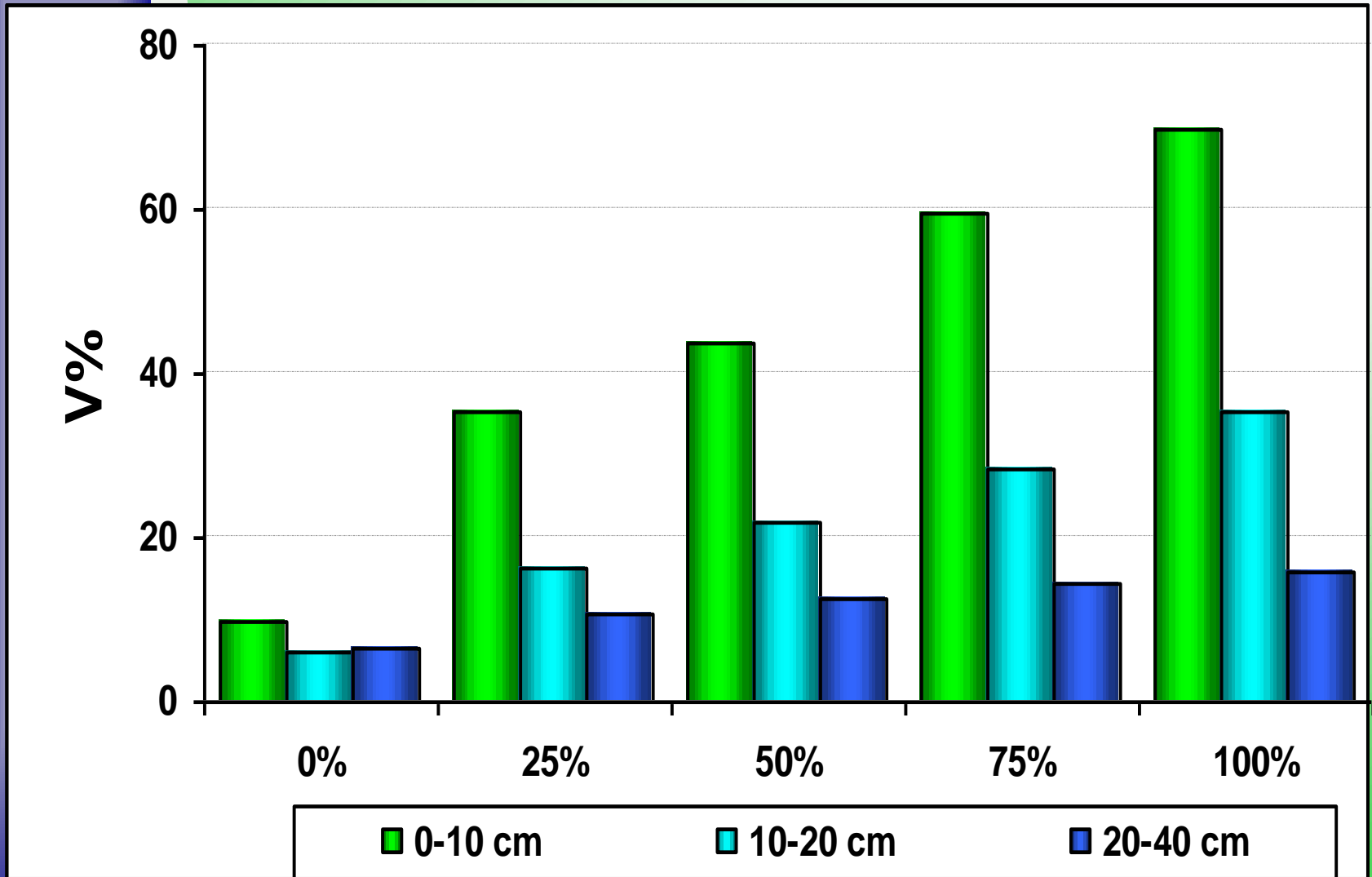


***CALAGEM EM  
PLANTIO DIRETO E  
PRODUTIVIDADE  
AGRÍCOLA***

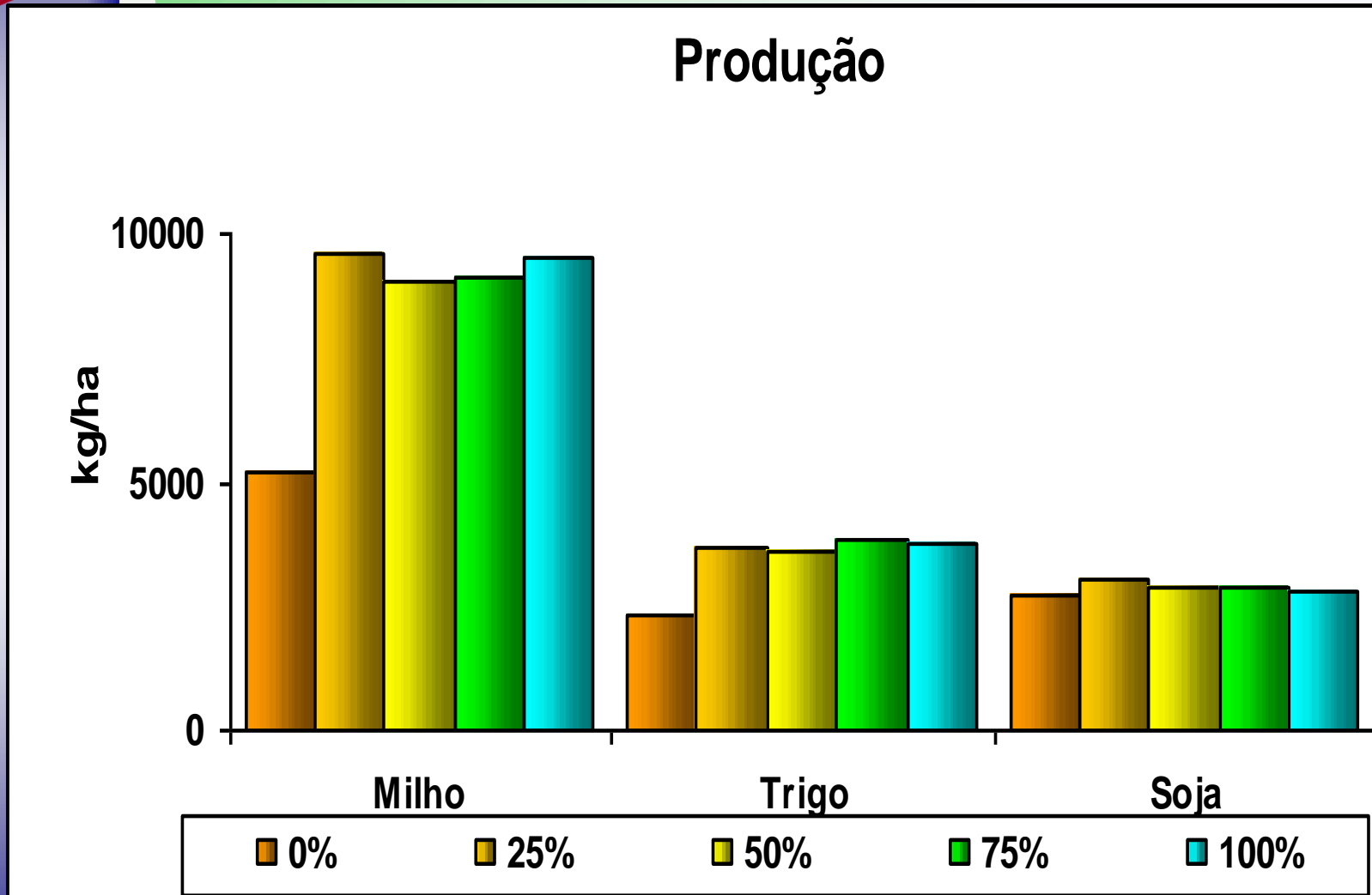
# Al e H + Al do Solo, 36 m

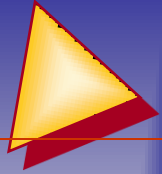


# Saturação por Bases, 36 m

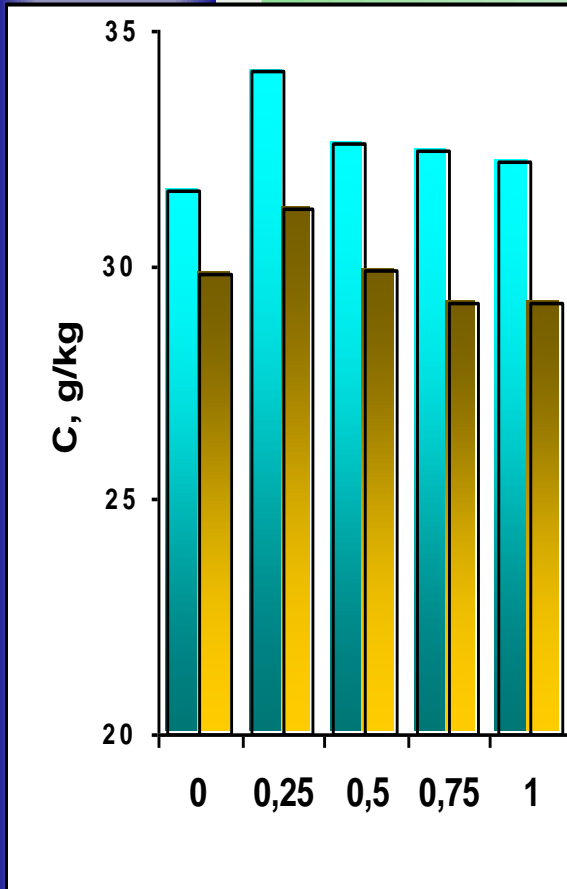


# Produção Agrícola

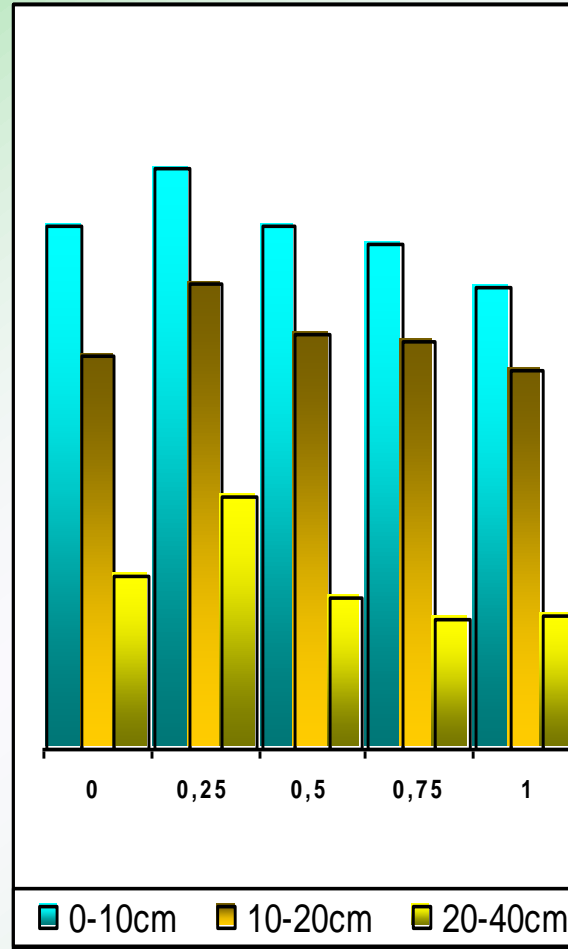




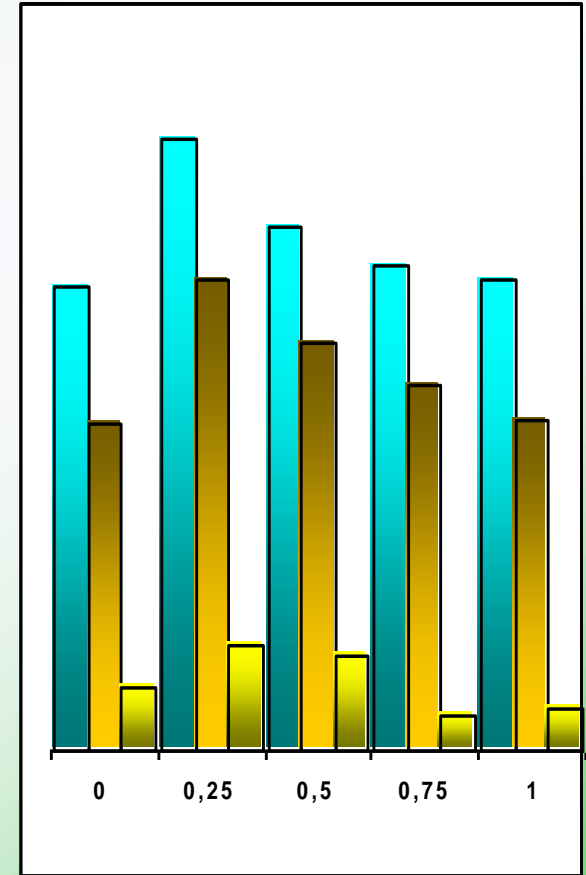
# Carbono no Solo



5 mês



12 mês

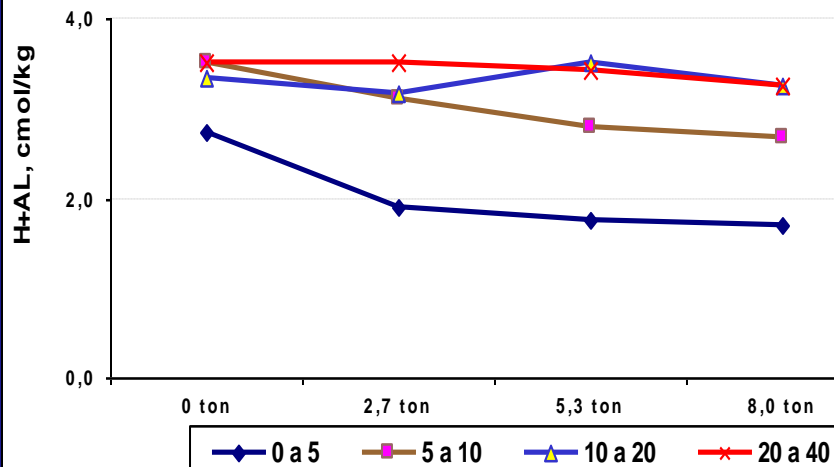


36 mês

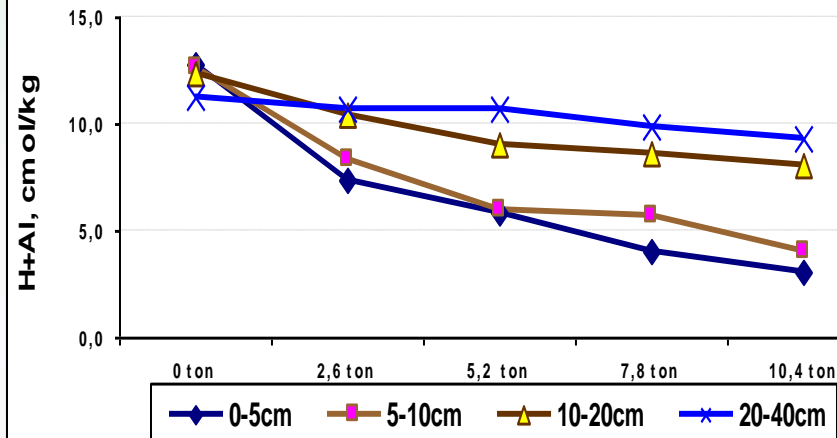


# H + Al, Mauá e Paranavaí

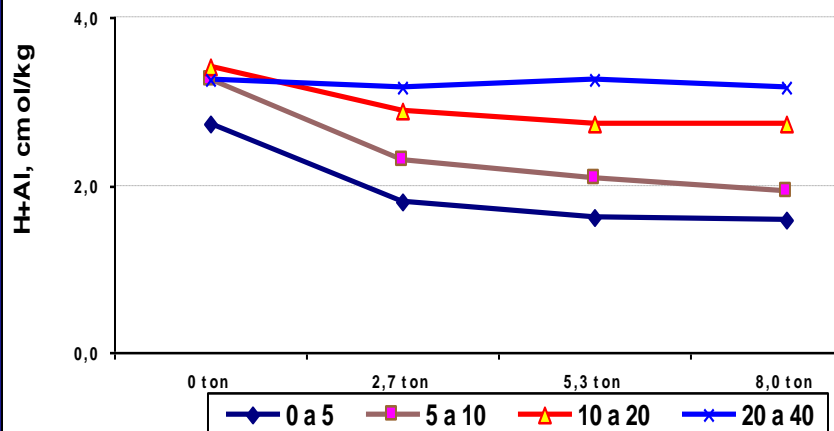
H+Al, 12 mês - Paranavaí



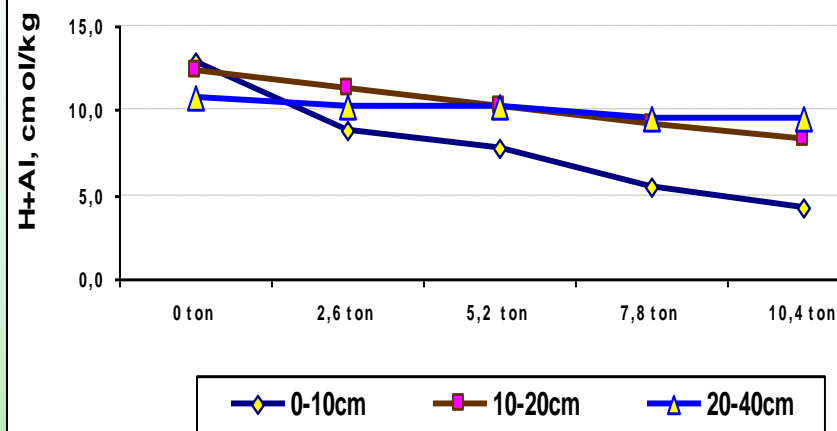
H+Al, 12 mês - Mauá



H+Al, 36 mês, Paranavaí

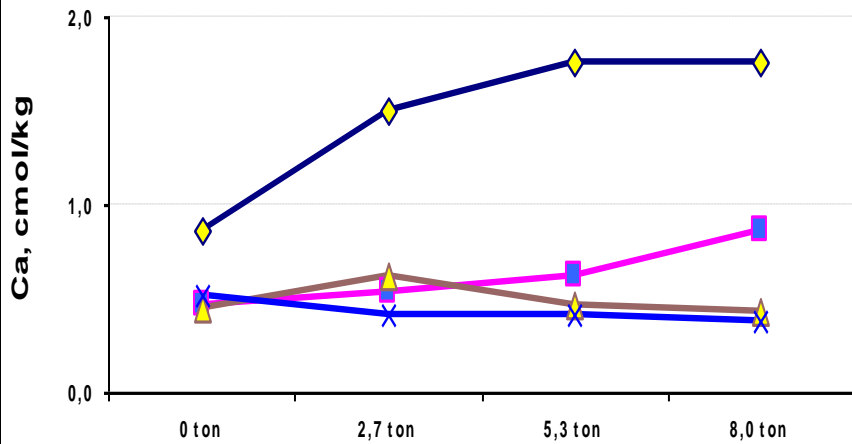


H+Al, 36 mês - Mauá

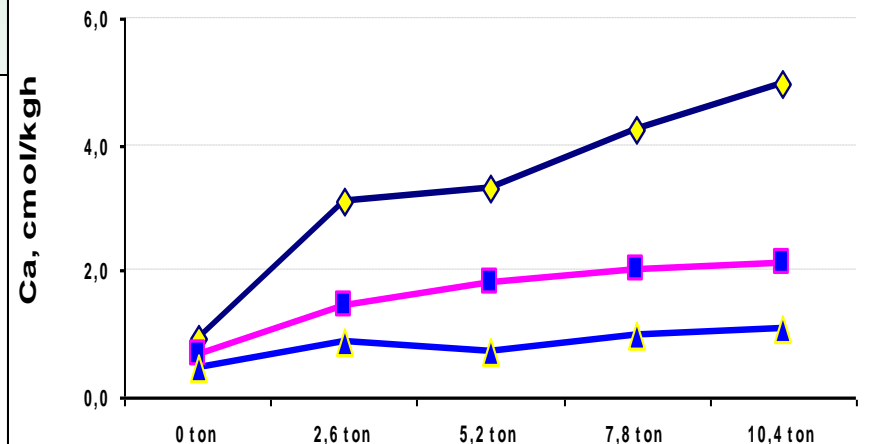


# Ca e Mg, 1 Ano - Mauá e Paranaíba

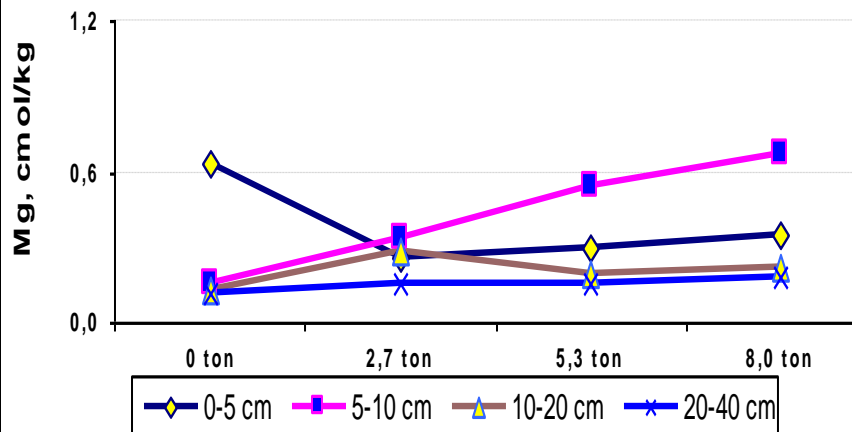
Ca, 12 mês - Paranaíba



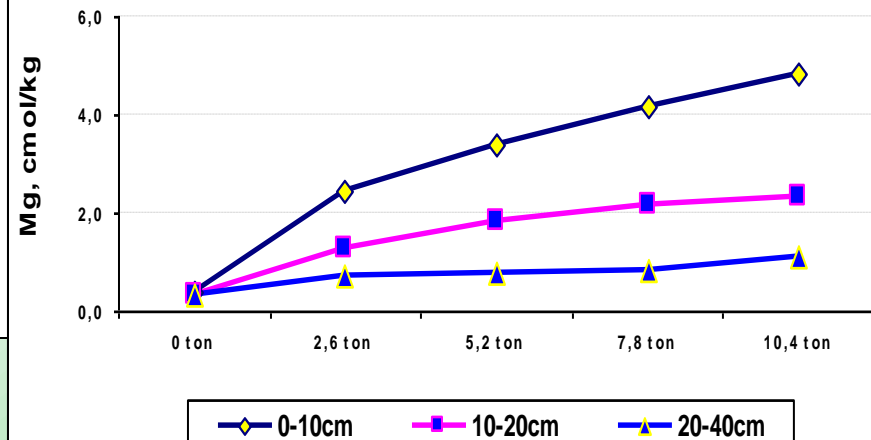
Ca, 12 mês - Mauá



Mg, 12 mês - Paranaíba

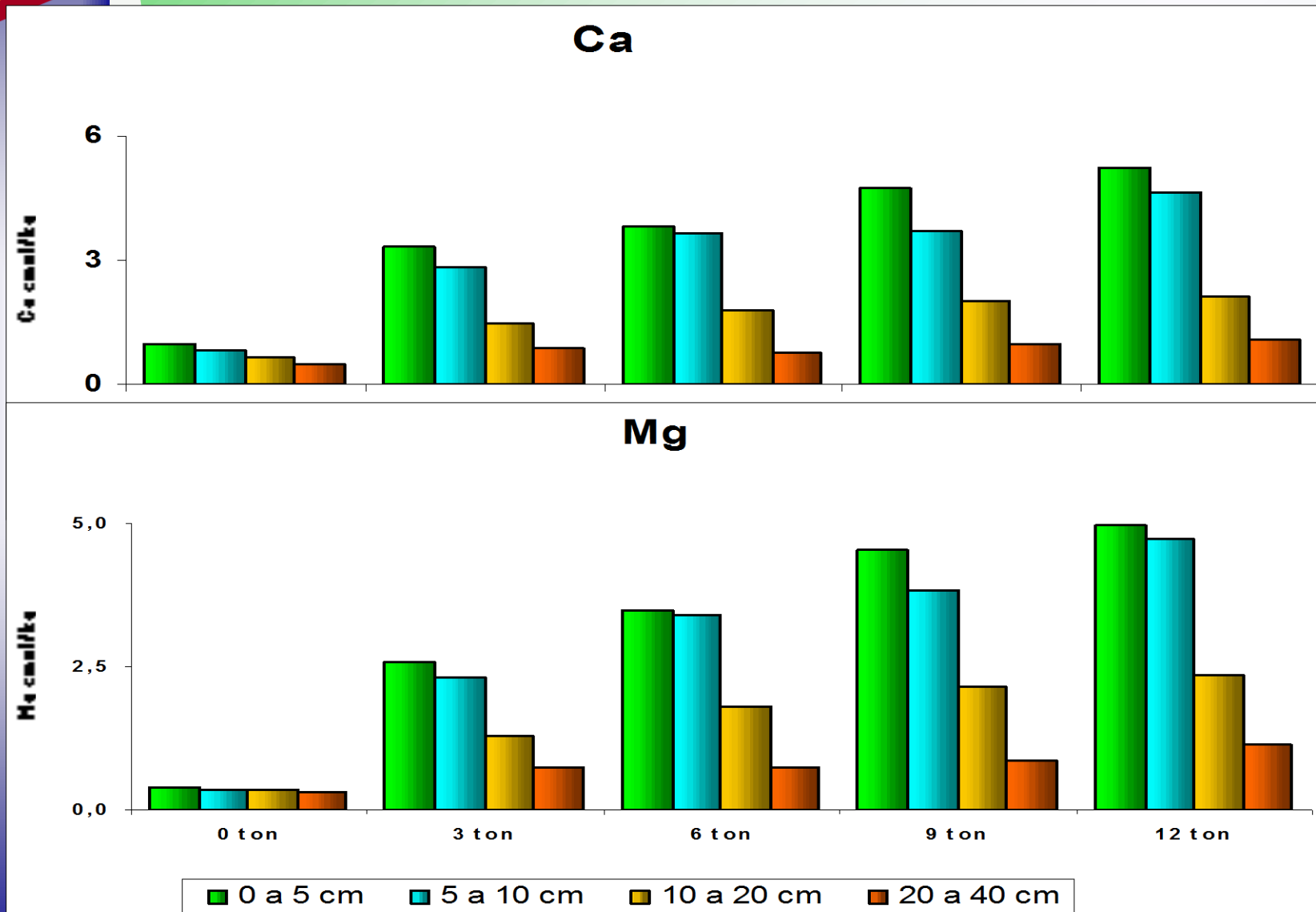


Mg, 12 mês - Mauá



# **III) TRANSPORTE DE CÁTIONS NO SOLO POR LIGANTES ORGÂNICOS**

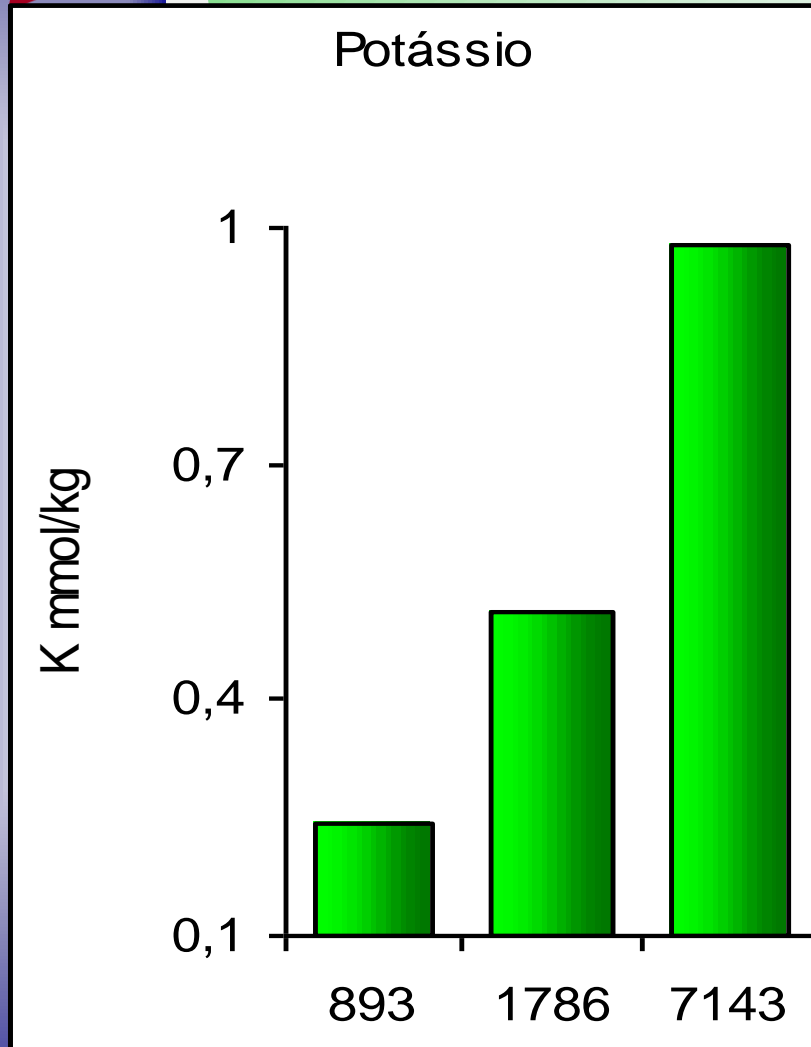
# Calcário na Superfície do Solo



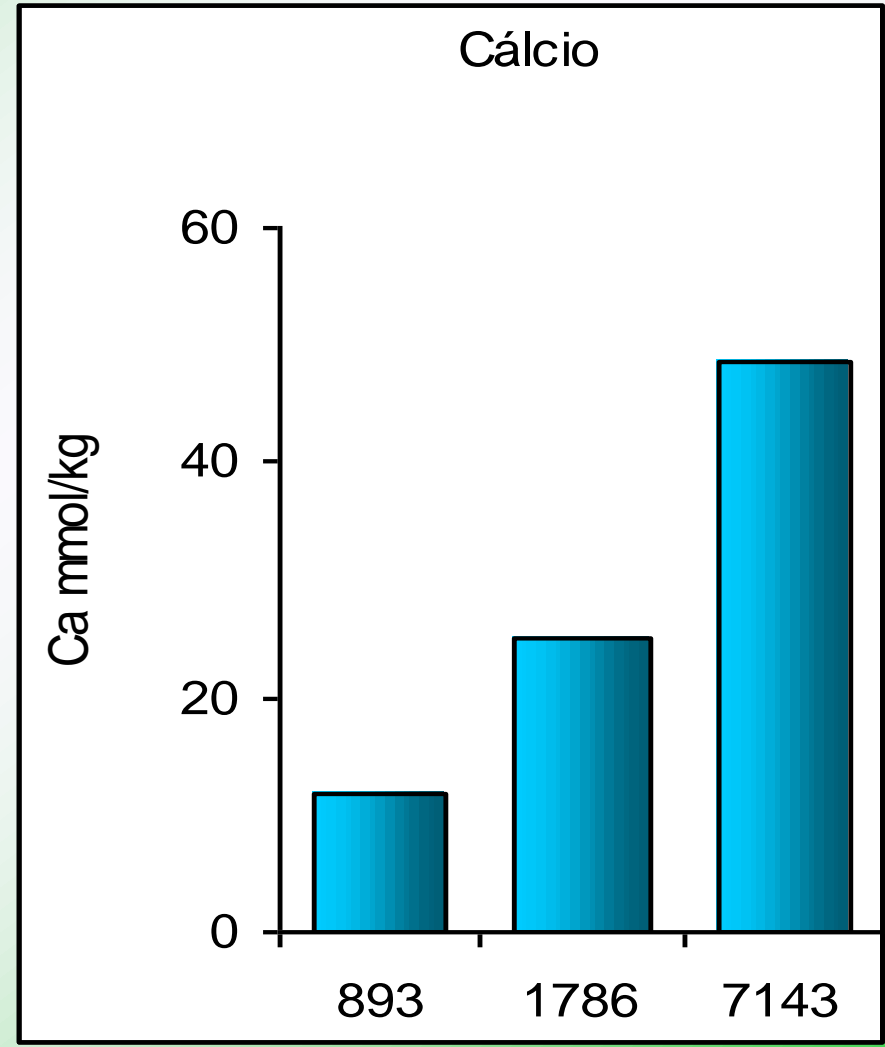


# Densidade de Cafeeiro

Pavan et al., 1994

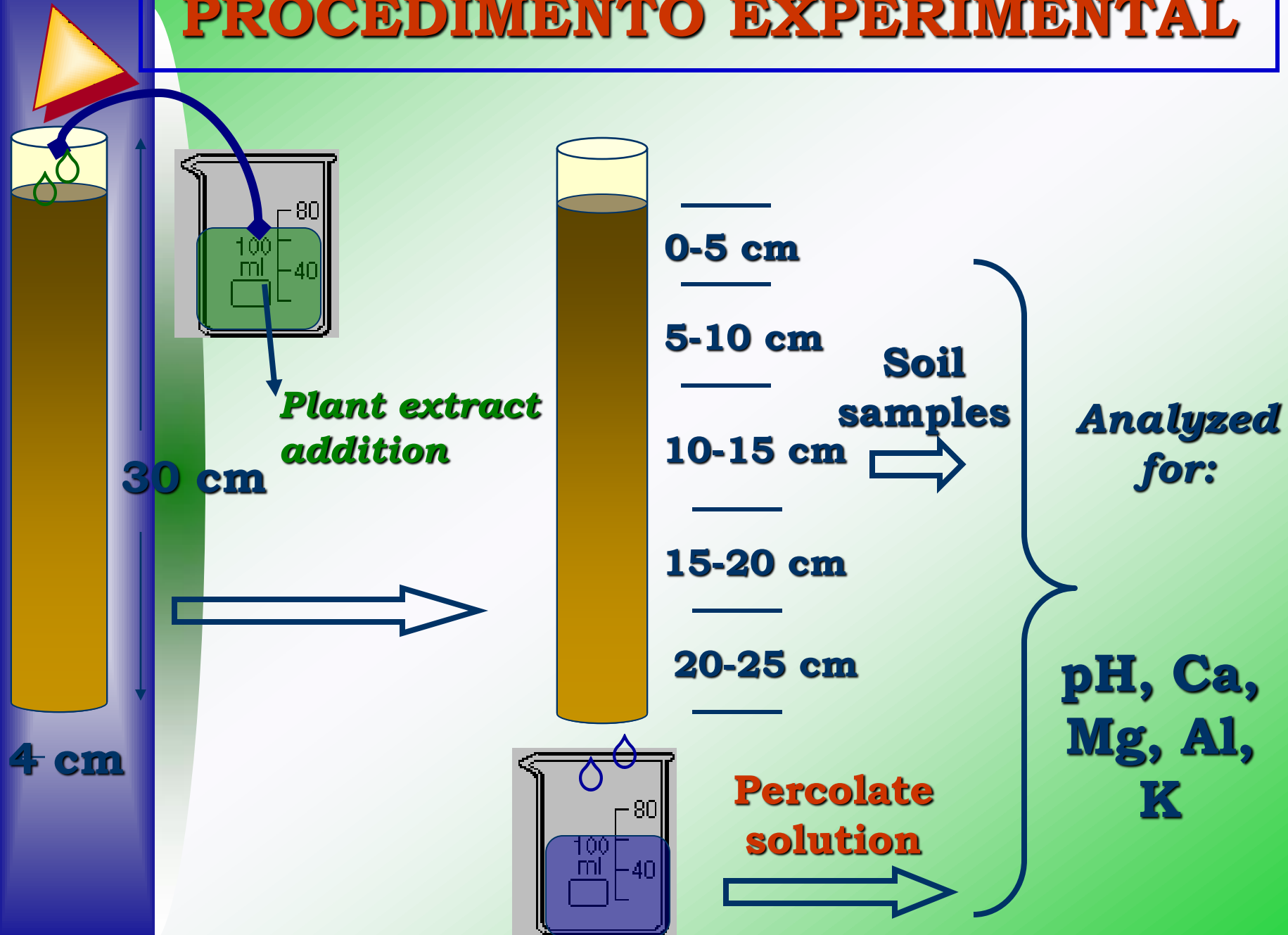


planta/ha



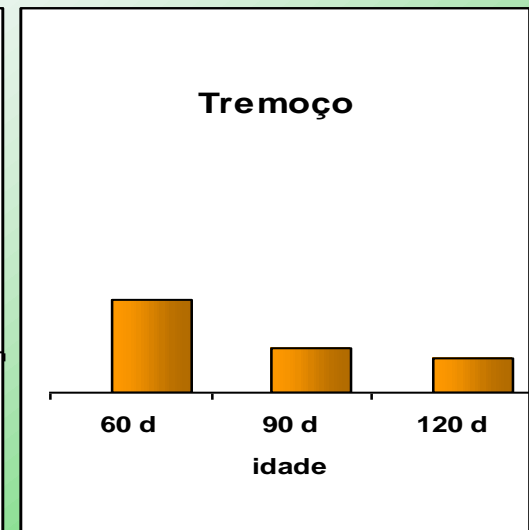
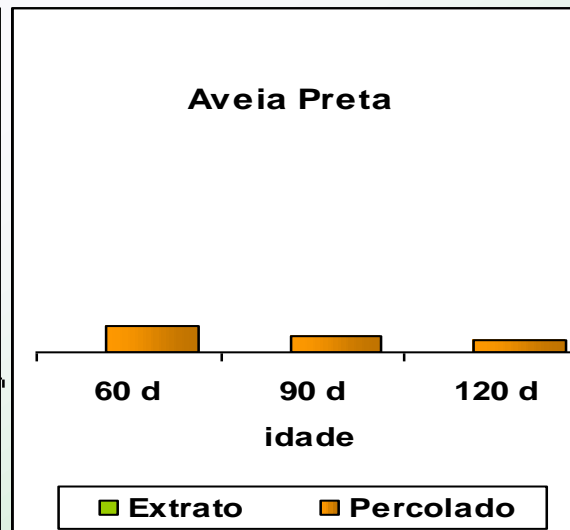
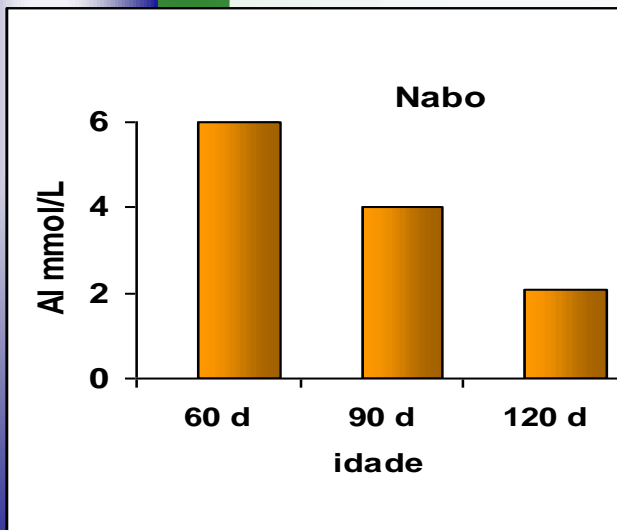
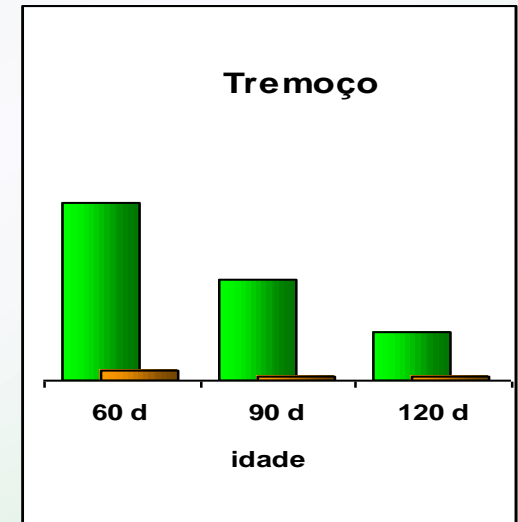
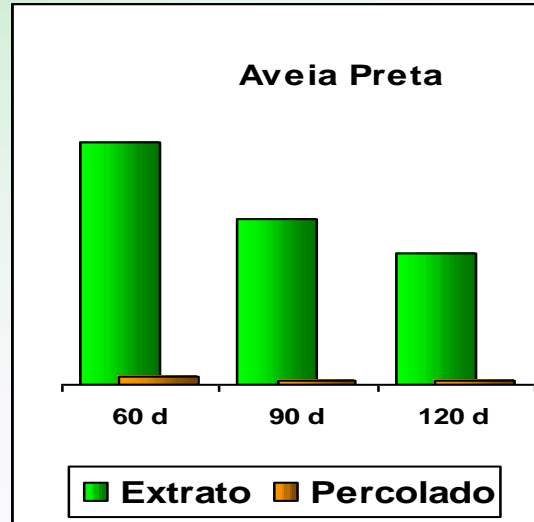
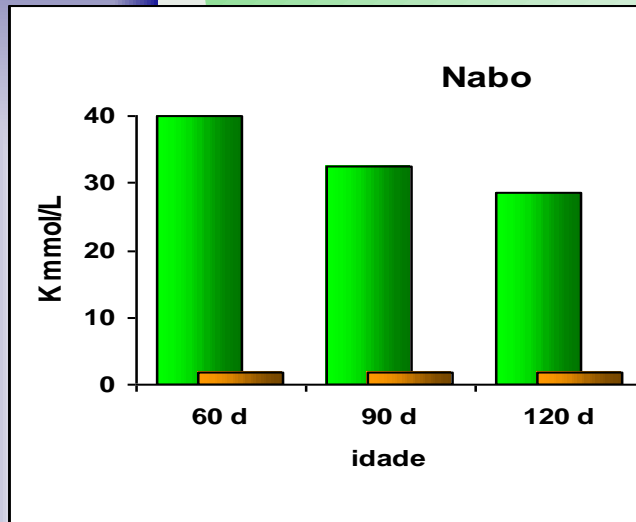
planta/ha

# PROCEDIMIENTO EXPERIMENTAL



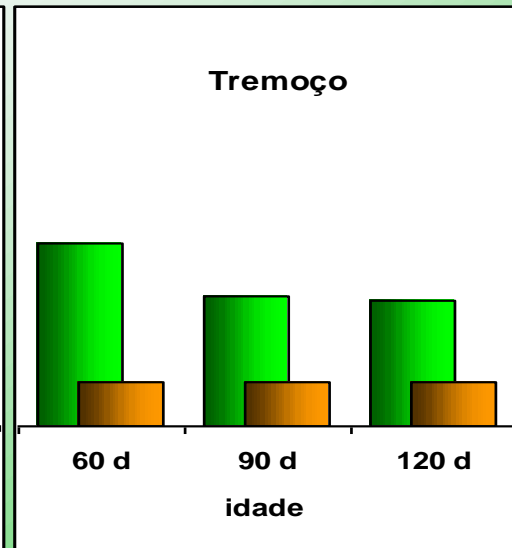
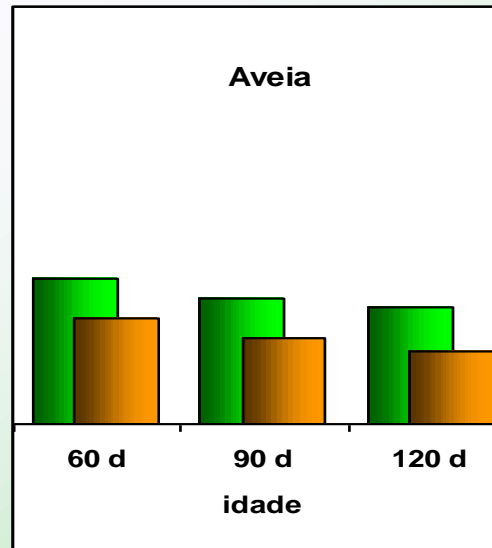
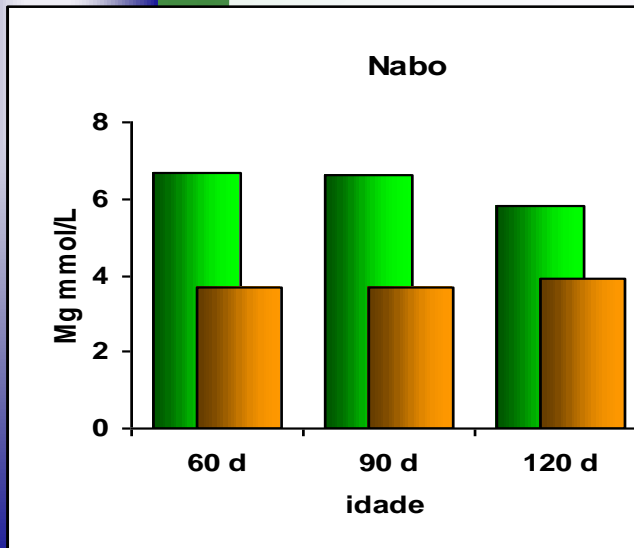
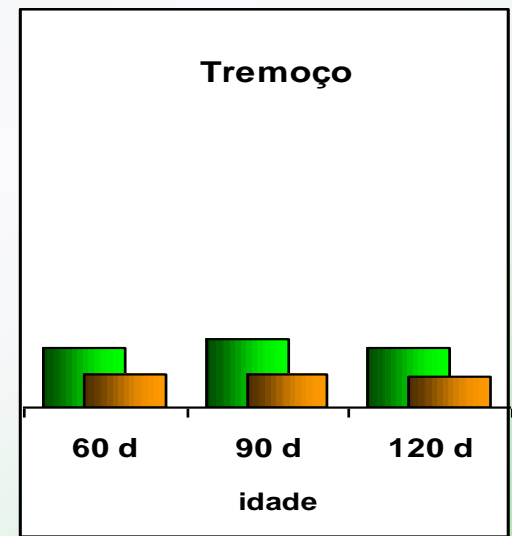
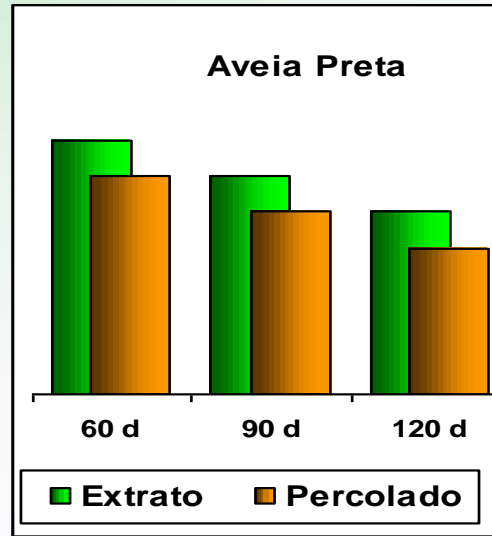
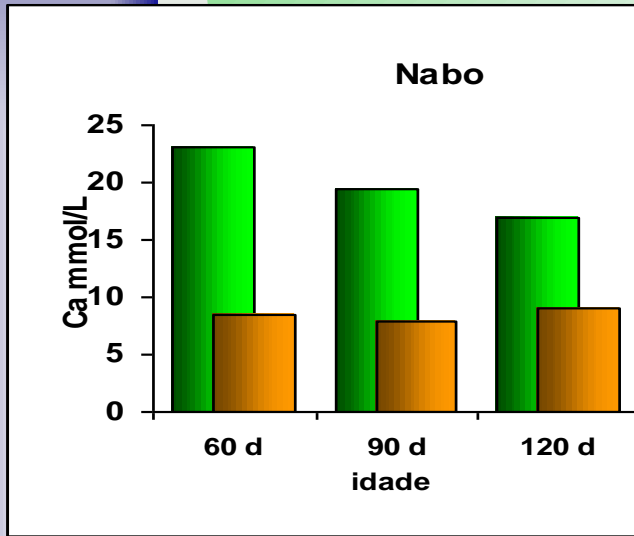


# [K] e [Al] no Extrato e na Solução Percolada

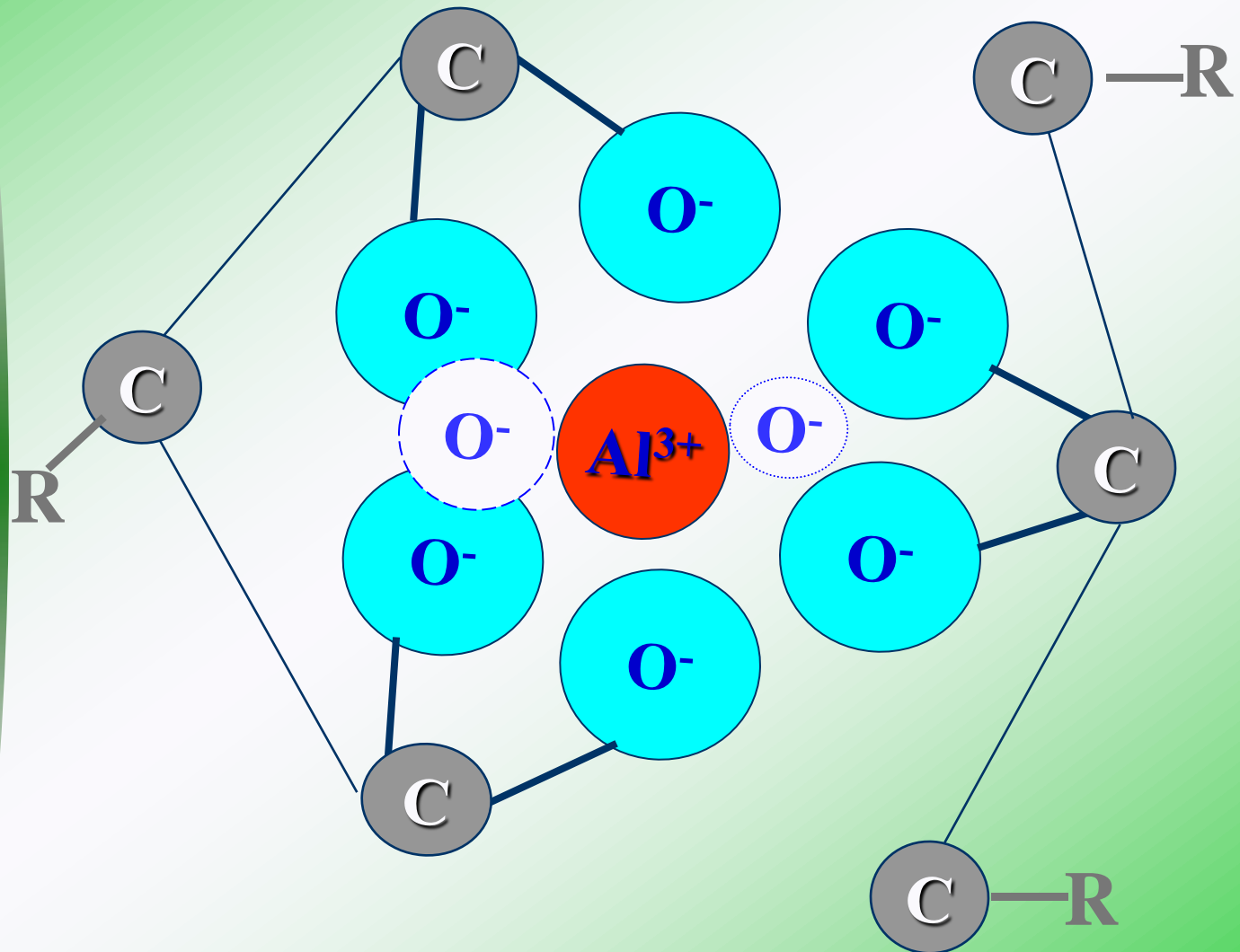




# [Ca] e [Mg] no Extrato e na Solução Percolada

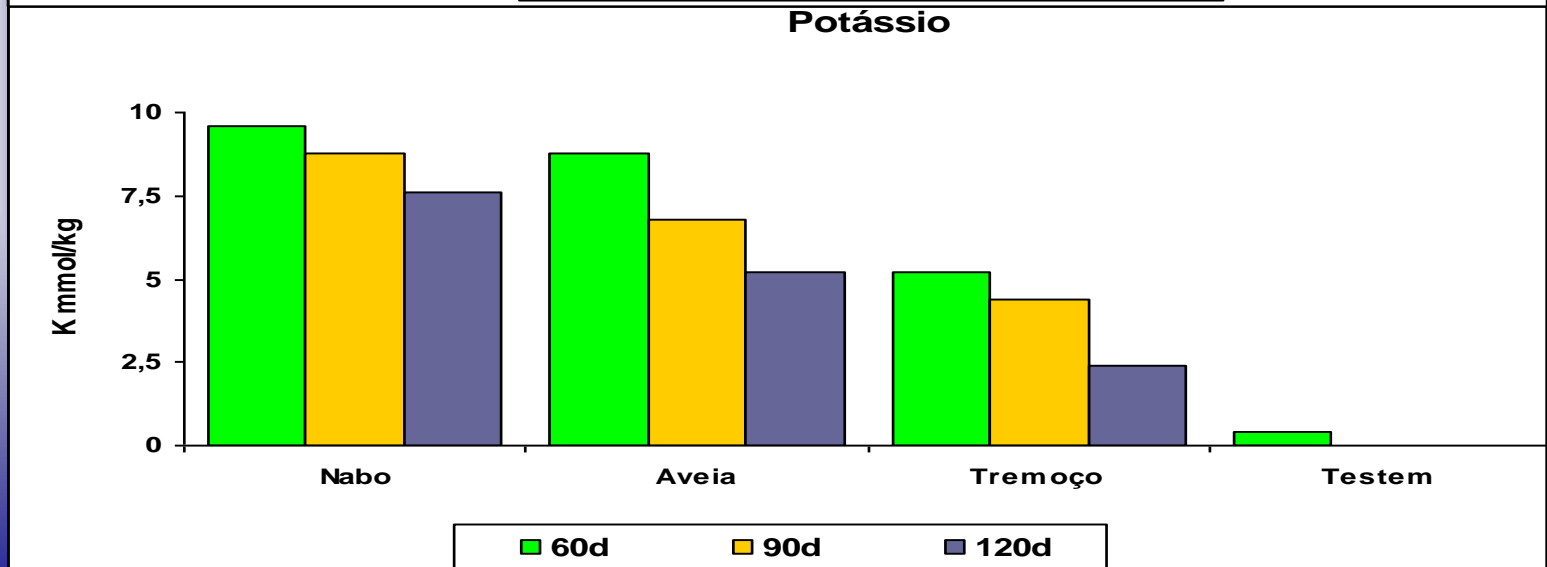
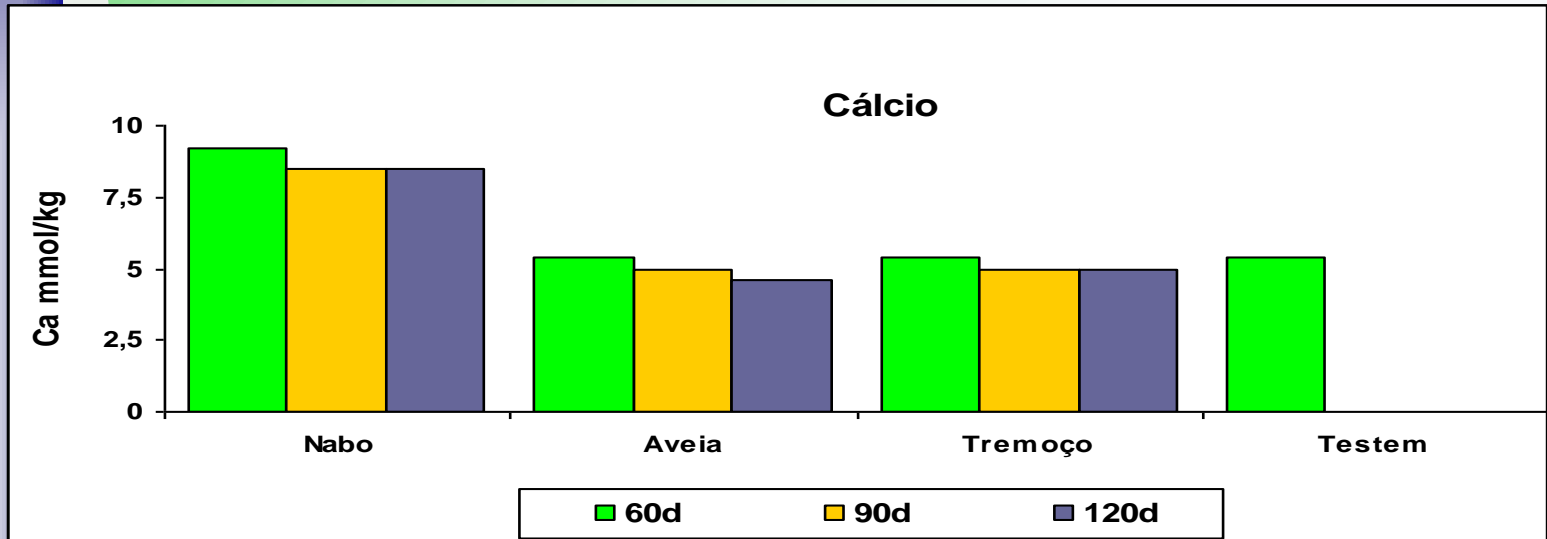


# Estrutura Al-quelato



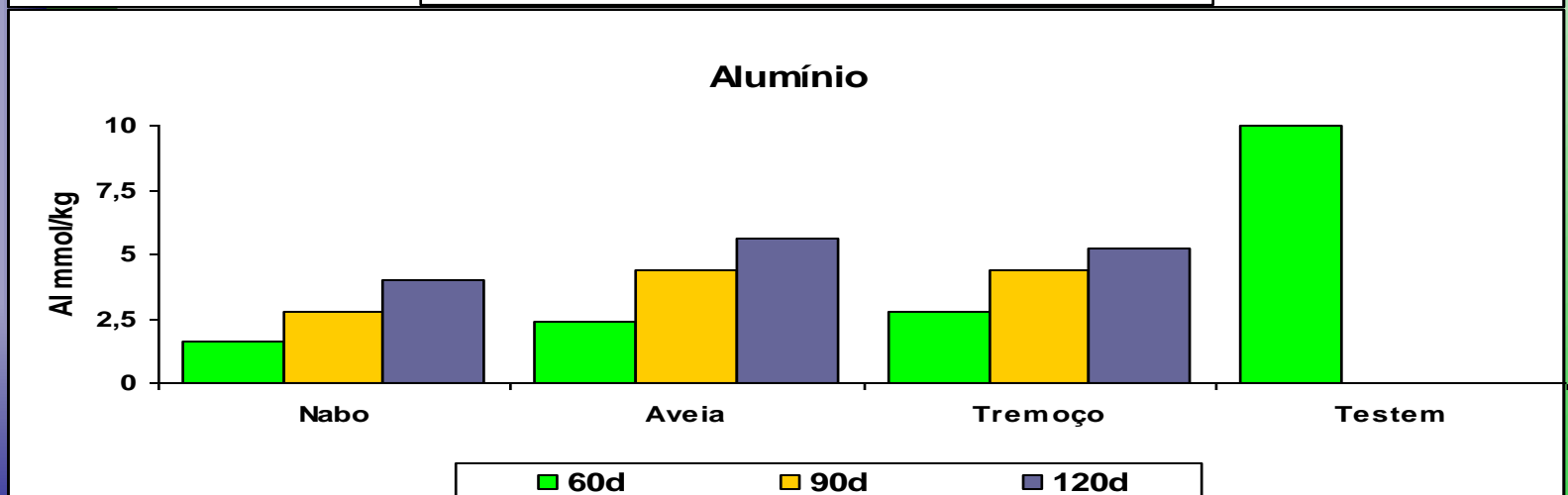
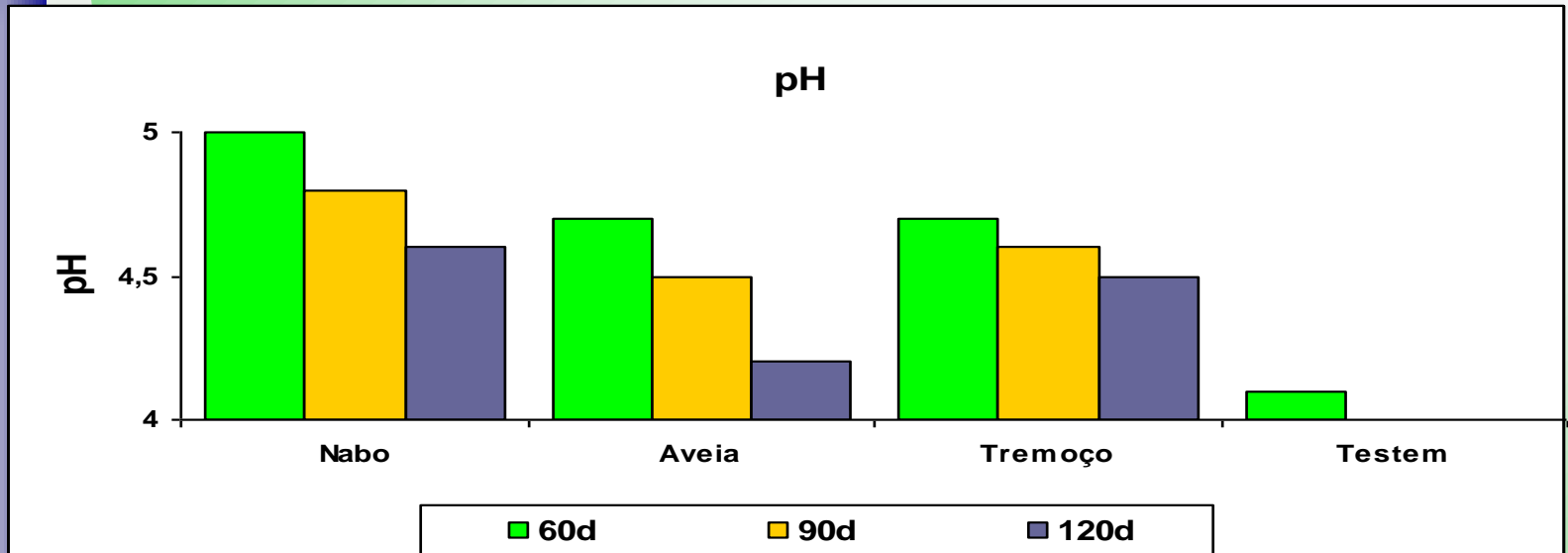


# Ca e K do Solo (0-5 cm) após Percolação do Extrato



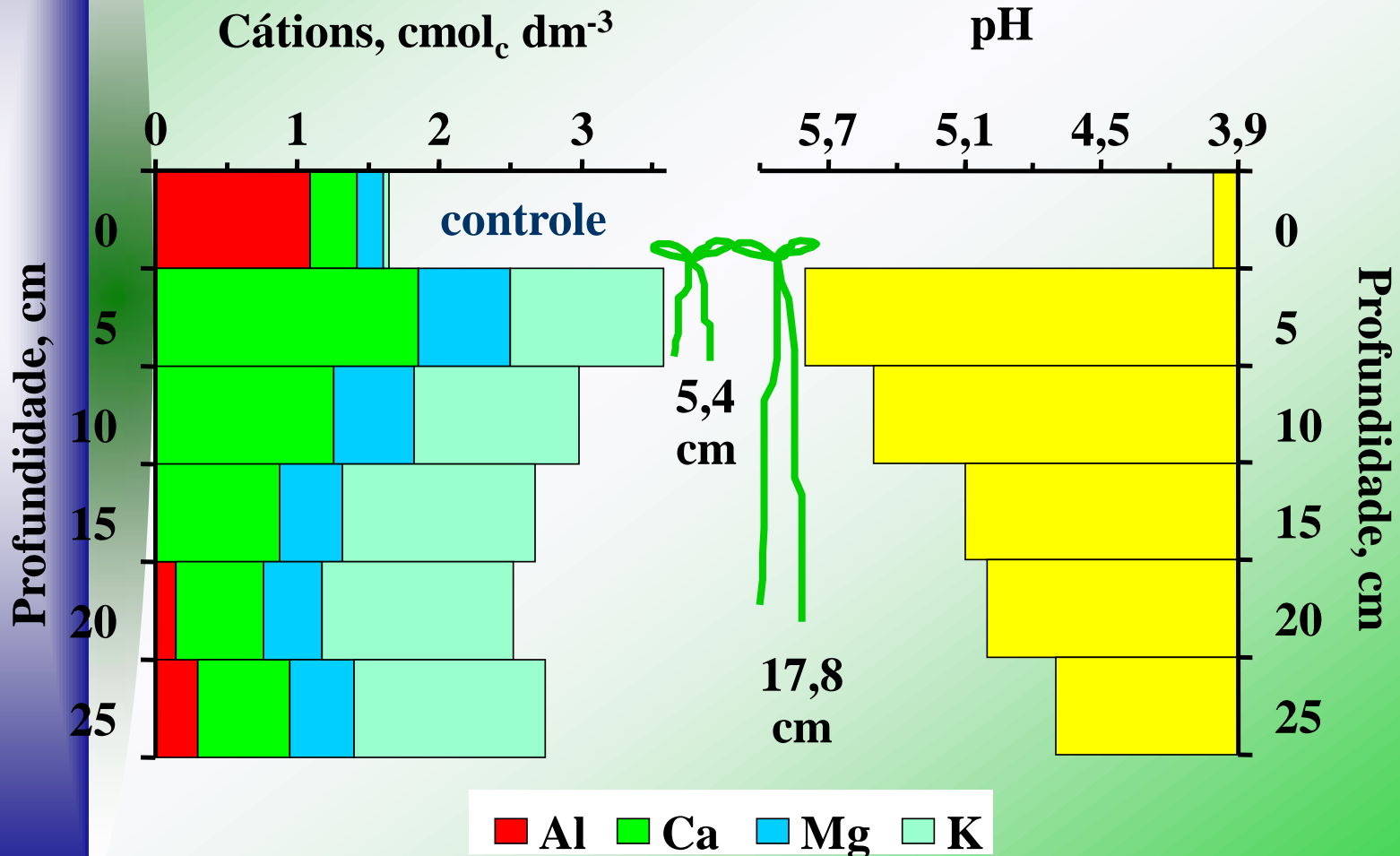


# pH e Al do solo (0-5 cm) após Percolação do Extrato

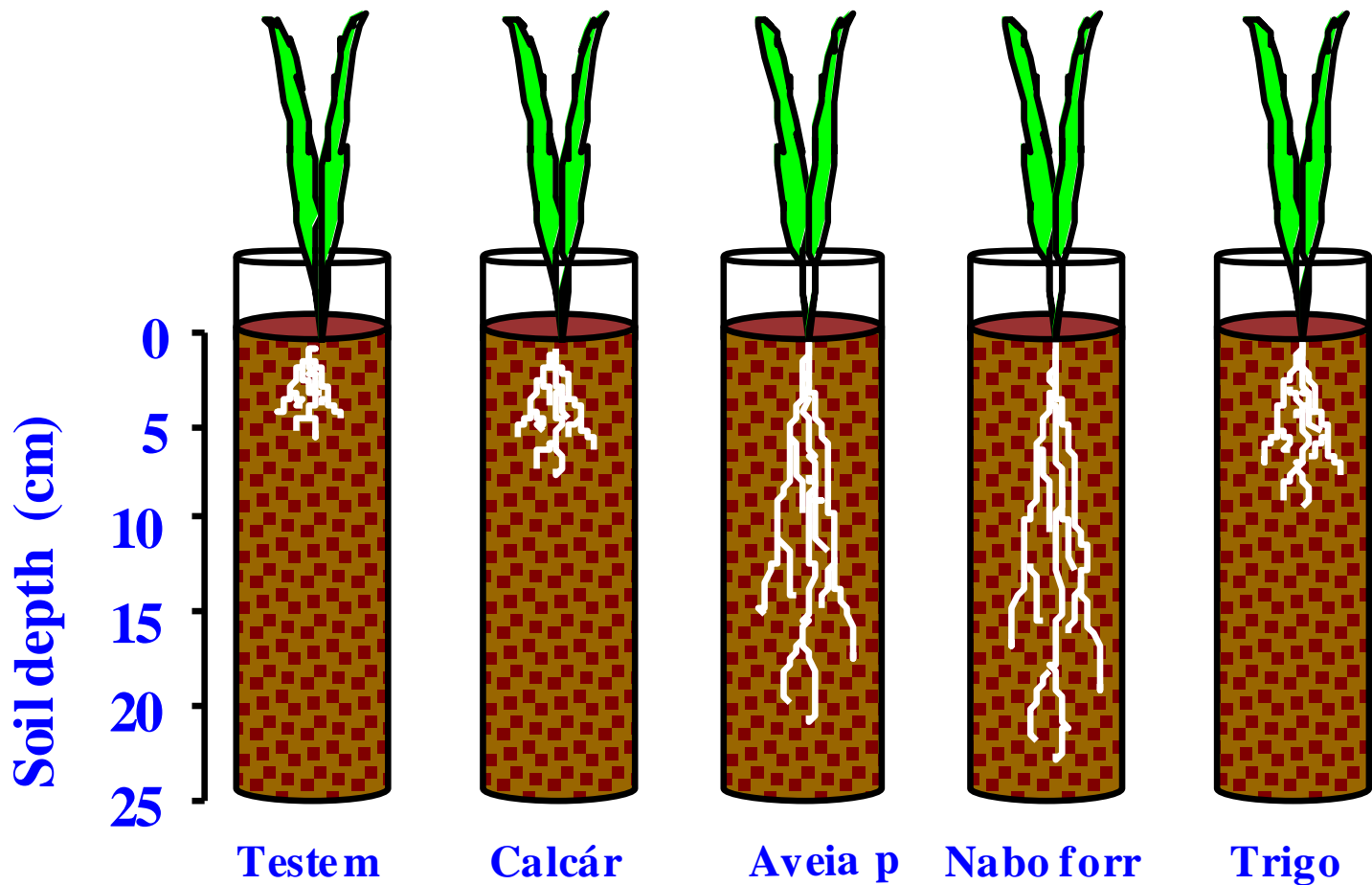


# Crescimento radicular de trigo, nabo forrageiro

Franchini et al. (1999a)



# Extrato vegetal no crescimento radicular (Franchini et al, 2001)





## Ordem de lixiviação de cátions no solo

- **Solos minerais (plantio convencional, baixa MO):**  
 $K^+ > Mg^{2+} > Ca^{2+} > Al^{3+}$
- **Complexos orgânicos (plantio direto, alta MO):**  
 $AlL > CaL > MgL > K^+$





# CONCLUSÕES

- ◆ **A acidez do subsolo pode ser neutralizada com resíduos vegetais**
- ◆ **Maiores teores de ácidos orgânicos encontram-se antes da maturação dos tecidos vegetais**
- ◆ **O efeito dos ácidos orgânicos é imediato**
- ◆ **O efeito sobre o pH e o Al é temporário**

# CONCLUSÕES

- ◆ **Redefinir época de manejo de adubos verdes**
- ◆ **Planejamento na diversificação de adubos verdes**
- ◆ **Manutenção de resíduos vegetais na superfície do solo**
- ◆ **Rotação de cultura comercial**



# PESQUISADORES

- **MARIO MIYAZAWA, QUÍMICA ANALÍTICA**
- **MARCOS A. PAVAN, QUÍMICA DO SOLO**
- **JULIO C. FRANCHINI, EMBRAPA, QUÍMICA DO SOLO**
- **ADEMIR CALEGARI, ADUBO VERDE**
- **JULIO C. D. CHAVES, CAFÉ**
- **ARNALDO COLOZZI FILHO, MICROBIOLOGIA**
- **DIVA S. ANDRADE, MICROBIOLOGIA**
- **ELIR DE OLIVEIRA, MANEJO DO SOLO**





**AGRADECIMENTO**

**Dr. YAMADA - POTAFOS**

**A TODOS OS  
PRESENTES**