

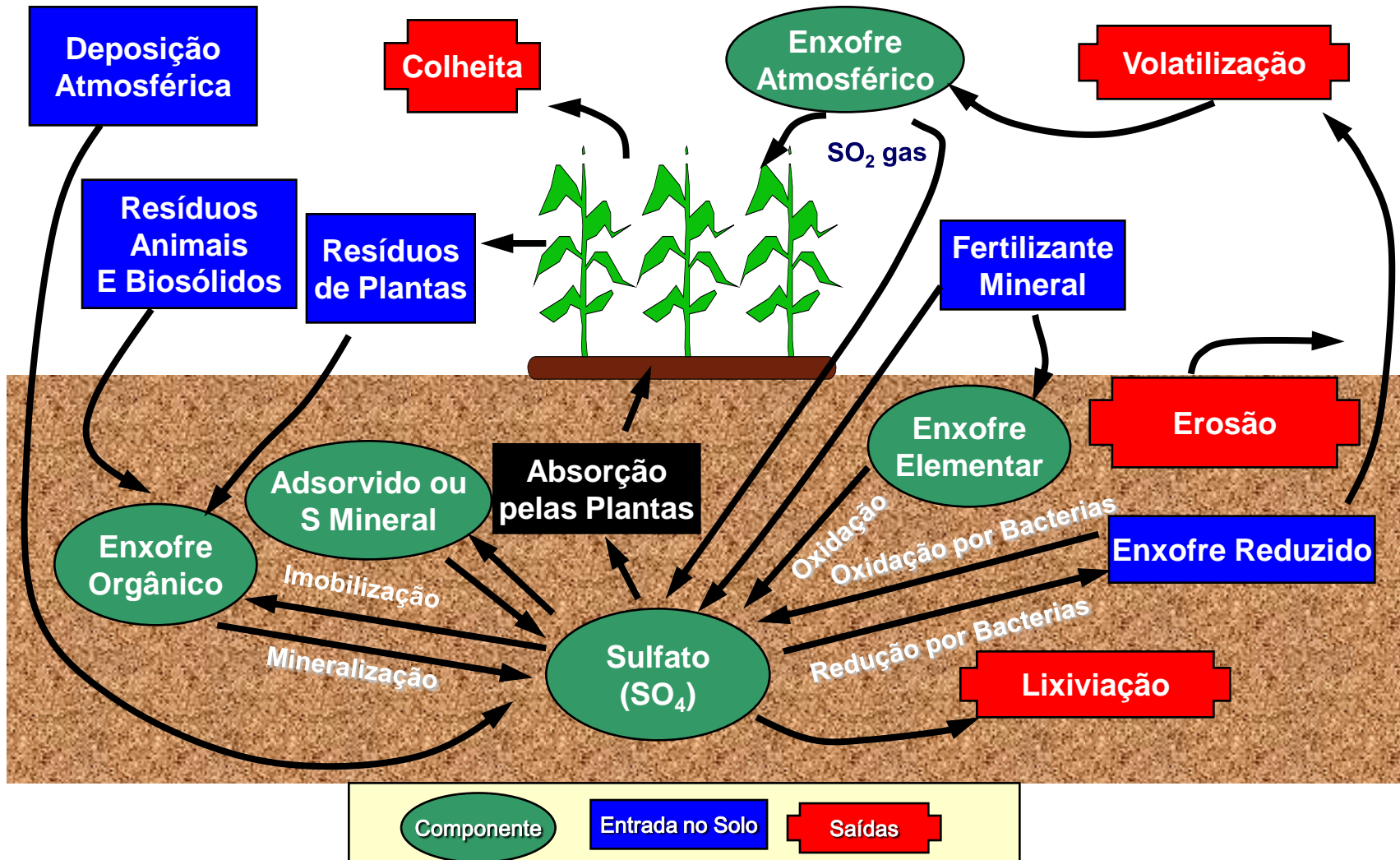
# Enxofre



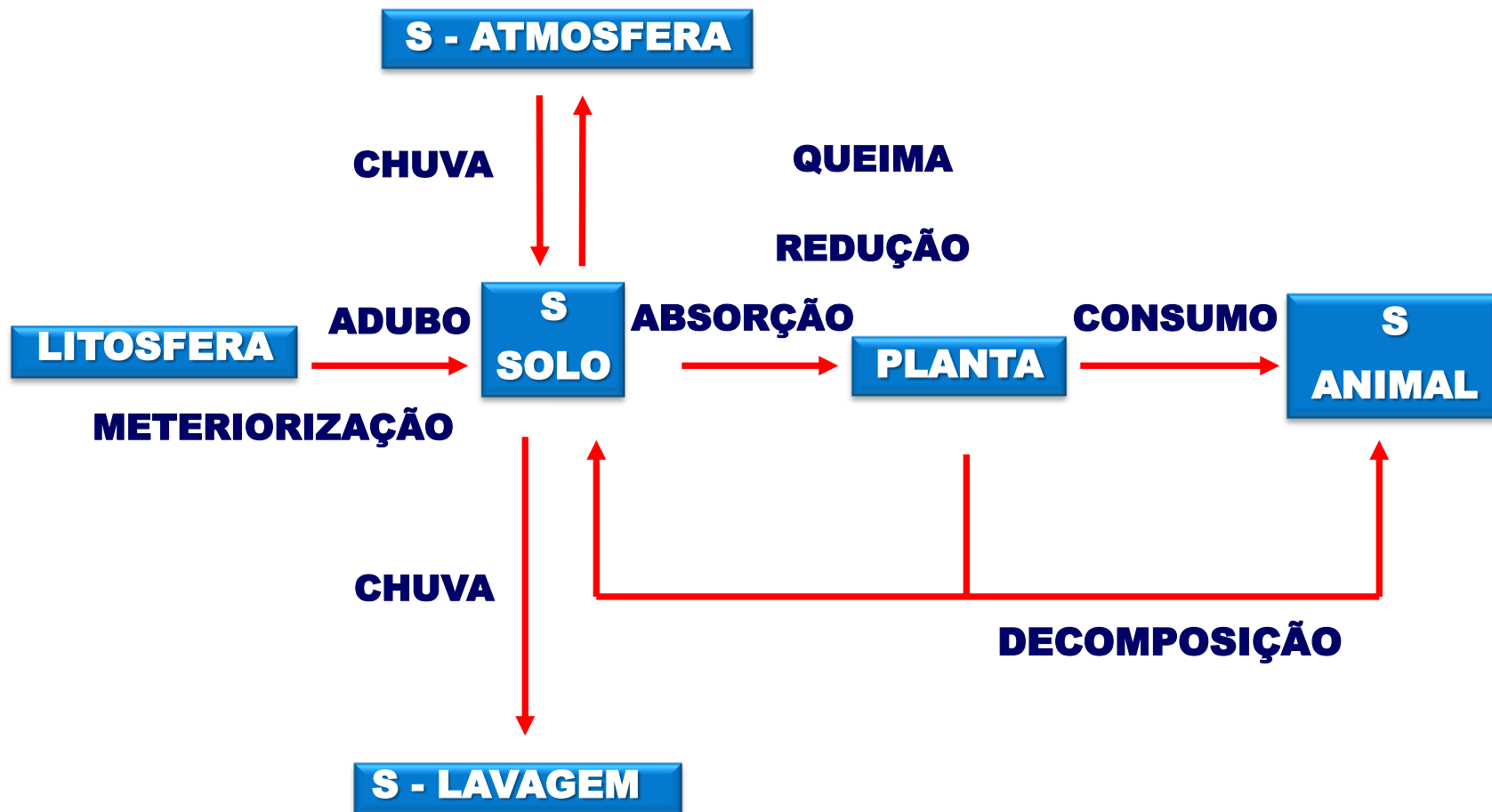
# Freqüência Relativa das Deficiências de Enxofre no Brasil




# Ciclo do Enxofre



# Representação esquemática dos principais componentes e processos do ciclo do enxofre.



# ESTADOS DE OXIDAÇÃO DO ENXOFRE NO SOLO (Bissani & Tedesco, 1988)

Anaerobiose  Aerobiose					
<b>Redução</b>			<b>Oxidação</b>		
Estado de oxidação	$S^{2-}$	$S^{\circ}$	$S^{2+}$	$S^{4+}$	$S^{6+}$
Composto ou Íons	$H_2S$	$S$	$S_2O_3^{2-}$	$SO_2$	$SO_4^{2-}$
<b>Denominação</b>	<b>Sulfetos</b>	<b>Enxofre Elementar</b>	<b>Tiossulfato</b>	<b>Dióxido de Enxofre</b>	<b>Sulfatos</b>

# Funções e Compostos em que o Enxofre participa na Planta (Hewitt & Smith, 1975)

## Enxofre

### Funções

Grupo Ativo de Enzimas e Coenzimas

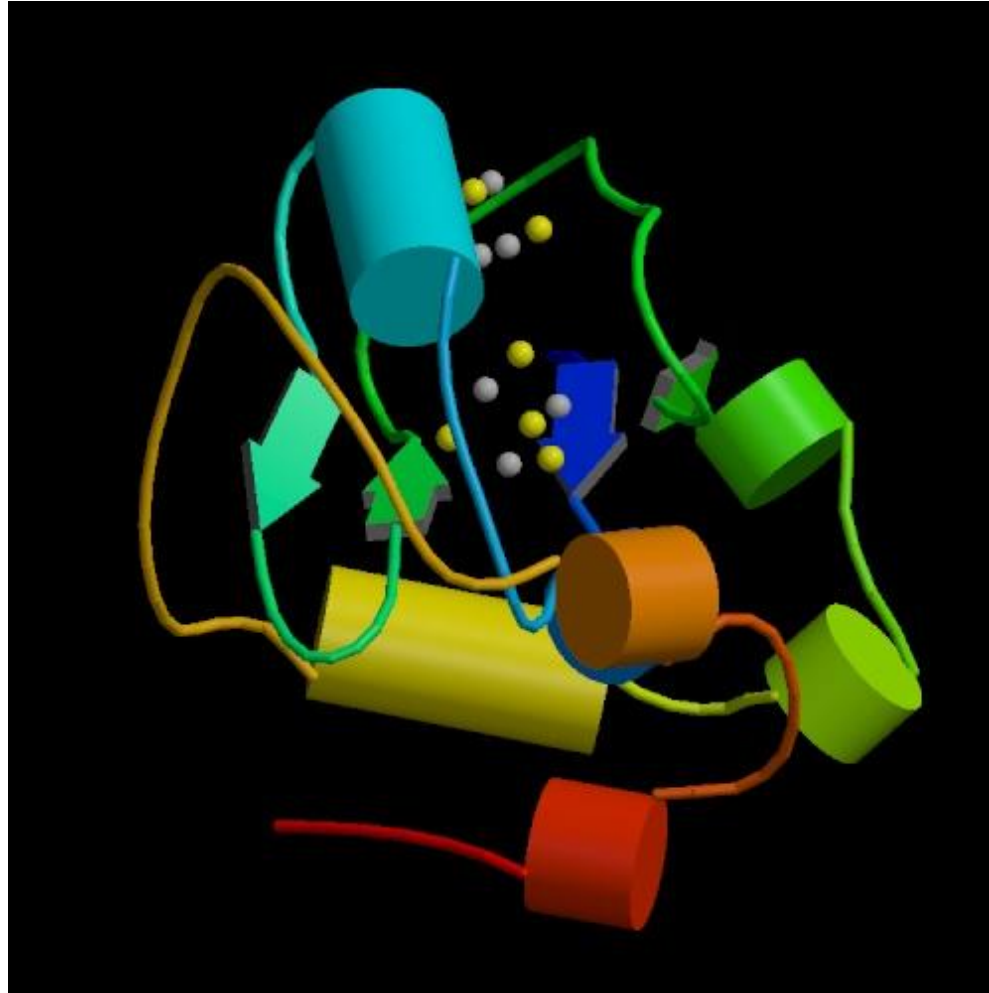
### Compostos

- Cisteína, Cistina, Metionina, Taurina, Glutathione, Sulfolipídeos e Coenzimas.

# Funções do Enxofre

- **EM AMINOÁCIDOS E PROTEÍNAS (MAIOR FRAÇÃO)**
- **NA MOLÉCULA DA FERREDOXINA**

# Ferredoxina

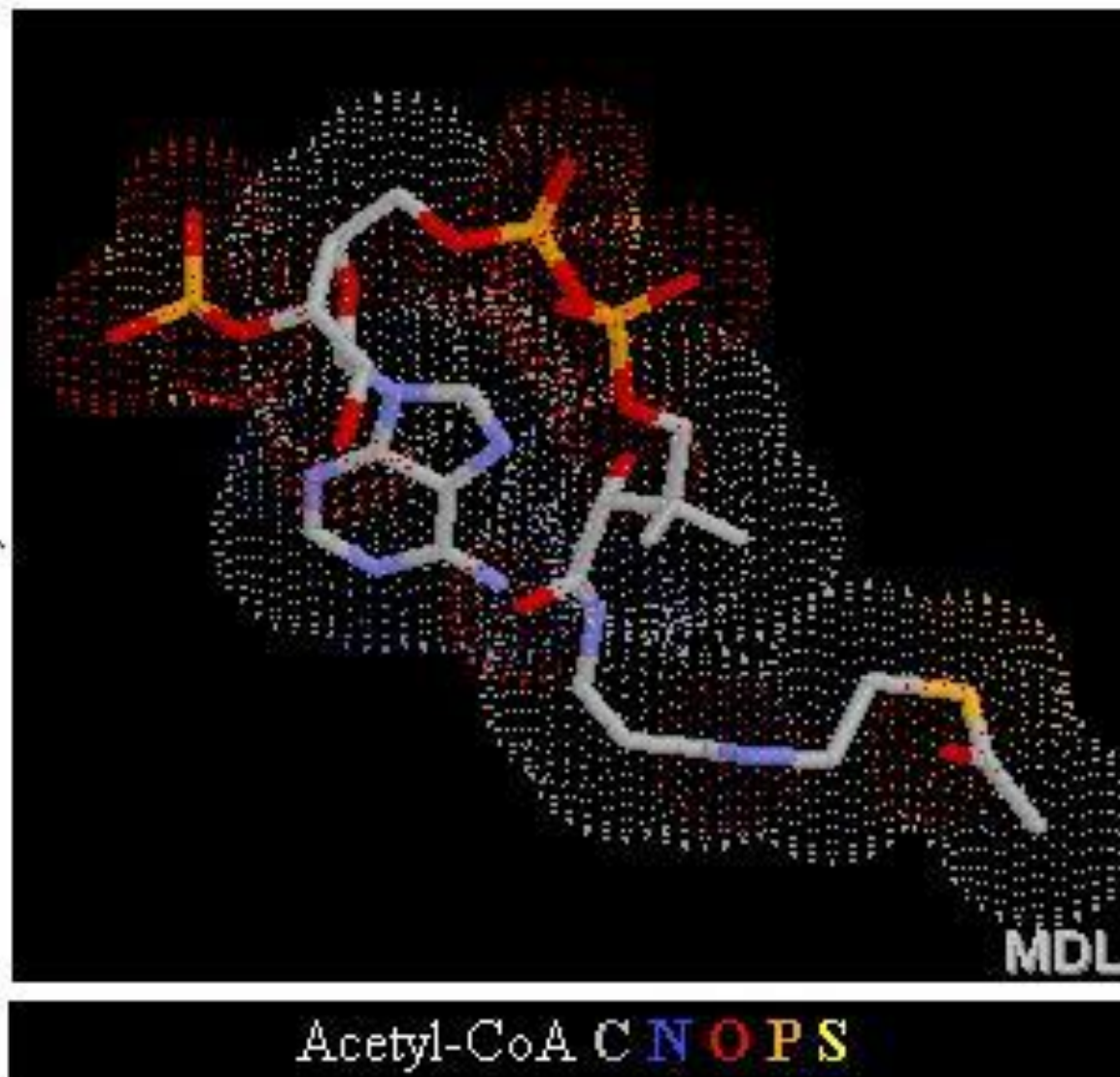




# Funções do Enxofre

- **EM AMINOÁCIDOS E PROTEÍNAS (MAIOR FRAÇÃO)**
- **NA MOLÉCULA DA FERREDOXINA**
- **NA COENZIMA A, NA BIOTINA E NA TIAMINA**

# Funções do Enxofre



# Funções do Enxofre

- EM AMINOÁCIDOS E PROTEÍNAS (MAIOR FRAÇÃO)
- NA MOLÉCULA DA FERREDOXINA
- NA CONEZIMA A, NA BIOTINA E NA TIAMINA
- EM AMINOÁCIDOS E PROTEÍNAS (MAIOR FRAÇÃO)
- NA FORMAÇÃO DE LIGAÇÕES DIPEPTÍDICAS
- PARTICIPAÇÃO DO -SH EM REAÇÕES ENZIMÁTICAS
- EM ÓLEOS GLICOSÍDEOS E EM COMPOSTOS VOLÁTEIS
- EM SULFOLIPÍDEOS

# Concentração e Formas de Enxofre na Solução do Solo, Xilema e Floema das Plantas

Nutriente	Solução do Solo Conc. ( $\mu\text{M}$ )		Xilema		Floema	
	Valores Médios	Forma	Conc. ( $\mu\text{M}$ )	Forma	Conc. ( $\mu\text{M}$ )	Forma
Enxofre	500	$\text{SO}_4^{2-}$	1.400	$\text{SO}_4^{2-}$	900	Sem $\text{SO}_4^{2-}$

# Teores Mínimos Adequados (Níveis Críticos) de Macronutrientes ( $\text{g kg}^{-1}$ ) em Algumas Culturas

Cultura	N	P	K	Ca	Mg	S
	----- $\text{g kg}^{-1}$ -----					
Abacaxi	15,0	1,20	30,0	5,00	3,00	-
Algodão	32,0	1,70	15,0	20,0	5,00	4,00
Arroz	30,0	1,20	20,0	6,00	3,00	-
Banana	26,0	2,20	28,0	6,00	3,00	2,00
Batata	50,0	3,00	30,0	10,0	3,00	-
Café	28,0	1,20	18,0	10,0	3,50	2,00
Cana	16,0	1,20	10,0	4,00	2,00	2,00
Citros	22,0	1,20	10,0	30,0	3,00	2,00
Feijão	30,0	3,00	20,0	25,0	5,00	2,00
Maçã	22,0	1,80	13,0	9,50	3,50	2,00
Milho	30,0	2,00	20,0	4,50	2,50	2,00
Pinus spp	13,0	2,00	10,0	-	2,00	2,00
Soja	45,0	2,50	17,0	10,0	4,00	2,50
Sorgo	30,0	5,00	22,0	3,50	2,50	-
Tomateiro	40,0	4,00	38,0	20,0	5,00	-
Videira	25,0	2,00	15,0	4,00	4,00	-

# Níveis Adequados de Macronutrientes para Algumas Hortaliças (Teores em Folhas, g kg<sup>-1</sup>)

Cultura	N	P	K	Ca	Mg	S
-----g kg <sup>-1</sup> -----						
Alho	25-30	3,0-4,0	36-44	5-7	2,5	4,0-7,0
Alface	28	4,0	62	13	4,0	3,0
Batata	38-48	3,0-4,0	40-50	20-23	8,0-10,0	3,0-4,0
Berinjela	48	4,0	42	35	3,0	2,0
Cenoura	29	2,0	22-35	25	3,0	4,0
Couve-Flor	23-40	5,0	28-50	35	5,0	15,0
Cebola	31	3,0	52	40	4,0	8,0
Espinafre	37	3,0	60	10	9,0	3,0
Ervilha	36	5,0	26	15	5,0	-
Morango	25-30	3,0-4,0	16-19	10-14	3,0-4,0	1,0-3,0
Pimentão	31	2,0	58	26	8,0	4,0
Quiabo	37	4,0	20	37	8,0	3,0
Repolho	-	7,0	40-50	20	5,0	7,0
Tomate	30-40	4,0	30	40	4,0	3,0

# FERTILIZANTES CONTENDO ENXOFRE

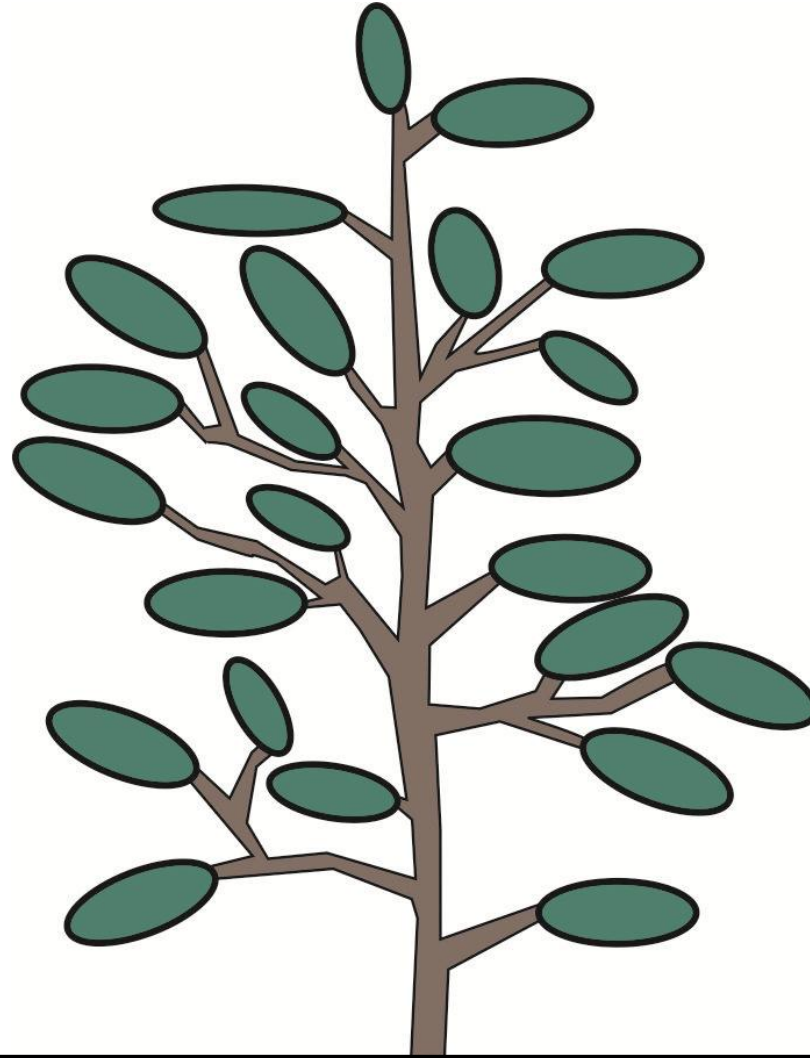
ADUBOS	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	CaO	MgO	S
	%					
Superfosfato Simples	-	18	12	20	-	12
Enxofre Elementar	-	-	95	-	-	95
Sulfato de Amônio	20	-	22	-	-	22
Sulfato de Potássio	-	-	50	-	0,5	18
Sulfato de Magnésio	-	-	-	-	20	25
Sulfato de Cálcio	-	-	-	26	-	15
Sulfato de K - Mg	-	-	18	-	5	20
Tiosulfato de Amônio	12	-	-	-	-	26

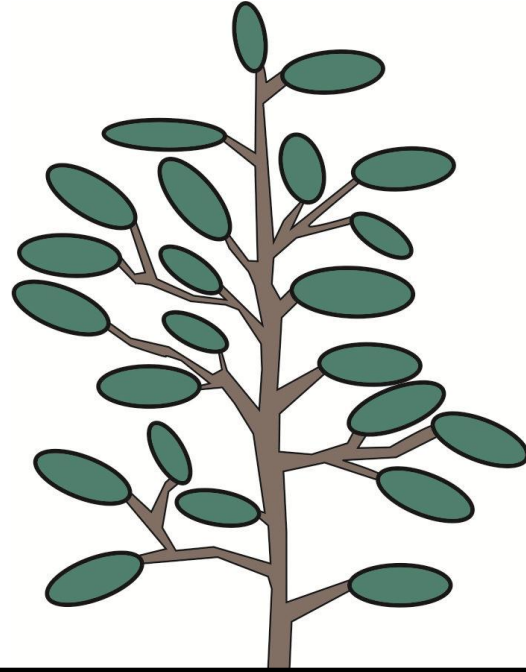
# Funções e Compostos em que o Nitrogênio e o Enxofre participam na Planta

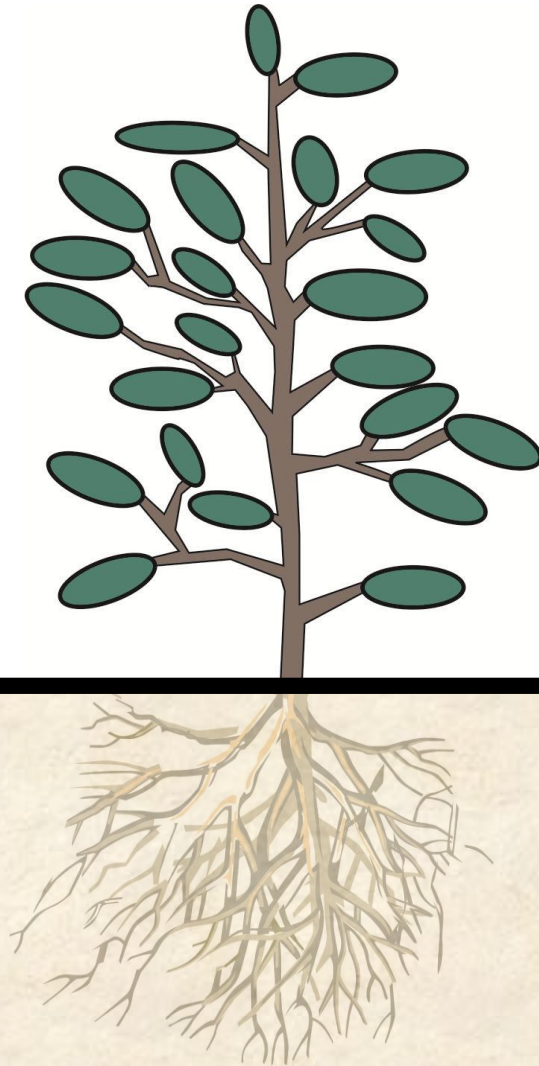
ELEMENTO	FUNÇÃO	COMPOSTOS
<b>N</b>	<b>Importante no metabolismo como composto</b>	<b>Aminoácidos e proteínas, aminas, amidas, aminoaçúcares, purinas, e pirimidinas, alcalóides, coenzimas, vitaminas e pigmentos</b>
<b>S</b>	<b>Grupo ativo de enzimas e coenzimas</b>	<b>Cisteína, cistina, metionina, taurina, glutathione, sulfolipídeos e coenzimas</b>

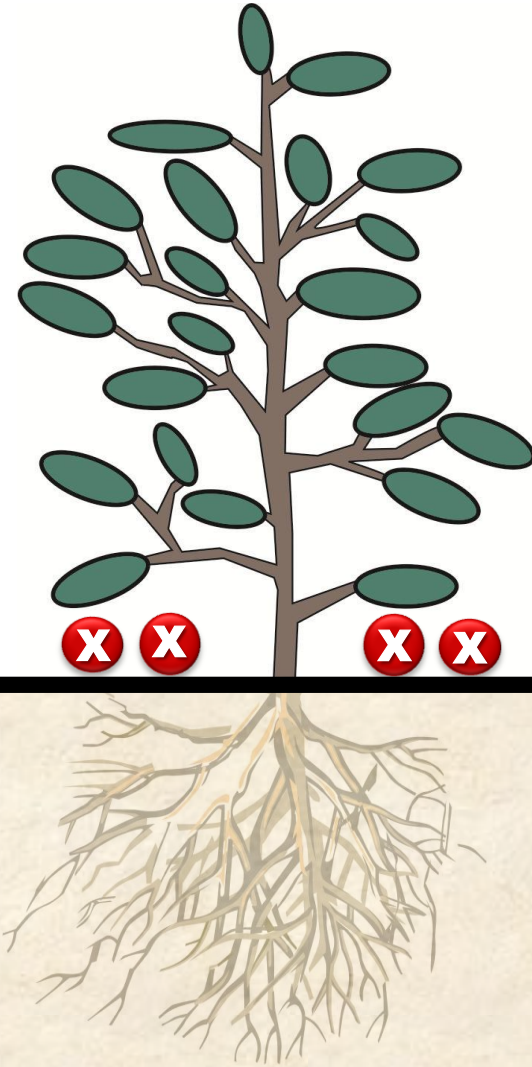


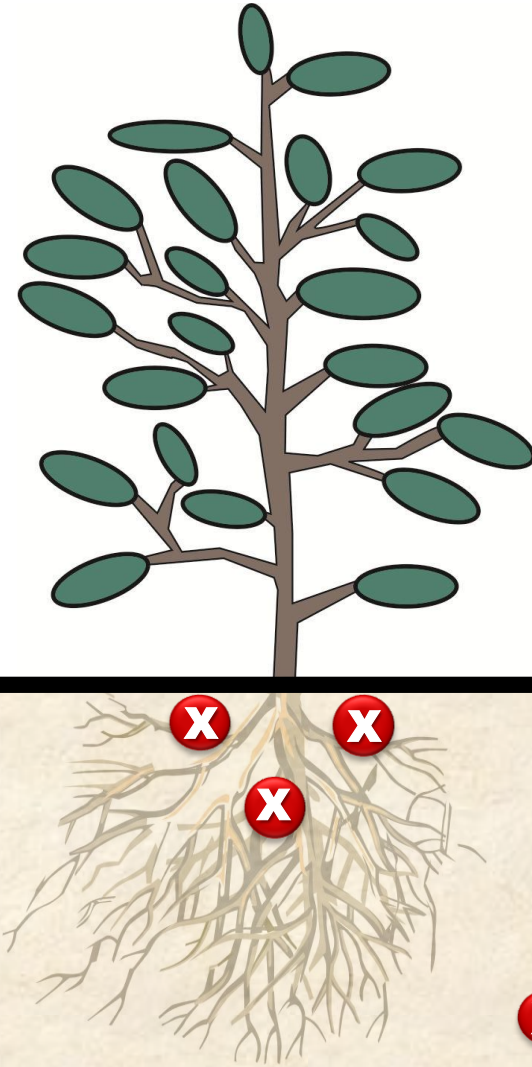
# SINTOMAS DE DEFICIÊNCIA

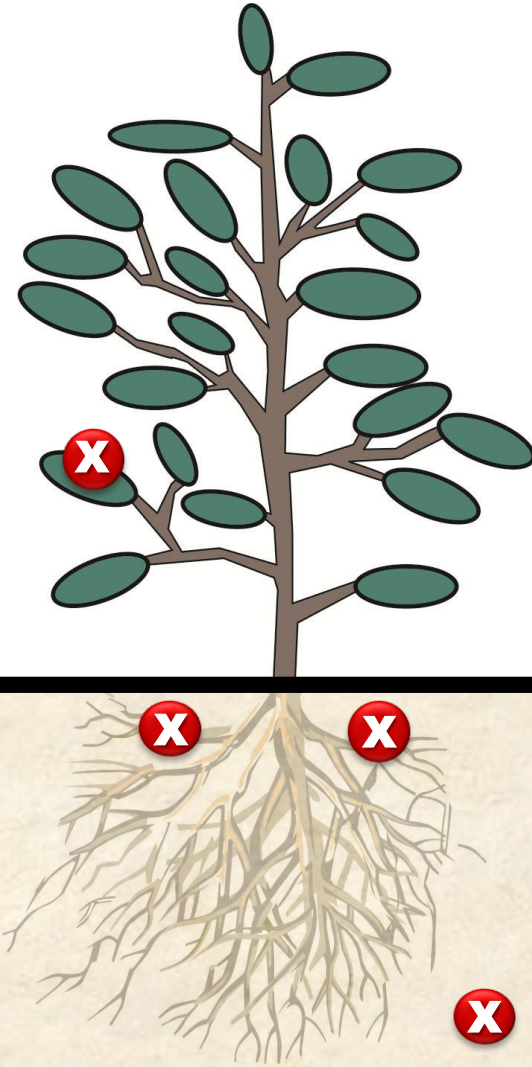


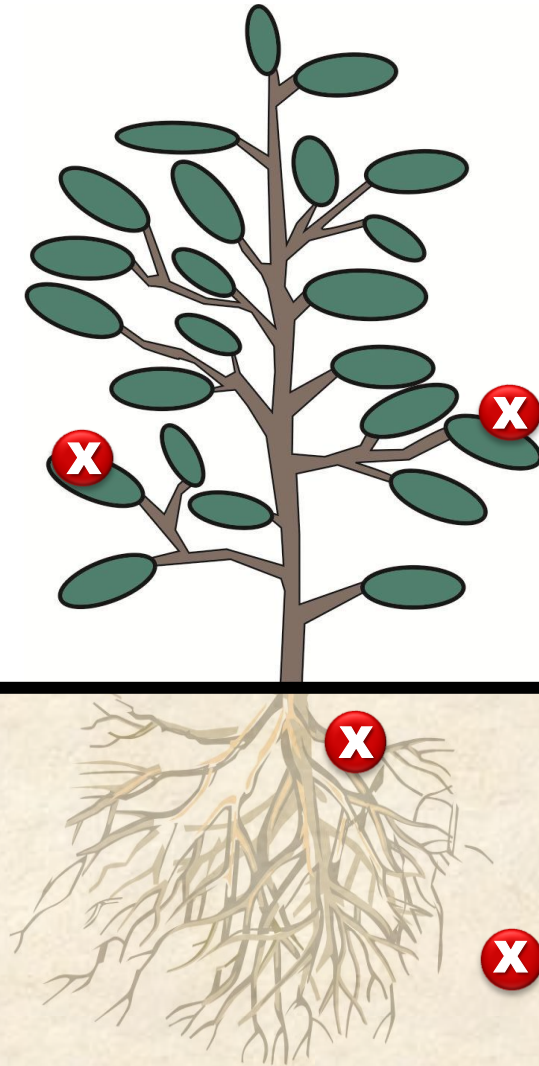


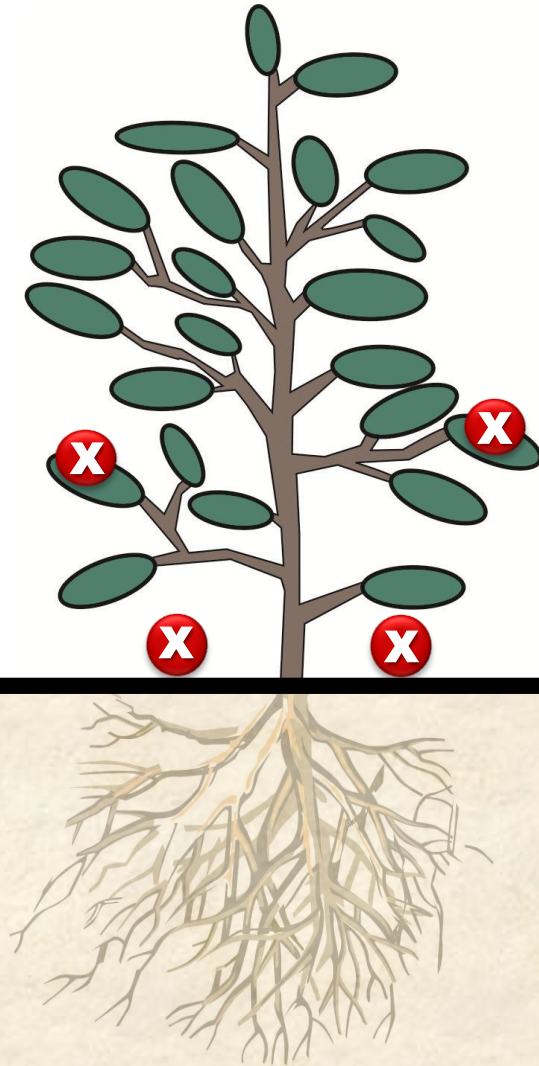




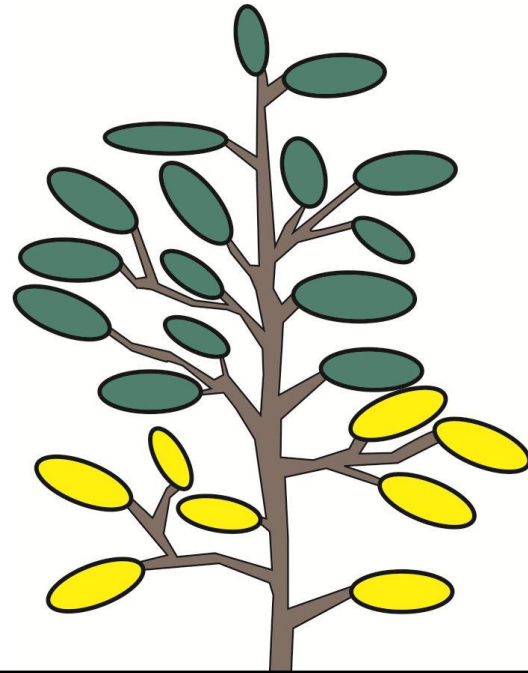




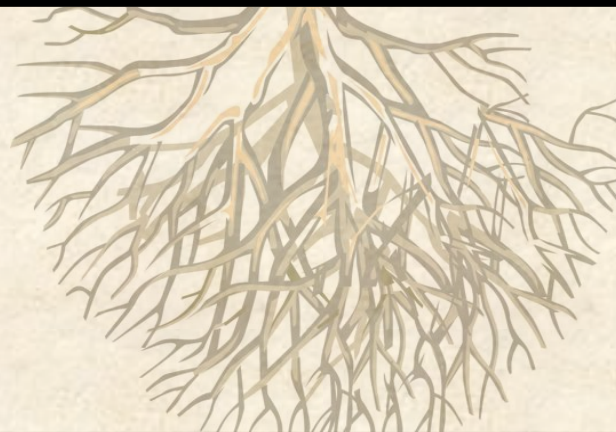
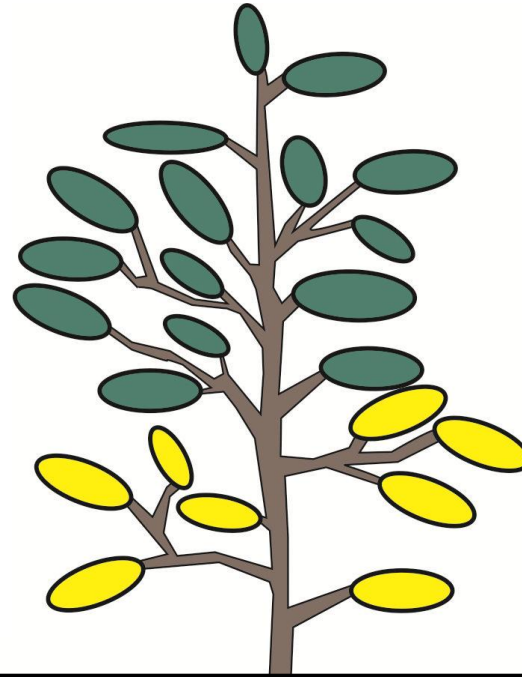






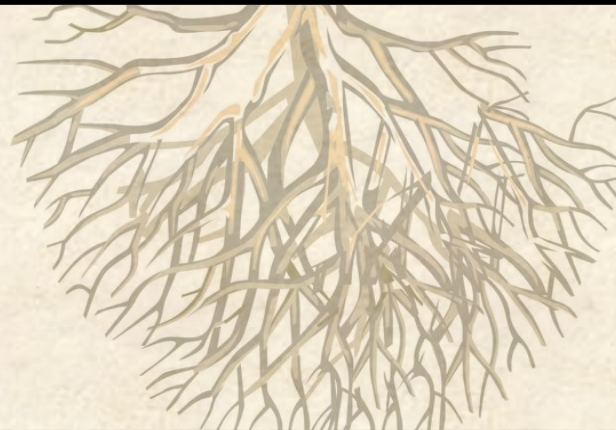
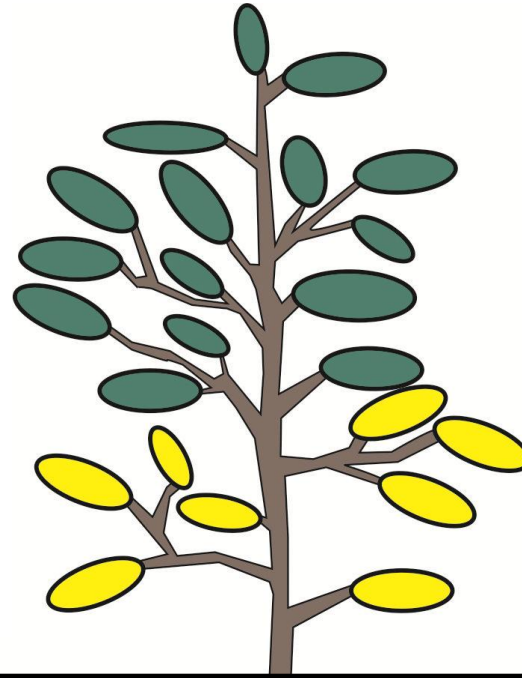


# FOLHAS VELHAS



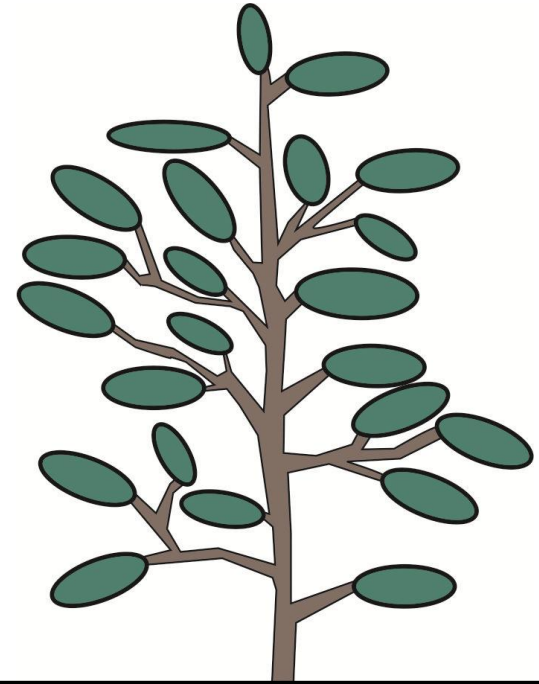
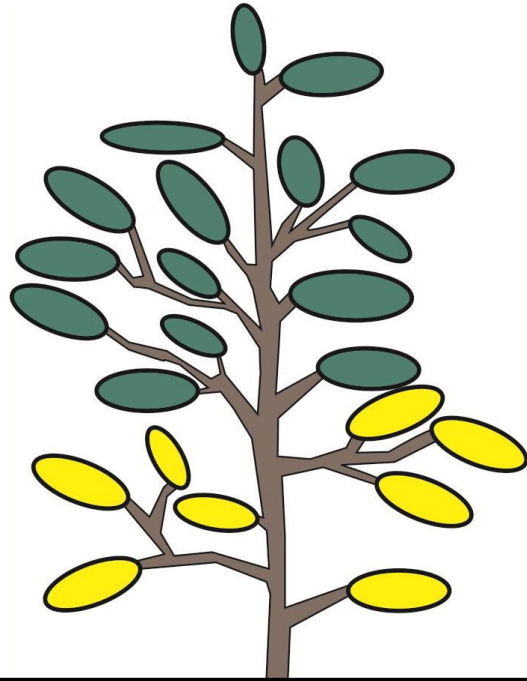
# FOLHAS VELHAS

N-P-K-Mg



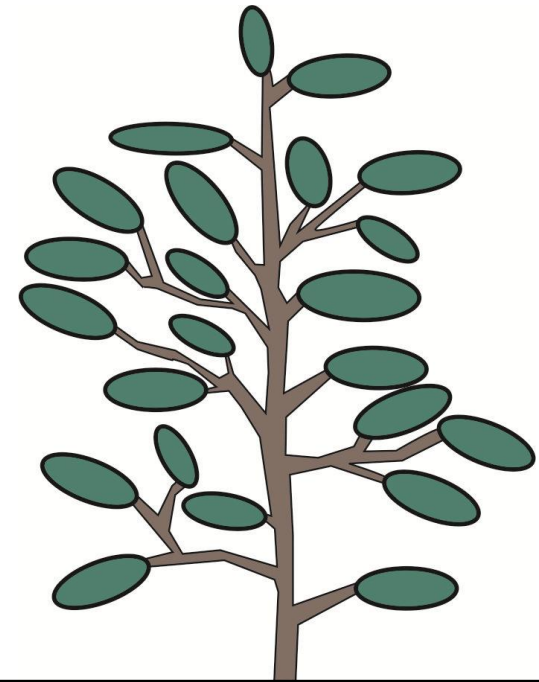
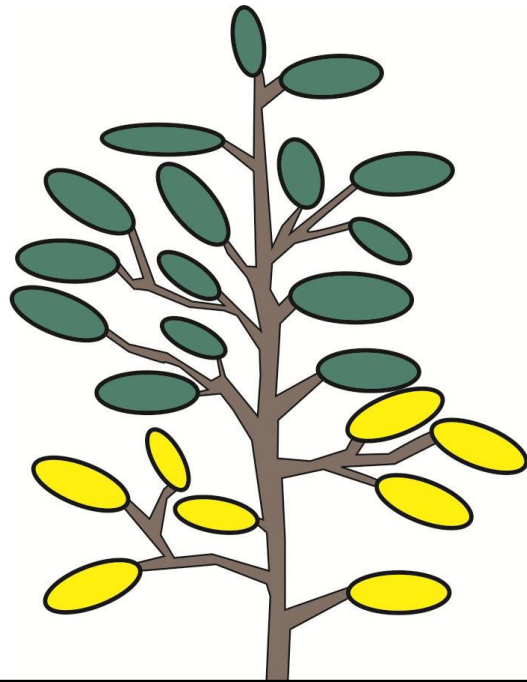
# FOLHAS VELHAS

N-P-K-Mg



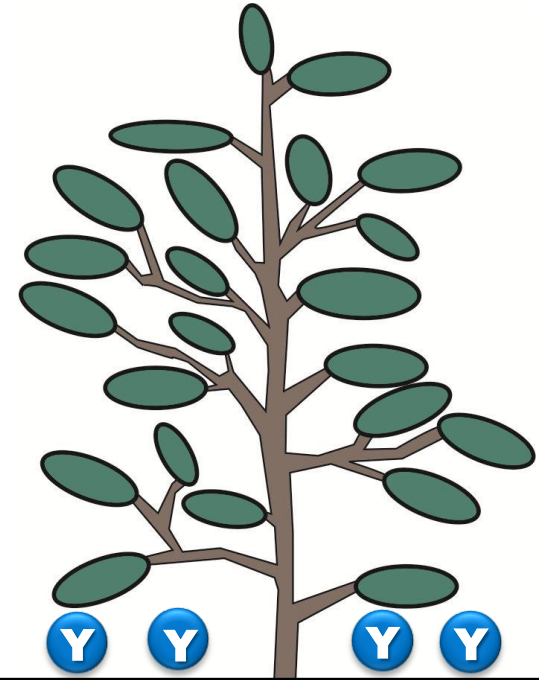
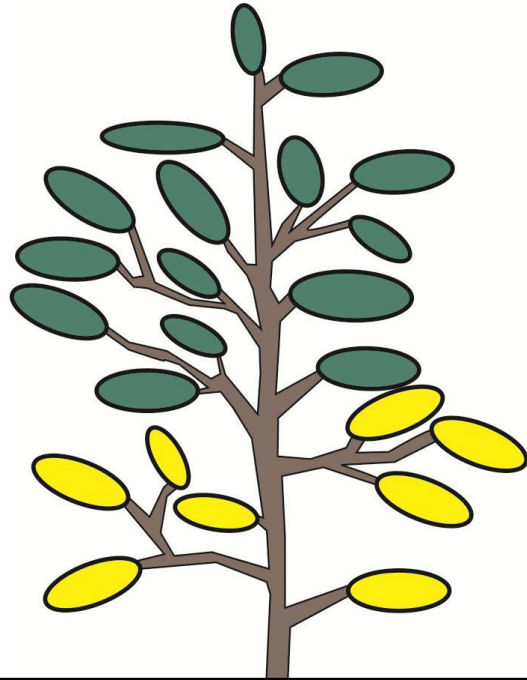
# FOLHAS VELHAS

N-P-K-Mg



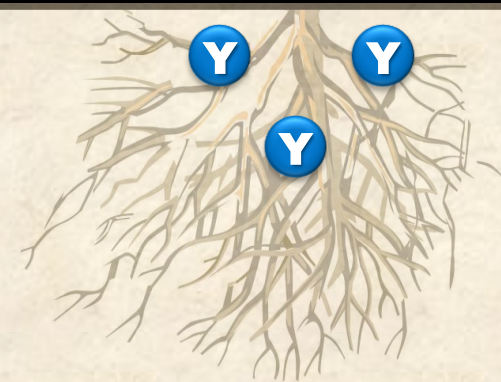
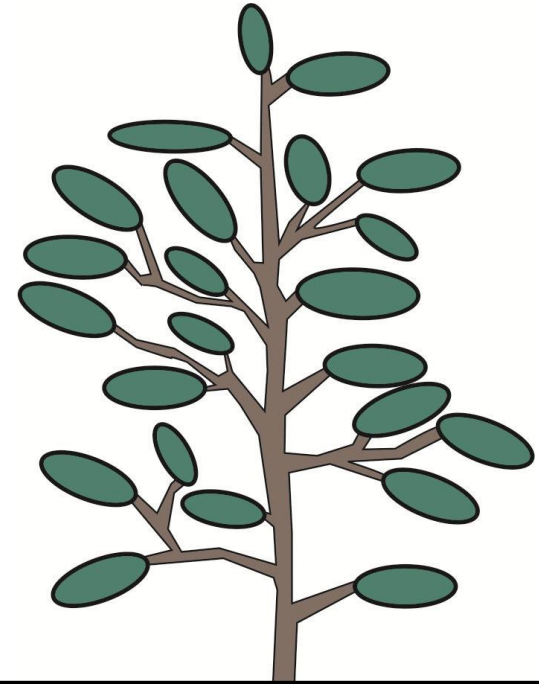
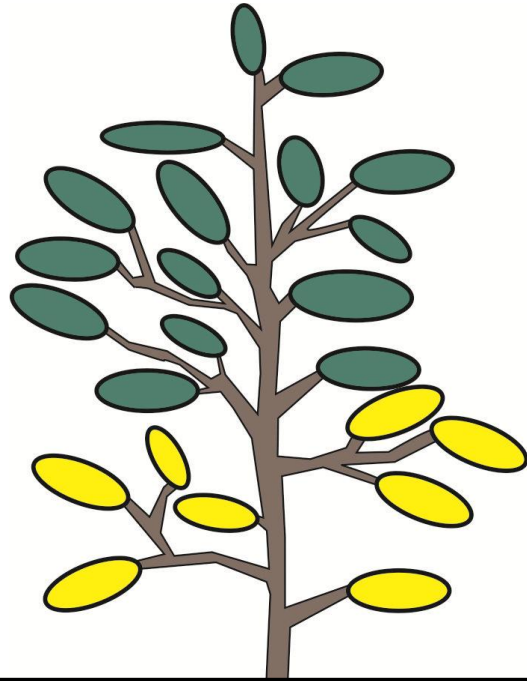
# FOLHAS VELHAS

N-P-K-Mg



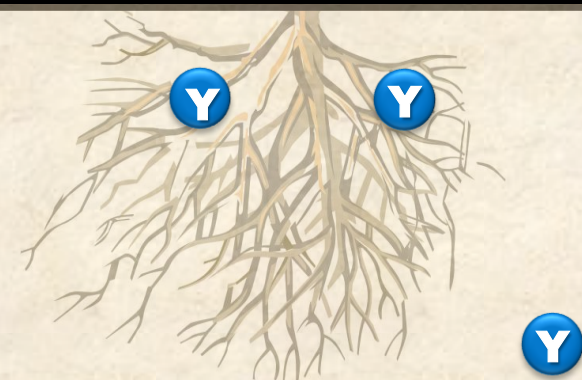
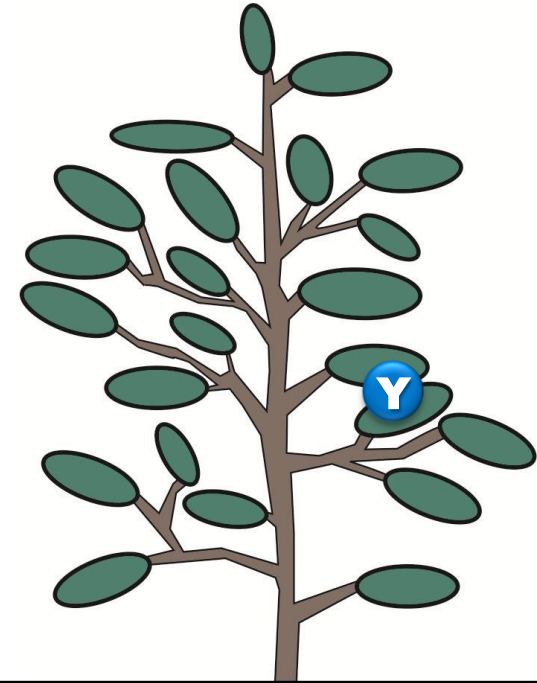
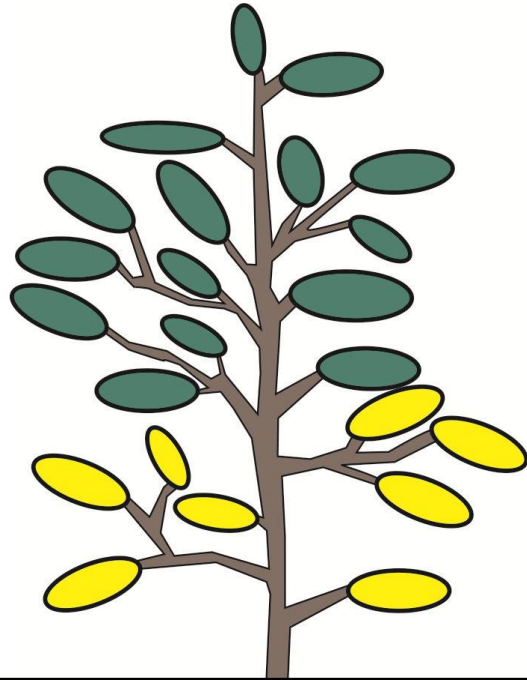
# FOLHAS VELHAS

N-P-K-Mg



# FOLHAS VELHAS

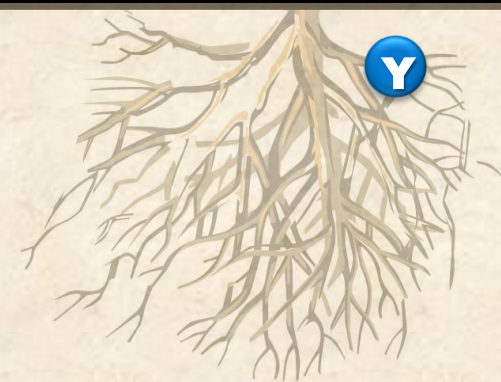
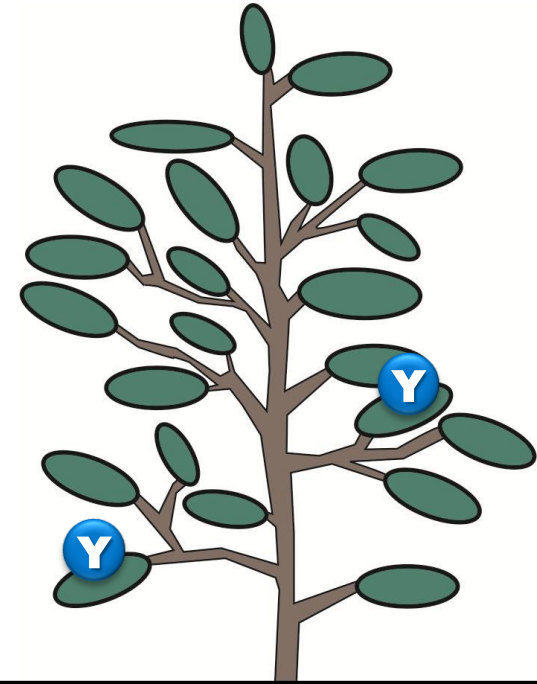
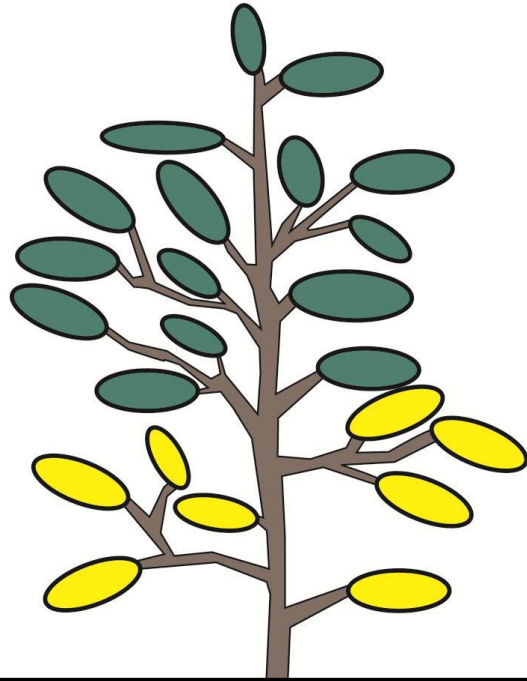
N-P-K-Mg





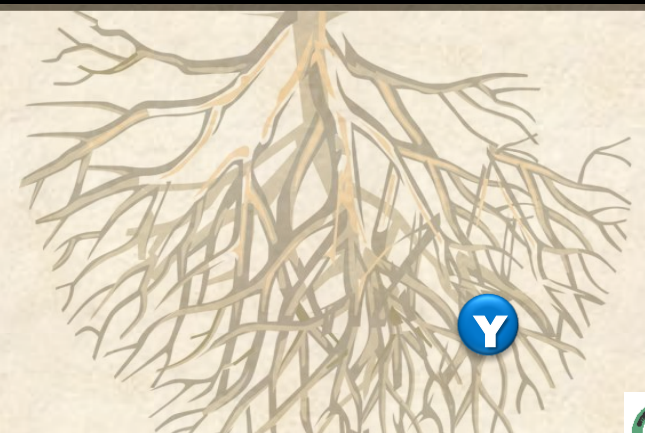
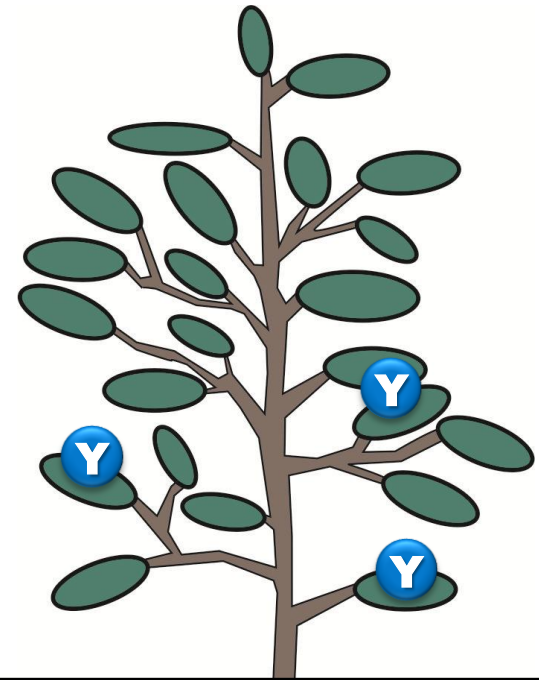
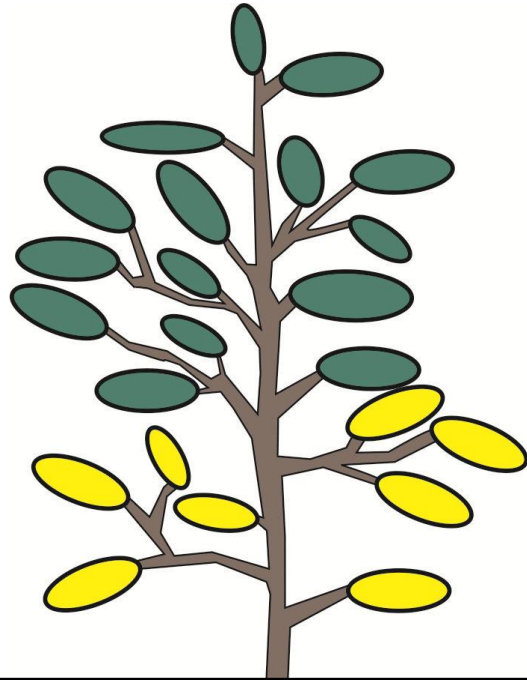
# FOLHAS VELHAS

N-P-K-Mg



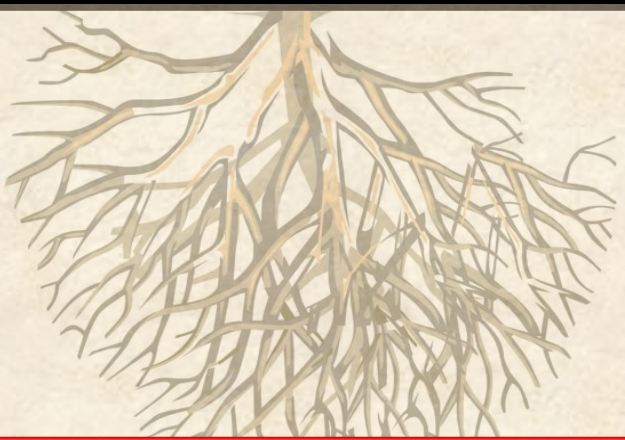
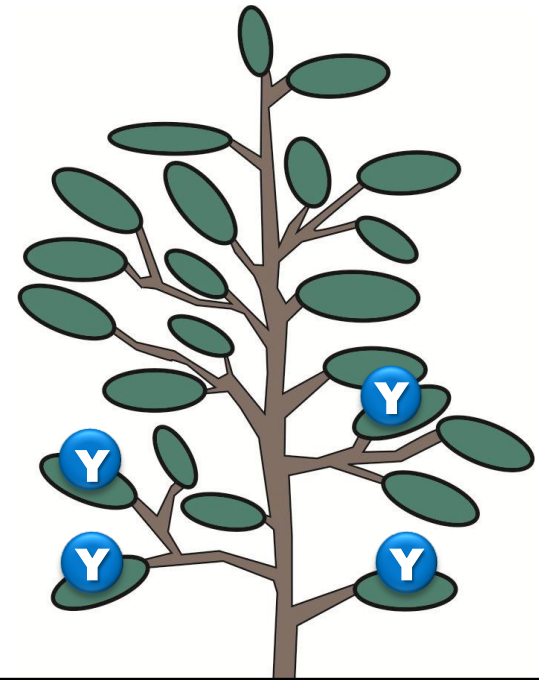
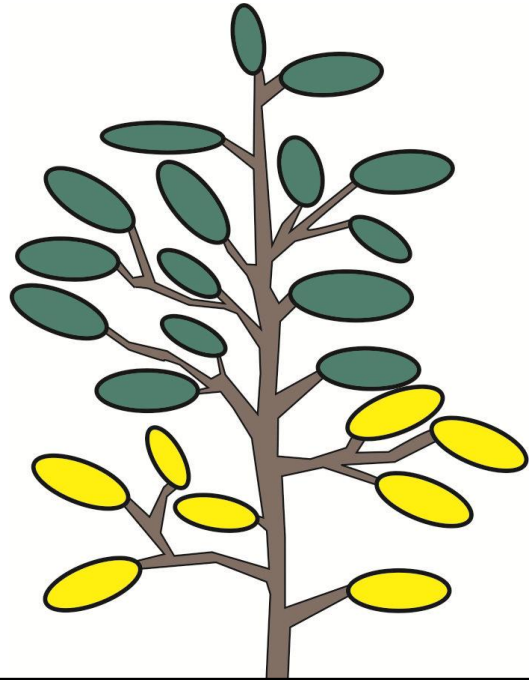
# FOLHAS VELHAS

N-P-K-Mg



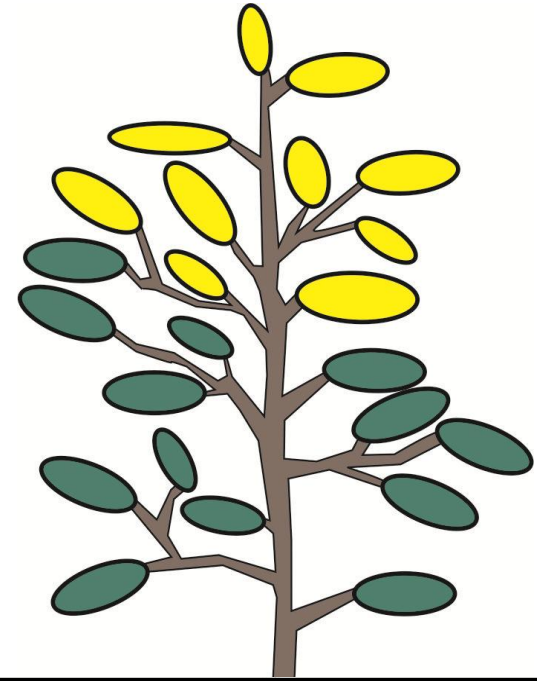
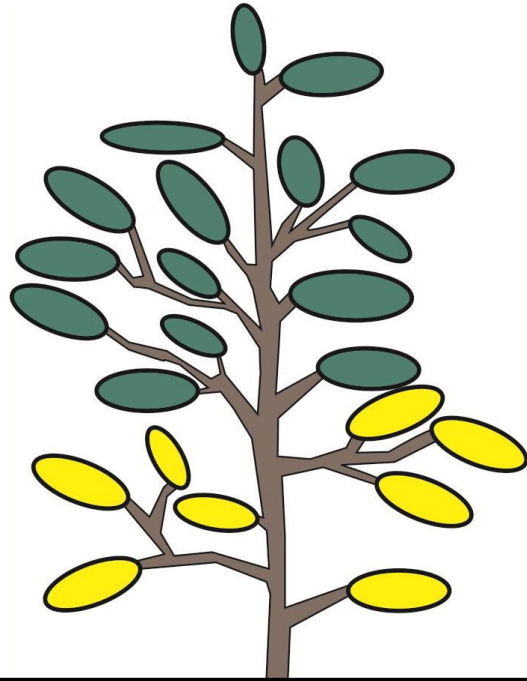
# FOLHAS VELHAS

N-P-K-Mg



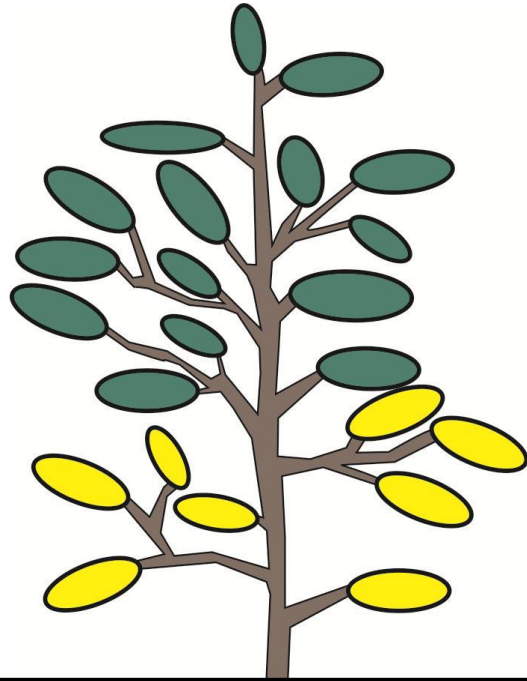
# FOLHAS VELHAS

N-P-K-Mg

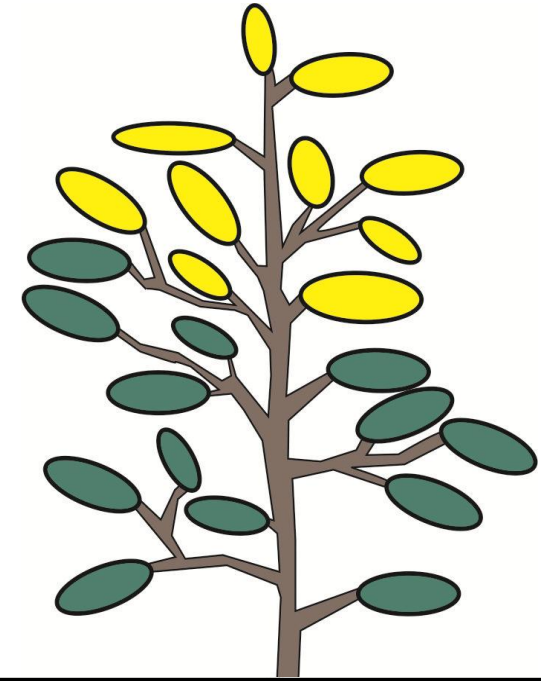


# FOLHAS VELHAS

N-P-K-Mg

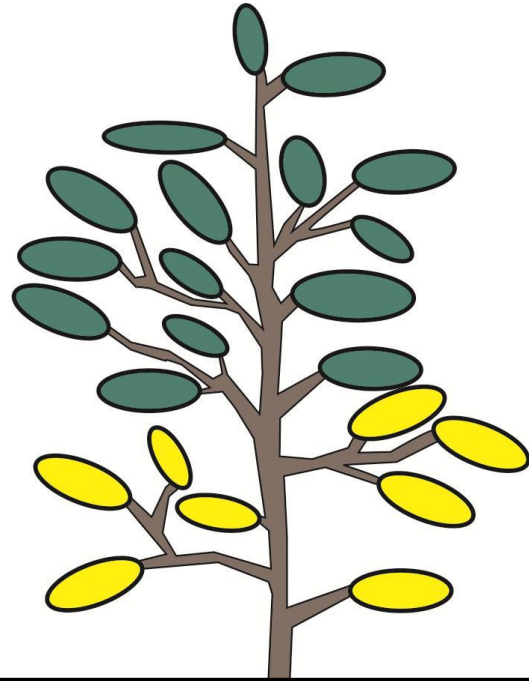


# FOLHAS NOVAS



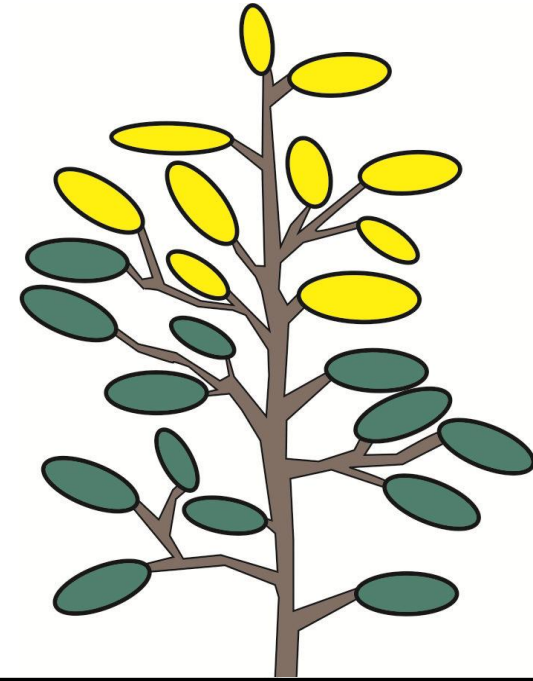
# FOLHAS VELHAS

**N-P-K-Mg**



# FOLHAS NOVAS

**Ca-S-B-Cu**  
**Fe-Mn-Zn**



# PRINCÍPIOS DE DIAGNOSE VISUAL DE DESORDENS NUTRICIONAIS

**SINTOMA**

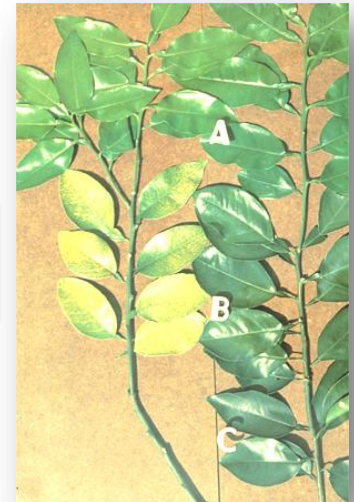
**PARTE DA PLANTA**

**DEFICIÊNCIA**

**CLOROSE**

**FOLHAS  
VELHAS E  
MADURAS**

**N**

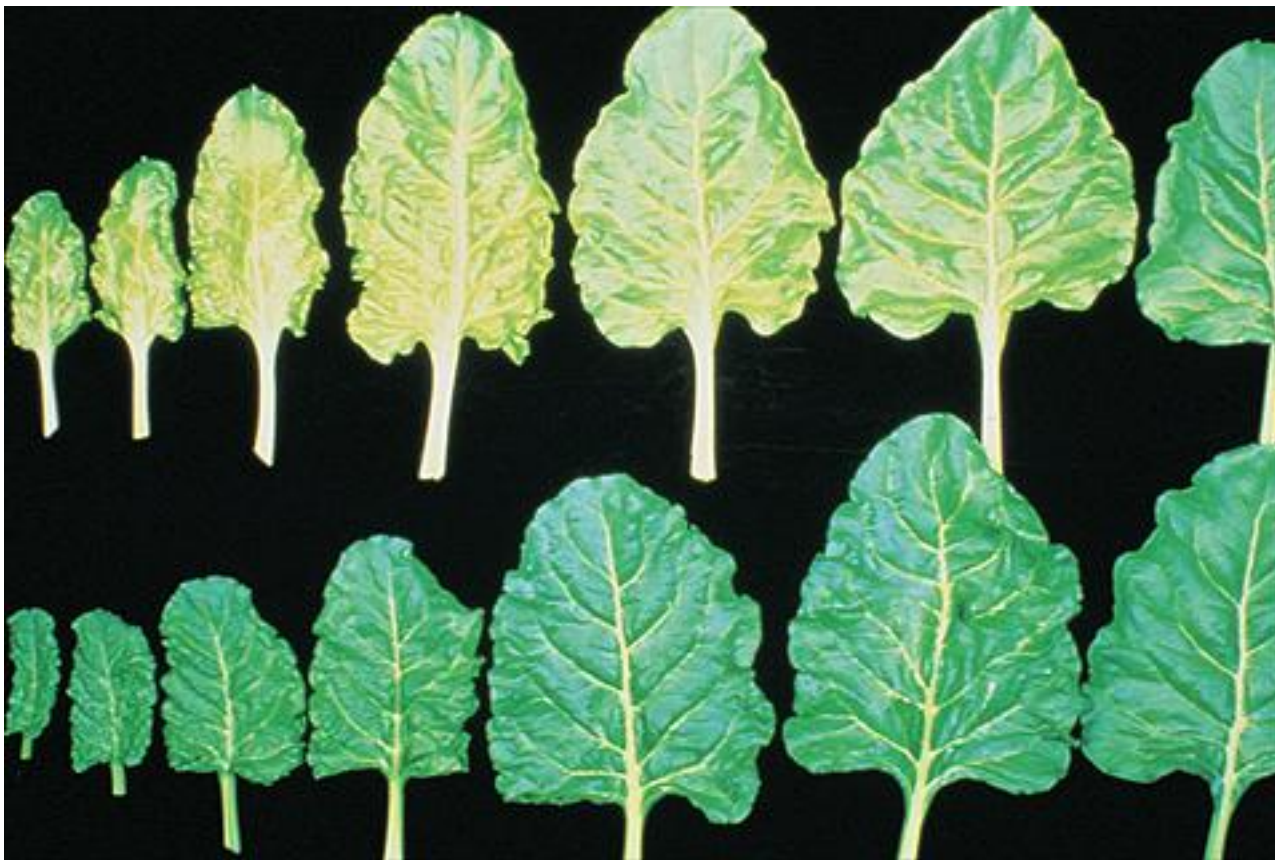


**FOLHAS  
NOVAS**

**S**



# Deficiências de Enxofre



**Beterraba**













# Enxofre

**Forma Absorvida:**

$\text{SO}_4^{2-}$

**Forma Incorporada:**

$\text{S}^{2-}$

**Mobilidade de Redistribuição:**

**Imóvel**

**Teores Médios:**

**1 a 3 g kg<sup>-1</sup>**

**Funções nas Plantas:**

**Aminoácidos**

**Características de deficiência:**

**Amarelecimento generalizado das folhas novas**





**Todos estamos matriculados  
na escola da vida, onde o  
mestre é o tempo**

**Cora Coralina, 1982**

**“Todos estamos matriculados na  
escola da vida, onde o mestre é  
o tempo.”**

**Cora Coralina (1982)**