Managing water and nutrients

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Irrigation field day
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Agriculture and Agri-Food Canada Agriculture et Agroalimentaire Canada

Canada

Collaborators

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Water in plants

Plant constituent (e.g.apple fruit ~ 80% water)

Solvent and transporter of nutrients, metabolites etc.

Chemical reactant

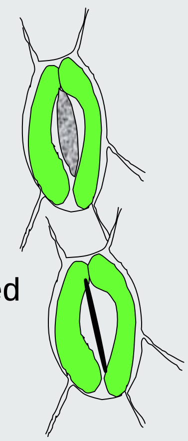
Maintains cell turgidity (important for growth and cell function)

Modifies tree micro-climate (cools through evaporation, increases humidity

Stomates

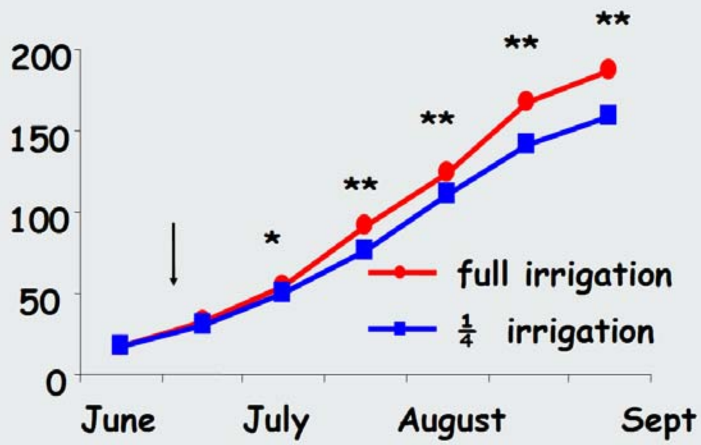
Open when
- guard cells are turgid
- internal CO_2 content low

Closed when
- guard cells are water stressed
- internal CO_2 content high



(100k – 350K/sq in)

Need to avoid detrimental stress (Gala/M.9)

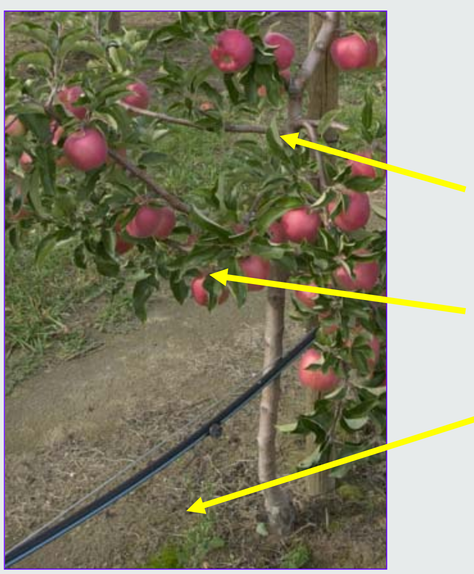


Strategies for managing water well

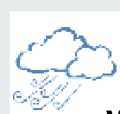
- **Applying water to meet plant requirements (irrigation scheduling)**

- **More conservative systems (micro-irrigation/mulching)**

Water Loss via Evapotranspiration



Solar radiation



Wind

Transpiration from leaf stomates

Evaporation from the leaf surface

Evaporation from the soil surface

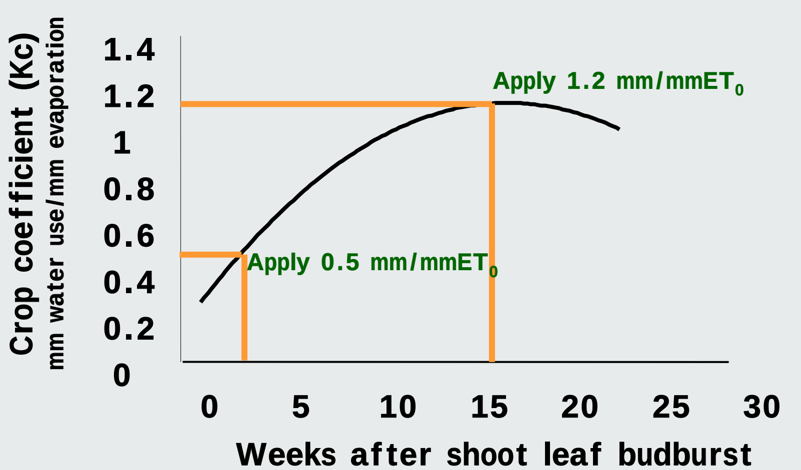
Estimating tree water use

Actual water use(mm) = **K** x ET_0 (mm)

K is the crop coefficient and is related to canopy size

K is the mm water required per mm of ET_0

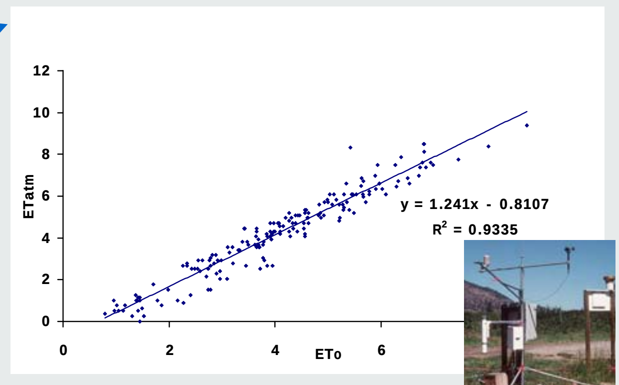
Change in the crop coefficient (Kc) over the growing season



Estimating evapotranspiration through evaporation

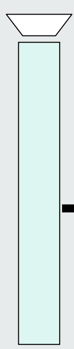
Atmometer

• Evaporation from this porous ceramic plate is measured electronically and is a measure of potential ET



Automating scheduling using an electronic atmometer

Electronically measure evaporation daily using an ATMOMETER



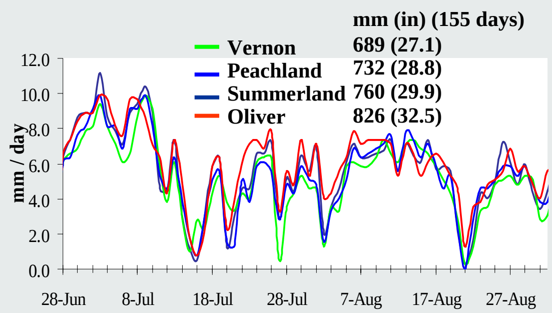
→ **Estimate amount of water used**

Data logger or computer programmed with crop coefficients etc.

→ **Replace water used next day**

Irrigation controller

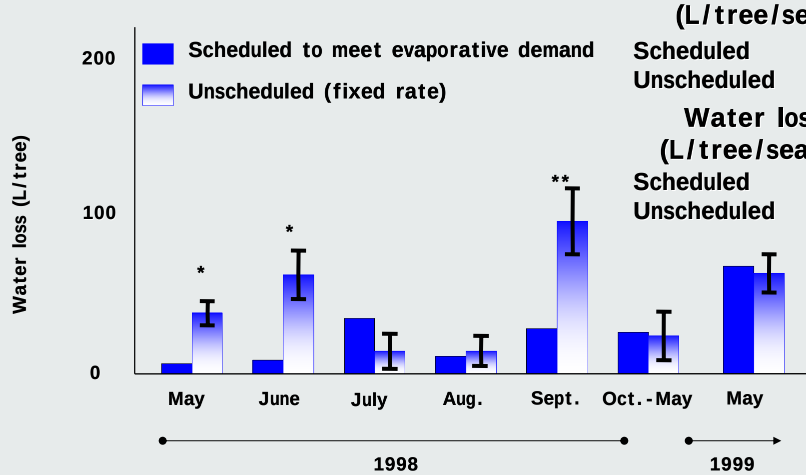
Automating scheduling using an electronic atmometer in 4 grower orchards



Growing with care program

- **4 orchards**
- **3 years**

Water use and loss of water beneath the root zone in response to irrigation scheduling



Water added (L/tree/season)

Scheduled	646
Unscheduled	1304

Water loss (L/tree/season)

Scheduled	168
Unscheduled	286

Other management strategies

- mulches to reduce soil water evaporation
- conservative irrigation systems
- deficit irrigation practices

Conservative irrigation systems

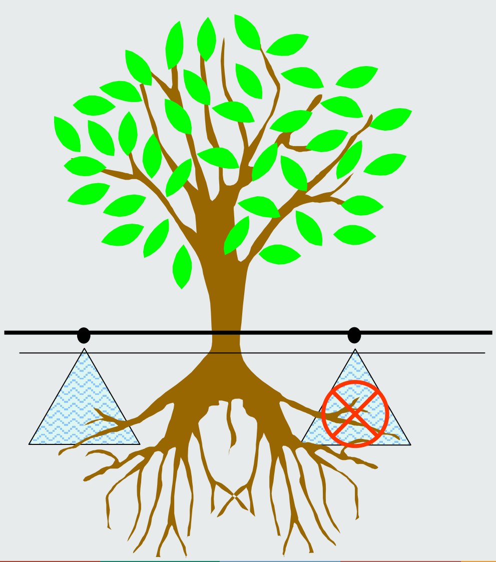
Drip irrigated – scheduled, with and without mulch
Remainder of field – AB sprinkler

Water saved with drip + mulch compared with sprinkler

	Drip Mulch	Sprinkler
Water use (acre-feet)	2.4	3.6
Change in TCSA (%) since 2000	120*a*	119*a*
Yield (lb/tree)	9.9*a*	7.3*b*
Fruit size (lb)	0.42	0.46
Starch (1-6)	3.44*a*	2.39*b*
Firmness (lb)	19.6	20.4

Means with same letters are not significantly different
[1]estimated from previous year

Deficit techniques-partial root zone drying



- Irrigation is restricted in part of root zone
- Only imposed during part of season
- Has potential to restrict tree growth without affecting fruit growth

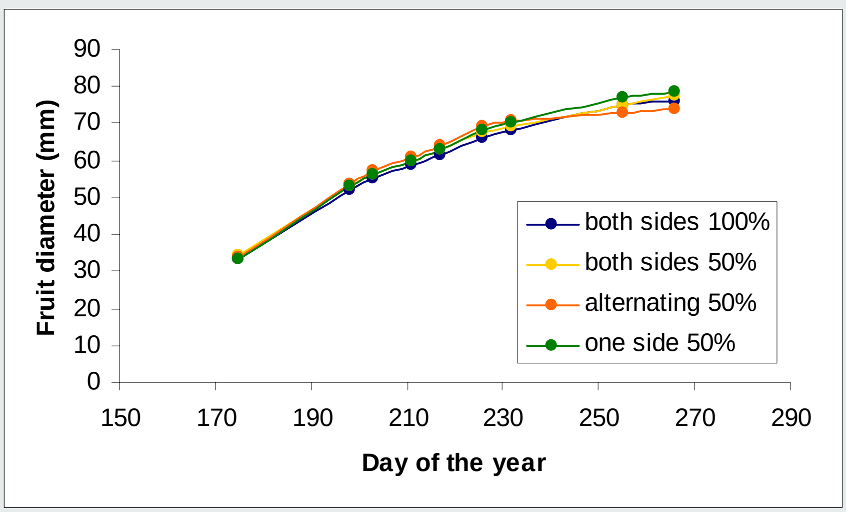
Partial root zone drying experiments

- drip system –scheduled to meet ET

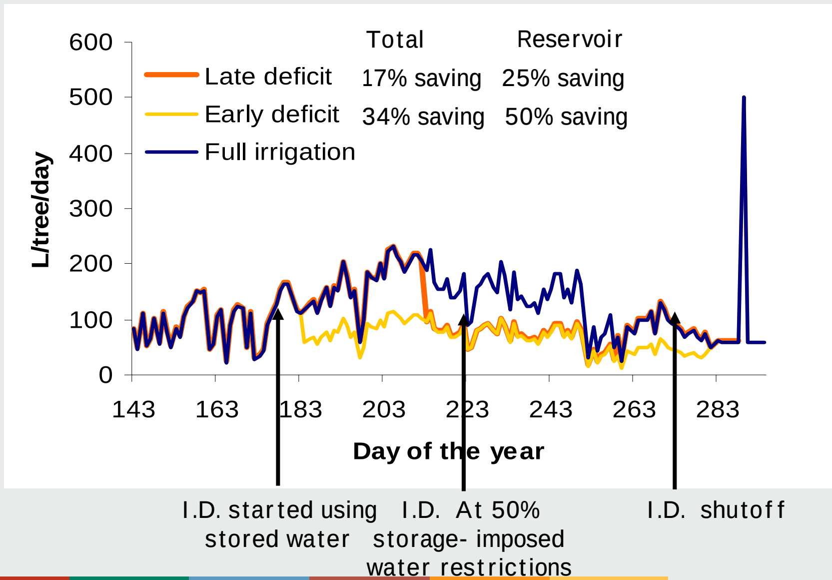
1. 100% water – 2drippers/tree
2. 50% water – 2 drippers/tree
3. 50% water – one side
4. 50% water – alternating

- Early imposition: mid-June to harvest
- Late imposition: early Aug to harvest

Partial root zone drying experiment Fruit size



Partial root zone drying experiment
Water savings



Link between water and N supply in irrigated systems

Linked because

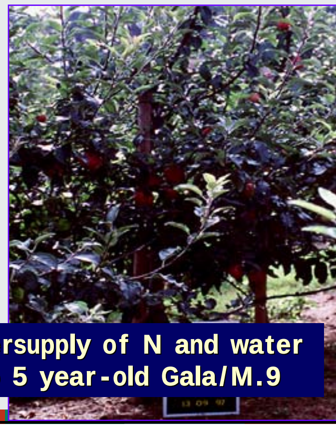
- **N is highly mobile in soil**
- **N availability affected by water movement through soil**
- **irrigation management key to N retention in root zone**

N and water can both be managed

- **to support and control growth**
- **to improve fruit quality**

Nitrogen management

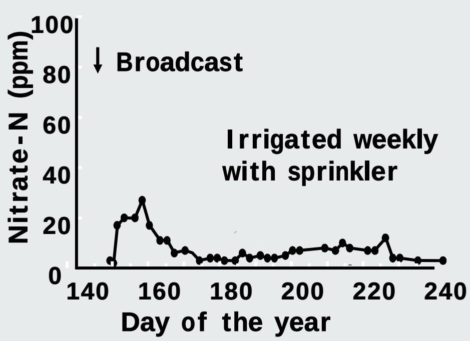
Reduction of water and N inputs can have beneficial impact on tree and fruit development and conserve resources

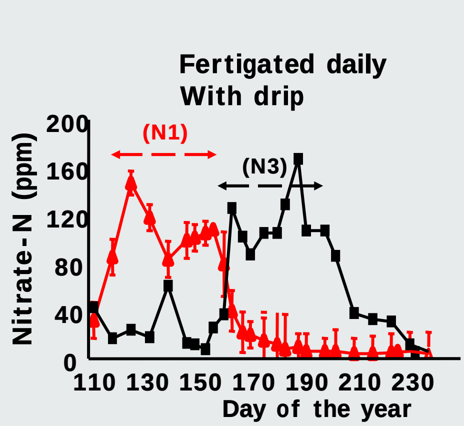


Oversupply of N and water to 5 year-old Gala/M.9

Control of soil N supply with fertigation

- retention in the root zone
- timing of inputs





Matching supply to demand

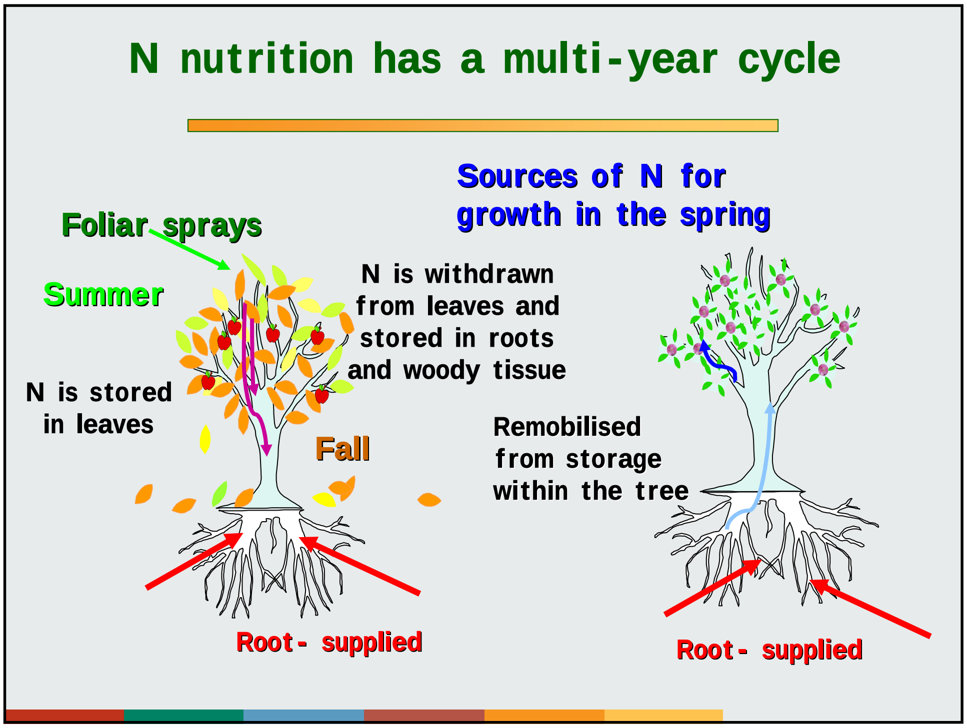
- amount
- timing

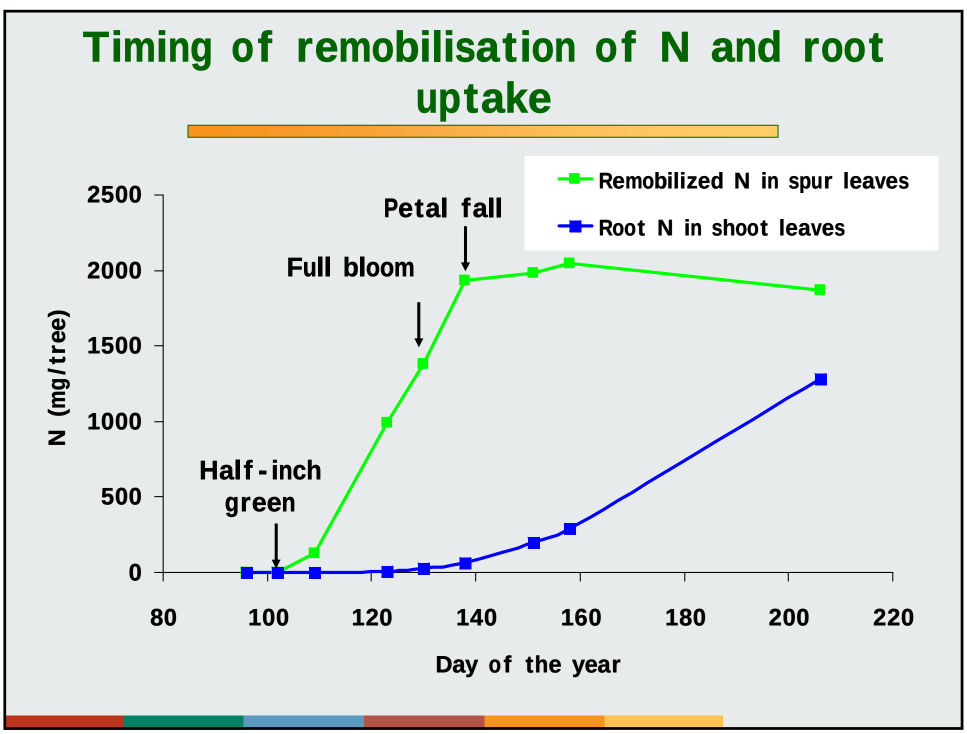
Nitrogen removal in fruit and senescent leaves of apple trees

	g/tree	kg/ha*
Golden Delicious/M.9 first year	2.7	8.9
Gala/M.9 third year	6.5	21.7
Elstar/M.9 fourth year	10.2	34.0
Gala/M.9 sixth year	12.3	41.0

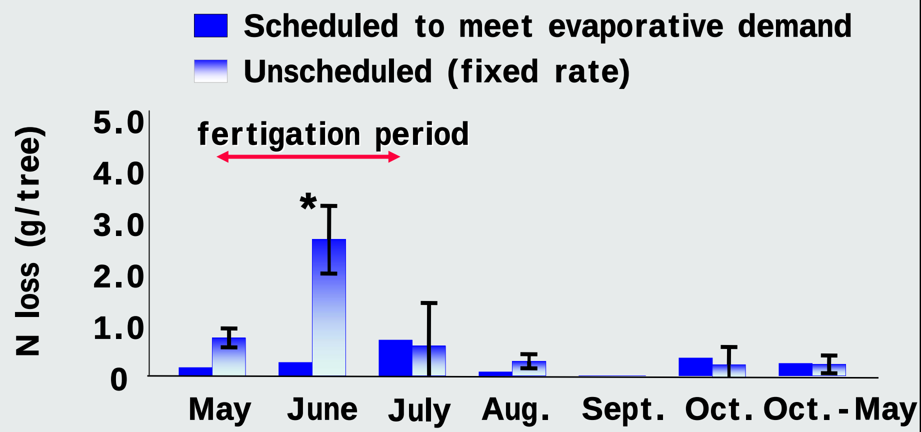
recommended rates of fertilizer 40-100 kg/ha

* assumes a tree density of 3300 trees/ha

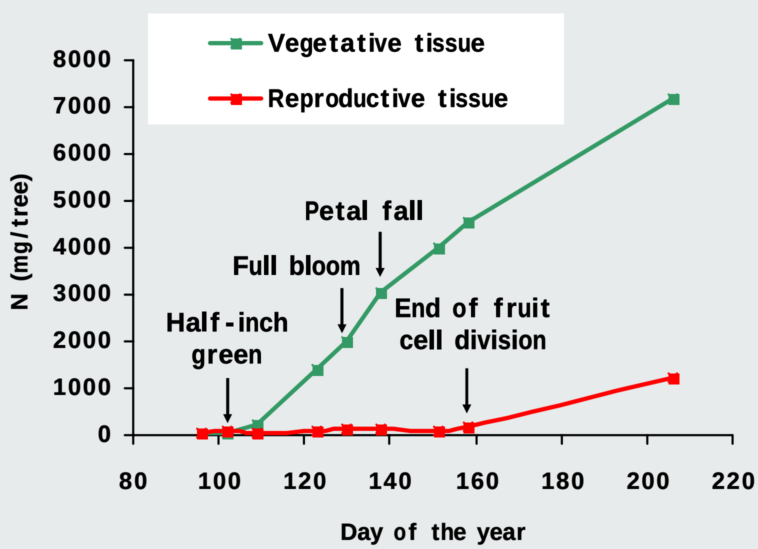

N nutrition has a multi-year cycle
Sources of N for growth in the spring
Foliar sprays
Summer
N is withdrawn from leaves and stored in roots and woody tissue
N is stored in leaves
Fall
Remobilised from storage within the tree
Root- supplied
Root- supplied


Timing of remobilisation of N and root uptake
Remobilized N in spur leaves
Root N in shoot leaves
Petal fall
Full bloom
Half-inch green
N (mg/tree)
2500
2000
1500
1000
500
0
80
100
120
140
160
180
200
220
Day of the year

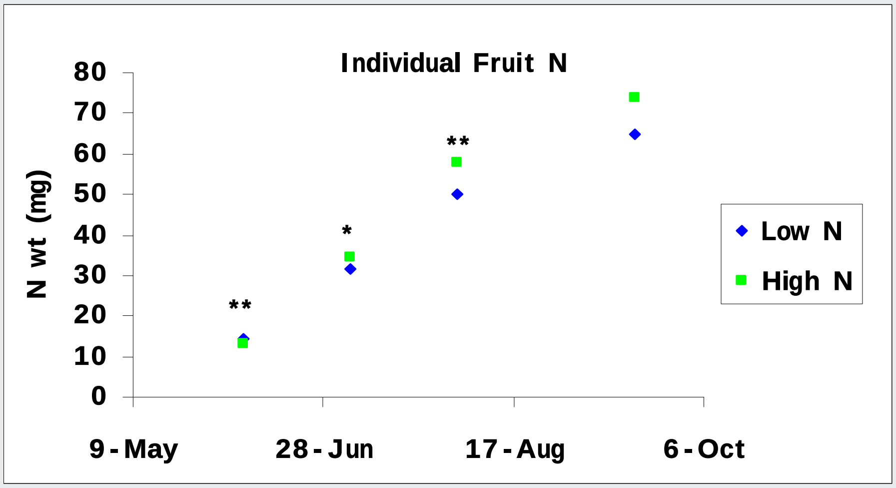
Loss of N beneath the root zone in response to irrigation scheduling



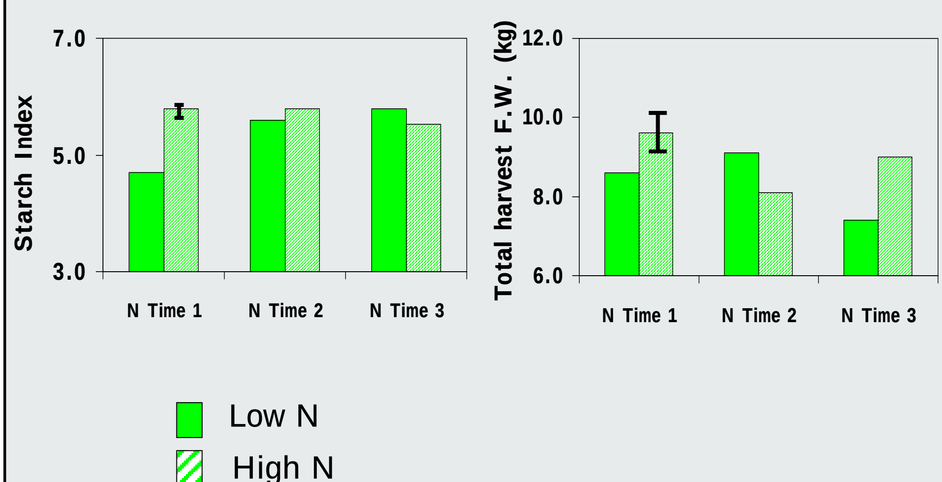
Timing of N inflow into leaves and fruit



Effect of rate of N applications on N inflow to fruit for Gala/M.9 (2001)



Effect of timing and rate of N applications on fruit harvest and maturity for Gala/M.9

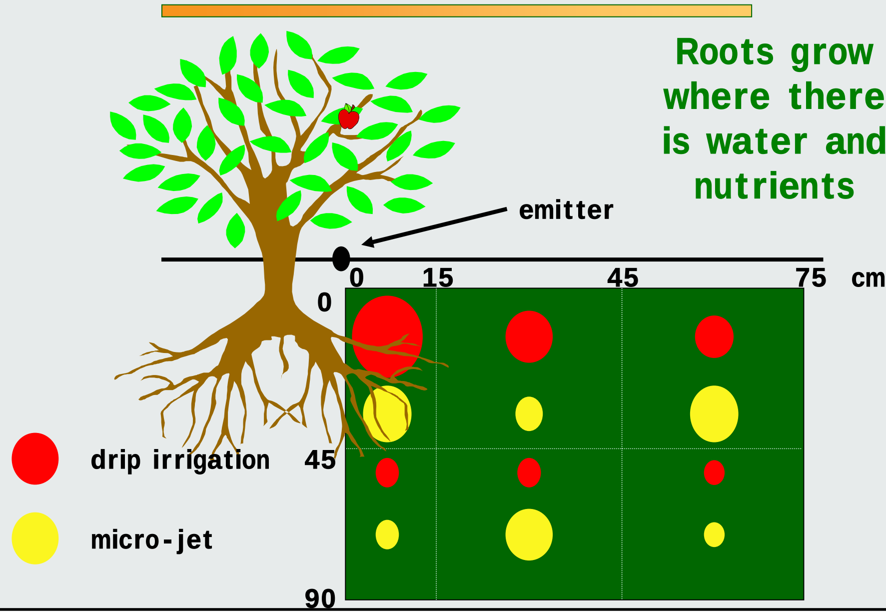


Nutrients of limited mobility

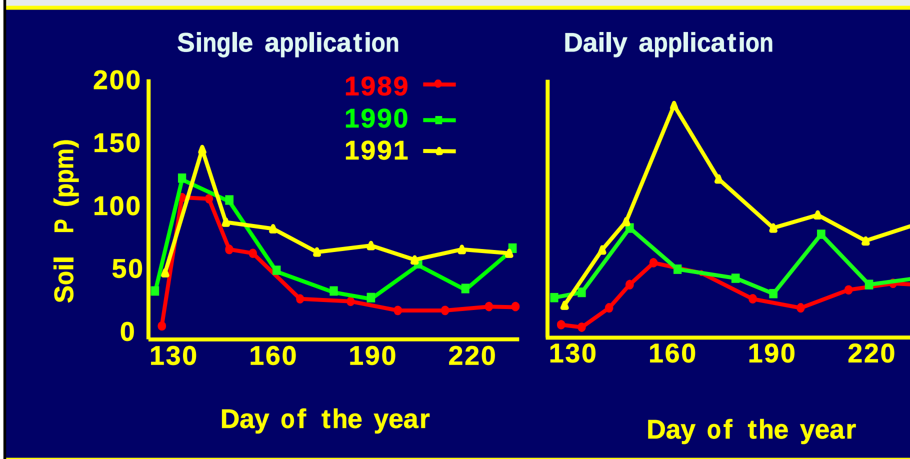
- Phosphorus (P)
- Potassium (K)

Where roots grow

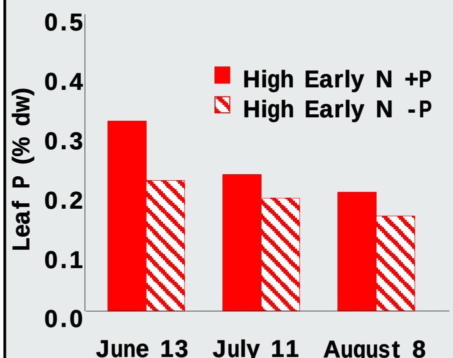
Roots grow where there is water and nutrients

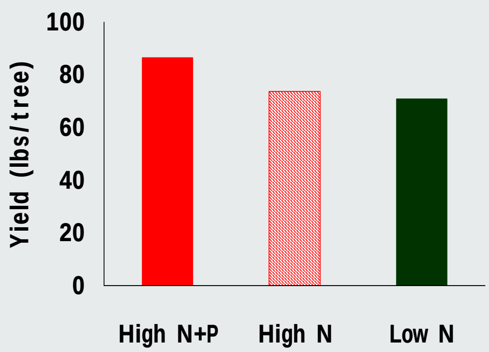


Fertigated phosphorus

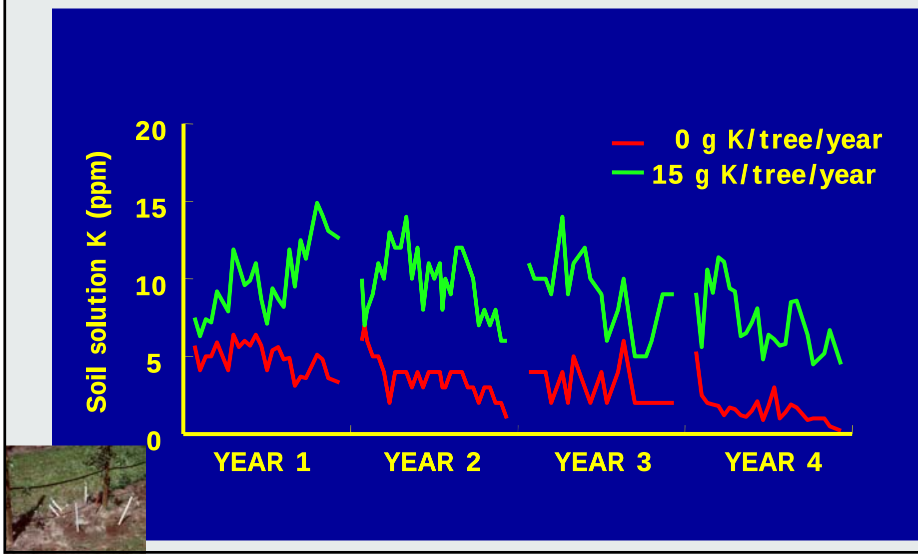


Pulsing phosphorus in early June

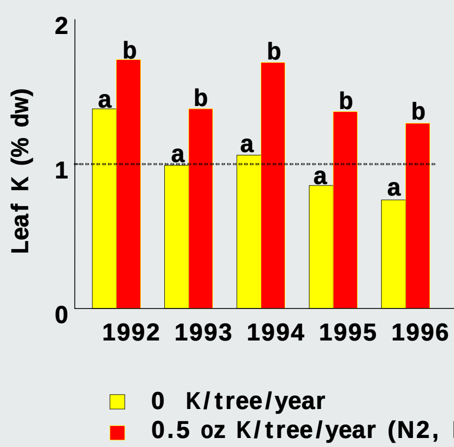




Soil solution K concentration in response to K fertigation



Effect of fertigated K on Leaf K concentration for four apple cultivars (Gala, Fuji, Spartan, Fiesta)



Thank you