Nutrient Requirements of 'Gala' Apple Trees

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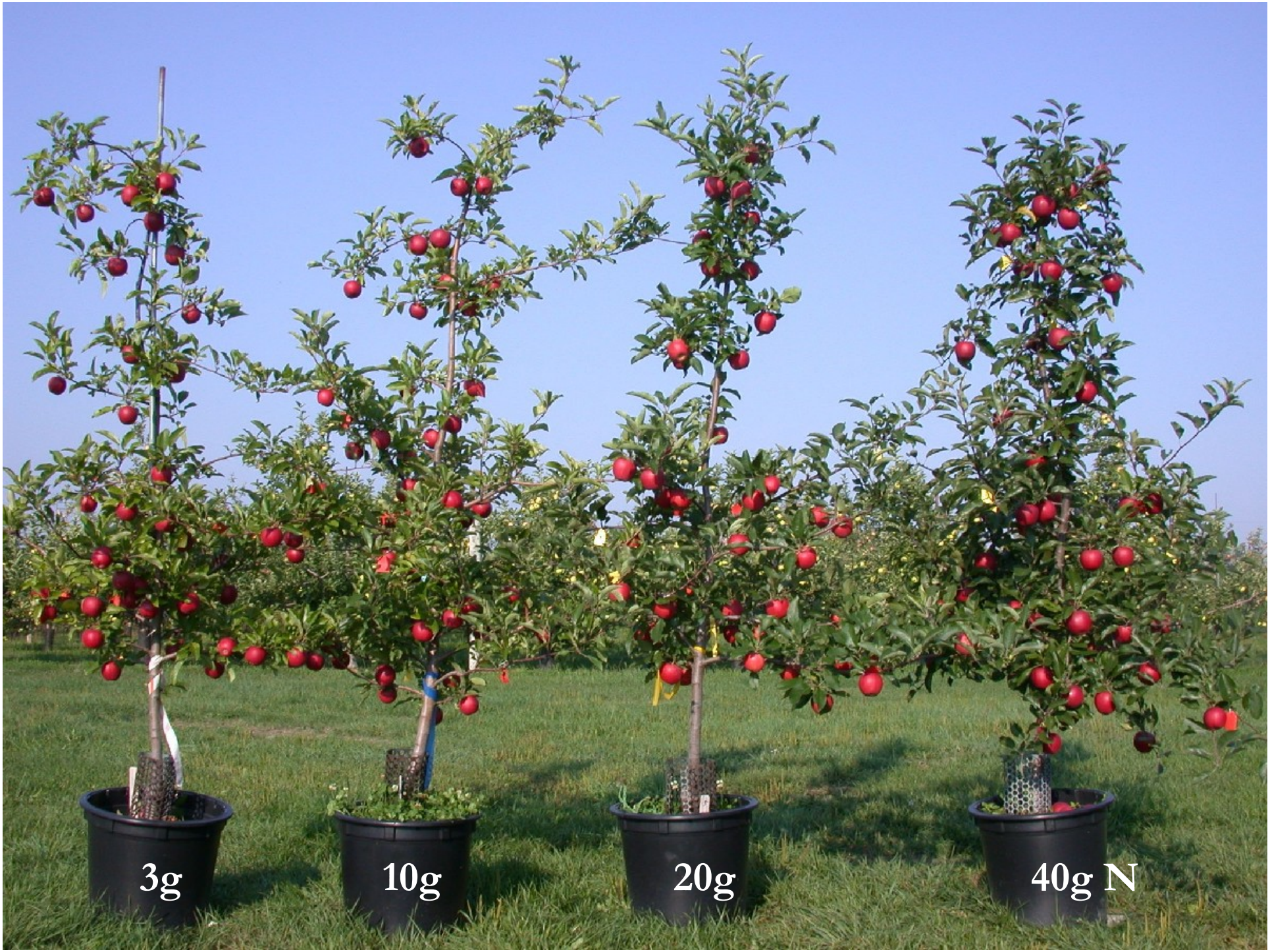
Apple trees on dwarfing rootstocks in high density orchards: crop earlier, have higher yield and smaller root system

- **When and how much nitrogen and other nutrients are required for high density 'Gala' trees to produce high yield and good size fruit?**


3g
10g
20g
40g N

Experimental Setup

- **Sixth-leaf Gala/M.26 were grown in sand culture at 3.5 by 11 feet spacing (1125 trees/acre).**
- **Each tree received 30 g N in Hoagland's solution during the entire growing season.**
- **Cropload was adjusted to 8.2 fruit/cm^2 TCA at 10 mm king fruit (~104 fruit/tree).**
- **Four trees were destructively sampled for analysis at each of 7 key developmental stages.**

Leaf and fruit nutrient status

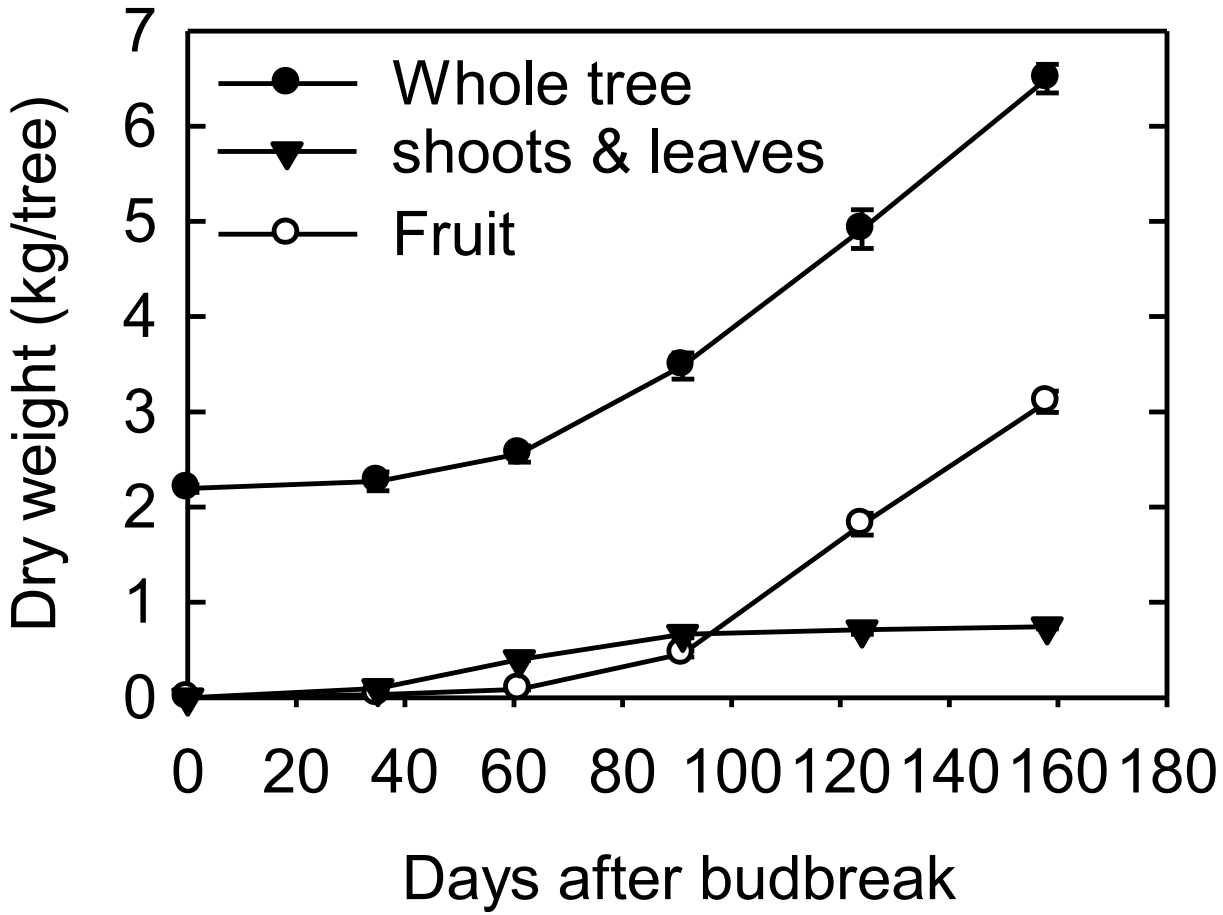
Macronutrients (%)

Tissue	*N*	*P*	*K*	*Ca*	*Mg*
Leaf	**2.00**	**0.18**	**1.61**	**1.10**	**0.39**
Fruit	**0.25**	**0.06**	**0.80**	**0.05**	**0.04**

Micronutrients (ppm)

Tissue	*B*	*Zn*	*Cu*	*Mn*	*Fe*
Leaf	**27.3**	**27.3**	**8.3**	**143.8**	**83.5**
Fruit	**21.8**	**3.5**	**3.8**	**7.8**	**25.3**

Dry matter accumulation of 6th-leaf Gala/M.26



Cropload: 8.2 frt/cm^{2}TCA

Fruit#/tree: 104

Yield:18.8Kg/tree

Leaf area/fruit: 550 cm^2/frt

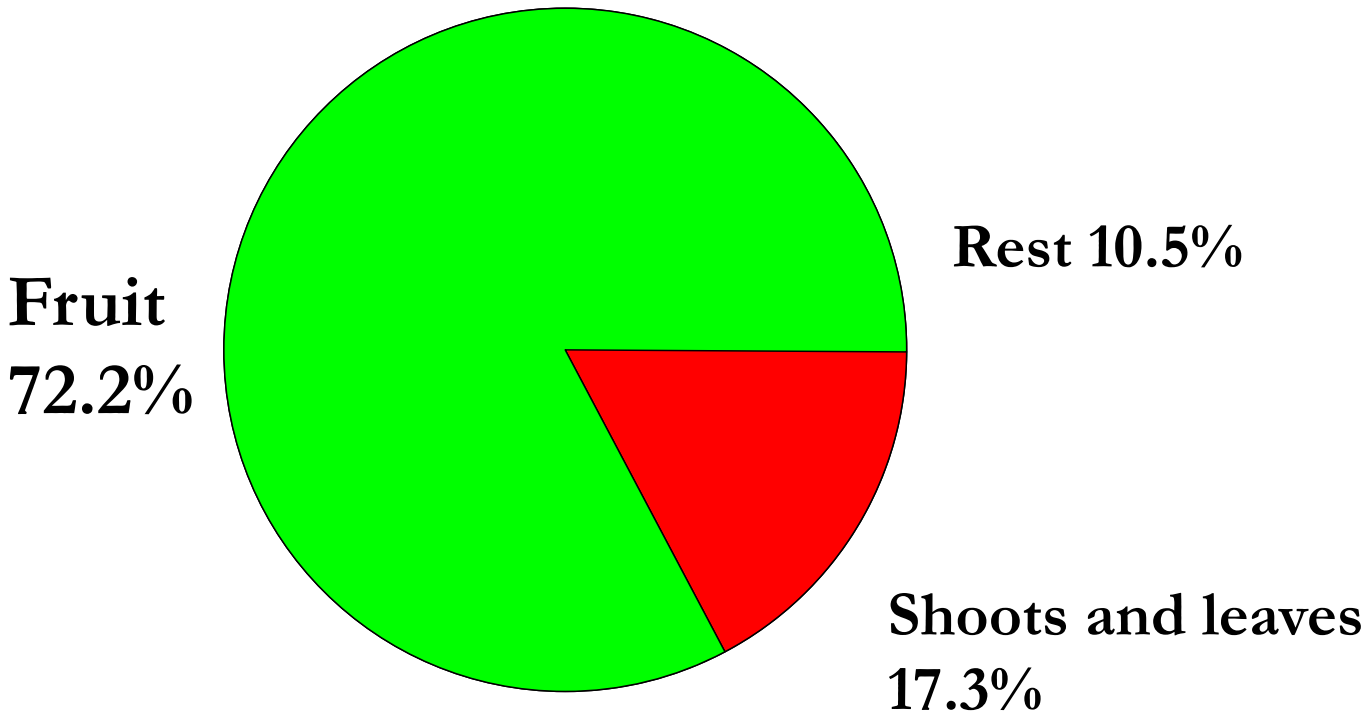
Fruit size: 181 g/fruit

Fruit firmness: 16.8 lbs

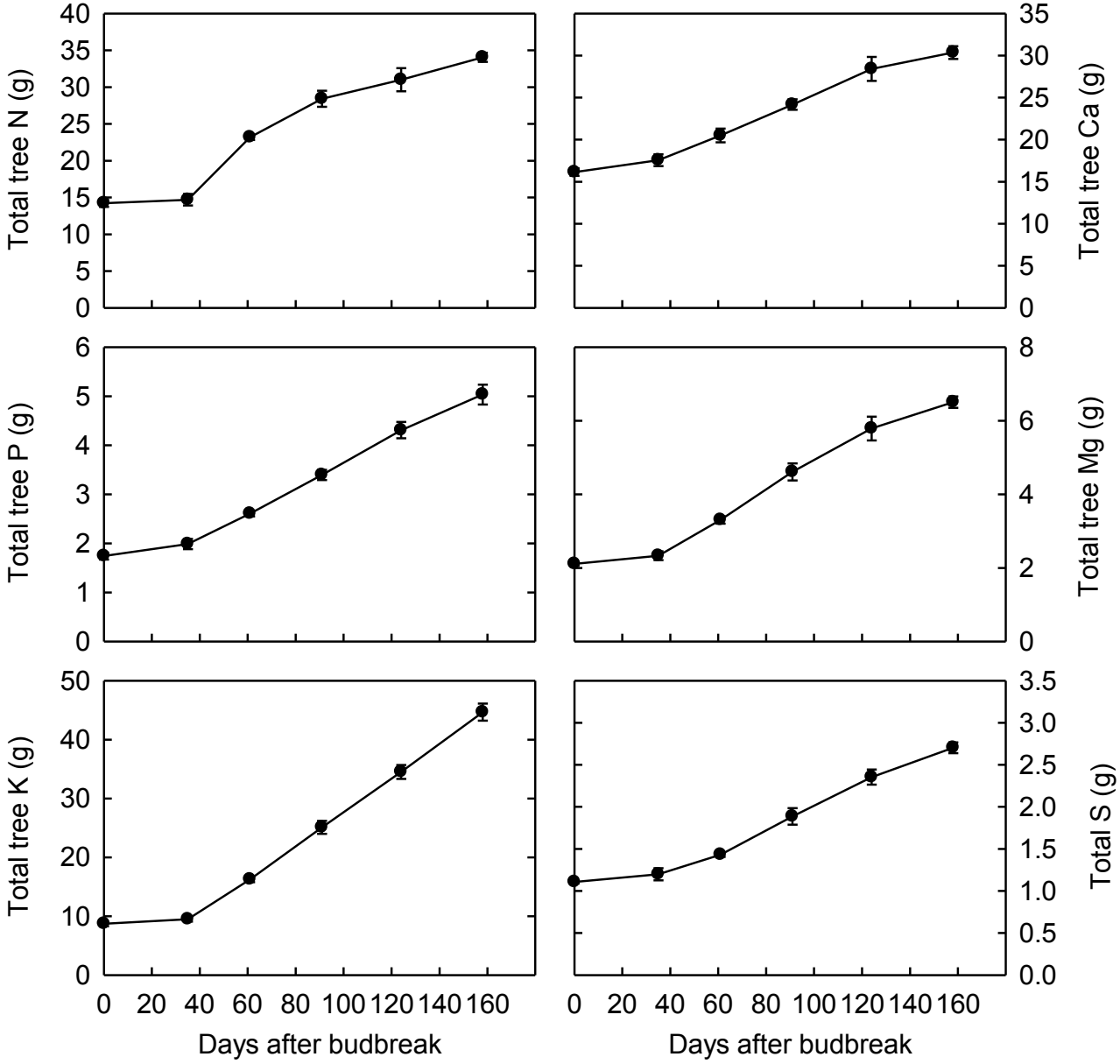
Soluble solids: 14.5%

Net dry matter gain and its partitioning

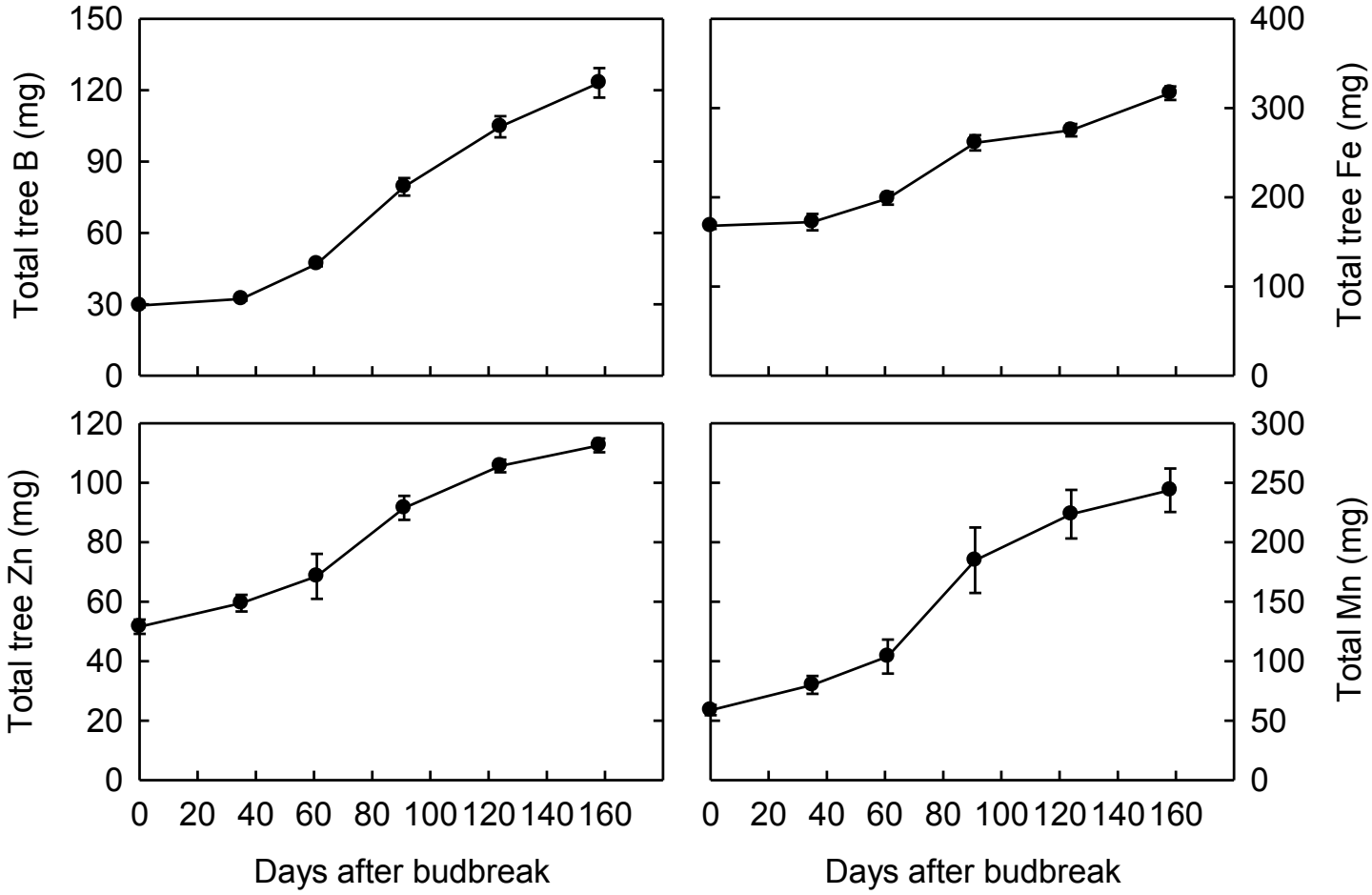
(Net DW gain: 4.3 kg)



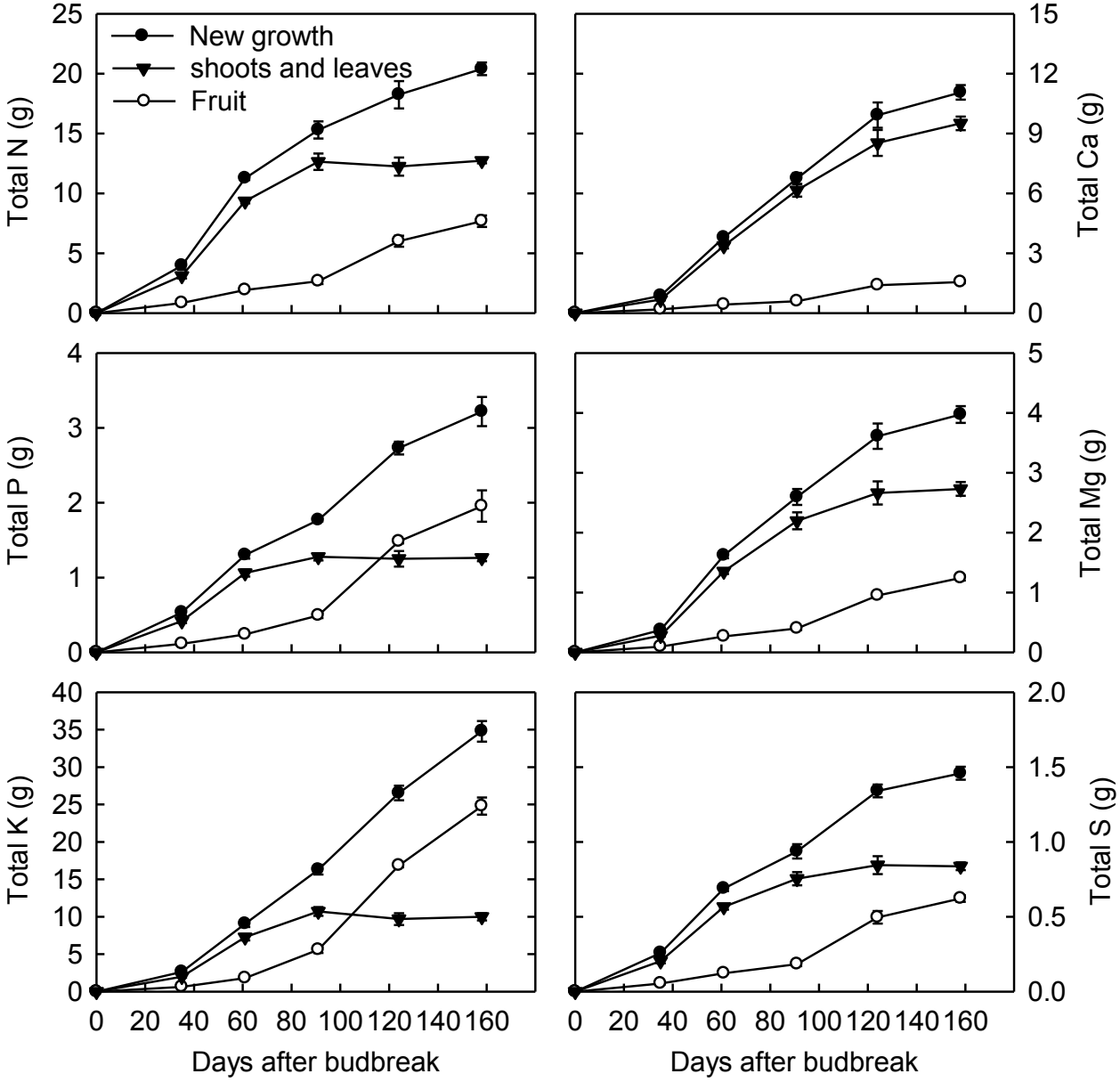
Macronutrient accumulation patterns of whole tree



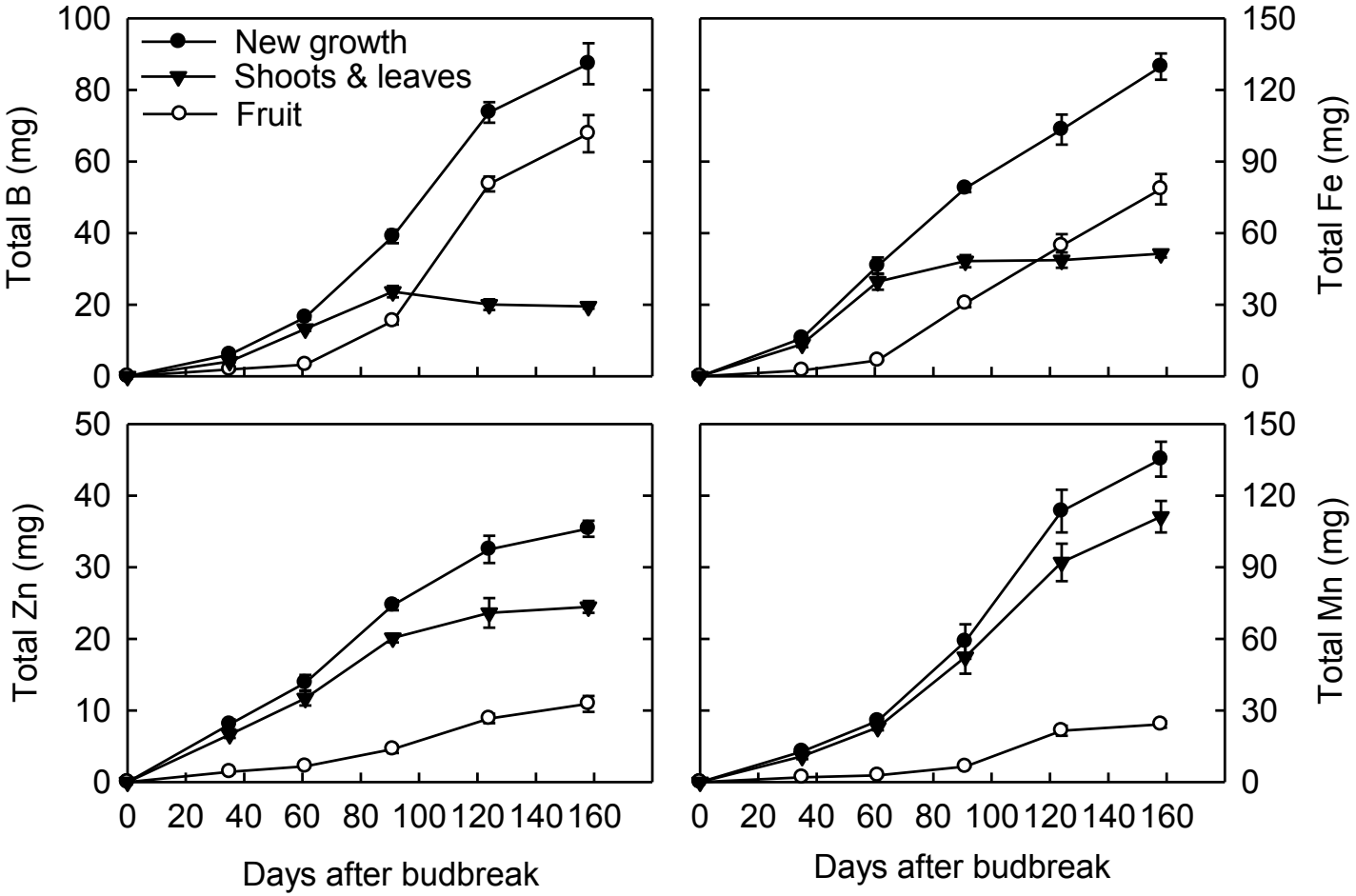
Micronutrient accumulation patterns of whole tree



Macronutrient accumulation patterns in new growth



Micronutrient accumulation patterns in new growth



Gala/M.26 nutrient requirements

(52.5 t/ha or 1110 bushels/acre)

Macronutrients (lbs/acre)

	N	*P*	*K*	*Ca*	*Mg*
Net gain	**50.0**	**8.2**	**89.4**	**35.4**	**10.9**
New growth	**50.7**	**8.0**	**86.5**	**27.5**	**9.9**

Micronutrients (lbs/acre)

	B	*Zn*	*Cu*	*Mn*	*Fe*
Net gain	**0.23**	**0.15**	**0.12**	**0.46**	**0.37**
New growth	**0.22**	**0.09**	**0.05**	**0.34**	**0.32**

Tree nutrient requirements in relation to yield

Macronutrients (lbs/acre)

Fruit yield (b/a)	*N*	*P*	*K*	*Ca*	*Mg*	*S*
500	**22.1**	**3.7**	**40.2**	**15.9**	**4.9**	**1.8**
750	**33.2**	**5.5**	**60.2**	**23.9**	**7.3**	**2.7**
1000	**44.3**	**7.4**	**80.3**	**31.8**	**9.8**	**3.6**
1250	**55.4**	**9.2**	**100.4**	**39.8**	**12.2**	**4.5**
1500	**66.4**	**11.1**	**120.5**	**47.7**	**14.7**	**5.4**
1750	**77.5**	**12.9**	**140.6**	**55.7**	**17.1**	**6.3**
2000	**88.6**	**14.8**	**160.6**	**63.6**	**19.6**	**7.2**

‘Gala’ fruit nutrient requirements

(52.5 t/ha or 1110 bushels/acre)

Macronutrients (lbs/acre)

Study	*N*	*P*	*K*	*Ca*	*Mg*
Palmer (2006)	**18.7**	**4.6**	**57.8**	**3.0**	**2.7**
Cheng (2009)	**19.1**	**4.9**	**61.6**	**3.9**	**3.1**

Micronutrients (lbs/acre)

Study	*B*	*Zn*	*Cu*	*Mn*	*Fe*
Palmer (2006)	**0.12**	**0.02**	**0.07**	**0.02**	**0.07**
Cheng (2009)	**0.17**	**0.03**	**0.03**	**0.06**	**0.19**

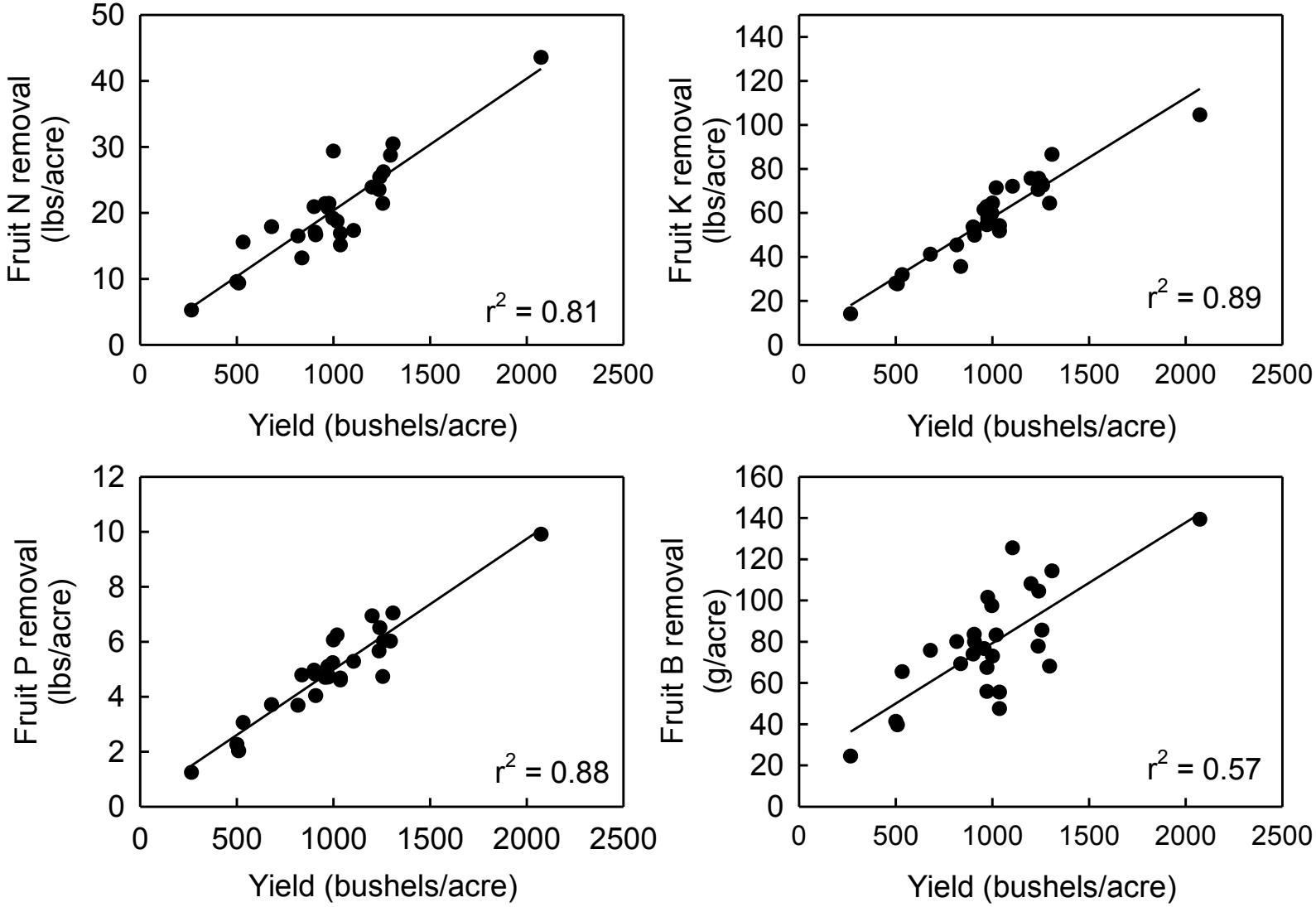
‘Gala’ nutrient removal by fruit harvest in relation to yield

Macronutrients (lbs/acre)

Yield (b/a)	*N*	*P*	*K*	*Ca*	*Mg*
500	8.6	2.2	27.7	1.8	1.4
1000	17.2	4.4	55.3	3.5	2.8
1500	25.7	6.6	83.0	5.3	4.2
2000	34.3	8.8	110.7	7.0	5.6

Nutrient removal by fruit harvest in relation to yield

('Gala' commercial orchards in New York)



Summary

- **Nutrient requirements at 1110 bu/acre: N: 50, P: 8.5, K: 90, Ca: 36, Mg: 11, B: 0.23, Zn: 0.15, Cu: 0.12, Mn: 0.46, and Fe: 0.37 lbs/acre; Tree nutrient requirements are yield-dependent.**
- **Highest N demand occurs from bloom to the end of shoot growth, followed by a lower but steady demand; many other nutrients show a relatively constant demand from bloom to harvest.**
- **Differential requirements by fruit and leaves**
  - **Timing: bloom to end of shoot growth for leaves; end of shoot growth to fruit harvest for fruit;**
  - **Amount: fruit needs more P, K, B, and Fe than leaves.**

For More Info

- Cheng, L., Xia, G., Lakso, A. N. and M. Goffinet. 2007 How does nitrogen supply affect 'Gala' fruit size? New York Fruit Quarterly 15(3), 3-5.
- Cheng L and R Raba 2009. New York Fruit Quarterly 17(4): 5-10.
- Cheng, L. 2010. Nitrogen nutrition and fertilization of apple trees. Compact Fruit Tree 43(1): 24-27.
- Cheng, L. and H. Wang. 2011. Nitrogen fertilization has differential effects on red color development and flesh starch breakdown of 'Gala' apple. New York Fruit Quarterly 19 (3): 11-15.
- Cheng, L., Hoying, S. and M. Miranda Sazo. 2014. Nutrient removal by fruit harvest and maintenance applications of nutrients in New York apple orchards. New York Fruit Quarterly 22(2): 15-19.

Acknowledgments

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