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Trials Prove K Fertilization of Apples can be Beneficial

Studies conducted in semi-arid region of British Columbia on potassium- and magnesium-deficient, coarse-textured soils.

Summary: *Broadcast application of 112 to 225 lbs/A of K as K Mag has been generally effective at increasing leaf K concentration and NH4OAc extractable K concentration in the major rooting zone in most orchards. Application of these rates of K Mag fertilizer did not increase leaf magnesium (Mg) concentration but prevented the decline in leaf Mg concentration, normally associated with K fertilization, while increasing root zone soil Mg availability. Fruit responses to K Mag fertilization were likely related to improved K nutrition and included in 2002 increased fruit titratable acidity (3 orchards), increased fruit size (2 orchards), increased red coloration (1 orchard), and decreased incidence of water core (1 orchard).*

Table 1. Leaf K (% dw) as affected by K Mag treatments, 'Fuji' orchards.

	Orchard and year									
	1			2			3		4	
Treatment										
lbs/A	'00	'01	'02	'00	'01	'02	'00	'01	'00	'01
Check	1.35	1.19	1.20	1.50	1.62	1.71	1.51	1.42	1.40	1.34
112 K Mag	1.31	1.30	1.36	1.60	1.73	1.83	1.62	1.51	1.40	1.40
225 K Mag	1.40	1.35	1.52	1.60	1.78	1.89	1.71	1.54	1.40	1.39

Table 2. Leaf Mg (% dw) as affected by K Mag treatments, 'Fuji' orchards.

	Orchard and year									
	1			2			3		4	
Treatment										
lbs/A	'00	'01	'02	'00	'01	'02	'00	'01	'00	'01
Check	0.32	0.35	0.35	0.16	0.18	0.24	0.21	0.24	0.31	0.30
112 K Mag	0.32	0.34	0.32	0.16	0.17	0.24	0.21	0.24	0.29	0.29
225 K Mag	0.32	0.33	0.32	0.16	0.16	0.23	0.20	0.23	0.31	0.30

Fertigation of nitrogen (N), phosphorus (P) and potassium (K), directly dissolved in irrigation water, has been effectively used on apple trees in the fruit production region of the Pacific Northwest of America. A large proportion of fruit growing soils in the Pacific Northwest developed under semi-arid conditions. They are frequently coarse-textured sandy loams or loamy sands with inherently low organic matter. Such soils present a number of management problems associated with their limited chemical and water retention capacity, including acidification and leaching of basic fertility elements including K, Mg, and Ca (calcium). In a recent survey of 20 typical NP fertigated, high-density apple orchards, many apparently deficient leaf K (3 orchards) or leaf Mg (magnesium) concentrations (8 orchards) were observed. K deficiency has been attributed to the development of a K depletion zone directly beneath drip fertigated emitters where the majority of tree roots occurs. Fertigation can correct K deficiency. K fertigation, however, decreases leaf Mg concentration and does not improve soil Mg content, which has also been decreased as soils acidify.

Thus a series of trials were established in the fruit growing region of the southern interior of British Columbia in order to test the effectiveness of co-application of K and Mg via broadcast or fertigated application in apple orchards.

Table 3. Statistically significant fruit quality effects with K Mag fertilzation in experimental orchards, 2002 harvest.

Orchard	1 Red color (%)	1 Fruit wt (g)	7 Fruit wt (g)	7 Titra-table acidity (mg 100ml^{-1})	9 Titra-table acidity (mg 100ml^{-1})	10 Titra-table acidity (mg 100ml^{-1})	11 Watercore (fraction)
Treatment (lbs/A)							
Check	81	261	184	9.9	8.2	7.1	0.72
112 K Mag	89	263	201	10.3	8.9	7.3	0.68
225 K Mag	88	22	217	10.7	9.2	7.6	0.47

Tree nutrition

Potassium. In 2000 to 2002, a range of leaf K concentrations was observed in both the 'Fuji' and 'Spartan' orchards. Annual leaf K concentration less than or equal to 1.3 percent (and thus close to the deficiency threshold of 1.0 to 1.2% for apple) was observed for check treatments at some time during the study in five 'Fuji' orchards (examples in Table 1), and three 'Spartan' orchards (data not shown). Midsummer leaf K concentration was decreased by heavy crop loads. Variations in annual leaf K concentrations partially relate to variations in crop load, which may explain the low leaf K concentrations for the check treatment observed for only a single year in orchard 10 (data not shown). Orchard 1, by contrast, was consistently low in leaf K concentration when not receiving K Mag fertilizer. In one Spartan orchard K concentrations were deficient without K Mag fertilization in 2002, even after three annual applications of 112 lbs/A of K as K Mag.

K Mag fertilizer applications significantly increased leaf K concentration in direct proportion to the amount applied in four orchards in 2000 and this effect increased to 8 of 14 orchards in 2001. K Mag fertilizer applications significantly increased leaf K concentration in 7 of 11 orchards in 2002, including the four orchards with lowest leaf K concentrations. This implies that broadcast K Mag fertilization is generally effective at improving tree K nutrition.

Magnesium. In contrast to leaf potassium concentrations, K Mag fertilization did not increase leaf Mg concentration (sample data for 'Fuji', Table 2). Only in orchard 1 in 2002 did application of K Mag decrease leaf Mg concentration. It therefore appears difficult to increase leaf Mg concentration in apple when co-applying K. However, it has been well documented that application of K fertilizer not containing Mg at rates between 112 to 225 lbs/A of K, as in this study, usually decreases apple leaf Mg concentration. This generally was not observed after application of K Mag since leaf Mg was not decreased upon application of up to 225 lbs/A of K as K Mag. Thus, K Mag fertilization at least maintains leaf Mg concentration when K fertilizer is being applied.

Fruit quality

Fruit quality parameters at harvest were significantly affected by K Mag fertilization in some orchards for both 2000 and 2001 harvests (data not shown). Results from the 2002 harvest are typical and indicate statistically significant results in 5 of the 10 orchards where detailed fruit quality measurements were made in 2002. Fruit parameters of prime importance for growers include percent red color, fruit size, and absence of major fruit disorders, since these have a direct effect on grower returns. In 2002, the most important fruit quality effects were measured in orchards 1 and 7, which also had the lowest leaf K concentrations when unfertilized (Table 3). Both orchards had increased fruit size, implying a yield response to K Mag fertilization. It was noteworthy that all orchards that showed fruit responses to K Mag fertilization had leaf K values < 1.4 percent. The only exception to this pattern was one orchard that had a leaf K concentration of 1.29 percent when not receiving K Mag fertilizer yet fruit that did not respond to fertilization. This orchard was also characterized by a high variation in vegetative growth and crop load within the experimental block.

Increases in red coloration and acidity of fruit have previously been associated with improved K nutrition of apple trees. K Mag fertilization failed to improve red color in orchard 7 containing 'Spartan,' which is a naturally highly colored cultivar averaging 95 percent red in this orchard. Higher fruit acidity (orchards 7 and 9) can be associated with improved fruit tartness and consumer acceptability. No incidence of fruit disorders at harvest was increased by K Mag fertilization (data not shown). In one 'Fuji' orchard, incidence of watercore disorder was decreased by K Mag fertilization.

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