Effect of Fertiliser Applications to the Soil after Harvest on Leaf Nutrient Concentrations in Mango

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ABSTRACT
Mango trees were fertilised with urea, calcium nitrate, potassium chloride, potassium nitrate, mono potassium phosphate, potassium sulfate, mono ammonium phosphate, soluble boron, or calcium hydroxide after harvest in late January 1998. In early May 1998, leaf samples were taken to assess the effect on leaf N, P, K, Ca, Mg, S, Zn, Mn, Cu, B, or Mo concentration.

Leaf nitrogen concentration was increased by potassium nitrate or mono ammonium phosphate application. None of the applications significantly affected leaf phosphorus or potassium concentration. Potassium chloride reduced leaf calcium concentration. There was no apparent effect of any of the applications on leaf magnesium concentration. Leaf sulfur concentration was significantly reduced by mono ammonium phosphate, and significantly increased by hydrated lime. No apparent effect was found on leaf zinc, manganese or copper concentration. Leaf boron concentration was significantly increased by soluble boron application. Potassium nitrate significantly increased leaf molybdenum concentration. It is concluded that assumptions generally made concerning the effects of fertiliser applications may not necessarily be correct.

UITTREKSEL
Mangobome is met ureum, kalsiumnitraat, potaschloried, potasnitraat, mono potasfosfaat, potassulfaat, mono ammonium-fosfaat, oplosbare boor, of kalsium hidroksied bemes na die oes in laat Januarie 1998. Vroeg in Mei 1998 is blaarmonsters geneem om die effek te evalueer op blaar N, P, Ca, Mg, S, Zn, Mn, Cu, B, of Mo konsentrasies. Blaar N-konsentrasie is deur die toedienning van KNO_3 of mono ammoniumfosfaat vermeerder. Nie een van die toediennings het blaarfosfor- of potas-konsentrasies beduidend beïnvloed nie. Potascloried het die blaar se kalsium-konsentrasie verminder. Die toediennings het geen beduidende invloed op blaar Mg-konsentrasie gehad nie. Die swawel-konsentrasie in blare is beduidend verminder deur mono ammoniumfosfaat en beduidend verhoog deur gebluste kalk. Geen noemenswaardige effek is in die blare se sink-, mangaan- of koper-konsentrasie gevind nie. Die blaar boor-konsentrasie is beduidend verhoog deur die toedienning van oplosbare boor. Potasnitraat het die blaar molibdeen-konsentrasie noemenswaardig verhoog. Mens kan dus tot die gevolgtrekking kom dat algemene aannames m.b.t. die toedienning van kunsmis nie noodwendig altyd korrek is nie.

INTRODUCTION

It is generally assumed that the application of a nutrient or number of nutrients to the soil will enhance the tree status of the nutrient or nutrients applied. Moreover, it is customarily presumed that the status of the remaining essential nutrients will not be affected. Nutrient interactions with the soil, which are dependent on soil composition and moisture content, and attributes of the tree, e.g., root distribution, rootstock, health, growth activity, and stress level, are influencing factors. The following examples demonstrate the the effect of certain influences.

In mango, temperature has been shown to affect growth, leaf dry weight, carbohydrate and mineral nutrient content (Chen *et al*., 1994). Trees grown in pots at the lower temperature regime of 20C day/15C night had lower levels of nutrients, particularly Fe, Zn and Mn, but higher dry weight percentages and carbohydrate contents, compared with trees grown at the regimes of 25C day/20C night, 25C day/20C night, or 30C day/25C night.

The effect of soil type and water availability on leaf nutrient concentration in mango was shown by Ponchner *et al.* (1993). It was found that Mn, B and Fe uptake followed rainfall patterns, being highest during rainy periods. Moreover, nutrient availability was related to soil type.

Chaudhary and Nauriyal (1985) showed that deficiency of calcium, magnesium and sulphur affected the uptake of other nutrients in mango. Severe Ca deficiency reduced leaf Ca and N, but raised the level of K and B. Severe Mg deficiency reduced leaf Mg, but raised the level of K and B. Severe S deficiency reduced leaf S, Ca and Mn, but increased the level of K, B, Cu and Fe.

Reddy *et al.* (1989) showed the effect of rootstock on growth, yield and leaf nutrient composition of a particular scion variety in mango. It was found that leaf N, P, K, Ca, Mg and S concentration differed significantly in relation to rootstock.

In the present study, the effect of a number of fertilizer applications to the soil after harvest on leaf nutrient concentrations after a number of months from application was assessed. The principle aim of the study was to demonstrate that assumptions generally made concerning the effects of fertilizer applications may not necessarily be correct.

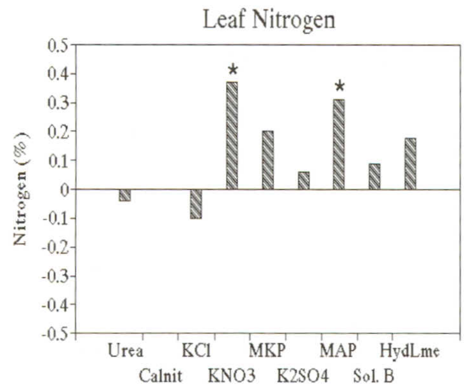

Fig. 1A *Differences relative to the control in leaf nitrogen concentration (%). '*' denotes statistical significance.*

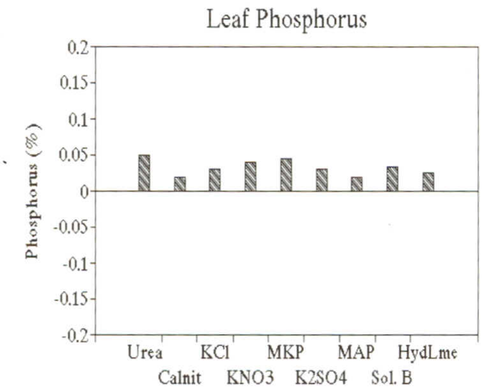

Fig. 1B *Differences relative to the control in leaf phosphorus concentration (%). '*' denotes statistical significance.*

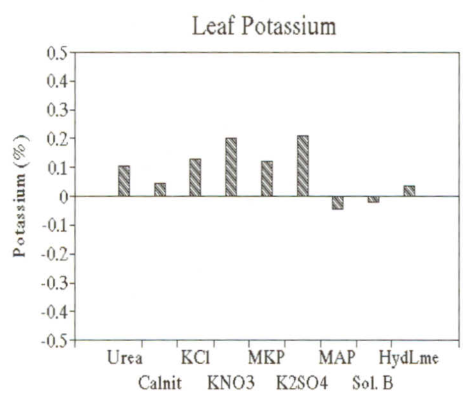

Fig. 1C *Differences relative to the control in leaf potassium concentration (%). '*' denotes statistical significance.*

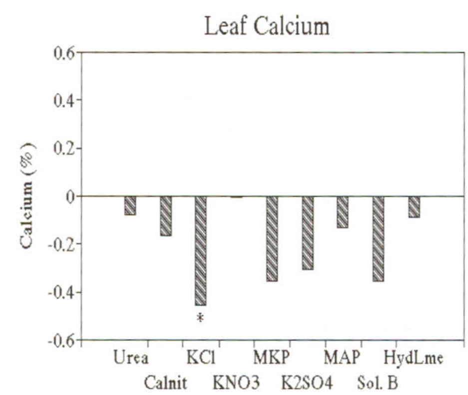

Fig. 1D *Differences relative to the control in leaf calcium concentration (%). '*' denotes statistical significance.*

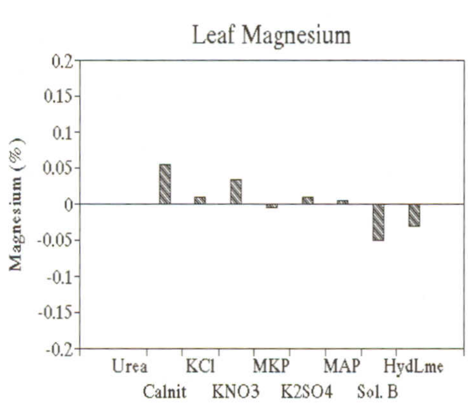

Fig. 1E *Differences relative to the control in leaf magnesium concentration (%). '*' denotes statistical significance.*

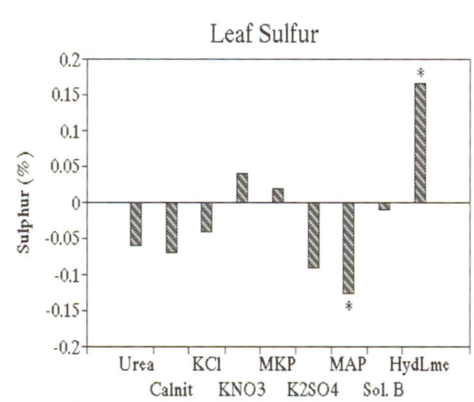

Fig. 1F *Differences relative to the control in leaf sulfur concentration (%). '*' denotes statistical significance.*

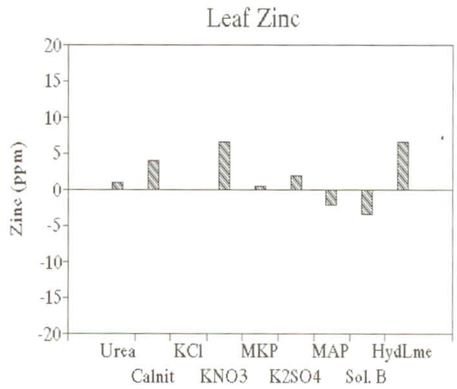

Fig. 2A *Differences relative to the control in leaf zinc concentration (ppm). '*' denotes statistical significance.*

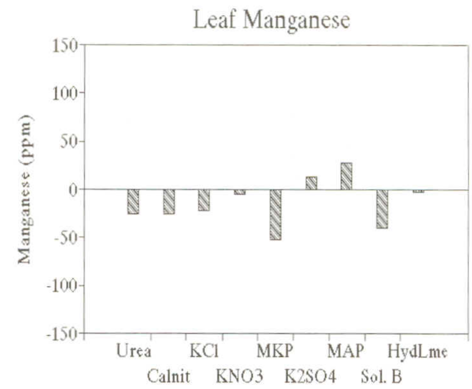

Fig. 2B *Differences relative to the control in leaf manganese concentration (ppm). '*' denotes statistical significance.*

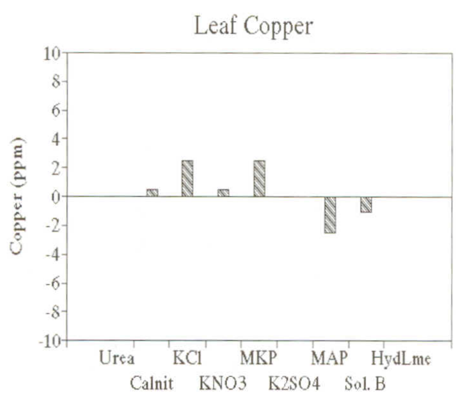

Fig. 2C *Differences relative to the control in leaf copper concentration (ppm). '*' denotes statistical significance.*

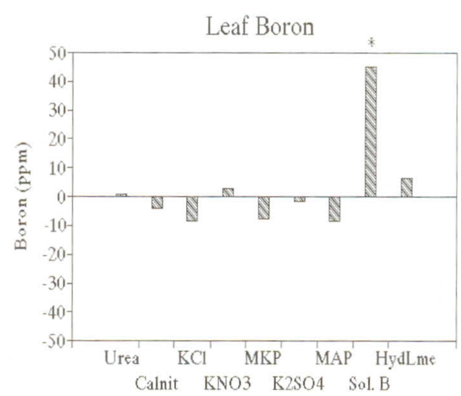

Fig. 2D *Differences relative to the control in leaf boron concentration (ppm). '*' denotes statistical significance.*

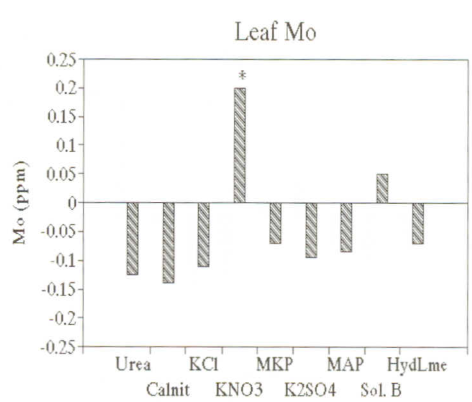

Fig. 2E *Differences relative to the control in leaf molybdenum concentration (ppm). '*' denotes statistical significance.*

Table 1 *Soil analysis results.*

Phosphorus (mg/kg) BRAY 1	1
Potassium (mg/kg)	84
Calcium (mg/kg)	365
Magnesium (mg/kg)	115
Sodium (mg/kg)	64
pH (water)	6.0
Resistance (ohms)	540
Clay (%)	17
Silt (%)	10
Sand (%)	73
Textural Class	SaLo

MATERIALS AND METHODS

Fifty, adjacent, four-year-old Tommy Atkins mango trees were selected in an orchard on a commercial farm in the Tzaneen region. Soil sampled from beneath each tree (0 to 30 cm depth) was thoroughly mixed, and submitted for analysis. The results of the analysis are shown in Table 1. The following fertilizers were separately applied, after the dissolution of each in 20 l of water, to the soil under each of five trees on 28 January 1998:

a. Urea (200 g N)

b. Calcium nitrate (253 g Ca, 200 g N)

c. Potassium chloride (585 g K)

d. Potassium nitrate (585 g K, 200 g N)

e. Mono potassium phosphate (585 g K)

f. Potassium sulphate (585 g K)

g. Mono ammonium phosphate (200 g N)

h. Soluble boron (10 g Foliarel - 21% B)

i. Calcium hydroxide (253 g Ca)

In most instances, the quantity of Ca, N, K or P applied was constant (see values for Ca, N, P or K above). Five untreated trees served as controls. On 21 May 1998, a leaf sample was taken from each tree for analysis. Four fruit bearing terminal shoots were selected per tree, one within each tree quadrant, and four leaves taken from each of them (one-year-old leaves taken). The leaves were analyzed for N, P, K, Ca, Mg, S, Zn, Mn, Cu, B and Mo by Central Agricultural Laboratories.

The soil under the trees was irrigated weekly to field capacity with micro-sprinklers from the time of fertilizer application until that of leaf sampling.

There were five single tree replicates of 10 treatments (including control) in a Complete Randomized Blocks design. The data (leaf nutrient concentrations) were subjected to analysis of variance incorporating multiple range testing (5% LSD). For each nutrient analysed, the average variances relative to the control are presented.

RESULTS

Leaf nitrogen was increased by KNO_3 or mono ammonium phosphate (MAP) application (Fig. 1A). The remaining applications had no significant effect on leaf N. None of the applications significantly affected the concentration of leaf phosphorus (Fig. 1B) or leaf potassium (Fig. 1C). Potassium chloride (KCl) application reduced leaf calcium concentration (Fig. 1D). There was no significant effect of any of the applications on leaf magnesium concentration (Fig. 1E). Leaf sulfur concentration was significantly reduced by mono ammonium phosphate (MAP) application, and significantly increased by hydrated lime (HydLme) application (Fig. 1F).

There was no apparent effect of the fertilizer applications on leaf zinc, manganese or copper concentration (Figs. 2A, 2B, and 2C). Leaf boron concentration was significantly increased by soluble boron (Sol. B) application (Fig. 2D). Potassium nitrate application significantly increased the concentration of molybdenum (Mo) in the leaves (Fig. 2E).

DISCUSSION AND CONCLUSION

Nitrate nutrition is generally associated with increased cation uptake (generally uptake of potassium, calcium and magnesium) (Arnold 1992; Peuke and Jeschke, 1993; Balik and Pribyl, 1994; Fernandes and Rossiello, 1995). Ammonium nutrition generally increases anion uptake, free amino-N/proteins ratios, and acidity of the root free space, and reduces carbohydrate levels in plant tissues. Nitrate nutrition on the other hand increases cation uptake, carbohydrate content in tissues, and alkalinization of the root free space (Fernandes and Rossiello, 1995).

Some of the results of the present study are difficult to explain. The increase in leaf nitrogen concentration following potassium nitrate application may relate to the soil's inability to fix nitrate and the ability of mango roots to readily take-up free nitrate. Calcium nitrate application had no apparent effect on leaf nitrogen, however.

The increase in leaf nitrogen following mono ammonium phosphate application might stem from ammonium uptake, or nitrate uptake following nitrification of the ammonium. Nitrogen did not increase as a result of urea application, however. Conversion of urea to ammonium as a result of urea hydrolysis would be expected.

The failure of soil applied phosphate to increase leaf phosphorus concentration was probably due to soil chemical constituent reactions with the phosphate rendering it unavailable for uptake. Reaction with aluminium, iron, manganese or calcium readily occurs.

Potassium application would be expected to increase leaf potassium. Potassium increases were apparent following potassium chloride, potassium nitrate, mono potassium phosphate and potassium sulphate application, but were not statistically significant.

Potassium chloride application reduced leaf calcium. The ability of applied potassium to diminish calcium and magnesium uptake is well recognized (Seggewiss and Jungk, 1988; Gerzabek and Schaffer, 1989; Huang and Grunes, 1992; Qiu, et al., 1995; Singh and Sharma, 1995).

The reduction in leaf sulfur concentration by mono ammonium phosphate application, and the increase in leaf sulfur concentration as a result of calcium hydroxide application, are difficult to explain. It is noteworthy that the calcium hydroxide used may have been contaminated with sulfur.

Relationships beween sulphur uptake and non sulfur containing fertilizer applications have been found. Nitrogen application rate and leaf sulfur content have been found in certain instances to be positively correlated (Zhao *et al.*, 1993; Du Plessis and Agenbag, 1994; Sharma, *et al.*, 1994). Moreover, application of phosphorus and calcium have been found to increase leaf sulfur (Tolgyesi, 1991; Shivaraj and Gowda, 1993). The foregoing relationships are, however, not consistent with the results of this study.

Boron application resulted in an appreciable increase in leaf boron. Boron in anionic form (borate) is not fixed by the soil, and hence, the effect of increasing leaf boron would be expected.

The increase in leaf molybdenum concentration in response to KNO_3 application is difficult to explain. An effect on molybdenum uptake by a fertiliser not containing molybdenum has been noted elsewhere. An increase in plant molybdenum in response to nitrogen application was found in winter wheat by Lasztity (1992).

Laboratory analysis error may have influenced the results. However, it is unlikely, in view of the non-systematic analysis of the leaf samples, that the increases or reductions found were the result of such error.

The present study clearly demonstrates that assumptions generally made regarding the effect of applied fertilisers may not necessarily be correct. Most of the application effects were probably site specific; this implying that to make generalisations concerning the responses found would be nearsighted. Professional advise concerning fertiliser application is required, and should rely on both soil and leaf analysis results.

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