Foliar absorption of molybdenum in *Vitis vinifera cv.* Merlot and the determination of Mo deficiency using nitrate reductase activity.

COOPERATIVE RESEARCH CENTRE FOR VITICULTURE

Thomas A. Phillips[1], Chris M.J. Williams[2,3], Steve D. Tyerman[1]

[1]Wine and Horticulture, School of Agriculture and Wine, The University of Adelaide, Glen Osmond, SA 5064, Australia
[2]South Australian Research and Development Institute, Plant Research Centre, GPO Box 397, Adelaide, SA 5001, Australia.
[3]Cooperative Research Centre for Viticulture, PO Box 145, Glen Osmond, SA 5064, Australia. Steve.Tyerman@Adelaide.edu.au

Introduction

Williams *et al* (in press) and Gridley (2003) have found that cv. Merlot with deficient molybdenum (Mo) concentrations in the petiole (0.05 – 0.09 mg/kg) responds to foliar applied Mo by a substantial increase in yield.

The measurement of Mo in plant tissues at deficient concentrations is costly so an alternative method of measuring Mo deficiency was investigated.

The method uses the Mo inducibility of nitrate reductase activity (NRA). Nitrate reductase reduces nitrate to nitrite and requires Mo as a cofactor. An index can be calculated which has been shown for other crops to be related to Mo deficiency:

$$\text{Mo index} = \frac{\text{NRA of tissue incubated with Mo}}{\text{NRA of tissue incubated without Mo}}$$

With regard to uptake rates of foliar Mo sprays (related to rain fastness) an understanding is required about the distribution and translocation of Mo in grapevines, and how it is affected by rootstock.

From previous work by Gridley (2003) it is likely that there are differences in uptake and translocation of Mo for Merlot vines on own roots compared with vines grafted to rootstocks.

Experimental Designs

Field experiment

- Field site with Merlot clone 2093 on own roots and 140 Ruggeri.
- Split plot design: Mo application for whole plots, rootstock in sub plots, 4 replicates.
- Mo application of two sodium molybdate sprays at 0.025% Mo for +Mo rows, and deionised water for controls.

Field measurments:

- node count, phenology, petiole Mo concentration pre foliar spray, at flowering and veraison, Fruitset – by collecting flower caps (3 bunches per vine), yield components, Millerandage – size grading and weighing berries from 6 bunches per vine.

Mo inducibility of NRA

- Leaf samples collected on three occasions from pre spray to flowering, and on three occasions from veraison to harvest.
- Leaf discs taken and mixed.
- Added to 2 vials with buffered nitrate solution, one with 1mM molybdate.
- Incubated in light for 4 hours, then vacuum infiltrated.
- Incubated in the dark at 40 deg. C to allow nitrite accumulation.
- Incubated in the dark at 40 deg. C to allow nitrite accumulation.
- NRA derived from nitrite production rate over 30 minutes.

Distribution and translocation

- Potted Merlot vines on own roots, Schwarzmann and 99 Richter.
- Greenhouse grown in Mo deficient media.
- Randomized complete block design, 4 replicates, with 3*2 factorial within blocks.
- 3 rootstocks*2 Mo application levels (+/-).
- Sodium molybdate applied to 4th oldest leaf of each vine, for +Mo treatment. 5000 mg/L Mo = 4-6 mg/ pot
- After 2 weeks, vines divided into:

  Apical leaves; apical petioles; basal leaves; basal petioles; combined new stem, tendrils, lateral shoots and primary shoot tip; old wood; and new roots.

Foliar absorption

- Used excised shoots of glasshouse grown Merlot vines.
- Randomized complete block design, 5 replicates, and a 5*3 factorial within blocks.
- 5 absorption periods: 0 hours – control, 12, 24, 48 & 96 hours.
- 3 Mo sources: sodium molybdate; Lig-moly® - lignin cheleated molybdate; Supa-moly® - molybdenum phosphate solution
- Shoots dipped in Mo solution (not controls)
- Later washed in deionised water before analysis
- Absorption taken as increase in shoot Mo content over controls

Aims

- Evaluate the effectiveness of the Mo inducibility of NRA as an assay of the Mo deficiency of Merlot, on own roots and 140 Ruggeri.
- Determine the rate of absorption of molybdenum, as sodium molybdate and as two proprietary brand Mo products, into the shoots of Merlot, under a specific set of environmental conditions, over 96 hours.
- Determine the distribution of molybdenum in Merlot on own roots and on the rootstocks Schwarzmann and 99 Richter, after growth in a Mo deficient media, and to determine the translocation of foliar applied Mo.

Results

Mo spray had a significant effect on yield and berry mass, but not fruit set.

		Full bloom petiole Mo conc.* (mg/kg)		Yield (kg/vine)		Mean berry mass (g)		% fruit set	
Own roots	control	0.08	a	3.5	a	0.33	a	36	a
Own roots	+Mo	7.57	b	6.2	b	0.56	b	46	a
140 Ruggeri	control	0.13	a	5.3	b	0.51	b	40	a
140 Ruggeri	+Mo	5.75	b	5.9	b	0.63	b	40	a

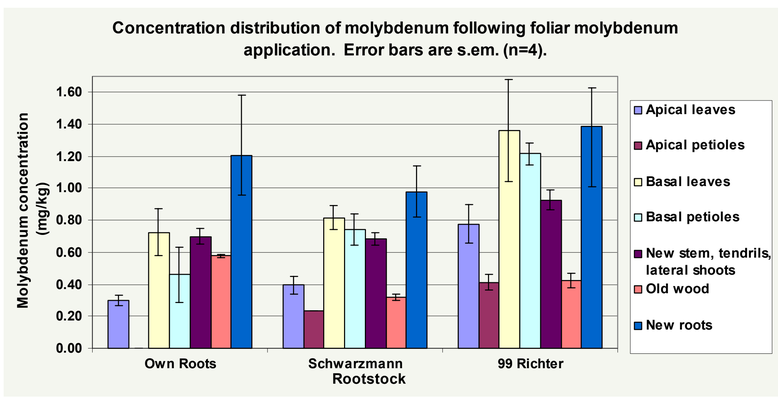
Treatments with same letter not significantly different (LSD 5%)
* Deficiency range 0.05 - 0.09 mg/kg (Williams et al in press)

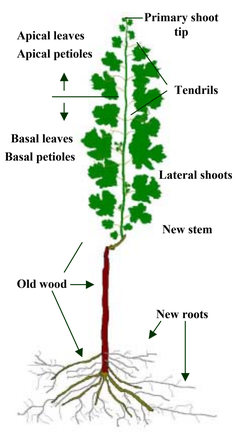
Own roots - control

Own roots - +Mo

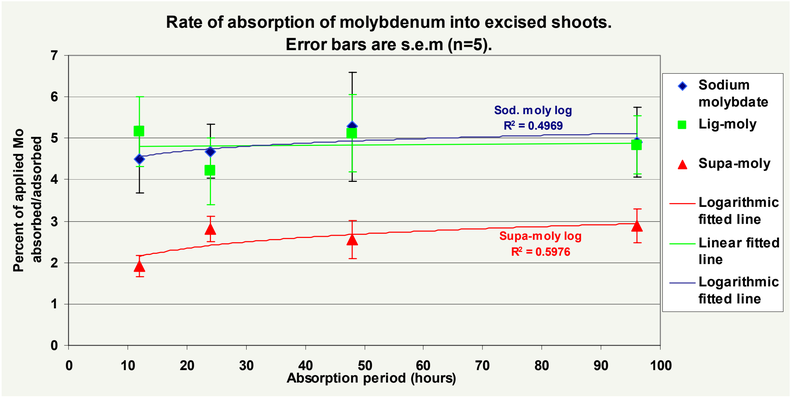
Mo index for untreated vines increased through the season, indicating increased Mo deficiency. A correlation between Mo index and berry weight was observed only for post veraison Mo index.

Translocation & distribution: a greater concentration of Mo was retained in old wood of own rooted vines.





Foliar absorption study: absorption is rapid but is low relative to the amount applied.



Conclusions

- Mo inducibility of NRA may be used between veraison and harvest to identify Mo deficiency associated with yield reduction.
- Mo deficiency may also affect berry growth later in the season than around flowering.
- Effect of rootstocks in reducing Mo deficiency in Merlot may be due in part to greater capacity to retranslocate Mo.
- Differences exist in the absorption/adsorption of Mo based on product.
- Total absorption/adsorption of foliar applied Mo is very low.

References

Gridley, K. (2003) The effects of molybdenum as a foliar spray on he fruit set and berry size in *Vitis vinifera* cv. Merlot. Honours Thesis, Wine and Horticulture, The University of Adelaide.

Williams, C.M.J., Maier, N.A., and Bartlett, L. (2004) Effect of molybdenum foliar sprays on yield, berry size, seed formation and petiolar nutrient composition of 'Merlot' grapevines. *Journal of Plant Nutrition (*In press)

We thank Wendy Sullivan for expert technical assistance