INVESTIGATION OF RELATIONSHIPS THROUGH WHICH BIODYNAMIC GROWING PRACTICES AFFECT PLANT GROWTH AND NUTRIENT COMPOSITION

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ABSTRACT

More research attention has been paid to development of indicators of soil quality in relation to environmental sustainability than to food quality. Challenges in measuring and showing relationships between soil quality, food quality and human health are discussed. Comparative and long-term studies have shown that organic and biodynamic farming methods and use of composts and manures favourably affect soil quality, enhancing organic matter content and soil organism activity. However, measured effects on food quality have been lacking or inconsistent. Antioxidants, nitrates, trace elements, protein quality and ratios between element concentrations can be measured in assessing food quality. Many of these factors vary considerably with growing conditions and soil management techniques. Effects of factors such as water, light, soil type, variety and nutrient supply on lettuce growth, lettuce nutrient requirements, and recent research into effects of light on plant signalling and nitrogen metabolism are reviewed and discussed.

Recent research into factors influencing food quality has focussed on integration of growth and differentiation forces into "vital quality" food. The biodynamic field-spray preparations 500 and 501 are used to balance effects of growth or "shade" forces from humus and fertilisers with the differentiating or "light' forces on plants. Literature indicates that the preparation 501 (silica-spray) appears to increase plant nutrient assimilation and production of more complex organic acids. Similar effects have been found for silica compounds applied to soil or nutrient solution.

The main objective of the experimental work conducted for this thesis was to investigate whether relationships exist between soil management techniques and application of biodynamic sprays and plant product quality.

Transplanted lettuces (cv. Canasta) were grown in a factorial designed field trial on Te Puke Series sandy loam with six treatments: control, soluble fertilisers (DAPCAN) and compost, each with, or without, biodynamic field-sprays 500 (twice) and 501 (3 times). High variability between plants within treatments and small differences between treatment means for most parameters measured prevented many statistically significant differences or relationships being found.

Compost amendments appeared to enhance water and nutrient uptake during a dry season. However compost application at a rate to provide equivalent nitrogen to the soluble fertilisers resulted in high leaf concentrations of nitrates and potassium and low DM% and concentrations of sugars, antioxidants, calcium and magnesium. Plants in treatments given compost had highest yields; highest N, P and K concentrations at 28 days from transplanting (DAT); and highest K at 48 DAT. Plants in treatments given soluble fertilisers had highest Ca, Mg, Fe, Zn, and Cu concentrations and greater Ca: P and K: Ca + Mg ratios at 48 DAT.

Application of biodynamic field-sprays appeared to have different effects on the plants in plots, depending upon whether they received compost or not. Plants in treatments given field-sprays but no compost had generally small head weight, greater dry matter % and root: shoot ratios at 28 DAT, and highest crude protein and Ferric reducing ability of plasma (FRAP) antioxidant concentration at 48 DAT. Plants in the biodynamic treatment, given compost and field-sprays, had highest P uptake between 28 and 48 DAT and highest fresh-weight at 48 DAT.

Measurements of nitrate and sugar contents of leaf cell sap and amino acid concentrations in leaves yielded few, or no, significant differences between treatment means. Microbial activity measured by soil respiration ex situ at 28 DAT was highest in composted plots and lowest in sprayed plots. Measurement of AM fungi colonisation of roots gave inconclusive results. In a sensory evaluation, no significant differences in taste, bitterness, sweetness and preference ranking were found between lettuces from the different treatments.

A greenhouse pot trial was undertaken to study the effects of the biodynamic silica spray in more detail. Lettuce transplants (cv. Cos Little Gem) were grown in the same soil and biodynamic compost as were used in the first trial and preparation 500 applied. Half the plants were sprayed 3 times with preparation 501. Measurements before and after the last spray time yielded insignificant differences in light absorption at most wavelengths, net photosynthesis and nitrate, sugar and amino acid concentration in leaves. Silica sprayed plants had higher rates of transpiration and stomatal conductance and higher estimated light absorption of blue and near infrared wavelengths 2½ hours after spraying.

Mainly inconclusive effects of treatments were due partly to the large natural plant to plant (within replication) variation. It was concluded that organic and biodynamic management of lettuces may result in some favourable quality attributes compared to soluble fertilisers but not necessarily all. Results are likely to be specific to particular climatic and soil conditions.

It is recommended that further trials be carried out to evaluate influences of biodynamic practices on vegetable food quality in controlled, well-replicated conditions, to improve likelihood of showing statistical differences between treatments. Such trials are needed in a variety of soil, climatic and management conditions, to better understand how different conditions and their interactions affect food quality parameters. Relationships between biodynamic preparation application, soil biota populations and activity, plant metabolism and food product quality, particularly nitrogen assimilation into complex molecules such as essential amino acids, should be explored.

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