EVALUATION OF FOLIAR METALOSATES® ON ARABLE CROPS IN THE U.K. AND IRELAND

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Since reporting the results of trial work involving Albion's Foliar Metalosates® at the 1996 International Conference on Plant Nutrition, a comprehensive trials programme has continued. Comparative studies undertaken by independent trials specialists over the past three years and covering cereals, potatoes and sugar beet are reported here. Although economic returns for the majority of arable crops has declined drastically since 1996, the need for a balanced and effective approach to plant nutrition has become even more important, to ensure reduced margins are optimised. Consequently the technical approach developed and promoted by Albion Laboratories involving both soil and plant tissue analysis has become even more relevant. It is clear that in the future farmers and growers will need to adopt a customised nutrition policy for their crops based on analytical work, not only to improve returns but also to minimise adverse environmental aspects to fertiliser application. This "holistic" approach to crop production will undoubtedly have benefits in terms of yield and quality, and should also improve plant health thereby reducing dependence on agrochemical inputs.

Cereals – Winter Wheat

Cereals in general and winter wheat in particular remains a very significant crop for Foliar Metalosate sales in the UK. This is in spite of a 40% decline in returns since 1996. Quality characteristics are becoming more important to discerning purchasers and this has enabled Metalosates to maintain a presence in an increasingly difficult market.

The trial reported here was undertaken to establish whether an individual element, identified as being deficient, was primarily responsible for influencing yield, or whether it was a combination of deficient elements which was critical.

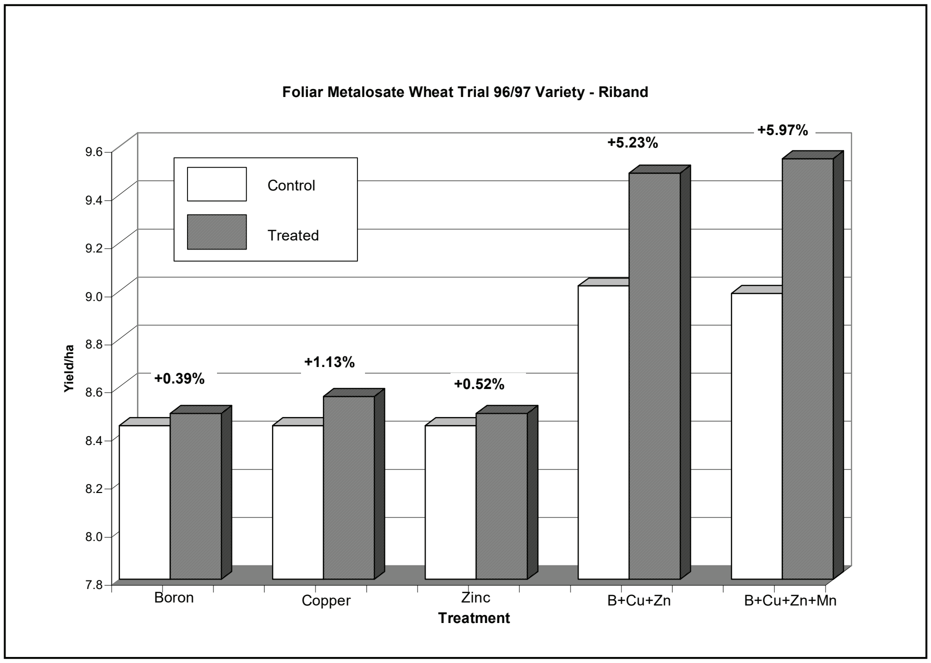
This trial was undertaken in a crop of 'Riband' wheat, which at growth stage 30 had shown in a T.E.A.M. plant tissue analysis report to be highly deficient in the following elements.

Element	Analysis mg/kg DM	Nutrient Index
Boron	1	-77
Zinc	19	-29
Copper	6	-27
Manganese	51	+15

Boron, zinc and copper reported significant deficiencies, which in terms of the nutrient index were further depressed by the presence of a high iron content (137 mg/kg DM). In contrast, manganese levels were above average both for concentration and nutrient index.

At growth stage 30, a single application of Boron 0.3 L/ha, Zinc 0.4 L/ha, or Copper 0.5 L/ha were compared to the combination treatments of Boron + Zinc + Copper and Boron + Zinc + Copper + Manganese.

Results



The individual element treatments of Boron +0.39%, Copper +1.13% and Zinc +0.52% produced minimal yield increases. However, when these deficient element treatments were combined, a yield increase of +5.23% was reported. This result was slightly enhanced by the addition of manganese, which was not a reported deficient element (yield increase +5.97%).

This trial has demonstrated the importance of undertaking a T.E.A.M. analysis and determining the combination of minerals most likely to achieve a yield response. It would appear that limiting elements when combined in a multi-element foliar application achieves a response proportionately greater than from the use of single element applications.

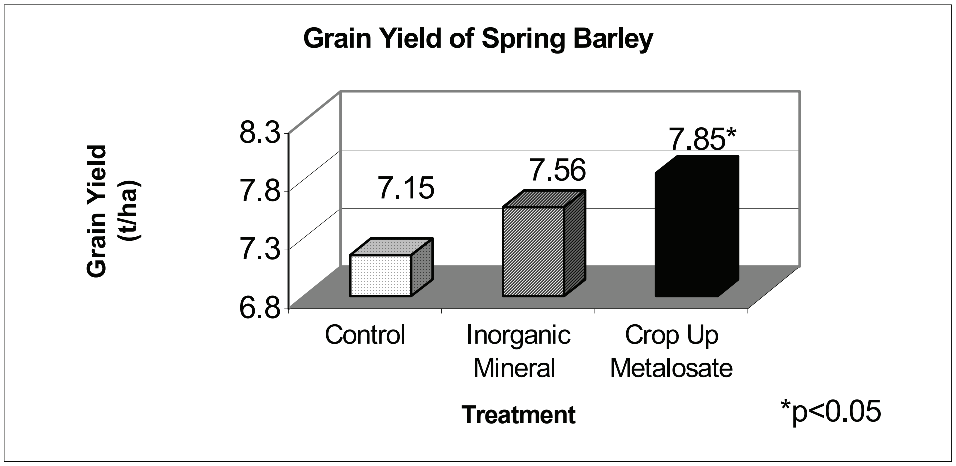
Cereals – Spring Barley

Spring barley is an economically important crop in Ireland, due to a combination of climatic and market factors. As a result, a comparative trial involving Foliar Metalosates was undertaken by the Lyons Research Farm of University College Dublin; this representing one of the key research farms in the Republic of Ireland.

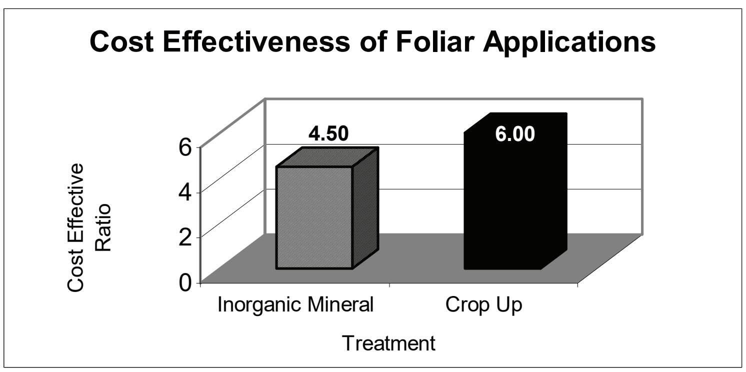
Spring barley (cultivar – 'Cooper') was drilled on 20th March 1996 into a sandy loam soil type. The trial design involved a three treatment by six plot replicated design. The treatments were a negative control, farm positive control represented by an inorganic foliar manganese product (2.0 L/ha) and Crop Up Foliar Metalosate (0.7 L/ha). Foliar treatments were applied twice in mid-May and mid-June.

Surprisingly, the University research team involved in the evaluation was only interested in a product evaluation, and not in a customised foliar programme supported by T.E.A.M. analysis.

Results



Against the control treatment, the inorganic manganese treatment increased yield by 0.41 t/ha, whilst Crop Up raised yield by 0.70 t/ha. These increases relative to the control treatment were 5.7% and 9.8% respectively. The Crop Up treatment was significantly different from the control. Yields overall were around the 7.4 tonne per hectare, which were considered to be satisfactory for this trials farm.



On comparing the returns from the increased yields, and costing barley at £95.00/tonne together with the input costs resulting from the foliar applications, produced a cost effective ratio of 6.0 for Crop Up and 4.5 for the Inorganic Manganese Treatment. In this case, even in the absence of a T.E.A.M. analysis service, a treatment of Crop Up which cost about three times more than the inorganic manganese foliar treatment, was considerably more cost effective in terms of a yield response.

Potatoes

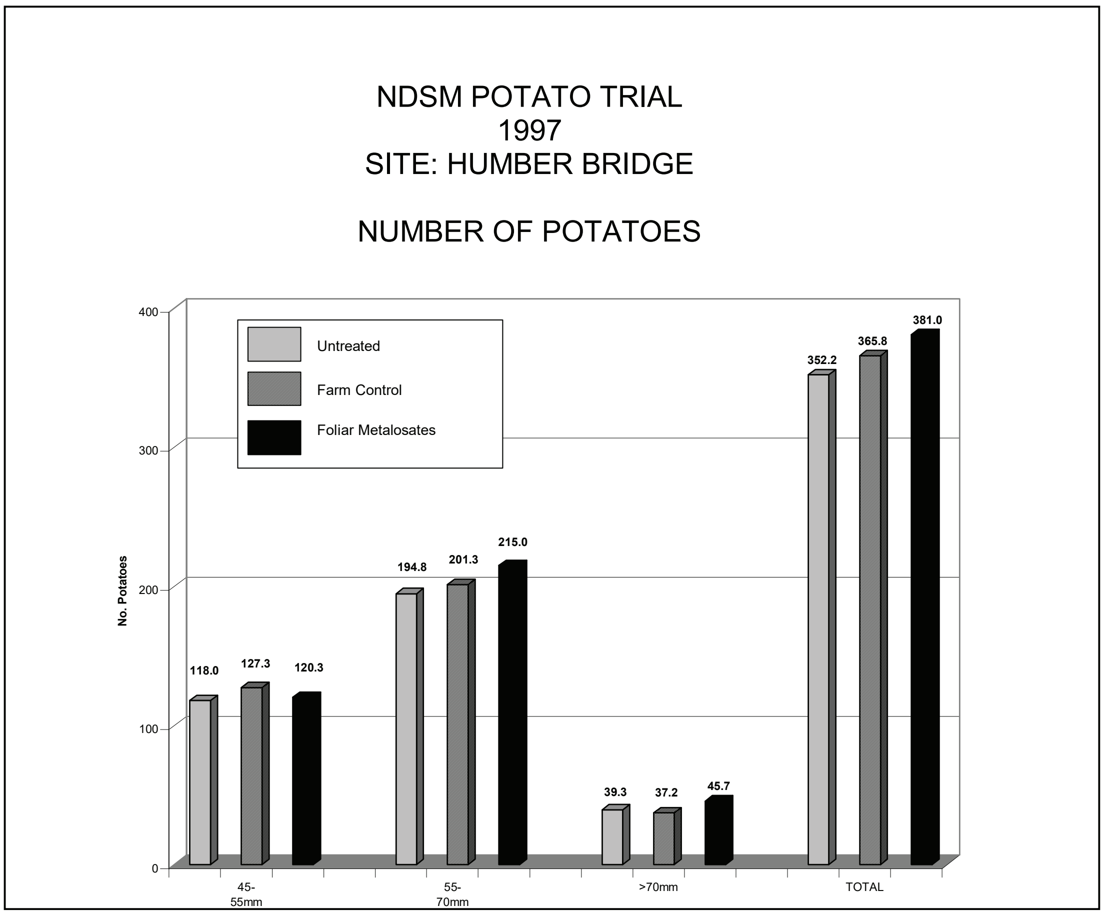
Unlike cereals, potatoes have considerably more potential for manipulating yield and quality by attention to nutrition, particularly in times of reduced product prices. This was demonstrated in the 1997 season by a comparative trial undertaken by the independent agronomy team of NDSM Ltd.

A maincrop of 'Estima' potatoes was planted in East Yorkshire on 16 April 1997. The objective of the trial was to assess the efficacy of a T.E.A.M. derived Foliar Metalosate programme relative to both a negative control treatment and the usual farm practice foliar applied inorganic manganese product. A randomised complete block design was applied with six replicates per treatment (10.0 metres long x 4 ridges wide).

The foliar treatments were as follows:

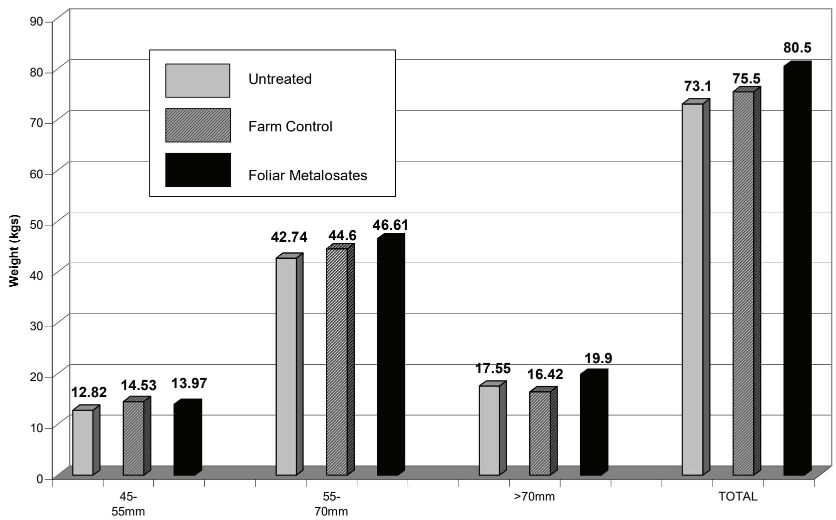
	Treatments		
Application Date	**Negative Control**	**Farm Practice**	**Foliar Metalosate**
21 June 1997	---	Inorganic Mn @ 1.0 l/ha	Mg @ 2.0 l/ha K @ 1.0 l/ha Mn @ 0.5 l/ha
24 July 1997	---	Inorganic Mn @ 1.0 l/ha	Zn @ 1.0 l/ha
7 August 1997	---	Inorganic Mn @ 1.0 l/ha	Multi Mineral @ 1.0 l/ha

The Foliar Metalosate treatments were based on T.E.A.M. reports which showed marked deficiencies of magnesium, potassium and manganese in June, followed by zinc in July. It is interesting to note that a marked improvement in the tissue concentration of the foliar applied elements was reported at the second leaf sampling in mid-July.



NDSM POTATO TRIAL 1997
SITE: HUMBER BRIDGE

YIELD OF POTATOES (kg)



1. Results

	Potato Yield	
Treatment	**Numbers**	**Weight (kg)**
Negative Control	352.2	73.1
Farm Practice	365.8 +3.9%	75.5 +3.3%
Foliar Metalosates	381.0* +8.2%	80.5* +10.0%
		* $p<0.05$

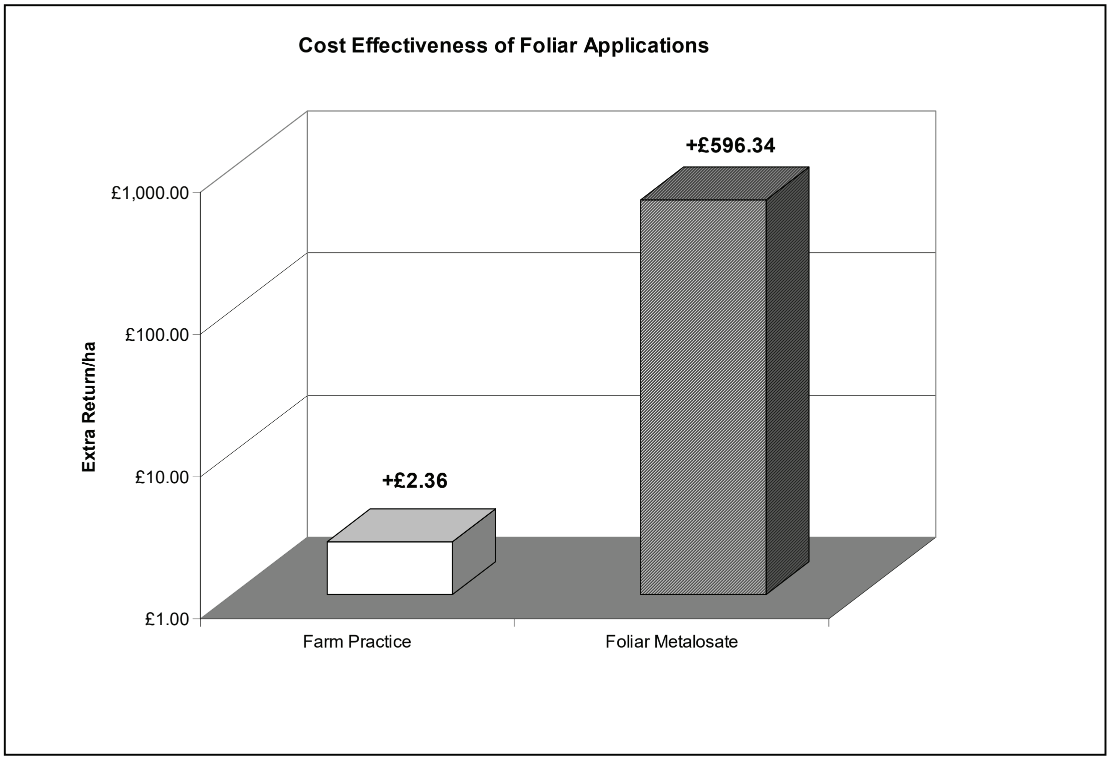
The number and weight of potatoes was related to the total yield from the six replicated plots.

In terms of potato numbers analysed by grade, it is obvious that the Foliar Metalosate treatment increased potato numbers in the grades above 55mm. This observation was reinforced by the yield and grade data which showed a marked increase in potato weight in the higher grades, particularly above 70mm. These increases were significantly different from the control treatment.

However, overall it was the increased tuber number response to Foliar Metalosates (+8.2%) which was significant, although clearly this was not at the expense of tuber weight (+10.1%)

2. Cost Effectiveness

Cost effectiveness is reported here in terms of incremental return per hectare equivalent, assuming that the trial plot responses would have occurred over a larger area.



The cost of the inorganic manganese foliar treatment has largely eliminated the 3.3% response in yield. In contrast, the Foliar Metalosate treatment has produced an additional £600 per hectare equivalent return, which relates to a cost effective ratio of x 11.0.

Sugar Beet

Foliar Metalosate trials were undertaken on sugar beet at three sites by British Sugar during the 1997 sugar beet season.

Each farm site was evaluated on the basis of four randomised blocks per treatment. Each block was composed of six rows of 12m length by 3m width. The following details relate to the three farm sites involved in the Foliar Metalosate trials.

Table 1

	Site: Bardwell	**Site: Uffington**	**Site: Bracebridge**
Date Drilled	25 March	25 March	3 April
Variety	Zulu	Jackpot	Madison
Plant Population (plants/ha)	110,000	90,000	To be counted
Fertiliser Application			
Nitrogen kg/ha	120	90	120
Potash kg/ha	80	200	102
Phosphorus kg/ha	0	50	0
Magnesium kg/ha	50	50	0
Sodium kg/ha	120	150	107
Foliar Metalosate Application			
1st Application – 12June			
Boron l/ha	0.5	1.0	1.0
Manganese l/ha	0.5	0.5	0.5
Magnesium l/ha	---	1.0	1.0
Iron l/ha	1.0	---	---
2nd Application – 6-8 July			
Boron l/ha	0.80	0.75	0.50
Multi-Mineral l/ha	1.25	1.25	1.0
Potassium l/ha	1.50	1.50	1.0
Date Beet Lifted	28 Sept	28 Sept	Early Nov.

Soil analysis was undertaken prior to the main spring fertiliser applications.

Bardwell had a predominantly sandy soil, the main features of which were a low potash and magnesium status, with manganese and boron also reporting poor levels.

Uffington, which is a heavier type silt loam soil, also showed a poor potash and magnesium status with a correspondingly high calcium level. Trace element levels were generally higher.

Bracebridge was intermediate between the other sites in terms of cation exchange capacity. It was also very low in potash and magnesium status with sodium levels also poor. In contrast to the other two sites, the trace element status of the soil was consistently low.

The fertiliser applications are presented in Table 1, and it is important to note that we had no influence over their balance or rate of application. This table also presents further details of the trial management and Foliar Metalosate applications.

Bardwell's initial plant tissue samples were characterised by a high phosphorus and sodium level, which is contrasted by a low iron, boron and manganese concentration. These three latter elements formed the basis of the initial foliar metalosate programme.

Uffington's leaf samples again showed high sodium, but in this case the potash level was low which reflected the soil status. In terms of trace elements, the early identified deficiencies of boron, manganese and magnesium were catered for in the first foliar metalosate application.

Similarly at Bracebridge the magnesium and manganese deficiencies identified by the leaf analysis were catered for in the first foliar Metalosate application.

<u>Results</u>

A summary of the results from each site is presented in Table 2:

Table 2

Trial Site: BARDWELL

Treatment	**Control**	**Foliar Metalosate**	**Difference**
% Sugar	19.93	19.87	-0.06 (0.3%)
Yield (tonnes/ha)	55.60	59.41	+3.81(6.9%)
Sugar Yield (tonnes/ha)	11.08	11.77	+0.69 (6.2%)
Amino N (mg/100g sugar)	169.8	159.0	-11.8(6.9%)
Potassium (mg/100 sugar)	845.7	857.0	+11.3 (1.3%)
Sodium (mg/100g sugar)	99.7	97.7	-2.0 (2.0%)

Trial Site: UFFINGTON

Treatment	**Control**	**Foliar Metalosate**	**Difference**
% Sugar	16.58	16.44	-0.14 (0.8%)
Yield (tonnes/ha)	60.25	61.50	+1.25 (2.1%)
Sugar Yield (tonnes/ha)	9.98	10.15	+0.17 (1.7%)
Amino N (mg/100g sugar)	178.7	171.8	-6.9 (3.9%)
Potassium (mg/100g sugar)	995.8	908.6	-87.2 (8.8%)
Sodium (mg/100g sugar)	232.0	250.9	+18.9 (8.1%)

Trial Site: BRACEBRIDGE

Treatment	**Control**	**Foliar Metalosate**	**Difference**
% Sugar	18.25	18.50	+0.25 (1.5%)
Yield (tonnes/ha)	66.19	64.44	-1.75 (2.6%)
Sugar Yield (tonnes/ha)	12.07	11.94	-0.14 (1.1%)
Amino N (mg/100g Sugar)	158.8	164.5	+5.7 (3.6%)
Potassium (mg/100g Sugar)	749.7	788.8	+39.1 (5.2%)
Sodium (mg/100g Sugar)	66.2	72.0	+5.8 (8.8%)

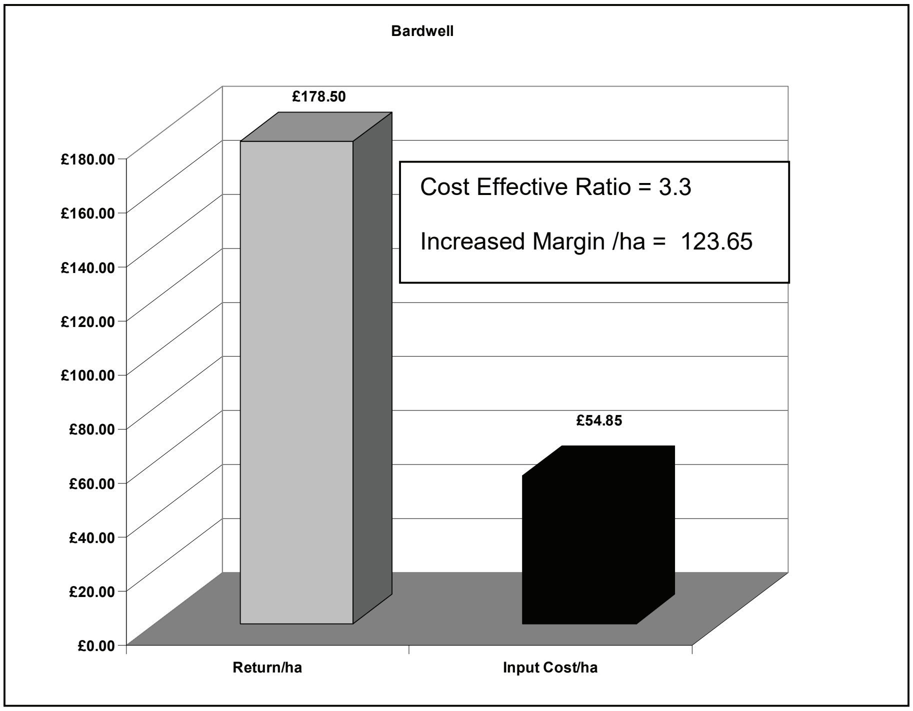
At Bardwell, clean beet yield was increased by 3.81 tonnes/ha or 6.9% on the foliar Metalosate treatment over control, there being little difference in % sugar content. Consequently, sugar yield reflected overall beet yield and was raised by 6.2% or 0.69 tonnes/ha on the Metalosate treatment. The undesirable components of amino acid N and sodium were reduced by 6.9% and 2.0% respectively, while the potassium correspondingly increased by 1.3%.

At Uffington, beet yield was improved by 1.25 tonnes/ha or 2.1%, % sugar content was also similar between treatments; the overall sugar yield was elevated by 0.17 tonnes/ha or 1.7%. As at Bardwell, the amino acid N levels were reduced on the chelate treatment, in this case by 3.9%. In contrast, at Uffington the potassium content was reduced and the sodium level increased by 8.8% and 8.1% respectively.

The Bracebridge trial site reported a reduction in yield of 1.75 tonnes/ha or 2.6% on the foliar metalosate treatment. This poorer yield was somewhat compensated for by a percent sugar increase of 0.28 units; the overall sugar yield being 12.07 and 11.94 tonnes respectively on control and foliar metalosate treatments. The undesirable components of amino nitrogen, potassium and sodium were all increased on the chelate treatment.

Overall, Bracebridge produced the highest sugar yield, although the lifting date was six weeks later than the other two sites. Bardwell demonstrated a good level of performance, in contrast to Uffington, where both the sugar yield and level of contaminants were high. In terms of Foliar Metalosate response, this was apparent at Bardwell but not at Bracebridge or Uffington.

In terms of cost effectiveness Bardwell was the only site to demonstrate an economic response to Foliar Metalosates. An additional return of £178.50 per hectare resulted from an input cost of £54.85 per hectare, thus resulting in a cost effective ratio of x 3.3 or an increased margin of £123.65 per hectare.



Discussion

Because of the variable response to Foliar Metalosate treatments across the three trial sites, attention has been directed at the potassium and sodium soil levels and resultant fertiliser recommendations.

The relationship between these elements as found in the various tissues analysed is presented in Table 3. The following points can be made:

1. Soils analysis shows:
   Bardwell – adequate levels of K and Na, in a balanced ratio.
   Uffington – low K and high Na, and consequently a low ratio.
   Bracebridge – high K relative to Na, therefore a high ratio.

2. Fertiliser response was to:
   Bardwell – apply a balanced K and Na regime.
   Uffington – apply a high K and Na input even though Na soil level was already high.
   Bracebridge – apply a reasonably balanced K and Na regime, although the K input was probably too high and the Na input too low.

3. Leaf analysis shows:
   Bardwell – adequate and balanced K and Na levels.
   Uffington – below average K and average Na values which reflect the fertiliser regime.
   Bracebridge – adequate K level, although Na value was above average (this is in contrast to fertiliser regime).

Consequently, K:Na ratios were within the expected range at Bardwell, but lower at Uffington and Bracebridge.

4. Root analysis indicated:
   Bardwell – mid-values for K and Na.
   Uffington – higher K and Na levels.
   Bracebridge – lower K and Na levels.

In summary, the imbalanced K and Na fertiliser regime at Uffington, in relation to soil values for these elements, is well reflected in leaf and root analysis. The relationship between soil, leaf and root are apparent for K but less so for Na at Bracebridge.

Overall, the good response to Foliar Metalosates at Bardwell is considered to be a reflection of the balanced macro-mineral regime, including K and Na. In contrast, the clearly imbalanced K and Na nutritional regime at Uffington is indicated to be a contributory factor to the poor response at this site. The position is less clear at Bracebridge, but an imbalanced K and Na soil nutrient supply may still be implicated in the lack of a response.

For the future, it must be an important prerequisite for Foliar Metalosate use that macro-fertiliser regimes are balanced to the level of available soil nutrients.

Table 3

COMPARISON OF POTASSIUM AND SODIUM LEVELS AND RATIOS

	Bardwell	**Uffington**	**Bracebridge**	**Target**
SOIL				
K (mg/litre)	154 (2)	70 (1)	209 (2)	200
K – CEC (%)	3.5	0.8	3.7	4
Na (mg/litre)	76 (L)	133 (M-H)	46 (L)	105
Na – CEC (%)	2.9	2.7	1.4	2.5
K:Na Ratio	2.0	0.5	4.5	1.9
CEC Ratio	1.2	0.3	2.6	1.6
FERTILISER				
K_20 (kg/ha)	80	200	102	---
Na (kg/ha)	120	150	107	---
LEAF				
K (%DM)	3.82	2.62	3.17	3-4
Na (%DM)	1.01	1.68	1.61	0.8-1.2
K:Na Ratio	3.8	1.6	2.0	3.5
ROOT – CONTROL TEST				
K (mg/100g Sugar)	845.7	995.8	749.7	
Na (mg/100g Sugar)	99.7	232.0	66.2	
K:Na Ratio	8.5	4.3	11.3	

Summary

Foliar Metalosate efficacy and cost effectiveness has been demonstrated across a wide range of crops in the UK and Ireland. The enhanced mineral bioavailability of Albion's amino acid chelates compared to inorganic salts has been apparent in a number of trials, based on a higher yield response resulting from a lower foliar input. However, the successful application of Foliar Metalosates is clearly dependent on two primary considerations. Firstly, the use of TEAM analysis is crucial to determining the optimal Foliar Metalosate programme. Secondly, the extent of a Foliar Metalosate response is largely influenced by soil chemistry. In situations where a mineral imbalance exists in soils, the opportunity for a foliar response will be diminished. Consequently attention to the mineral status of soils has become as important as using TEAM analysis to determine foliar recommendations.

The integrated approach of TEAM and soil analysis used in a customised manner to develop Foliar Metalosate programmes, represents the most cost effective approach to improving crop yield and quality in a European market of declining producer returns.