ZADCO FOR QUALITY GRO PTY LTD.

BIOMIN™ CALCIUM TRIAL SEEKA 2003-2004

EFFICACY OF BIOMIN™ CALCIUM ON KIWIFRUIT FRUIT ANALYSIS AND STORAGE LIFE COMPARED TO "STANDARD PRACTISES".

PRELIMINARY REPORT

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Calcium Nutrition of Kiwifruit using Biomin™ Calcium.

TESTING FOR PRODUCT PERFRMANCE, EFFICACY, AND KIWIFRUIT STORAGE POTENTIAL

CALCIUM DEFICIENCIES AND BIOMIN™ CALCIUM

For many years, there has been increasing interest in the use of Calcium foliar sprays because of the effect Calcium has on fruit quality and shelf life.

Calcium is an extremely important element in maintaining the strength of stems and stalks of plants. This mineral also regulates the absorption of nutrients across cell membranes. Calcium plays an important role in plant cell elongation and division, structure and permeability of the cell, nitrogen metabolism and carbohydrate metabolism[1]. Calcium is non-toxic, even in high concentrations and serves as a detoxifying agent by tying up toxic compounds and maintaining the cation-anion balance in cells. Further to this, Calcium is part of the cell wall and acts as the cement that binds the cell walls together it is one of the most significant factors affecting firmness and storage life of fruit.

There are a myriad of different formulations of Calcium available to growers with Calcium Chloride being amoung the least expensive and most commonly used. Biomin™ Calcium is a true chelate produced by J.H Biotech, Inc. which was specifically designed for use on plant crops. However, the methods of delivery of this element are not conventional, like the delivery methods of products such as Calcium Nitrate and Calcium Chloride. The latter products can marginally reduce a Calcium deficiency, but the speed by which the Calcium released from these products and transported into the growing points (such as fruit) is very slow compared to the transportation of the associated ions such as the nitrate or chloride components of these products which have negative effects on fruit quality.

Biomin™ Calcium is the only product on the market that can effectively and economically deliver Calcium to the growing points of the crop without the risk of phytotoxicity. Biomin™ Calcium is a Glycine chelated product. This means that every Calcium ion is bonded with two Glycine molecules creating a fully chelated Calcium product. The plant recognizes this molecule as a proteinaceous molecule allowing it to travel in the phloem instead of forcing it to use the xylem where Calcium is normally transported. This allows the Calcium to be a mobile element in the Glycine chelated form. This is the edge Biomin™ Calcium has over all other products existing in the marketplace.

AIM

To determine the efficacy of Biomin ™ Calcium in kiwifruit production through the use of leaf analysis and fruit analysis.

MATERIALS AND METHODS

Biomin Calcium was applied at a rate of 2kg/1000litres of water/ hectare (with Mobilizer). The annexes further detail the trial procedure and sample dates.

RESULTS

The two treatments compared gave very good indications as to how Biomin™ Calcium reacted within the vines, especially as to how the product is capable of translocating into the fruit where Calcium levels are most critical for postharvest storage potential as well as quality of fruit.

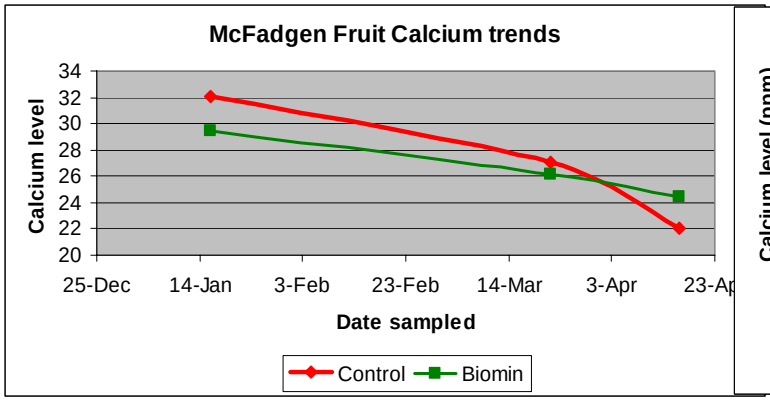
Table 1 gives an indication as to how the three blocks trialed responded to the treatments. On average, Biomin™ treated blocks had higher average fruit Calcium levels than the control blocks. The average increase over the three blocks was 15% which is quite significant

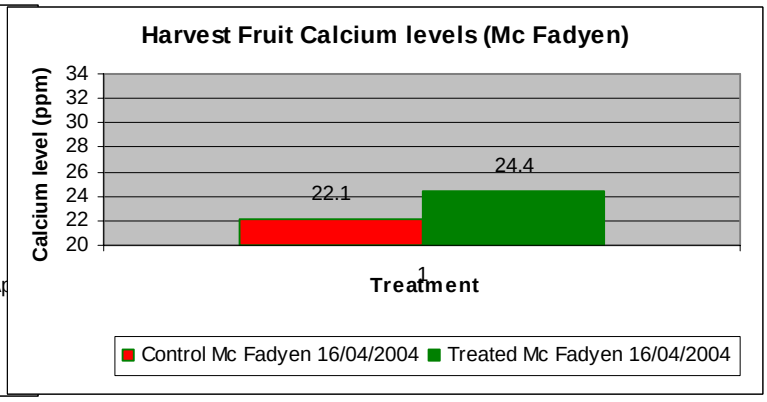
TABLE 1: SUMMARY OF FINAL FRUIT CALCIUM LEVELS AT HARVEST FOR ALL THREE BLOCKS SAMPLED

	Control	Biomin™	Average increase / decrease %
McFadgen	22.10	24.40	10.41%
DCD	24.20	31.90	31.82%
Muir	27.20	29.50	8.50%
Average	**24.87**	**28.60**	**15%**

Further to the above table, the initial and final Calcium levels give a further indication as to how the demand for Calcium throughout the season changed the overall levels of this element in the fruit. These can be found in the annex (tables 9-11) and graphically below.

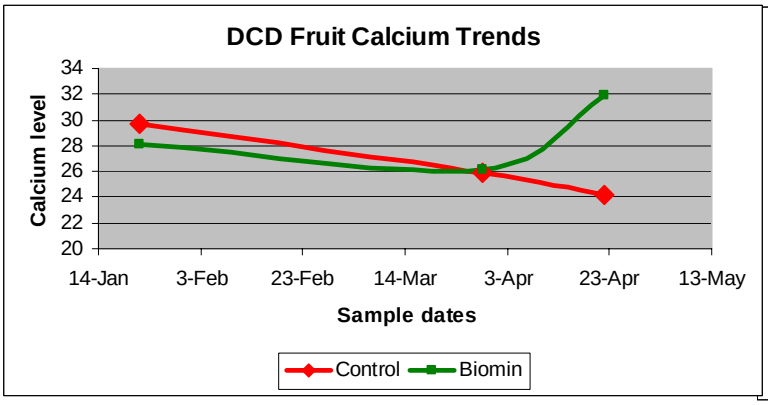
GRAPH 1: MCFADGEN FRUIT CALCIUM TRENDS AND FINAL HARVEST CALCIUM COMPARISONS

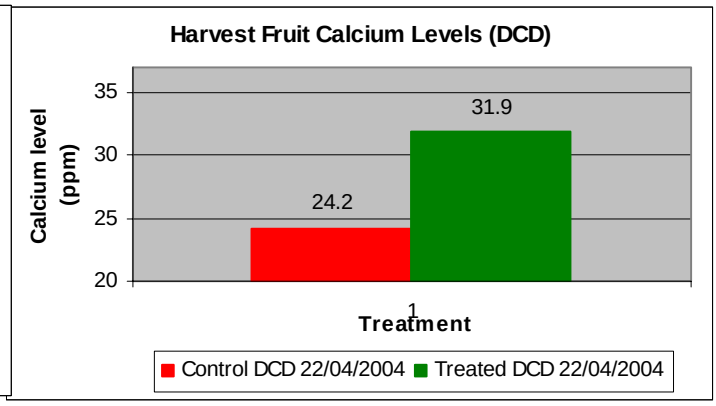




Graph 1 shows the sharp decline of Calcium levels in the McFadgen control block. There was a similar decline in the Biomin™ treated block, however the decline was not as sharp and the final calcium level in the Biomin™ block was higher than the control. The increase in Calcium content of the Biomin™ block was 10.41% over the control. This is a significant difference as the comparison is made in fruit calcium content. It would be easier to observe such a difference in leaf calcium levels as it is easier to increase leaf calcium content than it is to increase fruit calcium content.

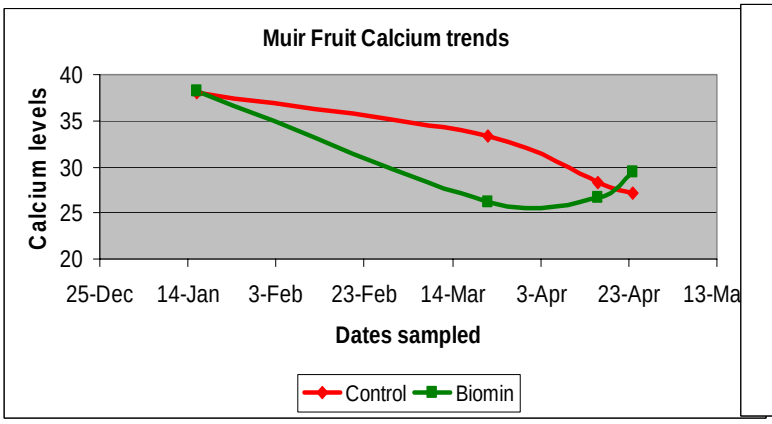
GRAPH 2: DCD FRUIT CALCIUM TRENDS AND FINAL HARVEST CALCIUM COMPARISONS

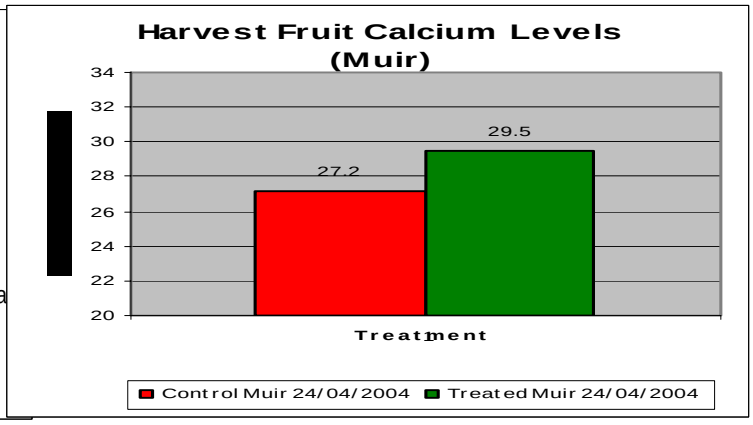




Graph 2 shows similar trends in Calcium accumulation by the fruit, however, the Control block continues to decline in total calcium levels in the fruit, however the trial block treated with Biomin™ Calcium has a steadier decline at first and then there is a rapid rise in fruit Calcium levels, possibly denoted by an application of Calcium. This particular block may have been more responsive to Calcium applications. The increase in Calcium content of the Biomin™ block was 31.82% over the control.

GRAPH 3: MUIR FRUIT CALCIUM TRENDS AND FINAL HARVEST CALCIUM COMPARISONS





Graph 3 shows some very unusual trends in fruit calcium levels compared to the other blocks. The lines represent a steep decline in Calcium levels of both control and Biomin™ blocks, however there was a steeper decline in the Biomin™ treated block. This decline was followed by a sharp increase in calcium levels after the applications of Biomin™ Calcium were made. The control block continued to decline. The overall increase in calcium levels for the Biomin™ treatment in the Muir block over the control was 8.5%.

DISCUSSION

The aim of this study was to determine the effects of preharvest calcium treatments on preharvest and postharvest quality of kiwifruit. The results indicate that preharvest treatments of Biomin™ Calcium have aided in increasing fruit calcium levels as well as possibly improving postharvest shelf life of fruit.

In kiwifruit, as in most fruits, storage quality is related to calcium concentration and many disorders are associated with low fruit calcium status. This study has shown, like many other studies done previously, that after an early rise, fruit calcium content decreases because calcium influx ceases by the mid-growth stage whereas volume growth continues until harvest. Calcium transport to the fruit is exclusively via the xylem and is not phloem mobile when using standard forms of Calcium. The xylem mobility of calcium best explains the decline in calcium accumulation in kiwifruit throughout the season. In a study done in New Zealand and Italy, researchers found that the xylem functionality declines after fruit has grown to half it's harvest size. As the xylem functionality deteriorates, the translocation of calcium through the xylem also deteriorates.

The patterns observed in this trial have shown however that the chelation technology existing in the formulation of Biomin™ Calcium. Biomin™ Calcium is a Glycine chelated product. This means that every Calcium ion is bonded with two Glycine molecules creating a fully chelated Calcium product. The plant recognizes this molecule as a proteinaceous molecule allowing it to travel in the phloem instead of forcing it to use the xylem where Calcium is normally transported. This allows the Calcium to be a mobile element in the Glycine chelated form. This is the edge Biomin™ Calcium has over all other products existing in the marketplace.

The trial has shown that applications of Biomin™ Calcium will positively increase the calcium content of fruit versus standard practices. The final fruit calcium levels are very important for overall fruit quality as well as post harvest shelf life of fruit. An overall average increase of 15% calcium content in fruit was observed where Biomin™ Calcium was applied. This is quite significant given that fruit calcium content was the measured parameter, not leaf levels. This increase shows that Biomin™ Calcium is highly systemic as well as mobile through the fruit cuticle, a characteristic not present in any other calcium product / formulation in the marketplace.

It would be advantageous if the following parameters were measured if possible on fruit put into storage; ethylene production and respiration rate, soluble solids, starch content and dry matter.

With the above parameters covered, the results will better indicate the true effects of Biomin™ Calcium on post harvest shelf life of fruit.

ANNEXES

TABLE 2: FRUIT ANALYSIS RESULTS FOR MCFADGEN BLOCK OVER TIME (START OF SAMPLING TO END OF SAMPLING – THUS FAR)

	Control Mc Fadyen	Treated Mc Fadyen	Control Mc Fadyen	Treated Mc Fadyen	Control Mc Fadyen	Treated Mc Fadyen
	22/01/2004	22/01/2004	29/03/2004	29/03/2004	22/04/2004	22/04/2004
Calcium	32.1	29.5	27.1	26.2	22.1	24.4
Potassium	**214**	**226**	**312**	**320**	**319**	**344**
Magnesium	11.4	10.6	12.7	12.2	12.5	11.8
Nitrogen	**119**	**120**	**159**	**118**	**168**	**151**
Phosphorous	19.1	19.2	26.9	22.5	26.8	25.1
Sulphur	**12.7**	**11.7**	**16**	**14.2**	**17**	**15.3**
Sodium	0.5	0.6	3	1.9	2.7	2.1
Iron	**0.24**	**0.28**	**0.27**	**0.22**	**0.22**	**0.36**
Manganese	0.09	0.11	0.08	0.08	0.06	0.09
Zinc	**0.13**	**0.13**	**0.12**	**0.12**	**0.11**	**0.11**
Copper	0.1	0.1	0.13	0.1	0.12	0.11
Boron	**0.17**	**0.17**	**0.2**	**0.21**	**0.19**	**0.18**
Mean weight	65.8	63.4	88.5	100	102	115
Dry Matter	**8.4**	**8.8**				

TABLE 3: LEAF ANALYSIS RESULTS FOR MCFADGEN BLOCK

25-Nov	Control McFadyen	Treated McFadyen
Nitrogen	**2.6**	**2.7**
Phosphorous	0.28	0.27
Potassium	**2.6**	**2.7**
Sulphur	0.4	0.42
Calcium	**1.74**	**1.77**
Magnesium	0.26	0.27
Sodium	**0.02**	**0.02**
Iron	61	68
Manganese	**46**	**65**
Zinc	49	33
Copper	**12**	**11**
Boron	31	33
Chloride	**0.65**	**0.68**

TABLE 4: FRUIT ANALYSIS RESULTS FOR DCD BLOCK OVER TIME (START OF SAMPLING TO END OF SAMPLING – THUS FAR)

	Control DCD	Treated DCD	Control DCD	Treated DCD	Control DCD	Treated DCD
	22/01/2004	22/01/2004	29/03/2004	29/03/2004	22/04/2004	22/04/2004
Calcium	29.7	28.1	25.9	26.2	24.2	31.9
Potassium	**196**	**201**	**310**	**307**	**317**	**297**
Magnesium	10.9	10.4	12.8	13	12.5	13.5
Nitrogen	**118**	**110**	**137**	**118**	**152**	**128**
Phosphorous	17.8	16.9	22.2	22.5	23.7	23.3
Sulphur	**11.5**	**10.8**	**14.1**	**15**	**15.1**	**14.5**
Sodium	1.2	0.4	2.3	1.5	2.8	1.8
Iron	**0.21**	**0.21**	**0.21**	**0.25**	**0.22**	**0.24**
Manganese	0.12	0.09	0.09	0.11	0.09	0.11
Zinc	**0.12**	**0.11**	**0.12**	**0.11**	**0.11**	**0.15**
Copper	0.07	0.08	0.1	0.1	0.11	0.11
Boron	**0.15**	**0.14**	**0.19**	**0.19**	**0.14**	**0.17**
Mean weight	65.4	63.5	92.7	98.9	111	108
Dry Matter	**8**	**7.5**				

TABLE 5: LEAF ANALYSIS RESULTS FOR DCD BLOCK

5-Dec	Control DCD	Treated DCD
Nitrogen	**2.7**	**2.8**
Phosphorous	0.27	0.24
Potassium	**2.8**	**2.9**
Sulphur	0.4	0.42
Calcium	**2.14**	**1.96**
Magnesium	0.3	0.28
Sodium	**0.01**	**0.01**
Iron	55	95
Manganese	**78**	**77**
Zinc	24	23
Copper	**10**	**13**
Boron	32	34
Chloride	**0.49**	**0.62**

TABLE 6: FRUIT ANALYSIS RESULTS FOR MUIR BLOCK OVER TIME (START OF SAMPLING TO END OF SAMPLING – THUS FAR)

	Control Muir	Treated Muir	Control Muir	Treated Muir	Control Muir	Treated Muir	Control Muir	Treated Muir
	16/01/2004	16/01/2004	22/03/2004	22/03/2004	16/04/2004	16/04/2004	24/04/2004	24/04/2004
Calcium	38.1	38.2	33.4	26.2	28.3	26.6	27.2	29.5
Potassium	**208**	**207**	**297**	**307**	**299**	**303**	**327**	**308**
Magnesium	11.4	10.8	12.9	12.7	12	11.1	12.4	11.7
Nitrogen	**108**	**118**	**119**	**129**	**119**	**169**	**159**	**145**
Phosphorous	19.9	20.3	26.1	28.1	25.9	27.5	27.3	24.4
Sulphur	**11.2**	**12.7**	**14.5**	**16**	**15.9**	**17.3**	**16.3**	**15.8**
Sodium	1.2	0.5	2.9	2.8	2.1	1.9	2.5	2
Iron	**0.24**	**0.24**	**0.25**	**0.28**	**0.25**	**0.25**	**0.25**	**0.26**
Manganese	0.14	0.13	0.13	0.09	0.1	0.08	0.11	0.08
Zinc	**0.14**	**0.13**	**0.13**	**0.15**	**0.11**	**0.09**	**0.12**	**0.12**
Copper	0.11	0.09	0.16	0.12	0.13	0.11	0.13	0.11
Boron	**0.14**	**0.16**	**0.2**	**0.17**	**0.19**	**0.18**	**0.2**	**0.19**
Mean weight	63.6	65.2	101	95.6	108	100	103	102
Dry Matter	**7.8**	**7.6**						

TABLE 7: LEAF ANALYSIS RESULTS FOR MUIR BLOCK

5-Dec	Control Muir	Treated Muir
Nitrogen	**2.3**	**2.4**
Phosphorous	0.27	0.29
Potassium	**3**	**2.5**
Sulphur	0.38	0.35
Calcium	**1.94**	**2.13**
Magnesium	0.26	0.27
Sodium	**0.01**	**0.01**
Iron	59	57
Manganese	**75**	**77**
Zinc	18	20
Copper	**10**	**10**
Boron	31	33
Chloride	**0.58**	**0.48**

TABLE 8: SUMMARY OF TRIAL SAMPLE DATES FOR LEAF AND FRUIT ANALYSIS (AS PER SEEKA STAFF)

Trial:- Biomin™ Calcium Trial

Supervisors:- Steve Butler, Tim Callaghan, Russel Butterworth & Managers

Ski McFadgen	Control	Biomin™
1st Leaf test (before spraying)	27/11/03	27/11/03
2nd leaf tests 35 days later	4/12/03	4/12/03
3rd leaf test (end of cell expansion B/4 harvest)	15/12/03	15/12/03
4th Leaf test (after harvest)	02/01/04	02/01/04
5th Fruit test	08/04/04	08/04/04
Packed in Conv Store – long term Storage Time in 6 trays from each block. Pack as separate MU's	23/04/04	23/04/04
Ski DCD Casuarina		
1st Leaf test (before spraying)	5/12/03	5/12/03
2nd leaf tests 35 days later	22/12/03	22/12/03
3rd leaf test (end of cell expansion B/4 harvest)	12/01/04	12/01/04
4th Leaf test (after harvest)	08/04/04	08/04/04
5th Fruit Test	23/4/04	23/4/04
Packed in Conv Store – long term Storage Time in 6 trays from each block. Pack as separate MU's		

Ski Muir		
1st Leaf test (before spraying)	17/12/03	17/12/03
2nd leaf tests 35 days later	04/01/04	04/01/04
3rd leaf test (end of cell expansion B/4 harvest)	21/01/04	21/01/04
4th Leaf test (after harvest)	24/03/04	24/03/04
5th Fruit Test	18/04/04	18/04/04
Packed in Conv Store – long term Storage Time in 6 trays from each block. Pack as separate MU's		

TABLE 9: PERCENTAGE INCREASE OR DROP IN FRUIT CALCIUM LEVELS FROM BEGINNING OF SEASON UNTIL HARVEST (MCFADGEN)

	McFadgen		**Percentage drop or increase in Calcium**
	Initial Calcium level	**Final Calcium level**	
Control	32.1	22.1	(31.15)%
Biomin™	29.5	24.4	(17.29)%

TABLE 10: PERCENTAGE INCREASE OR DROP IN FRUIT CALCIUM LEVELS FROM BEGINNING OF SEASON UNTIL HARVEST (DCD)

	DCD		**Percentage drop or increase in Calcium**
	Initial Calcium level	**Final Calcium level**	
Control	29.7	24.2	(18.52)%
Biomin™	28.1	31.9	+13.52%

TABLE 11: PERCENTAGE INCREASE OR DROP IN FRUIT CALCIUM LEVELS FROM BEGINNING OF SEASON UNTIL HARVEST (MUIR)

	Muir		Percentage drop or increase in Calcium
	Initial Calcium level	Final Calcium level	
Control	38.1	27.2	(25.72)%
Biomin™	38.2	29.5	(22.80)%