

RESEARCH TOWARDS OPTIMIZING SOIL AND FOLIAR APPLICATIONS OF BORON AND CALCIUM IN 'HASS' AVOCADO

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PLEASE NOTE THAT DAMU IS NOT USUALLY RECOMMENDED AS A SOIL APPLICATION AND IS CURRENTLY REGISTERED AS A FOLIAR APPLICATION.

ABSTRACT

Optimised nutrient applications, specifically boron (B) and calcium (Ca), are linked to improved cell wall integrity which ensures improved fruit quality because of reduced pathological problems and reduced sensitivity to physiological disorders such as lenticel damage. The need exists to identify products which can effectively increase leaf and fruit Ca and B contents. The main aim was to compare the efficacy of six bi-weekly soil applications of Ca and B, during the period from full flowering, including the following important first 8 weeks of fruit set (products from Tessenderlo Kerley, Levity, AECI, Cosmocel and DuxAgri), compared to three calcium nitrate and one commercial boron applications during the same period. The leaf Ca contents of the different treatments with five different Ca products resulted in leaf Ca levels between 1.14% and 1.00% which were lower than the norm of 1.2% to 2.0%. The high rainfall during the season was possibly a contributing factor to the low levels. The soil treatment calcium nitrate applied monthly obtained the highest leaf Ca content of 1.14% that differed significantly from the three application (September to December) treatments with calcium nitrate, Mainstay and PurCal which obtained values of 1.03%, 1.04%, and 1.00%, respectively. There was no significant difference in leaf Ca content of CaTs applied three times compared to calcium nitrate applied monthly, with values of 1.13% and 1.14%, respectively. There is no evidence that applying smaller dosages of Ca during flowering and early fruit development, as compared to commercially applied timings, led to increased leaf Ca content. There is currently no fruit pulp norm for Ca. A previous SAAGA funded project indicates that the highest fruit pulp Ca value obtained (with a leaf Ca content of 1.2%) was 0.10%. The fruit pulp Ca contents of the different treatments with five different Ca products resulted in values between 0.08% and 0.11%. Fruit from the CaTs treatment resulted in significantly higher fruit pulp Ca (0.110%) compared to the two calcium nitrate treatments which both obtained 0.093%. This indicates a possible higher efficacy of CaTs towards increasing Ca in the fruit. A similar trend was observed with the fruit skin. Mainstay and PurCal obtained significantly lower fruit pulp Ca contents (0.080% and 0.083%, respectively) and fruit skin Ca contents (0.133% and 0.104%, respectively), compared to the two calcium nitrate treatments and CaTs. The leaf B contents of the different treatments with five different B products resulted in values between 19.00 mg/kg and 53.66 mg/kg. The Soluble Boron and SprayBor treatments resulted in values slightly higher than the lower margin of the norm of 50-80 mg/kg B.

The need exists to find a measure to adjust the dosages according to the B lost due to leaching during a high rainfall season. The Microflex Super treatment exhibited the lowest leaf B content of 19 mg/kg. However, it only contains 2% B compared to SprayBor and Soluble Boron that contain 16.5% and 17%, respectively. The fertilizer adviser of the producer decided that additional B will be applied from 2024 if too low soil B is expected. The heavy rains surely decreased available B. Applications of Soluble Boron and SprayBor obtained significantly higher leaf B contents (53.33 mg/kg and 53.66 mg/kg, respectively) compared to Damu and Boro-Pro with values of 31.00 mg/kg and 30.00 mg/kg, respectively. It is uncertain if these products, Damu and Boro-Pro, are more prone to leaching due to the high rainfall. Similarly, Soluble Boron and SprayBor also obtained significantly higher fruit pulp B contents (85.67 mg/kg and 84.00 mg/kg, respectively) compared to Damu and Boro-Pro with 31.00 mg/kg and 30.00 mg/kg, respectively. A similar trend was observed for the fruit skin B contents of these products. The treatments with calcium nitrate + Soluble Boron and CaTs (calcium thiosulphate) + SprayBor, applied three times and six times, respectively, during flowering and early fruit develop-

ment, resulted in significant higher yields of 1 126.80 kg/ha and 1 085.09 kg/ha. The other treatments resulted in fruit yields ranging between 913.73 and 965.29 kg/ha. This can be attributed to higher cell wall integrity attained by higher boron and calcium contents in the fruit skin and fruit pulp that assisted in reducing fruit drop. The soil Ca contents varied between 538 and 1 656 mg/kg. Treatments 1, 2, and 3 that included calcium nitrate and CaTs exhibited higher values ranging between 889 and 1 656 mg/kg. It could be that these products are less prone to leaching, leading to higher leaf Ca contents. The soil boron contents of samples taken on 25 May showed that applications with Soluble Boron (contains boric acid) and SprayBor (sodium borate) resulted in soil B contents ranging between 1.04 and 3.50 mg/kg which was higher compared to the other treatments that ranged between 0.25 and 0.70 mg/kg. Soluble Boron and SprayBor were the only products for which applications could result in the leaf B contents being slightly higher (53.33 to 53.66 mg/kg) than the 50 mg/kg higher margin of the SAAGA norm. Regardless of if adjuvants were added or not, all foliar applications in 2023 led to a percentage increase of leaf Ca of 11.24% to 30.02%. The summer leaf flush coincided with three foliar applications that were applied in the period from the last week of November to the first week of January. Two previous ExperiCo projects on lenticel and orchard cold damage, which included foliar applications of Calcimax and Albina, resulted in insufficient movement of Ca into the leaf and fruit. These were applied prior to harvest with no prominent leaf flush present and the summer flush already fully hardened. The wax layer of hardened leaves prevents effective penetration of Ca. Therefore, the efficacy of foliar applications of Ca products will be optimised when applied during periods when new growth is present, as could be achieved in the present trial. The addition of Eckosil with Calcimax led to a marginal increase in leaf Ca contents compared to no adjuvant added, with values of 1.06% and 1.03%, respectively. Eckosil improved the efficacy of Trazex Ca + B which led to a significant percentage increase (25%) in leaf Ca content compared to the untreated control. Trazex Ca + B applied with no adjuvant resulted in only a 17% increase.

Eckosil did not improve the efficacy of Albina, but the addition of Inex-A led to a significant increase in leaf Ca content (values of 0.930% and 1.047%, respectively). InCa when applied without and with Eckosil and Inex-A, resulted in leaf Ca levels of 1.047%, 1.060%, and 1.078%, respectively, although these did not differ significantly. It is interesting to note that this product contains the least Ca and B contents, compared to the other products, but applications resulted in higher levels compared to the other products. It could be that this formulation improves localised calcium movement. It will be interesting to test its efficacy when sufficient Ca is present in the soil. All foliar applications, with and without Eckosil and Inex-A, except for Trazex alone (no Eckosil or Inex-A added), led to a significant increase in leaf B varying between 20.05% and 66.09%, compared to the untreated control. Si (Eckosil) added as an adjuvant slightly increased the leaf B of all products, but the increase was only significant in the case of Trazex Ca + B. Inex-A, an adjuvant with penetrating ability, proved to be extremely effective in improving the efficacy of both Flo-Bor and Damu, which resulted in percentage increases of 60.08% and 66.09%, respectively. In the case of Trazex Ca + B and InCa, the addition of Inex-A led to a 40% and 36.07% increase, respectively, compared to the untreated control. Applications of Flobor and Damu with Inex-A, obtained significantly higher values (26.67 mg/kg and 67.67 mg/kg, respectively) compared to Trazex Ca + B and InCa with Inex-A (26.67 mg/kg and 23.33 mg/kg, respectively). With and without an adjuvant, all boron foliar treatments led to the percentage increase of fruit skin B varying between 10.19% and 35.19%, significantly higher when compared to the untreated control. Similarly, all boron foliar treatments (with and without an adjuvant) resulted in an increase in fruit pulp B, varying between 16.68% and 42.86%, which were significantly higher compared to the untreated control. In most cases there was a significant increase in fruit skin B contents when Inex-A was used as adjuvant compared to Eckosil. With regards to the fruit pulp, the Inex-A treatments resulted in slightly higher values, but it did not differ significantly from the Eckosil treatments. Damu and Eckosil had compatibility problems that led to less pronounced increases in both fruit pulp and skin B contents. Indra soil applications led to a significant increase in fruit yield (1 297.96 kg fruit/ha compared to 1 141.65 kg fruit/ha for the control). The climate is changing and weather patterns are becoming less predictable. More crops are losing yield due to periods of high or low temperatures. By priming crops to allow them to cope when the weather gets tough, Indra helps farmers to safeguard yields and quality, and needs to be investigated further.

INTRODUCTION

The demand for calcium (Ca) of avocado fruit is greatest within the first 8 weeks after fruit set (Witney *et al.*, 1990a; Bower *et al.*, 1989). After this time, fruit stomata become non-metabolically functional lenticels (Blanke, 1995) and the waxy cuticle thickens (Coates *et al.*, 1993). These physiological, anatomical, and morphological changes limit fruit transpiration rate. Thus, it is important to create conditions that favour Ca transport to the fruit during the early stages of development and there is a need to conduct research on this important aspect. Since Ca and B are important to ensure fruit skin integrity and cell

wall thickness, the maximum accumulation of these nutrients at early stages of fruit development is important.

During 2020, the third year of the avocado lenticel damage trial done by ExperiCo, it was found that B, when applied as a late season foliar spray, could effectively be absorbed into the fruit skin and pulp. However, increasing the Ca levels in fruit was more difficult to achieve. Furthermore, the addition of Panaf1 (a lipid-amino acid which proved to be an excellent fungicide penetrator when applied with foliar applications in other crops; Pan African Farms) and Wetcit (an excellent wetter with penetrating proper-

ties; Oro Agri) were both effective in achieving increased penetration of B into the fruit, but not for Ca. This required further research to test other penetrators and find effective solutions. Foliar applications of the two nutrients during the first 8 weeks of fruit development may ensure optimum absorption while stomata are still functional on the fruit skin, which needs to be verified. Furthermore, the need exists to determine whether applications of Ca and B by soil or foliar or both are best. The South African avocado industry has a long focus on continually improving fruit quality delivered to the consumer, which often necessitates adoption of improved production practices. Optimised nutrient applications, specifically B and Ca, are linked to improved cell wall integrity which ensures improved fruit quality and, as a result, reduced pathological problems and reduced sensitivity to physiological disorders such as lenticel damage.

OBJECTIVES

- To compare the efficacy of 6 bi-weekly soil applications of Ca and B (including products from Tessenderlo Kerley, Levity, AECI, Cosmocel, and DuxAgri), starting at full flowering and including the following important first 8 weeks after fruit set, towards increasing leaf and fruit Ca and B contents, compared to the commercial standard of three calcium nitrate and one boron applications during the same period.
 - o To identify which soil applied products provide increased leaf and fruit Ca and B contents.
- To verify the advantage of including foliar applications of Levity, AECI, Cosmocel, and DuxAgri products in combination with soil applications, to increase leaf and fruit Ca and B contents.
 - o To verify the need for 5 foliar applications of different B and Ca products in the period from the cauliflower stage of flowering, including the following important first 8 weeks of fruit set.

MATERIALS AND METHODS

The need existed to identify other Ca and B products available for soil and foliar applications to be tested and compared to commercially applied products.

Information and treatment dosages of identified Ca and B nutrient products to be tested in soil and foliar applications:

☐ Levity Crop Science Nutrient Products

INDRA

To improve boron supply for fruit and flower development in avocado, transpiration and translocation need to be addressed differently. Simply supplying additional boron to either soil or foliage will have limited benefit without doing so. Maintaining normal transpiration during stressful growing conditions is vital to maintain adequate movement of boron from roots to leaves to be available for translocation and to prevent general plant deficiency. Maintaining normal photosynthesis is vital to ensure the plant has adequate levels of C7 sugar synthesis to enable translocation to developing fruit.

- Indra is a product that improves transpiration and

photosynthesis during stress conditions.

- It stimulates antioxidant production in avocado, which helps to protect it against osmotic stress.
- Used regularly throughout the season, Indra can help crops maintain water transport and photosynthesis during drought, high temperatures, or where water has a high salt content.

Dosage: Use monthly during stress periods at 1 L/ha and can be applied foliarly or through irrigation.

ALBINA

Calcium is poorly absorbed by flowers and fruit, therefore a high percentage of calcium applied is wasted as fruit are not able to absorb it efficiently.

- Albina contains Levity's pioneering LoCal technology. It stimulates calcium absorption into parts of crops where conventional products cannot and is registered as a foliar application for avocados.

Dosage: Applied foliarly every 14 days at 1 L/ha

DAMU

Levity has developed Damu, a foliar that can promote translocation of boron to fruit and flowers. *(Please note that Damu is not usually recommended as a soil application and is currently registered as a foliar application.)*

- Damu combines boron with stimulants that increase the speed of uptake and phloem loading for translocation to fruit.
- This approach allows small applications to be more effective than large applications of conventional products.
- Damu can be foliarly applied to improve avocado fruit and flower development and retention.
- It can promote production under high density plantings, and crops grown under shade netting by maintaining better boron transport from leaves to fruit.

Dosage: Use during fruit and flower development periods every 4-6 weeks, applied foliarly at 2 L/ha. Use adequate water for good coverage.

☐ AECI Plant Health Nutrient Products

SPRAYBOR®

- A water-soluble form of boron (water soluble sodium borate, 165 g/kg), which can either be applied as a foliar spray or as a direct soil treatment.

Dosage: 1.0-2.5 kg/ha (soil application), 100-200 g/100 L water (foliar application).

FLO-BOR®

Currently it is frequently used commercially by most growers as a foliar B application during flowering (at cauliflower stage).

- Flo-Bor® is a solution containing chelated boron (129 g/L) registered for avocado as foliar application but applied either as a foliar spray or as a soil application.

Dosage: 50-150 ml/100 L water.

CALCIMAX®

- A liquid organic calcium complex for use as a foliar nutrient on various crops to prevent or correct calcium deficiencies and related physiological disorders.
- Active ingredients include calcium (Ca) - 100 g/L (carbohydrate chelate complex), boron (B) - 6.5 g/L. Apply as a medium cover spray in 1 000-3 000 L water/ha.

Dosage: 500 ml/100 L water.

□ Cosmocel Ca and B products

MAINSTAY CALCIUM

- A 100% pure liquid calcium with zero nitrates, sulphates or chlorides. Other calcium supplements often include unwanted/unnecessary chemicals known as counter-ions, e.g., calcium nitrate (CaNO₃), calcium carbonate (Ca (CO₃)₂) or calcium chloride (CaCl₂).

Mainstay Calcium is a liquid suspension with a high concentration of neutralised calcium oxide (40% w/v), with "high speed" assimilation technology, formulated with Cosmocel Nutri-shield Micro-Encapsulated technology providing a reacted ionic calcium with excellent availability in the soil, high plant absorption and utilisation.

Dosage: Application for avocados 30 L/ha (50% during flowering and fruit set, and 50% applied as 2 equal applications later in the season).

TRAZEX CA + B

- A foliar nutrient product containing Ca and B known for excellent absorption into avocado leaves in Australia.

Dosage: 2-3 kg/ha.

□ Tessenderlo Kerley Ca product

CATS® (Calcium Thiosulphate)

- A clear liquid fertilizer containing calcium and sulphur that reduces the harmful effects of salt, such as sodium, in the soil, and can work as a soil amendment.
 - o Multipurpose: brings key nutrients and acts as soil amendment.
 - o Boosts crop quality, consistency, crop colour, and shelf life. Delivers 100% readily available calcium and sulphur. Liquid fertilizer without nitrogen or chloride.
 - o Enhances root growth.

Active thiosulfate benefits

- o Enhances crop protein and chlorophyll content, assists in the synthesis and functioning of enzymes in the plant and optimises fertilizer efficiency by stabilising nitrogen.
- o Improves availability of nutrients in the soil, particularly phosphorus, and micronutrients

and their uptake by the crop.

- o Solubilises soil nutrients (calcium, potassium, magnesium, iron, and manganese).
- o Energy efficient assimilation in the plant and beneficial soil microorganism interaction.
- o Provides prolonged sulphur nutrition.
- o A controlled and localised pH adjustment effect.

Dosage: 50-100 L/ha.

□ DuxAgri Ca and B products

INCA (PlantImpact™)

- A patented calcium and boron foliar application containing CaT™ technology that is designed to improve localised calcium movement, reducing calcium disorders and increasing marketable yield.
 - o CaT technology stimulates selective ion transport channels in membranes, increasing the calcium concentration within cells and in doing so improves localised calcium movement.
 - o Once delivered via the xylem, calcium typically moves into tissues via the apoplastic pathway where water (with solutes) moves between cells or through cell walls, but does not enter the cell membrane.
 - o When movement via the apoplastic flow is limited due to low transpiration, movement via the symplastic pathway is likely to become more important.
 - o InCa calcium is able to move directly through cells instead of around plant cells, allowing calcium to move faster and more directly which increases calcium concentrations within cells.

Dosage: 1-3 L/ha applied 14-21 days apart from bud break until harvest.

BORO-PRO

- Boro-Pro® is carbon-complexed with Micro Carbon Technology® which ensures efficient and effective uptake of boron in roots and leaves.
 - o Boron is required for cell division and normal tissue differentiation and maturation.
 - o It enhances pollen viability and pollination in flowering crops and supplies boron nutrition necessary for proper growth and maturation.
 - o Boron functions with calcium to form an "inter-cellular cement" to maintain plant structural integrity.
 - o Boron also improves protein metabolism and reduces nitrate accumulation in leaves and improves sugar transport in plants.

Dosage: 1.25-2.5 L/ha.

PURCAL

- PurCal® is carbon-complexed with Micro Carbon Technology® which ensures efficient and effective uptake of calcium in roots and leaves. It contains 100 g Ca/kg derived from calcium chloride and calcium acetate.
 - o The N lost in PurCal plots needs to be balanced if needed.

- o Similar application timings as indicated for the commercial Ca and B soil applications (Table 2A and 2B) were applied. For dosages applied see Table T5A and T5B.

Dosage: 10-40 L/ha.

□ **Nutrico**

SOLUBLE BORON (17% B, 170 g/kg)

- Soluble Boron is an In Line product supplied by Nutrico in South Africa and is a water soluble, crystalline powder containing:
 - o Boric acid for the correction of boron deficiencies. Boric acid is created from the mixture of borax with other naturally occurring minerals such as boracite and colemanite.

Dosage: 24 kg/ha.

TRIAL 1

The main objective was to compare the efficacy of six bi-weekly soil applications of Ca and B during the first 8 weeks after fruit set, towards increasing leaf and fruit Ca and B contents, to one commercial application close to the same period.

Avocado fruit's demand for Ca is greatest within the first 8 weeks after fruit set (Witney *et al.*, 1990a; Bower *et al.*, 1989). After this time, fruit stomata become non-metabolically functional lenticels (Blanke, 1995) and the waxy cuticle thickens (Coates *et al.*, 1993). These physiological, anatomical, and morphological changes limit fruit transpiration rate. Thus, it is important to create conditions that favour Ca and B transport to the fruit during the early stages of development. Although B can be translocated later in fruit development from the leaves, when the direct transpiration stream toward the fruit becomes non-existent, the increased absorption of B during the first 8 weeks after fruit set will be beneficial. Smaller dosages of both B and Ca applied on a bi-weekly basis will be more available in the 30 cm of the upper soil without the risk of leaching as is the case of one large application. Initially four comparable high nitrogen orchards from Westfalia farms would have been identified for this trial. However, they indicated that they apply Ca and B by hand and not through irrigation, and could only provide two orchards. The two orchards were 40 years old and it was decided to source younger orchards from other producers to replace the Westfalia orchards. Two 'Hass' orchards (drip irrigation) that were planted in 2020 (3 years old) on a farm near Tzaneen were identified for this trial.

One orchard was used for the soil applications (Palesa orchard 6). Making use of a randomized block design, the different treatments were marked out (7 trees per rep x 5 reps, 350 trees with 35 trees per row, 10 rows). Soil applications of Ca and B started in the third week of September. It was planned to do three monthly Ca applications. However, due to high rainfall, the third application (TA) was done in the last week of December and the sixth application of the smaller dosage applications (TB) were applied

in the second week of January. The Ca and B treatments were applied as a drench (10 L evenly applied with watering cans).

Trial 1: Treatment 1 (T1A) and (T1B)

- The different treatments included the producer protocol for Ca (calcium nitrate) and B (Microflex) soil applications (see dosages in Table 1 (T1A)) which are done on a monthly basis.
- This was followed by 6 smaller treatments of Ca (calcium nitrate) and B (Microflex) to replace three treatments during the period of flowering until week 8 of fruit set (T1B), starting from the third week of September, on a two-weekly basis.

Trial 1: Treatment 2 (T2A) and (T2B)

As a second control (T2), Westfalia's protocol for Ca (calcium nitrate) and B (Soluble Boron) soil applications were included (Table 1, T2A).

- Commercial applications of B and Ca were performed.
- Calcium nitrate (74.8 kg calcium nitrate/ha; 408 trees/ha) applied in three equal amounts starting the third week of September, that coincided with the period of flowering and end eight weeks after fruit set (Table 1, T2A).
- The first application (T1A) was followed by six smaller calcium nitrate applications of 37.4 kg/ha each on a bi-weekly basis, starting from flowering stage until eight weeks after fruit set (T2B, starting in the third week of September).
- The B soil applications (T1A) included Soluble Boron: two soil applications were done, the first in the third week in September and the second in March the following year (16.33 kg/ha and 8.17 kg/ha, respectively).
- The first application (T1A) was followed by six smaller Soluble Boron applications of 2.72 kg/ha each on a bi-weekly basis, starting from flowering stage until eight weeks after fruit set (T2B, starting in the 3rd week September).

Trial 1: Treatment 3 (T3A) and (T3B)

In this treatment, commercial calcium nitrate soil applications (T2) were replaced with CaTs (calcium thiosulphate), a calcium product from Tessenderlo Kerley containing calcium and sulphate. Soluble Boron (T2A) were replaced by SprayBor (a water-soluble form of boron - water soluble sodium borate, 165 g/kg) from AECI Plant Health.

- Similar application timings as indicated for the commercial Ca and B soil applications (see Treatment 2 above and Table 1) were used for the CaTs and SprayBor treatments (see Table 1; 3A and 3B for the dosages applied).
- Some producers use SprayBor commercially.
- The N lost in CaTs and SprayBor plots needs to be balanced if needed.

Trial 1: Treatment 4 (T4A) and (T4B)

In this treatment the commercial calcium nitrate soil applications were replaced with Mainstay Calcium (Mainstay Calcium is a liquid suspension with a high

concentration of neutralised calcium oxide (40% w/v) with "high speed" assimilation technology, formulated with Cosmolcel Nutri-shield Micro-Encapsulated technology providing a reacted ionic calcium with excellent availability in the soil, high plant absorption and utilisation) and Soluble Boron was replaced by Damu (a product of Levity Crop Science that combines boron with stimulants that increase the speed of uptake and phloem loading for translocation to fruit).

- Similar application timings as indicated for the commercial Ca and B soil applications (See Treatment 2 and Table 1) were used for the Mainstay Calcium and Damu treatments (see 4A and 4B for the dosages to be applied).
- The N lost in Mainstay Calcium plots needs to be

balanced if needed.

Trial 1: Treatment 5 (T5A) and (T5B)

In this treatment the commercial calcium nitrate soil applications were replaced with PurCal (this Huma Gro product provided by DuxAgri is carbon-complexed with Micro Carbon Technology® which ensures efficient and effective uptake of calcium in roots and leaves. It contains 100 g/kg derived from calcium chloride, and calcium acetate). Soluble Boron was replaced by Boro-Pro (this Huma Gro product provided by DuxAgri is carbon-complexed with Micro Carbon Technology®; a product which ensures efficient and effective uptake of boron in roots and leaves).

- Similar application timings as indicated for the

Table 1: The proposed application dosages of products of Tessengerlo Kerley, Levity Crop Science, Cosmolcel, Nutrico, and DuxAgri were done at the same time as the commercial application times of calcium nitrate and Soluble Boron (T2A). Additionally, smaller bi-weekly applications were included as indicated, to verify if more frequent applications will lead to increased absorption of Ca and B into leaves and fruit of 'Hass' avocado

		Cauli flower		Full Flowering			Fruit set			Fruit growth to maturity				Total
		Ψ		Ψ			Ψ							
				Flowering			Fruit set			Fruit growth to maturity				
		July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
T1A	Ca Nitrate	11	12	1	2	3	4	5	6	7	8	9	10	
	kg/ha	18	18	23	23	23	21	21	17	16	16	16	16	228 kg/ha
T1B	Ca Nitrate	14	15	1	2	3	4	5	6	7	8	9	10	11
	kg/ha	16	16	69 kg/ha /6 = 11.5kg/ha			21	21	17	16	16	16	16	228 kg/ha
T1A	Microflex	11	12	1	2	3	4		6	7	8	9	10	
	kg/ha	3	3	3	3	3	3	3	3	3	3	3	3	33 kg/ha
T1B	Microflex	14	15	1	2	3	4	5	6	7	8	9	10	11
	kg/ha	3	3	9 kg/ha /6 = 1.5kg/ha x 6			3	3	3	3	3	3	3	33 kg/ha
T2A	Ca Nitrate			1	2	3								
	kg/ha			74.8	74.8	74.8								224.4 kg/ha
T2B	Ca Nitrate			1	2	3	4	5	6					
	kg/ha			224.4 kg/ha /6 = 37.4 kg/ha x 6										224.4 kg/ha
T2A	Soluble Boron			1						2				
	kg/ha			16.33						8.17				24.5 kg/ha
T2B	Soluble Boron			1	2	3	4	5	6	7				
	kg/ha			16.33 kg /6 = 2.72kg/ha x 6							8.17			24.5 kg/ha
T3A	CaTs			1	2	3								
	L/ha			52	52	52								156 L/ha
T3B	CaTs			1	2	3	4	5	6					
	L/ha			156 L/ha /6 = 26 L/ha x 6										156 L/ha
T3A	SPRAYBOR			1						2				
	kg/ha			16.33						8.17				24.5 kg/ha
T3B	SPRAYBOR			1	2	3	4	5	6	7				
	kg/ha			16.33kg/ha /6 = 2.72 kg/ha x 6							8.17			24.5 kg/ha
T4A	Mainstay Ca			1	2	3								
	L/ha			5.07	5.07	5.07								15.2 L/ha
T4B	Mainstay Ca			1	2	3	4	5	6					
	L/ha			15.2 L/ha /6 = 2.54 L/ha x 6										15.2 L/ha
T4A	Damu (B)			1						2				
	L/ha			2L						1L				3 L/ha
T4B	Damu (B)			1	2	3	4	5	6	7				
	L/ha			2L/ha /6 = 333 ml/ha x 6							1L			3 L/ha
T5A	Purcal (CaO)			1	2	3								
	L/ha			15	15	15								45 L/ha
T5A	Purcal (CaO)			1	2	3	4	5	6					
	L/ha			45L/ha /6 = 7.5 L/ha x 6										45 L/ha
T5A	Boro-Pro (B)			1						2				
	L/ha			2L						1L				3 L/ha
T5B	Boro-Pro (B)			1	2	3	4	5	6	7				
	ml/ha			2L/ha /6 = 333 ml/ha x 6							1L			3 L/ha

commercial Ca and B soil applications (See Treatment 2 and Table 1) were used for the PurCal and Boro-Pro treatments (see 4A and 4B for the dosages to be applied).

- The N lost in Mainstay Calcium plots needs to be balanced if needed.

Trial 1: Harvest and cold storage

Fruit were harvested on 3 May 2024: 5 cartons (Count 16, 2 cartons per tree replicate) of each treatment were sampled.

Trial 1: Fruit ripening and evaluation

- Fruit were stored at the relevant export temperature (6 °C) for a period of 25 days to simulate the sea export period.
 - o The fruit were ripened at 20 °C temperature.
 - o Evaluation was done upon ripening and included a full set of fruit quality parameters including physiological disorders (grey pulp, black cold damage, lenticel damage, vascular browning, vascular staining) and pathological disorders (anthracnose and stem-end rot).

Trial 1: Soil and leaf samples

- Soil nutrient results were collected from the producer at the start of the trial and soil samples were taken at the end of the soil and foliar applications. Leaf and fruit samples were planned to be collected 3 and 4 weeks after the last soil and foliar application, but it was necessary to wait for the summer leaf flush to harden (15 May). Fruit samples (10 fruit per treatment) were taken upon harvest (3 May) for nutrient analyses. Mineral contents were determined on the leaves, fruit skin, and fruit pulp.

TRIAL 2

The main objective was to verify the efficacy of foliar applications of Levity, AECI, Cosmocel, and DuxAgri products in combination with soil applications to increase leaf and fruit Ca and B contents.

Trial 2: Foliar applications of B and Ca

The greatest demand for Ca in an avocado fruit is within the first 8 weeks after fruit set (Witney *et al.*, 1990a; Bower *et al.*, 1989). After this time, fruit stomata become non-metabolically functional lenticels (Blanke, 1995) and the waxy cuticle thickens (Coates *et al.*, 1993). These physiological, anatomical, and morphological changes limit fruit transpiration rate. In this regard, Ca and B applied foliarly are more effectively absorbed when stomata are functional compared to later in the season where only lenticels are present, irrespective of differences in the thickness of the wax layer.

The foliar sprays (7 trees per treatment) were applied in a high nitrogen orchard with the commercially applied calcium nitrate and Nitroflex (B and other micronutrients). A total of five sprays were planned, three weeks apart, during the period from cauliflower stage of flowering (mid-August) until eight weeks after fruit set (November to early December). However, a heat wave during mid-September after only two ap-

plications led to excessive leaf drop. It was decided to commence with the remainder of the spray applications once the trees had recovered. Three sprays were applied in the period from the end of November to the first week of January. Leaf samples were gathered after the summer leaf flush hardened in mid-May.

- Treatment T1 included no foliar application of B and Ca.
- Treatment T2 included AECI Plant Health B and Ca products that are currently commercially used on avocados by most South African producers.
- Treatment T3 included Levity Crop Science B and Ca products that are less known in South Africa but used by producers in the Australian avocado industry.
- Treatment T4 included a Cosmocel B and Ca products which is less known in South Africa but used by producers in the Australian avocado industry.
- Treatment T5 included DuxAgri products that increase the movement of Ca within the tree, and increase the uptake of Ca and B.

Trial 2: Foliar applications - Treatments 2A

T2A included AECI Ca and B products.

- Each of these sprays included a combination spray of chelated B (Flo-Bor, 150 ml/100 L water) and chelated Ca (Calcimax, 500 ml/100 L water).
- No adjuvant was applied.

Trial 2: Foliar applications - Treatments 2B

T2B includes AECI Ca and B products.

- Each of the sprays included a combination spray of chelated B (Flo-Bor, 150 ml/100 L water) and chelated Ca (Calcimax, 500 ml/100 L water).
- An adjuvant from DuxAgri, namely Eckosil (contains an ortho silicate), was included. It was chosen because Si increases the movement of Ca and B. This product has a neutral pH that makes mixing with other products easier.

Trial 2: Foliar applications - Treatment 2C

T2C included AECI Ca and B products.

- Each of the sprays included a combination spray of chelated B (Flo-Bor 150 ml/100 L water), chelated Ca (Calcimax 500 ml/100 L water), and a penetrator Inex-A (0.5 L/ha). Inex-A is a product from Cosmocel. It is a water-soluble adjuvant which acts as a wetter, spreader, and penetrator.

Trial 2: Foliar applications - Treatment T3A

T3A included Levity Ca and B products.

- Each of the sprays included a combination spray of B (Damu, 2 L/ha) and Ca (Albina, 1 L/ha).
- No wetter was added.

Trial 2: Foliar applications - Treatment T3B

T3B included Levity Ca and B products.

- Each of the sprays included a combination spray of B (Damu, 2 L/ha) and Ca (Albina, 1 L/ha).
- An adjuvant from DuxAgri, namely Eckosil (contains an ortho silicate), was included. It was chosen because Si increases the movement of Ca and B. This product has a neutral pH that makes mix-

ing with other products easier.

Trial 2: Foliar applications - Treatment T3C
T3C included Levery Ca and B products.

- Each of the sprays included a combination spray of B (Damu, 2 L/ha) and Ca (Albina, 1 L/ha).
- A penetrator, Inex-A from Cosmocel, was added. Inex-A is a water-soluble adjuvant which acts as a wetter, spreader, penetrator, and retention agent.

Trial 2: Foliar application - Treatment T4A
Treatment 4A included a Ca and B product from Cosmocel. It is a foliar nutrient product containing Ca and B known for excellent absorption into avocado leaves in the Australian avocado industry.

- Each of the sprays included B and Ca (Trazex Ca + B, 2 L/ha).
- No adjuvant/penetrator was applied.

Trial 2: Foliar application - Treatment T4B
Treatment T4B included a Ca and B product from Cosmocel. It is a foliar nutrient product containing Ca and B known for excellent absorption into avocado leaves in the Australian avocado industry.

- Each of the five sprays included a spray of B and Ca (Trazex Ca + B, 2 L/ha).

- An adjuvant from DuxAgri, namely Eckosil (contains an ortho silicate), was included. It was chosen because Si increases the movement of Ca and B. This product has a neutral pH that makes mixing with other products easier.

Trial 2: Foliar application - Treatment T4C
Treatment T4C included a Ca and B product of Cosmocel. It is a foliar nutrient product containing Ca and B known for excellent absorption into avocado leaves in the Australian avocado industry.

- Each of the sprays included B and Ca (Trazex Ca + B, 2 L/ha).
- A penetrator, Inex-A from Cosmocel, was added. Inex-A is a water-soluble adjuvant which acts as a wetter, spreader, penetrator, and retention agent.

Trial 2: Foliar application - Treatment T5A
Treatment T5A included InCa, a Ca + B foliar product of DuxAgri. InCa (PlantImpact™) is a patented calcium foliar application containing CaT™ technology that is designed to improve localised calcium movement. CaT technology stimulates selective ion transport channels in membranes, increasing the calcium concentration within cells and in doing so improves localised calcium movement.

Table 2: Leaf Ca and B contents (leaf five of non-bearing fruit branches), as well as fruit pulp and fruit skin Ca and B contents of three-year old 'Hass' trees from the Tzaneen region, that were treated with five different soil B products at different timings. Additionally, the yield (kg fruit/ha) and fruit quality parameters are also included

Soil applications: Leaf and fruit Ca and Boron content for different Calcium and Boron products applied, as well as fruit quality parameters																				
Ca + B Products applied	Treatment	Leaf Ca	Fruit		Leaf B	Fruit		Yield	Fruit quality parameters : Incidence											
		Norm: (1.2-2) %	Pulp	Skin		Norm (50-80) mg/kg	Pulp		Skin	Days	DTR	Anthraco- se	Stem end rot	Greypulp	Vascular Browning					
			Ca				B		%											
			%				mg/kg													
Calcium Nitrate and Microflex Super applied mothly	T1A	1.14 c	0.093 bc	0.163 b	19 a	32.33 a	51.67 a	941.72 a	5.32b	0.00	1.33a	1.33a	0.00							
Calcium Nitrate and Soluble boron applied 3X (W3-Sept to W4-Dec)	T2A	1.03 ab	0.093 bc	0.160 b	53.33 d	85.67 d	112.67 e	1126.80 c	6.10c	0.00	2.67a	0.00a	0.00							
Calcium Theosulphate (CaTs) and SPRAYBOR applied 3X (W3-Sept to W4-Dec)	T3A	1.13 c	0.110 d	0.177 d	53.66 d	84.00 d	100.67 d	1085.09 bc	6.08c	0.00	1.33a	1.33a	0.00							
Mainstay (CaO) and DAMU applied 3X (W3-Sept to W4-Dec)	T4A	1.04 ab	0.080 a	0.133 a	31.00 c	65.33 c	83.33 b	913.73 a	5.04a	0.00	1.33a	0.00a	0.00							
PurCal (CaO) and BoroPro applied 3X (W3-Sept to W4-Dec)	T5A	1.00 a	0.083 ab	0.104 a	30.00 c	54.67 b	83.00 b	965.29 ab	5.02a	0.00	2.67a	1.33a	0.00							
Ca and B products were applied in smaller dosages during flowering and early fruit development																				
Calcium Nitrate and Microflex Super applied 6X (W3 Sept -W2 Jan +1X in other months)	T1B	1.12 c	0.097 c	0.167 bc	22.67 b	34.33 a	60.67 a	941.72 a	5.28b	0.00	2.67a	1.33a	0.00							
Calcium Nitrate and Soluble boron applied 6X (W3 Sept -W2 Jan)	T2B	1.10 bc	0.093 bc	0.167 bc	53.33 d	82.00 d	98.67 d	1126.80 c	6.08c	0.00	2.67a	1.33a	0.00							
Calcium Theosulphate (CaTs) and SPRAYBOR applied 6X (W3 Sept -W2 Jan)	T3B	1.13 c	0.110 d	0.177 d	53.33 d	84.67 d	110.67 e	1085.09 bc	6.08c	0.00	4.00a	0.00a	0.00							
Mainstay (CaO) and DAMU applied 6X (W3 Sept -W2 Jan)	T4B	1.03 ab	0.083 ab	0.133 a	31.33 c	70.00 c	85.67 b	913.73 a	5.04a	0.00	4.00a	1.33a	0.00							
PurCal (CaO) and BoroPro applied 6X (W3 Sept -W2 Jan)	T5B	1.02 a	0.083 ab	0.037 a	31.67 c	63.67 c	82.67 b	965.29 ab	5.08a	0.00	2.67a	0.00a	0.00							
		Prob > F ₃	0.0003	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	No variance	0.9914	0.9022	No variance							

- Dosage of InCa: 3 L/ha and no wetter/penetrator was applied.

Trial 2: Foliar application - Treatment T5B

Treatment T5B included InCa, a Ca foliar product of DuxAgri. InCa (PlantImpact™) is a patented calcium foliar application containing CaT™ technology that is designed to improve localised calcium movement. CaT technology stimulates selective ion transport channels in membranes, increasing the calcium concentration within cells and in doing so improves localised calcium movement.

- Dosage of InCa: 3 L/ha.
- An adjuvant from DuxAgri, namely Eckosil (contains an ortho silicate), was included. It was chosen because Si increases the movement of Ca and B. This product has a neutral pH that makes mixing with other products easier.

Trial 2: Foliar application - Treatment T5C

Treatment T5C included InCa, a Ca foliar product of DuxAgri. InCa (PlantImpact™) is a patented calcium foliar application containing CaT™ technology that is designed to improve localised calcium movement. CaT technology stimulates selective ion transport channels in membranes, increasing the calcium concentration within cells and in doing so improves localised calcium movement.

- Dosage of InCa: 3 L/ha.
- A penetrator, Inex-A of Cosmocel, was added. Inex-A is a water-soluble adjuvant which acts as a wetter, spreader, penetrator, and retention agent.

Initially a combination treatment with Messenger was also planned but the treatment exhibited significant leaf drop during the heatwave and it was decided to remove the treatment from the trial. It was decided to include this treatment in the trial again during 2024.

TRIAL 3

To ascertain the efficacy of Indra soil application during stress conditions to improve the leaf and fruit B and Ca.

Trial 3: Soil applications

Soil applications of Indra were done by diluting the correct amount of the product in 10 L of water per tree and applying it with water cans (T2). An untreated control was included where no Indra was applied. Indra was applied once a month during stress conditions, from August to December. Leaves and fruit were sampled at harvest to determine mineral contents. Fruit yield per treatment was measured by weighing the harvested crates per tree.

Trial 3: Trial layout and statistical analysis

Trial layout

- Trial 1: five replicates per treatment (seven trees per replicate).
- Trial 2: seven single tree replicates.
- Trial 3: four replicates per treatment.

Data for each trial were subjected to one-way analysis of variance (ANOVA) using Statistica (statistical software).

RESULTS AND DISCUSSION

Trial 1: Leaf, as well as fruit pulp and fruit skin Ca contents.

The main objective was to compare the efficacy of different soil applied Ca and B products, at different times, towards increasing leaf and fruit Ca and B contents.

- The leaf Ca contents of the different treatments (Table 2) with five different Ca products resulted in values between 1.14% and 1.00% which were lower than the norm of 1.2% to 2.0%. Possible contributing factors for this low Ca content could be high rainfall during the season and that the trees were still young (three years old). The need exists to find a measure to adjust the dosages according to the Ca lost due to leaching during a high rainfall season. In discussion with Bram Snijder it was decided to increase the number of soil nutrient analyses of the 2024 soil fertilizer trial depending on rainfall.
- The soil treatment of calcium nitrate applied monthly (Table 2, 12 applications, T1A) obtained the highest leaf Ca content of 1.14% that differed significantly from the three application (September to December) treatments with calcium nitrate, Mainstay Calcium and PurCal that obtained 1.03%, 1.04%, and 1.00%, respectively (T2A, T4A and T5A).
- There was no significant difference in leaf Ca content of CaTs (T3A) applied three times compared to calcium nitrate applied monthly (12 applications, T1A), with values of 1.13% and 1.14%, respectively.
- There is no evidence (Table 2) that by applying smaller dosages during flowering and early fruit development (T1B, T2B, T3B, T4B, and T5B), there was better Ca uptake compared to commercially applied timings (T1A, T2A, T3A, T4A, and T5A).
- There is currently no fruit pulp norm for Ca. A previous SAAGA funded project indicated that the highest fruit pulp Ca value obtained (with a leaf Ca content of 1.2%) was 0.10%. The pulp Ca contents of the different treatments with 5 different Ca products resulted in values between 0.08% Ca and 0.11% (Table 2).
- Fruit from the CaTs treatment resulted in significantly higher fruit pulp Ca (T3A, 0.110%), compared to the two calcium nitrate treatments (T1A and T2A) which both obtained 0.093%. This indicated a possible higher efficacy of CaTs in increasing fruit Ca. A similar trend was observed with the fruit skin.
- Mainstay Calcium and PurCal obtained significantly lower fruit pulp Ca contents (0.080% and 0.083%, respectively) and fruit skin Ca contents (0.133% and 0.104%, respectively), compared to the two calcium nitrate treatments and CaTs (T1A, T2A and T3A).

Trial 1: Leaf, as well as fruit pulp and fruit skin B contents.

- The leaf B contents of the different treatments (Table 2) with five different B products resulted in values of 19.00 mg/kg to 53.66 mg/kg. The Soluble Boron and SprayBor treatments resulted in values within the norm of 50-80 mg/kg B. This was possibly due to high rainfall during the season. The need exists to find a measure to adjust the dosages according to the B lost due to leaching during a high rainfall season.
- The Microflex Super treatment exhibited the lowest leaf B content of 19 mg/kg. However, it only contains 2% B compared to SprayBor and Soluble Boron which contain 16.5% and 17%, respectively (Table 2). The fertilizer adviser of the producer decided that additional B will be applied from 2024, if too low soil B is expected. The high rainfall contributed to less availability of B.
- Soluble Boron and SprayBor obtained significantly higher leaf B contents (53.33 mg/kg and 53.66 mg/kg, respectively) compared to Damu and Boro-Pro with values of 31.00 mg/kg and 30.00 mg/kg. It is uncertain if these products, Damu and Boro-Pro, are more prone to leaching due to the high rainfall.
- Similarly, applications of Soluble Boron and SprayBor obtained significantly higher fruit pulp B contents (85.67 mg/kg and 84.00 mg/kg, respectively) compared to Damu and Boro-Pro with 31.00 mg/kg and 30.00 mg/kg, respectively.
- A similar trend was observed for the fruit skin B contents of these products.

Trial 1: Yield

- The treatments with calcium nitrate + Soluble Boron and CaTs (calcium thiosulphate) + SprayBor [T2] and [T3] applied 3 times and 6 times during flowering and early fruit development, resulted in significantly higher yields of 1 126.80 kg/ha and 1 085.09 kg/ha (Table 2). The significant higher leaf B content compared to the other treatments stands out. The other treatments resulted in fruit yield ranging between 913.73 and 965.29 kg/ha.

- This can be attributed to higher cell wall integrity attained by higher boron and calcium (Table 2) contents in the fruit skin and fruit pulp that surely helped to reduce fruit drop.

Trial 1: Fruit quality parameters

To verify fruit quality of trees subjected to different Ca and B, it is good to include quality parameters, namely no. of days to ripen (DTR), pathological disorders, grey pulp, and vascular browning, that can be linked to differences in cell wall integrity. The following results were obtained (Table 2):

- The treatments with calcium nitrate + Soluble Boron and CaTs (calcium thiosulphate) [T2] and applied 3 times and 6 times during flowering and early fruit development, resulted in significantly higher DTR with values ranging between 6.08 and 6.10 days (Table 2). The other products ripened at an average between 5.04 and 5.28 days.
- The different treatments showed no or a low incidence of grey pulp (between 0 and 1.33%). As a high nitrogen orchard (2.56-2.7% N), fruit are prone to develop a higher incidence of grey pulp. However, the fruit were harvested early in the season (27% DM) on 3 May and higher grey pulp incidence will be more prominent later in the season.
- There was no vascular browning present in ripened fruit for all treatments.
- A low incidence of stem-end rot was present (between 1.33% and 4%) that did not differ significantly between treatments.

It is important to verify the leaf nutrient composition of all the other nutrients as it affects the overall health of the trees (Table 3):

- The leaf N contents varied between 2.57% and 2.67%, values higher than the norm. This high nitrogen orchard was planted on an old banana orchard explaining the high nitrogen present. As only T1A, T2A, T1B, and T2B included calcium nitrate soil applications and nitrogen was not added in the other treatments, additional N needed to be applied in these treatments. It was decided to add

Table 3: Leaf nutrient composition of fruit from trees (5 replicates, 7 trees per rep, 35 trees in total per treatment) subjected to different soil Ca and B applications

Leaf nutrient composition May 2024													
Treatment	N 2.2 - 2.4 %	P 0.12 - 0.20 %	K 0.75 - 1.15 %	Ca 1.2 - 2.0 %	B 50-80 mg/kg	Mg 0.5 - 0.6 %	Mo - mg/kg	Fe 75 - 150 mg/kg	Mn 75 - 250 mg/kg	Zn 30 - 100 mg/kg	Cu 5 - 15 mg/kg	Na - mg/kg	S - %
T1A	2.63	0.16	1.04	1.14	19.00	0.48*	0.24*	95.00*	227.67*	23.00*	10.00*	61.00	0.25
T2A	2.63	0.14	0.99	1.03	53.33	0.39	0.13	92.33	163.67	21.67	9.00	55.33	0.24
T3A	2.56	0.13	1.07	1.13	53.67	0.38	0.13	89.33	184.67	19.67	9.00	56.33	0.24
T4A	2.57	0.13	0.99	1.04	31.00	0.40	0.15	83.33	177.67	19.00	8.67	57.00	0.22
T5A	2.58	0.13	1.00	1.00	30.00	0.40	0.12	79.67	196.67	18.33	8.33	56.67	0.22
T1B	2.70	0.15	1.04	1.12	22.67	0.41	0.25*	107.33*	232.33*	22.67*	10.67*	54.33	0.25
T2B	2.70	0.14	0.97	1.10	53.33	0.39	0.14	93.33	195.00	22.67	9.33	54.00	0.23
T3B	2.61	0.13	1.05	1.13	53.33	0.40	0.07	83.00	191.33	20.00	8.33	52.67	0.23
T4B	2.65	0.14	1.03	1.03	31.33	0.41	0.12	88.33	195.33	19.67	8.33	53.33	0.22
T5B	2.65	0.14	1.06	1.02	31.67	0.39	0.14	80.00	161.00	19.33	8.00	55.00	0.23

*Microflex Super contains Mg, Mo, Fe, Mn, Zn and Cu, applied in [T1A] & [T1B]

Table 4: Soil mineral composition from treatment blocks (5 reps, 7 trees per rep, 35 trees in total per treatment) subjected to different Ca and B soil applied products

Treatments	pH	P	K	Na	Ca	Mg	EXCH	Ca:Mg	(Ca+Mg)	Mg:K	S-VAL	Na:K	T-VAL	Dens.	S	Zn	Cu	Mn	Fe	B	NH4-N	NO3-N
	KCl	Bray I	AmAc	AmAc	AmAc	AmAc	ACID KCl	AmAc	/K AmAc	AmAc	AmAc	AmAc	AmAc	AmAc	AmAc	DTPA	DTPA	DTPA	DTPA	(Hot WS)		
	6 -6.5	18 -60	70 -250	< 50	500-2000	200-400		2.5 -5 :1	4 -5	3:1						5 -20	3 -10	6 -40	4 -20	0.25 -12		
-	mg/kg						cmol+/kg	mg/kg		cmol+/kg					mg/kg							
T1A R1	6.0	20.0	200	18.0	1150	221	0.0	3.5	9.8	2.2	9.0	0.1	9.0	1.1	13.5	1.7	1.1	5.4	18.8	0.44	6.5	25.9
T1A R2	5.4	12.0	150	20.0	896	177	0.0	3.1	15.4	3.8	6.4	0.2	6.4	1.1	7.4	1.1	1.8	13.5	17.7	0.25	6.4	9.0
T1A R3	4.5	16.0	143	15.0	957	136	0.0	2.5	10.5	3.0	4.3	0.2	4.4	1.1	13.9	0.3	3.8	19.9	16.2	0.55	5.8	31.8
T2A R1	5.9	23.0	225	15.0	1177	130	0.0	5.5	12.1	1.9	7.6	0.1	7.6	1.1	10.7	1.2	0.8	4.2	12.9	3.50	5.6	18.2
T2A R2	6.2	23.0	238	19.0	1656	157	0.0	5.5	15.7	2.1	10.3	0.1	10.3	1.1	14.7	1.6	1.1	4.8	9.5	2.40	5.7	16.2
T2A R3	5.7	10.0	190	22.0	1174	156	0.0	4.6	14.7	2.6	7.7	0.2	7.7	1.1	10.7	0.7	2.8	17.3	9.8	2.58	6.4	4.8
T3A R1	5.7	30	225	17.0	1014	166	0.0	3.7	11.2	2.4	7.1	0.1	7.1	1.1	23.0	1.3	0.9	7.0	17.6	1.59	4.8	12.6
T3A R2	5.6	16.0	281	27.0	889	154	0.0	3.5	8.0	1.8	6.6	0.2	6.6	1.0	26.0	0.8	1.4	6.1	15.5	2.50	1.5	5.2
T3A R3	4.6	20.0	134	15.0	987	89	0.0	4.1	10.8	2.1	4.1	0.2	4.1	1.1	46.9	0.2	2.2	14.4	14.5	1.43	1.2	0.7
T4A R1	5.6	23.0	203	22.0	752	164	0.0	3.6	11.9	2.6	6.8	0.2	6.8	1.0	11.7	1.3	1.2	9.6	18.1	0.55	1.5	5.2
T4A R2	5.1	9.0	114	16.0	538	91	0.0	3.6	11.8	2.6	3.8	0.2	3.8	1.1	6.9	0.4	0.8	4.9	14.9	0.66	1.4	1.6
T4A R3	5.0	9.0	185	14.0	709	141	0.0	3.1	10.0	2.5	5.2	0.1	5.2	1.0	8.6	0.4	2.6	17.8	11.8	0.49	1.4	2.5
T5A R1	5.5	22.0	190	16.0	756	186	0.0	3.3	13.5	3.2	7.1	0.2	7.1	1.1	11.7	1.2	1.3	10.3	16.5	0.53	1.7	14.8
T5A R2	5.4	10.0	179	17.0	768	145	0.0	3.6	12.1	2.6	6.1	0.2	6.1	1.0	8.2	0.7	1.5	8.3	12.3	0.71	1.0	1.3
T5A R3	4.9	13.0	208	15.0	653	131	0.0	3.0	8.2	2.0	4.9	0.1	4.9	1.1	13.6	0.6	1.7	10.5	15.7	0.36	4.1	6.0
T1B R1	5.0	23.0	127	19.0	957	132	0.0	3.5	15.0	3.3	5.3	0.3	5.3	1.0	5.0	0.9	2.1	9.5	37.2	0.25	5.8	10.8
T1B R2	5.7	36.0	240	22.0	952	211	0.0	2.8	8.4	2.3	7.4	0.1	7.4	1.0	9.0	1.0	1.5	5.8	18.1	0.25	7.5	11.8
T1B R3	5.1	12.0	168	19.0	855	144	0.0	3.2	11.5	2.7	5.5	0.2	5.5	1.1	8.4	0.7	2.0	10.8	15.1	0.27	5.6	5.0
T2B R1	4.9	9.0	120	27.0	926	117	0.0	3.3	13.3	3.1	4.5	0.4	4.5	1.0	10.8	0.5	2.0	13.9	15.6	2.60	6.4	6.2
T2B R2	5.1	4.0	129	16.0	787	152	0.0	3.2	15.7	3.8	5.6	0.2	5.6	1.0	8.6	0.6	3.2	24.0	12.2	2.89	1.9	5.0
T2B R3	4.9	3.0	130	27.0	836	125	0.0	3.6	14.2	3.1	5.2	0.4	5.2	1.0	11.6	0.3	2.7	21.6	13.6	1.92	2.0	1.5
T3B R1	5.6	20.0	197	19.0	1004	151	0.0	3.8	11.8	2.5	6.5	0.2	6.5	1.0	11.9	1.2	1.1	8.3	19.2	1.02	1.9	3.7
T3B R2	5.3	14.0	158	15.0	886	142	0.0	3.8	13.8	2.9	6.1	0.2	6.1	1.1	10.2	0.6	1.6	10.8	12.5	1.40	1.6	2.0
T3B R3	4.8	5.0	78	31.0	961	131	0.0	3.5	24.5	5.4	5.2	0.7	5.2	1.1	7.5	0.6	3.0	25.1	17.2	1.41	1.7	3.0
T4B R1	5.9	23.0	224	37.0	800	201	0.0	3.5	13.4	3.0	8.4	0.3	8.4	0.9	22.2	1.4	1.4	9.2	16.6	0.27	1.8	2.8
T4B R2	5.3	7.0	173	35.0	821	230	0.0	2.5	14.7	4.3	7.1	0.3	7.1	1.0	7.4	0.8	1.8	12.8	11.3	0.25	1.8	2.1
T4B R3	5.6	8.0	174	38.0	785	172	0.0	4.2	16.5	3.2	7.9	0.4	7.9	1.0	85.8	1.0	1.8	8.7	10.4	0.26	1.9	6.4
T5B R1	5.1	15.0	111	31.0	743	165	0.0	2.8	17.8	4.8	5.5	0.5	5.5	1.1	7.4	1.4	1.3	9.9	23.0	0.27	2.0	3.3
T5B R2	4.8	25.0	223	31.0	769	128	0.0	3.7	8.6	1.8	5.6	0.2	5.6	1.0	15.6	0.7	1.8	11.0	20.0	0.25	1.9	2.9
T5B R3	5.77	34	238	19	759	209	0.0	3.7	13.1	2.8	8.7	0.1	8.7	1.0	19.9	2.0	1.5	11.8	15.6	0.27	2.4	3.3

nitrogen to these treatments in the second year of the trial so that the N levels were comparable.

- The leaf P, K, Fe, Mn, and Cu contents were within the SAAGA avocado norms for all the treatments (7 trees per replicate, 5 replicates).
- The leaf Mg content was below the SAAGA norm of 0.5-0.6%, ranging between 0.38% and 0.48%. The producer indicated that additional Zn foliar sprays would be applied during the 2024 season.
- Microflex Super contains Mg, Mo, Fe, Mn, Zn, and Cu, and was only applied in [T1A] and [T1B]. The producer asked that it be applied in all the treatments to make sure that the trees all receive similar applications of the important micronutrients.

Soil samples were taken on 25 May 2023 to get an indication of the soil element composition and to plan recommendations for soil applications for 2024 (Table 4):

- The soil pH was mostly below the 6 to 6.5 SAAGA norm ranging between 4.6 and 5.9. Only T1R1 and T2R2 showed pH values closer to the lower margin of the norm (6 and 6.2, respectively). This needs to be addressed.
- Soil K, Na, Fe, Ca, and B contents were within the SAAGA norm.
 - o The soil Ca contents varied between 538 and

1 656 mg/kg. Applications with treatments 1 and 2 that included calcium nitrate, and 3 that included CaTs, showed higher values ranging between 889 and 1 656 mg/kg. It is unknown whether these products are less prone to leaching, which could explain the higher leaf Ca contents observed.

- o In the case of soil boron contents, a similar trend was observed: applications with treatment 2 that included Soluble Boron, and treatment 3 that included SprayBor, resulted in soil B contents ranging between 1.04 and 3.50 mg/kg that were higher compared to the other treatments that ranged between 0.25 and 0.70 mg/kg. Soluble Boron and SprayBor were the only products applied that resulted in leaf B contents slightly higher (53.33-53.66 mg/kg) than the 50 mg/kg lower margin of the SAAGA norm.
- There is a lot of variation in the soil P content. Seventeen samples were below the lower margin of the 18 to 60 mg/kg SAAGA norm (ranging between 3 and 15 mg/kg) and the remaining 13 samples fell within the SAAGA norm between 20 and 36 mg/kg, although still quite far from the upper margin.
- Most of the soil samples (26 of 30 total) had soil Mg contents ranging between 186 and 89 mg/kg

that were below the SAAGA norm of 200 to 400 mg/kg. This resulted in negative ratios of (Ca + Mg)/K and Mg:K.

Trial 2: Leaf, as well as fruit pulp and fruit skin Ca and B contents of foliar treatments of different Ca and B products (Table 5).

For the untreated control (T1) where no foliar sprays were applied, a very low leaf Ca content were observed (0.836%, Table 5). The fertilizer adviser of the producer decided that additional Ca and B will be applied from 2024 onwards. Gypsum, which is commercially normally applied every third year, was applied in 2023 in the trial orchards. However, gypsum takes time to dissolve and it would take a few months to see the full effects thereof. Hence, there would be more available for the trees in the 2024 season, emphasising the importance of additional Ca applications.

- Regardless of if adjuvants were added or not, all foliar applications led to an increase of leaf Ca of between 11.24% and 30.02% (Table 5). The summer leaf flush coincided with the three foliar applications that were applied in the period of the last week of November to the first week of January. Two previous avocado projects on lenticel damage and orchard cold damage, which included foliar applications of Calcimax and Albina, resulted in no movement of Ca into the leaf and fruit.
- These were applied prior to harvest with no prominent leaf flush present and the summer flush already fully hardened. The wax layer of hardened leaves prevents effective penetration of Ca. Therefore, the efficacy of foliar applications of Ca products will be optimised when applied during periods when new growth is present.

- The addition of Eckosil with Calcimax (T2B) led to a marginal insignificant increase in leaf Ca contents compared with no adjuvant applied (T2A), with values of 1.03% and 1.06%, respectively.
- Eckosil improved the efficacy of Trazex Ca + B (T4B) and led to a significant percentage increase (25%) in leaf Ca contents compared to the untreated control. Trazex Ca + B applied with no adjuvant added (T4A) only led to a 17% increase.
- Eckosil did not improve the efficacy of Albina (T3B), but the addition of Inex-A (T3C) led to a significant increase in leaf Ca contents (values of 0.930% and 1.047%, respectively).
- InCa, when applied without and with Eckosil and Inex-A, resulted in leaf Ca levels of 1.047%, 1.060%, and 1.078%, respectively, although these did not differ significantly. It is interesting to note that this product contains the least Ca and B contents, compared to the other products, but resulted in higher values compared to the other products. It could be that this formulation improves localised calcium movement. It will be interesting to test its efficacy when sufficient Ca is present in the soil.
- The inability of Ca to penetrate through the fruit skin with a developed wax layer is demonstrated with results obtained with no adjuvant added (T2A, T3A, T4A, and T5A). The addition of Si (Eckosil) did not improve absorption into the fruit skin and pulp.
- Inex-A proved to be an excellent and effective penetrator, leading to 34.04-48.9% increase in fruit pulp Ca contents for all Ca products tested. Inex-A is not yet registered for use on avocado. Registration is in progress and any queries regarding the product registration status can be directed to Cosmolcel.

Table 5: Leaf Ca and B contents (leaf 5 of non-bearing fruit branches) as well as fruit pulp and fruit skin Ca and B contents of three-year old 'Hass' trees from the Tzaneen region, that were subjected to different foliar applications with and without adjuvants (Eckosil and Inex), including 5 Ca products. Stats: Anova one way, Fishers LSD, P<0.05

Foliar applications of Calcium and Boron products														
Treatments	Ca & B Products	Adjuvant	Leaf Ca (norm: 1.2 - 2)		Fruit Pulp Ca		Fruit Skin Ca		Leaf B (norm 50-80)		Fruit Pulp B		Fruit Skin B	
			%	% Increase	%	% Increase	%	% Increase	(mg/kg)	% Increase	%	% Increase	%	% Increase
T1	UTC	-	0.836 a	-	0.047 ab	-	0.097 a	-	16.66 a	-	28.00 a	-	36.00 a	-
T2A	Calcimax & Flo-bor	Adjuvant not added	1.030 d	23.21	0.043 ab	-8.51	0.093 a	-4.12	20.00 b	20.05	33.00 b	17.86	40.33 b	12.03
T3A	Albina & DAMU		0.977 c	16.87	0.043 ab	-8.51	0.097 a	0.00	20.67 bc	24.07	32.67 b	16.68	40.00 b	11.11
T4A	Trazex Ca + B		0.980 c	17.22	0.040 a	-14.89	0.097 a	0.00	18.00 a	8.04	33.33 b	19.04	39.67 b	10.19
T5A	INCA		1.047 de	25.24	0.040 a	-14.89	0.093 a	-4.12	20.67 bc	24.07	32.33 b	15.46	40.33 b	12.03
T2B	Calcimax & Flo-bor		1.060 de	26.79	0.047 ab	0.00	0.097a	0.00	20.67 bc	24.07	37.56 c	32.14	46.66 c	29.61
T3B	Albina & DAMU	Eckosil	0.930 b	11.24	0.040 a	-14.89	0.100 a	3.09	19.67 b	18.07	38.67 c	38.11	45.33 c	25.92
T4B	Trazex Ca + B		1.047 de	25.24	0.043 ab	-8.51	0.100 a	3.09	21.00 bc	26.05	38.66 c	38.07	46.00 c	27.78
T5B	INCA		1.060 de	26.79	0.047ab	0.00	0.097 a	0.00	21.67 cd	30.07	38.67 c	38.11	46.00 c	27.78
T2C	Calcimax & Flo-bor		1.073 e	28.35	0.063d	34.04	0.120 b	23.71	26.67 f	60.08	40.00 c	42.86	48.00 d	33.33
T3C	Albina & DAMU	INEX	1.057 de	26.44	0.067 d	42.55	0.120 b	23.71	27.67 f	66.09	38,67 c	38.11	48.00 d	33.33
T4C	Trazex Ca + B		1.067 de	27.63	0.063cd	34.04	0.110 b	13.40	23.33 e	40.04	39.33 c	40.46	48.33 d	34.25
T5C	INCA		1.087 e	30.02	0.07 d	48.94	0.110 b	13.40	22.67 de	36.07	39.33 c	40.46	48.33 d	34.25
Prob > F ₂			0.0000	-	0.0000	-	0.0000	-	0.0000	-	0.0000	-	0.0000	-

Table 6: Average yield (kg fruit/ha) of 'Hass' trees with and without soil applications of Indra (treatments applied from August to December)

Indra soil application		
Treatment		Yield kg fruit/ha
UTC	T1A	1141.65a
Indra applied monthly August to Dec	T2A	1297.96b
	Prob.> F	0.0146

- Inex-A is the first penetrator in ExperiCo avocado projects for which applications did not lead to leaf drop or phytotoxic damage.
- All foliar applications, with and without Eckosil and Inex-A, except for Trazex alone (no Eckosil or Inex-A added), had a significant increase in leaf B varying contents between 20.05% and 66.09% compared to the untreated control (Table 5).
- Eckosil (Si) added as adjuvant slightly increased the leaf B of all product applications, but the increase was only significant in the case of Trazex Ca + B.
- Inex-A, an adjuvant with penetrating ability, proved to be extremely effective in improving the efficacy of both Flo-Bor and Damu, which resulted in percentage increases of 60.08% and 66.09%, respectively. In the case of Trazex Ca + B and InCa, the addition of Inex-A led to 40% and 36.07% increases, respectively, compared to the untreated control.
- Applications of Flo-Bor and Damu with Inex-A obtained significantly higher B levels (26.67 mg/kg and 67.67 mg/kg, respectively) compared to Trazex Ca + B and InCa with Inex-A (26.67 mg/kg and 23.33 mg/kg, respectively).
- With and without an adjuvant, all boron foliar treatments exhibited significantly higher B levels in the fruit skin compared to the untreated control (percentage increases of between 10.19 and 35.19) (Table 5).
- Similarly, all boron foliar treatments (with and without an adjuvant) exhibited significantly higher fruit pulp B levels compared to the untreated control (percentage increases of between 16.68 and 42.86) (Table 5).
- In most cases there was a significant increase in fruit skin B contents when Inex-A were used as an adjuvant, when compared to Eckosil for fruit skin.
- With regards to the fruit pulp, the Inex-A treatments resulted in slightly higher values but these did not differ significantly from the Eckosil treatments.
- Damu and Eckosil had compatibility problems that led to less pronounced increases in both fruit pulp and skin B contents.

Trial 3: To ascertain the efficacy of Indra soil application during stress conditions to improve the leaf and fruit B and Ca.

Indra soil applications were done once a month during stress conditions from August to December. Leaves and fruit were sampled at harvest to determine mineral contents. As a result of the heat wave in September, a lot of leaf drop was seen in both treatments. Although early termination of the trial was considered, only three applications were left thus the trial was completed. Fruit yield per treatment was measured by weighing the harvested crates per tree.

- The Indra soil applications led to a significant increase in fruit yield (1 297.96 kg fruit/ha compared to 1 141.65 kg fruit/ha) (Table 6).

The climate is changing and weather patterns are becoming less predictable. More crops show lower yield due to periods of high or low temperatures. Priming crops to be more resilient to weather extremes can help farmers to safeguard yield and quality.

CONCLUSIONS

The need exists to identify products which can effectively increase leaf and fruit Ca and B contents. The main aim was to compare the efficacy six bi-weekly soil applications of Ca and B during the period from full flowering including the following important first 8 weeks of fruit set (including products from Tessenderlo Kerley, Levity, AECI, Cosmocel and DuxAgri) towards increasing leaf and fruit Ca and B contents compared to three calcium nitrate and one commercial boron applications during the same period. The leaf Ca contents of the different treatments with five different Ca products resulted in values between 1.14% and 1.00% which were lower than the norm of 1.2% to 2.0%. The high rainfall during the season was possibly a contributing factor to the low levels. Results indicated:

- The soil treatment calcium nitrate applied monthly obtained the highest leaf Ca content of 1.14% which differed significantly from the three application (September to December) treatments of calcium nitrate, Mainstay Calcium, and PurCal that obtained values of 1.03%, 1.04%, and 1.00%, respectively.
- There was no significant difference in leaf Ca contents of applications where CaTs was applied three times compared to calcium nitrate applied monthly, with values of 1.13% and 1.14%, respectively.

There is no evidence that applying smaller dosages of Ca during flowering and early fruit development, compared to commercially applied timings, led to increased leaf Ca contents.

There is currently no fruit pulp norm for Ca. A previous SAAGA funded project exhibited fruit pulp Ca levels (with a leaf Ca content of 1.2%) of 0.10%:

- The pulp Ca contents of the different treatments with five different Ca products resulted in levels of between 0.08% and 0.11% Ca.
- Fruit from the CaTs treatment had significantly higher fruit pulp Ca (0.110%), compared to the two calcium nitrate treatments which both obtained 0.093%. This indicates a possible higher ef-

ficacy of CaTs to increase Ca in the fruit. A similar trend was observed with the fruit skin.

- Mainstay Calcium and PurCal applications obtained significantly lower fruit pulp Ca contents (0.080% and 0.083%, respectively) and fruit skin Ca contents (0.133% and 0.104%, respectively), compared to the two calcium nitrate treatments and CaTs.

The leaf B contents of the different treatments with five different B products had values between 19.00 mg/kg and 53.66 mg/kg. The Soluble Boron and SprayBor treatments resulted in values slightly higher than the norm of 40-50 mg/kg B. This was possibly due to high rainfall during the season. The need exists to find a measure to adjust the dosages according to the B lost due to leaching during a high rainfall season.

- The Microflex Super treatment exhibited the lowest leaf B content of 19 mg/kg. However, it only contains 2% B compared to SprayBor and Soluble Boron that contain 16.5% and 17%, respectively. The fertilizer adviser of the producer decided that additional B will be applied from 2024, if too low soil B is expected. The heavy rains surely decreased availability of B.
- Soluble Boron and SprayBor applications obtained significantly higher leaf B contents (53.33 mg/kg and 53.66 mg/kg, respectively) compared to Damu and Boro-Pro applications with values of 31.00 mg/kg and 30.00 mg/kg. It is uncertain if these products, Damu and Boro-Pro, are more prone to leaching due to the high rainfall.
- Similarly, Soluble Boron and SprayBor applications also obtained significantly higher fruit pulp B contents (85.67 mg/kg and 84.00 mg/kg, respectively) compared to Damu and Boro-Pro applications with 31.00 mg/kg and 30.00 mg/kg, respectively.
- A similar trend was observed for the fruit skin B contents of these products.

The treatments with calcium nitrate + Soluble Boron and CaTs (calcium thiosulphate) + SprayBor applied three times and six times, respectively, during flowering and early fruit development, resulted in significant higher yields of 1 126.80 kg/ha and 1 085.09 kg/ha. The significant higher leaf B content compared to the other treatments stands out. The other treatments resulted in fruit yields ranging between 913.73 kg/ha and 965.29 kg/ha.

- This can be attributed to higher cell wall integrity attained by higher boron and calcium contents in the fruit skin and fruit pulp that helped to reduce fruit drop.

The soil Ca contents varied between 538 mg/kg and 1 656 mg/kg. Treatments 1, 2, and 3 which included calcium nitrate and CaTs showed higher values ranging between 889 mg/kg to 1 656 mg/kg. It could be that these products are less prone to leaching, which leads to higher leaf Ca contents.

The soil boron contents of samples taken on 25 May showed that Soluble Boron (contains boric acid) and

SprayBor (Sodium borate) applications resulted in soil B contents ranging between 1.04 mg/kg and 3.50 mg/kg which were higher compared to the other treatments that ranged between 0.25 mg/kg and 0.70 mg/kg. Soluble Boron and SprayBor were the only products that could result in leaf B contents slightly higher (53.33-53.66 mg/kg) than the 50 mg/kg upper margin from the SAAGA norms.

Regardless of if adjuvants were added or not, all foliar applications in 2023 led to a percentage increase of leaf Ca of between 11.24% and 30.02%. The summer leaf flush coincided with the three foliar applications that were applied in the period of the last week of November to the first week of January. Two previous ExperiCo projects on lenticel and orchard cold damage, which included foliar applications of Calcimax and Albina, showed insufficient movement of Ca into the leaf and fruit. In these projects, the products were applied prior to harvest with no prominent leaf flush present and the summer flush already fully hardened. The wax layer of hardened leaves prevents effective penetration of Ca. Therefore, the efficacy of foliar application of Ca products will be optimised when applied during periods when new growth is present, as could be achieved in the present trial.

- The addition of Eckosil to Calcimax led to a marginal increase in leaf Ca contents compared to no adjuvant added, with values of 1.06% and 1.03%, respectively, although the difference was not significant.
- Eckosil improved the efficacy of Trazex Ca + B and led to a significant increase (25%) in leaf Ca content compared to the untreated control. Trazex Ca + B applied with no adjuvant added only led to a 17% increase.
- Eckosil did not improve the efficacy of Albina, but the addition of Inex-A led to a significant increase in leaf Ca contents (values of 0.930% and 1.047%, respectively).
- InCa applied alone and with either Eckosil or Inex-A, resulted in leaf Ca contents of 1.047%, 1.060%, and 1.078%, respectively, although these did not differ significantly. It is interesting to note that this product contains the least Ca and B contents, compared to the other products, but resulted in higher values compared to the other products. It could be that this formulation improves localised calcium movement. It will be interesting to test its efficacy when sufficient Ca is present in the soil.

All foliar applications, with and without Eckosil and Inex-A, except for Trazex alone (no Eckosil or Inex-A added), led to a significant increase in leaf B varying between 20.05% and 66.09%, compared to the untreated control.

- Si (Eckosil) added as adjuvant slightly increased the leaf B of all products, but the increase was only significant in the case of Trazex Ca + B.
- Inex-A, an adjuvant with penetrating ability, proved to be extremely effective in improving the efficacy of both Flo-Bor and Damu, which resulted in percentage increases over the UTC of 60.08%

and 66.09%, respectively.

- o In the case of Trazex Ca + B and InCa, the addition of Inex-A led to 40% and 36.07% increases, respectively, compared to the untreated control.
- o Flo-Bor and Damu with Inex-A obtained significantly higher values (26.67 mg/kg and 67.67 mg/kg, respectively) compared to Trazex Ca + B and InCa with Inex-A (26.67 mg/kg and 23.33 mg/kg, respectively).
- With and without an adjuvant, all boron foliar treatments applied led to a percentage increase of fruit skin B varying between 10.19 and 35.19, which were significantly higher compared to the untreated control.
- Similarly, all boron foliar treatments (with and without an adjuvant) exhibited an increase in fruit pulp B, varying between 16.68% and 42.86% which are significantly higher compared to the untreated control.
- In most cases there was a significant increase in fruit skin B content when Inex-A was used as an adjuvant, compared to Eckosil.
- With regards to the fruit pulp, the Inex-A treatments resulted in slightly higher values, but did not differ significantly from the Eckosil treatments.
- Damu and Eckosil had compatibility problems that led to less pronounced increases in both fruit pulp and skin B contents.

Indra soil applications led to a significant increase in fruit yield of 1 297.96 kg fruit/ha compared to the 1 141.65 kg fruit/ha for the untreated control. The climate is changing and weather patterns are becoming less predictable. More crops are losing yields due to periods of high or low temperatures. By priming crops to allow them to cope when the weather gets tough, Indra helps farmers to safeguard yields and quality.

Most important findings

Trial 1

- Calcium nitrate (applied monthly) and CaTS (applied three times during flowering and eight weeks after fruit set) were the most effective products to

increase leaf Ca contents.

- CaTS was the most effective to increase fruit Ca content.
- Soluble Boron and SprayBor were the most effective to increase B contents in the leaves, fruit pulp, and fruit skin.

Trial 2

- All products were effective in increasing leaf Ca contents.
- No product on its own was effective in increasing fruit Ca. With the addition of Inex-A, exceptional Ca levels were seen in all treatments.
- Optimised Ca and B contents in leaves: apply during periods when young growth is present.
- All products significantly increased the B contents of leaves, fruit pulp, and fruit skin. The addition of Eckosil and, to a larger degree Inex-A, further improved B uptake of the foliar applications.

Trial 3

- Indra increased yield.

PLEASE NOTE THAT DAMU IS NOT USUALLY RECOMMENDED AS A SOIL APPLICATION AND IS CURRENTLY REGISTERED AS A FOLIAR APPLICATION.

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