WAC 061

"Reguladores de crecimiento vegetal para aumentar la producción y controlar el vigor vegetativo en huertos de aguacateros de secano en ambientes tropicales"

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"Plant growth regulators to increase production and control vegetative vigor in rain fed avocado orchards in tropical environments"

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Introduction

- Little information is available on the use of plant growth regulators (PGRs) for increasing fruit yield and size and controlling vegetative growth of tropical avocados grown in rain fed environments.

- **Avocado production in Brazil:**

✓ Diversity of climates (subtropical: Cwa, Cwb, Cfa, Cfb)

✓ Red, deep soils (oxisols, ultisols)

✓ 10 months of fresh fruit supply for domestic market

✓ Successful rain-fed avocado production

✓ Becoming increasingly important and profitable

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Introduction

- Avocado production is based on 5 hybrid Brazilian cultivars (WI x G):

‘Geada’ **‘Hass’** **‘Fortuna’** **‘Quintal’** **‘Breda’** **‘Margarida’**

Jan-Mar ← **Mar-Jul** → **Aug-Sep** **Jul-Oct**

10 months of fresh fruit supply for domestic market

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Introduction

- Main growing areas in **São Paulo** and **Minas Gerais** states: occurrence of stressful environmental conditions during **Pre-flowering** (May-June), **Flowering** (July-August) and **Fruit set** (September):

➢Monthly rainfall **< 60 mm** from April till September

➢**Low relative humidity**, sunny days, warmer temperatures (min: 8-10^{o}C; max: 24-30^{o}C)

➢High **wind** intensity (August-September)

➢Negative impact on fruit yield and quality

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Objective

To evaluate the effects of different PGRs for controlling regrowth vigor after pruning and increasing fruit yield and size, both in tropical and ‘Hass’ non-irrigated avocado orchards in subtropical environments.

Foliar application

Soil application

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Material and Methods

Between 2011 and 2016, **four trials** were set up in hybrid and 'Hass' rain fed commercial avocado orchards at different regions in São Paulo state:

Year	Objective	Cultivar	Trial
2011-2012	Regrowth control	**'Breda'** (WI x G)	1) Foliar and soil applied triazols and shoot tip removal after spring pruning
2014-2015		**'Fortuna'** (WI x G)	2) Foliar applied PGRs and shoot tip removal after pruning in autumn and spring
2012-2013	Increase fruit yield and size	**'Margarida'** (WI x G)	3) Foliar applied PGRs at bloom
2015-2016		**'Hass'** (M x G)	4) Foliar applied PGRs at bloom and in December

TRIAL 1: Foliar and soil applied triazols and shoot tip removal AFTER SELECTIVE LIMB PRUNING IN SPRING

Fazenda 3 Pinheiros, Taquarivaí, São Paulo State

Cfa climate; 23º55 S, 48º41 W; 555 m altitude

8-year old **'Breda'** orchard, 10 x 6 m spacing (167 trees/ha)

Results and discussion

TRIAL 1: Regrowth shoot length in pruned **'Breda'** avocado trees on 3 dates after different PGR applications.

Treatment	Mean regrowth length (cm)			Difference in the period (cm)
	30 Jan 12 13 DAA	15 Fev 12 29 DAA	7 Mar 12 49 DAA	
T0: Control	65.4 a	74.6 a	80.1 a	14.7 ab
T1: 1% Cultar® (foliar)	66.2 a	70.9 a	73.6 a	**7.4 bc**
T2: 1% Sunny® (foliar)	61.3 a	63.1 a	65.4 a	**2.1 c**
T3: Shoot tip removal	---	---	---	---
T4: 4 L/ha Cultar® (soil)	69.7 a	75.4 a	80.7 a	11.0 abc
CV (%)	39.8	38.6	38.5	47.8
P-value	0.6821	0.5606	0.3242	**0.0006**

Results and discussion

TRIAL 1: Vegetative and flower buds on regrowth shoots of pruned **'Breda'** avocado trees under different treatments.

Treatment	Buds per regrowth shoot	
	Flower buds	Vegetative buds
T0: Control	0.43 c	10.85 a
T1: 1% Cultar® (foliar-applied)	**4.24 ab**	**7.09 bc**
T2: 1% Sunny® (foliar-applied)	**6.31 a**	**5.03 c**
T3: Shoot tip removal (manual)	0.77 c	0.80 d
T4: 4 L/ha Cultar® (soil-applied)	2.97 bc	11.30 ab
CV (%)	44.69	42.88
P-value	**0.001**	**0.001**

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TRIAL 2: FOLIAR AND SOIL APPLIED PGRs AND SHOOT TIP REMOVAL AFTER:

SELECTIVE LIMB PRUNING
(May 2013, autumn, after harvest)

and

HEIGHT REDUCTION
(October 2013, spring pruning)

Fazenda Santa Elisa, Timburí, São Paulo State

Cfa climate, 23º20 S; 49º60 W, 800 m altitude

11-year old non-irrigated **'Fortuna'** orchard, 10 x 10 m spacing (100 trees/ha)

TRIAL 2:

Triazol foliar sprayings in **'Fortuna'** avocados after selective limb removal in Autumn:

SHOOT LENGTH REDUCTION

Treatment	Mean shoot length (cm)			Difference in the period (cm)
	17 Oct 13 0 DAA	31Oct 13 14 DAA	20 Nov 13 34 DAA	
T0 (Control)	62.46 a	102.17 a	127.04 a	64.58 a
T1 (Tip removal)	49.12 a	----	----	----
T2 (1% Cultar®)	64.29 a	**79.83 b**	**96.13 b**	**31.81 b**
T3 (1% Sunny®)	56.33 a	**73.29 b**	**89.83 b**	**33.50 b**
CV (%)	20.82	16.56	17.63	33.34
P-value	0.0765	**0.0017**	**0.0016**	**0.0003**

Foliar and soil PGR applications in **'Fortuna'** avocados after Spring pruning:

NO EFFECT ON SHOOT LENGTH

Treatment	Mean shoot length (cm)			Difference in the period (cm)
	9 Dec 13 0 DAA	27 Dec 13 18 DAA	10 Jan 14 32 DAA	
T1 (Control)	45.31 a	76.03 a	91.81 a	46.50 a
T2 (1% Cultar® foliar)	48.19 a	79.53 a	95.77 a	47.58 a
T3 (1% Sunny® foliar)	49.88 a	76.63 a	95.56 a	42.69 a
T4 (1200 ppm Viviful® foliar)*	49.28 a	73.15 a	87.32 a	38.04 a
T5 (4 L/ha Cultar® soil)	49.13 a	79.66 a	94.38 a	45.25 a
T6 (4 L/ha Sunny® soil)	48.16 a	82.06 a	98.04 a	49.88 a
T7 (4 L/ha Viviful® soil)	47.43 a	72.97 a	91.84 a	44.41 a
CV (%)	15.11	13.16	14.27	22.24
P-value	**0.9087**	**0.4889**	**0.7830**	**0.1873**

* Viviful® = 27.5% Prohexadione-Ca

TRIAL 2: Triazol spraying in **'Fortuna'** avocados after selective limb removal in Autumn:

INCREASED FLOWER BUDS AND INDETERMINATE INFLORESCENCES ON REGROWTH SHOOTS

after spraying with **uniconazole** (1% Sunny®) or **paclobutrazole** (1% Cultar®) on 30-40 cm regrowth shoots:

Treatment	Buds (%)		Inflorescence type (%)		Flowering intensity (0-5)
	Vegetative	Flower	Determinate	Indeterminate	
T0 (Control)	81.1 ab	18.9 bc	13.26 a	61.7 ab	1.63 bc
T1 (Shoot tip removal)	85.0 a	15.0 c	0.0 b	25.0 b	1.57 c
T2 (1% Cultar®)	**64.3 bc**	**35.7 ab**	**2.5 ab**	**76.6 a**	**2.42 ab**
T3 (1% Sunny®)	**58.1 c**	**41.9 a**	**9.2 ab**	**74.1 a**	**2.71 a**
CV (%)	34.12	50.34	48.58	38.12	47.99
P-value	0.0006	0.0006	0.0024	0.0050	0.0008

TRIAL 2: Foliar and soil applied PGRs after spring pruning in 'Fortuna' avocados:

INCREASED FLOWER BUDS AND INDETERMINATE INFLORESCENCES ON REGROWTH SHOOTS

After a single **1% Sunny®** foliar spraying or **4 L/ha Cultar®** soil application

Treatment	Buds (%)		Inflorescence type (%)		Flowering intensity (0-5)
	Vegetative	Flower	Determinate	Indeterminate	
T1 (Control)	27.5 a	72.5 a	1.4 a	98.6 c	4.3 a
T2 (1% Cultar® foliar)	22.3 a	77.7 a	0.2 ab	99.7 abc	4.5 a
T3 (1% Sunny® foliar)	26.2 a	73.8 a	**0.1 b**	**99.9 a**	4.3 a
T4 (1200 ppm Viviful® foliar)	21.1 a	78.9 a	1.6 a	98.4 bc	4.4 a
T5 (4 L/ha Cultar® soil)	22.7 a	77.3 a	**0.1 b**	**99.9 a**	4.4 a
T6 (4 L/ha Sunny® soil)	17.5 a	82.5 a	0.3 b	99.8 ab	4.7 a
T7 (4 L/ha Viviful® soil)	26.5 a	73.5 a	0.5 ab	99.5 abc	4.2 a
CV (%)	56.53	21.55	39.40	12.87	19.85
P-value	0.2300	0.2300	**0.0004**	**0.0004**	0.5542

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TRIAL 3: FOLIAR PGRs SPRAYINGS AT FLOWERING

Fazenda 3 Pinheiros, Taquarivaí, São Paulo State, September 2012

Cfa climate; 23º55 S, 48º41 W; 555 m altitude

8-year old **'Margarida'** orchard, 10 x 6 m spacing (167 trees/ha)

Triazoles and Prohexadione-Ca INCREASED FRUIT YIELD AND SIZE

Treatment	Yield (Kg/tree)	Fruit weight (g)	Fruit Length/ Diameter ratio
T1 (Control)	118.45 ab	677.36 c	1.05 a
T2 (0.7% Cultar®)	**26.58 b**	**885.34 a**	**1.05 a**
T3 (0.7% Sunny®)	**151.83 a**	**847.71 ab**	**1.10 a**
T4 (550 ppm Viviful®)*	**113.50 ab**	**810.44 b**	**1.03 b**
CV (%)	22.03	18.09	5.12
P-value	0.0490	< 0.0001	< 0.0001

*** Viviful®: 27.5% Prohexadione-Ca**

TRIAL 4: FOLIAR PGRs SPRAYINGS AT FLOWERING

Fazenda Campo de Ouro, Piraju, SP

Cfa climate, 23º55 S; 48º41 W, 750 m altitude

7-year old non-irrigated **'Hass'** orchard, 8.5 x 5.5 m spacing (214 trees/ha)

T2: 68.75 mg L^{-1} Prohexadione-Ca
T3: 175 mg L^{-1} Paclobutrazol
T4: 35 mg L^{-1} Uniconazole
T5: 2.5 mL L^{-1} Trinexapac-ethyl
T6: 25 mg L^{-1} 6-benzyladenine
T7: 50 mg L^{-1} GA_3 IN DECEMBER

Treatment	Yield (Kg/tree)	Fruit weight (g)	Fruit Length/ Diameter ratio
T1 (Control)	168.20 a	**209.51 b**	**1.36 bc**
T2 (250 ppm Viviful®)	137.18 a	**201.33 b**	**1.40 a**
T3 (0.07% Cultar®)	216.75 a	**209.60 b**	**1.35 c**
T4 (0.07% Sunny®)	145.13 a	**214.69 ab**	**1.30 d**
T5 (0.1% Moddus®)	155.20 a	**209.59 b**	**1.37 abc**
T6 (1250 ppm MaxCel®)	152.48 a	**212.56 ab**	**1.40 a**
T7 (125 ppm Progibb 40®)	124.95 a	**228.09 a**	**1.39 ab**
CV (%)	31.34	18.34	7.13
P-value	0.2500	**0.0002**	**<0.0001**

TRIAL 4: Fazenda Campo de Ouro, Piraju, SP

7-year old non-irrigated **'Hass'** orchard

- **A single** gibberellin **spraying in December** increased fruit size and pulp firmness and maintained green skin color after cold storage

Treatment	% fruit < 170 g	Pulp firmness after 14 days (Newtons	Skin color after 14 days (0:green; 5:black)
T1 (Control)	16.0 ab	2.47 b	5.0 a
T2 (250 ppm Viviful®)	**26.0 a**	2.77 b	4.6 a
T3 (0.07% Cultar®)	12.0 ab	3.37 b	4.6 a
T4 (0.07% Sunny®)	17.0 ab	2.76 b	4.6 a
T5 (0.1% Moddus®)	19.0 ab	2.91 b	4.6 a
T6 (1250 ppm MaxCel®)	**9.0 b**	2.69 b	4.4 a
T7 (125 ppm Progibb 40®)	**7.0 b**	**14.32 a**	**2.8 b**
CV (%)	50.59	32.28	17.72
P-value	**0.0103**	**0.0157**	**0.0036**

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Conclusion

In rain fed commercial orchards:

- A single triazole spraying at full bloom reduced shoot growth in all the varieties, increased yield in ‘Margarida’ avocados and increased fruit size of ‘Hass’ avocados.
- A single triazole soil application after selective limb pruning did not always control regrowth vigor, but increased floral buds on regrowth shoots when applied before or after flowering, in ‘Breda’ and ‘Fortuna’ avocados.
- A single gibberellin spraying in December increased fruit size and pulp firmness and extended the green skin color of ‘Hass’ avocados.

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Thank you very much
Muchas Gracias
Muito obrigado

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