Universidade de São Paulo
Escola Superior de Agricultura “Luiz de Queiroz”

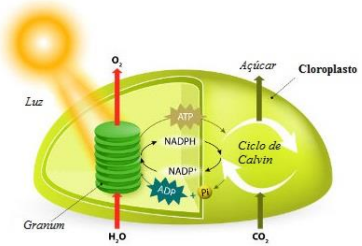
Controle Químico

Efeito Secundário de Fungicidas

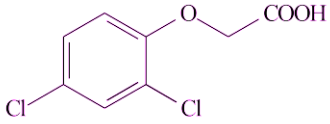
Arnaldo Farina
Cláudia Almeida
Jacson Ferreira

Piracicaba, maio de 2017

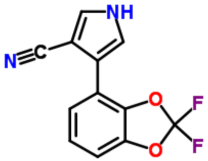
Introdução

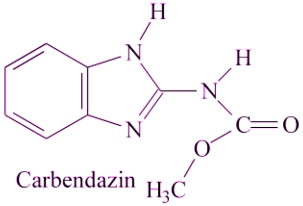


- Descoberta do primeiro fungicida 1885;
- Maior parte dos trabalhos - eficiência contra patógenos fúngicos e resíduos na cultura;
- Quantidade razoável relatam sobre efeitos secundários desses compostos;
- Processos fisiológicos afetados;
- Disponibilidade de nutrientes para o desenvolvimento da planta;

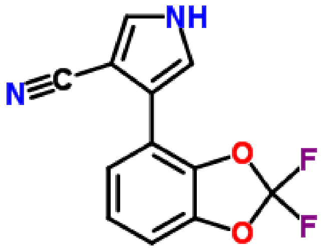


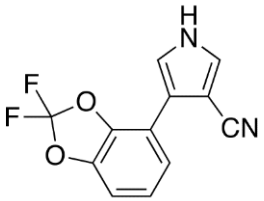
2,4 D



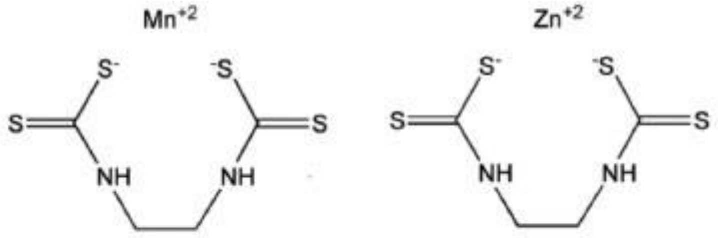


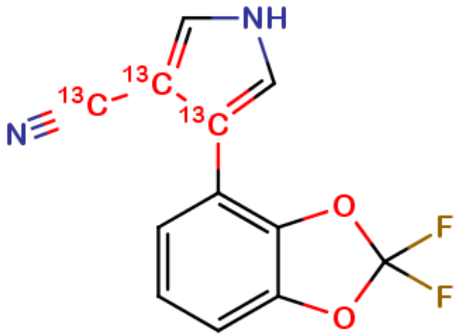
Carbendazin





Efeito secundário de fungicidas imóveis





The effect of application of copper fungicides on photosynthesis parameters and level of elementary copper in hops

K. Krofta, J. Pokorny, T. Kudrna, J. Jezek, J. Pulkrábek, J. Krivanek, D. Becka

PLANT SOIL ENVIRON., *58*, 2012 (2): 91–97

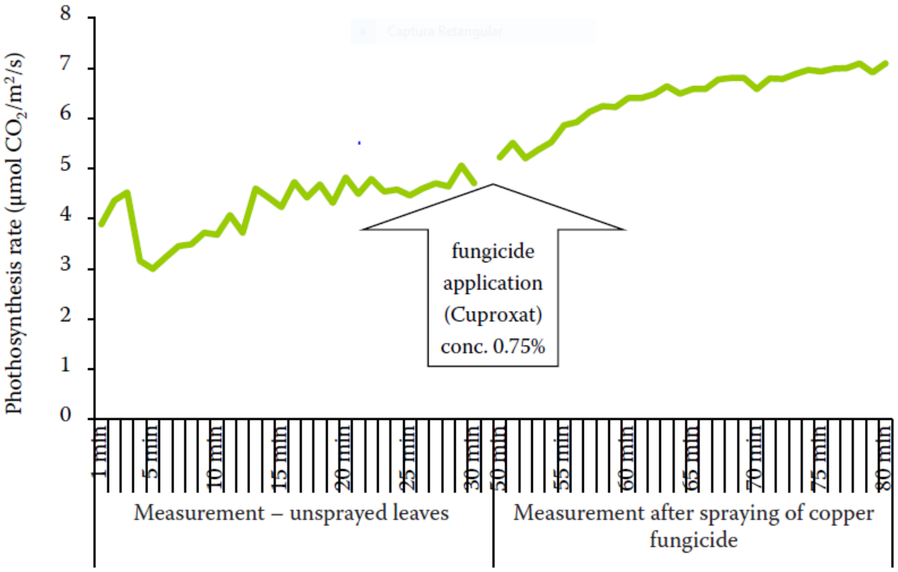


Figura 1. The course of photosynthesis rates of hop plants before and after application of copper fungicide in 2010.

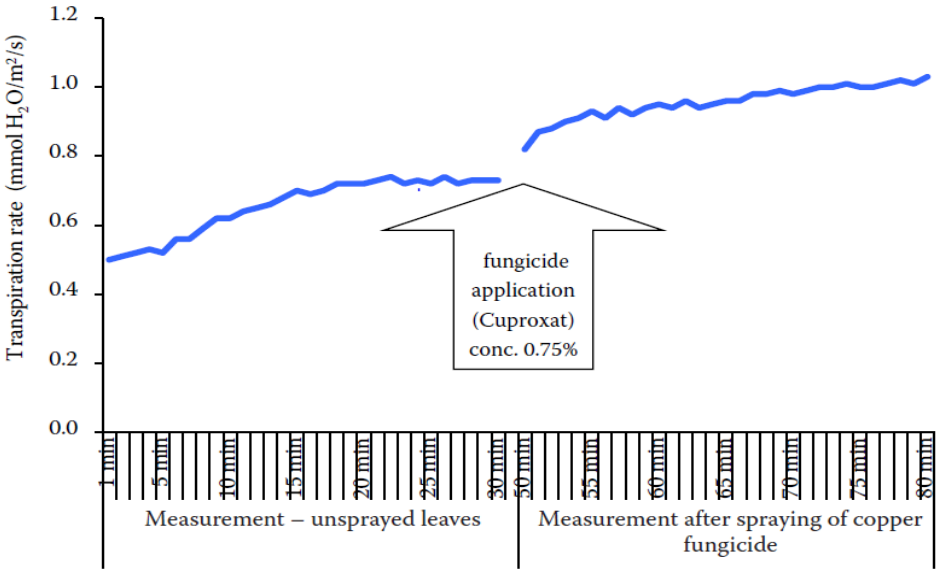
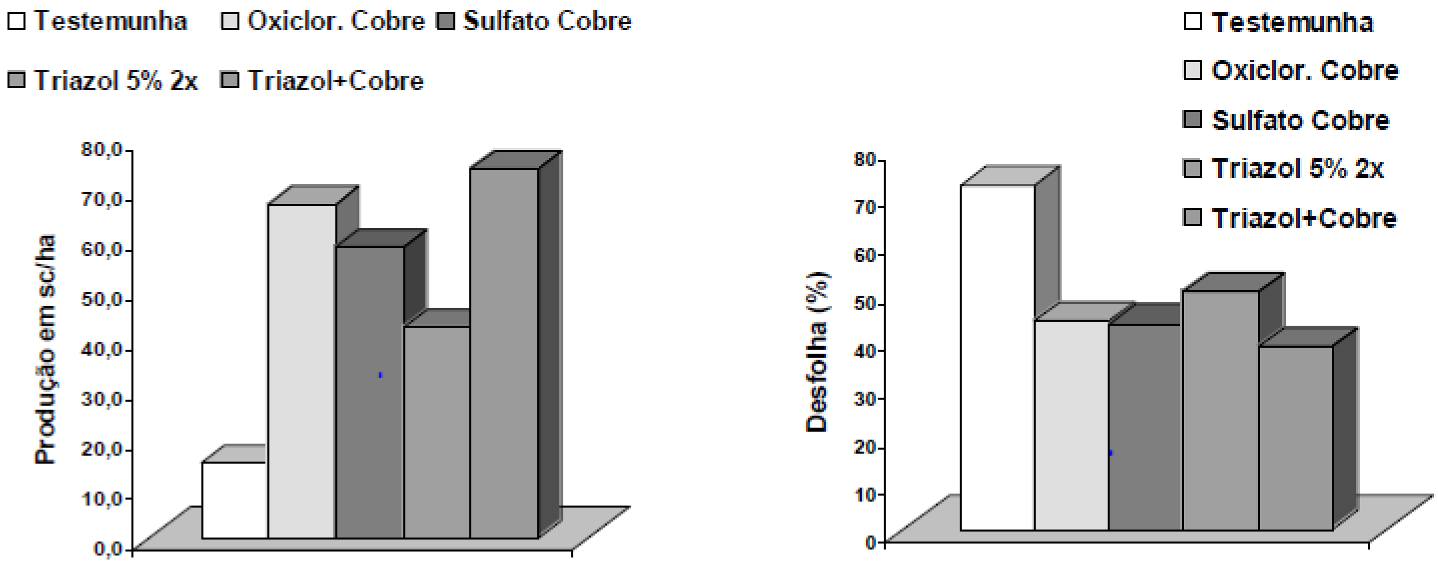


Figura 2. The course of transpiration rates of hop plants before and after application of copper fungicide in 2010.

Benefícios do cobre na cafeicultura

Vicente Luiz de Carvalho; Rodrigo Luz da Cunha; João Paulo Felicori Carvalho

Empresa de Pesquisa Agropecuária de Minas Gerais, n.3, maio, 2007.



Produção 2002

Desfolha 2001

Gráfico 2 - Efeito do cobre aplicado isoladamente e associado a sistêmico na produção e na preservação de folhas do cafeeiro

Growth and fruit quality of ‘Braeburn’ apple (*Malus domestica*) trees as influenced by fungicide programmes suitable for organic production

J. W. Palmer; S. B. Davies; P. W. Shaw; J. N. Wünsche

New Zealand Journal of Crop and Horticultural Science, 2003, Vol. 31

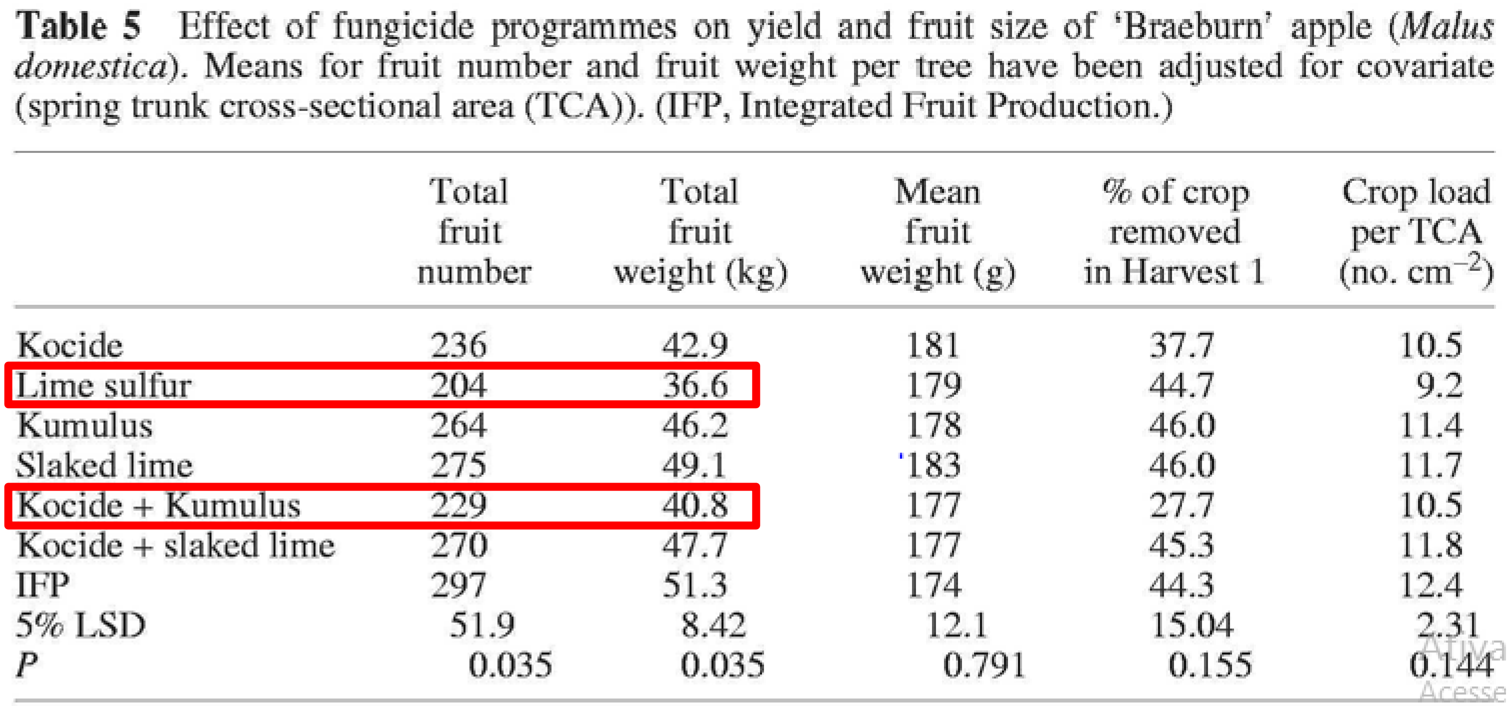


Table 5 Effect of fungicide programmes on yield and fruit size of ‘Braeburn’ apple (*Malus domestica*). Means for fruit number and fruit weight per tree have been adjusted for covariate (spring trunk cross-sectional area (TCA)). (IFP, Integrated Fruit Production.)

	Total fruit number	Total fruit weight (kg)	Mean fruit weight (g)	% of crop removed in Harvest 1	Crop load per TCA (no. cm^{-2})
Kocide	236	42.9	181	37.7	10.5
Lime sulfur	204	36.6	179	44.7	9.2
Kumulus	264	46.2	178	46.0	11.4
Slaked lime	275	49.1	183	46.0	11.7
Kocide + Kumulus	229	40.8	177	27.7	10.5
Kocide + slaked lime	270	47.7	177	45.3	11.8
IFP	297	51.3	174	44.3	12.4
5% LSD	51.9	8.42	12.1	15.04	2.31
P	0.035	0.035	0.791	0.155	0.144

Different responses of young and expanded lettuce leaves to fungicide Mancozeb: chlorophyll fluorescence, lipid peroxidation, pigments and proline content

M.C. DIAS; P. FIGUEIREDO; I.F. DUARTE; A.M. GIL; C. SANTOS

PHOTOSYNTHETICA 52 (1): 148-151, 2014

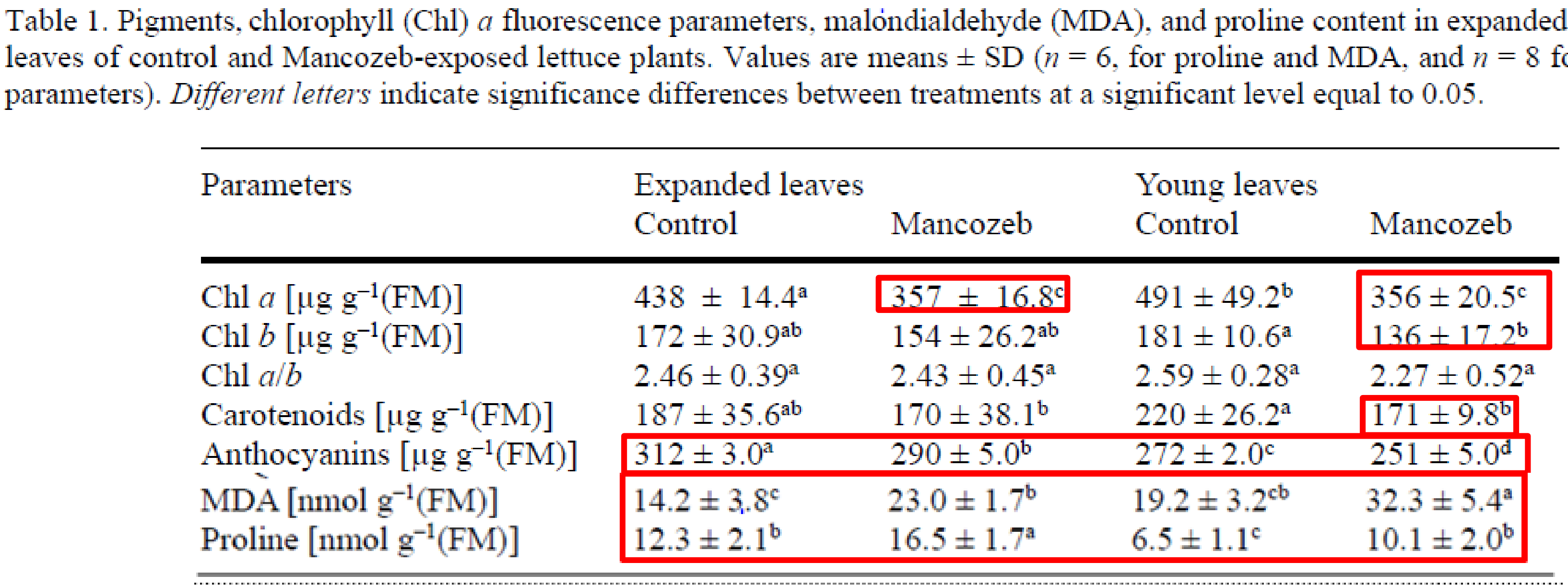


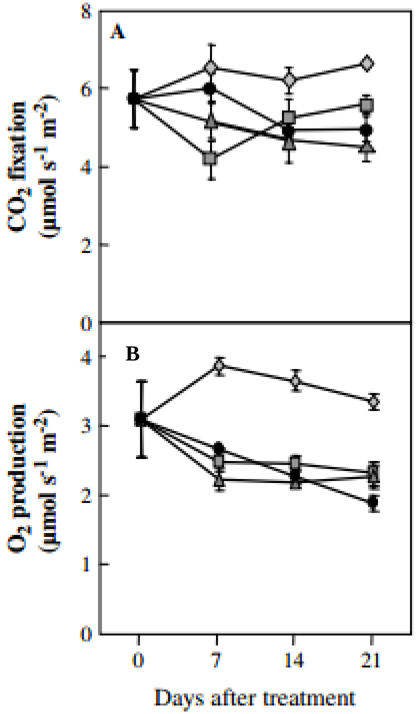
Table 1. Pigments, chlorophyll (Chl) *a* fluorescence parameters, malondialdehyde (MDA), and proline content in expanded and young leaves of control and Mancozeb-exposed lettuce plants. Values are means ± SD ($n = 6$, for proline and MDA, and $n = 8$ for the other parameters). *Different letters* indicate significance differences between treatments at a significant level equal to 0.05.

Parameters	Expanded leaves Control	 Mancozeb	Young leaves Control	 Mancozeb
Chl *a* [µg g^{-1}(FM)]	438 ± 14.4^{a}	357 ± 16.8^{c}	491 ± 49.2^{b}	356 ± 20.5^{c}
Chl *b* [µg g^{-1}(FM)]	172 ± 30.9^{ab}	154 ± 26.2^{ab}	181 ± 10.6^{a}	136 ± 17.2^{b}
Chl *a*/*b*	2.46 ± 0.39^{a}	2.43 ± 0.45^{a}	2.59 ± 0.28^{a}	2.27 ± 0.52^{a}
Carotenoids [µg g^{-1}(FM)]	187 ± 35.6^{ab}	170 ± 38.1^{b}	220 ± 26.2^{a}	171 ± 9.8^{b}
Anthocyanins [µg g^{-1}(FM)]	312 ± 3.0^{a}	290 ± 5.0^{b}	272 ± 2.0^{c}	251 ± 5.0^{d}
MDA [nmol g^{-1}(FM)]	14.2 ± 3.8^{c}	23.0 ± 1.7^{b}	19.2 ± 3.2^{cb}	32.3 ± 5.4^{a}
Proline [nmol g^{-1}(FM)]	12.3 ± 2.1^{b}	16.5 ± 1.7^{a}	6.5 ± 1.1^{c}	10.1 ± 2.0^{b}

Effects of fludioxonil and pyrimethanil, two fungicides used against *Botrytis cinerea*, on carbohydrate physiology in *Vitis vinifera* L

Gaelle Saladin, Christian Magne, Christophe Clement

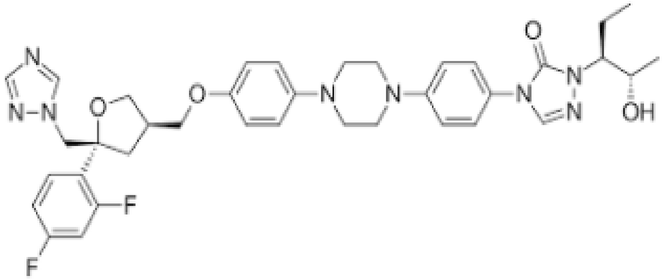
Pest Manag Sci 59:1083–1092 , 2003



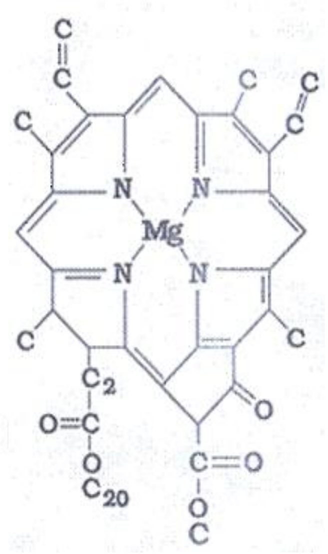
- 26 e 36%

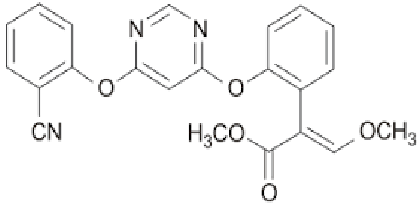
- 40%

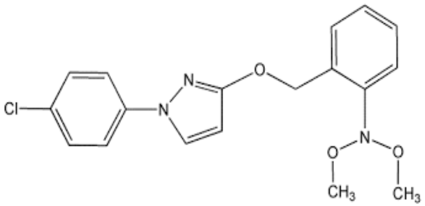
Figure 1. Influence of fludioxonil on gas exchanges. (A) Carbon dioxide fixation in plantlets *in vitro*. (B) Oxygen production in plantlets grown *in vitro*. Fludioxonil concentrations *in vitro*: (◇) 0 mM, (□) 1.2 mM, (△) 6 mM, (●) 30 mM.



Efeito secundário de fungicidas móveis

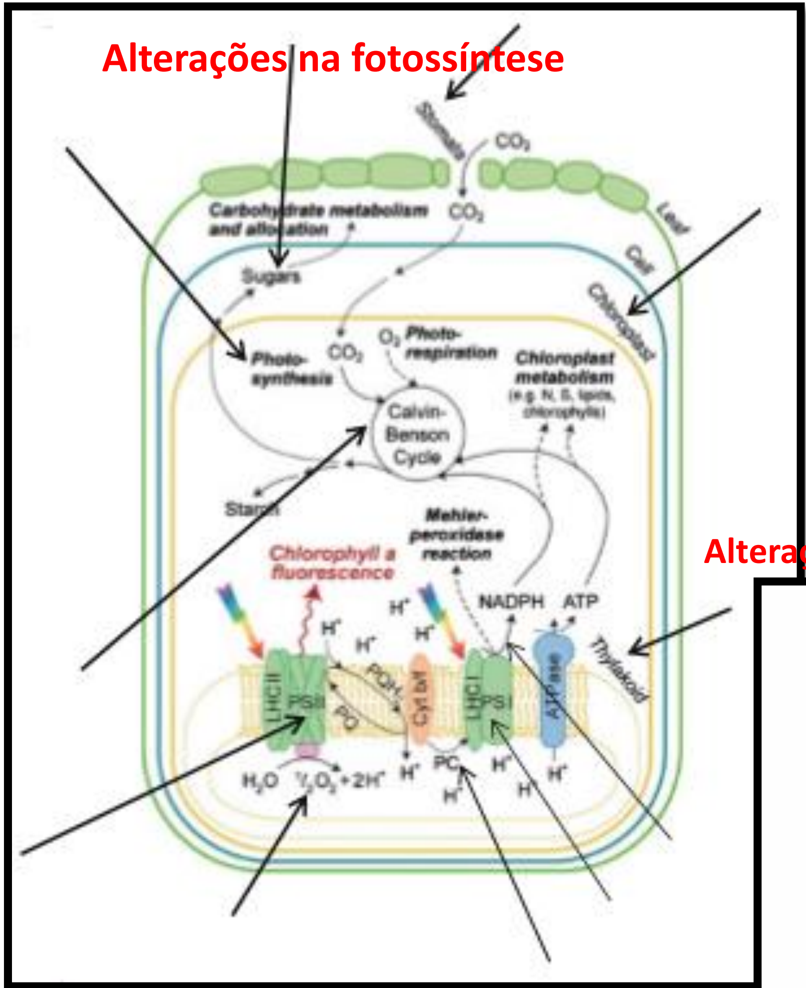






Efeito fisiológico dos fungicidas

Alterações na fotossíntese

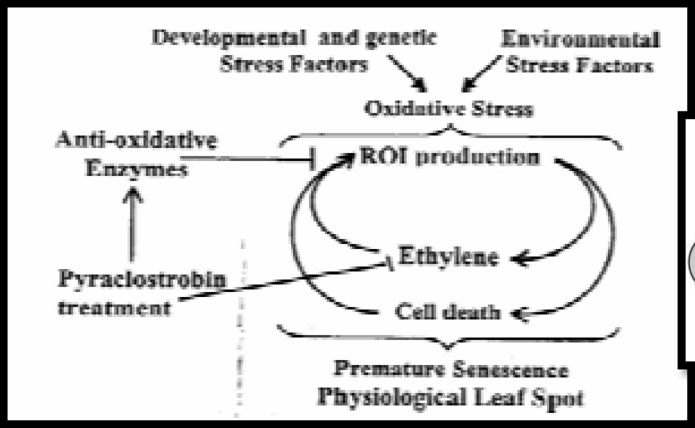


Alterações podem ser positivas ou danosas

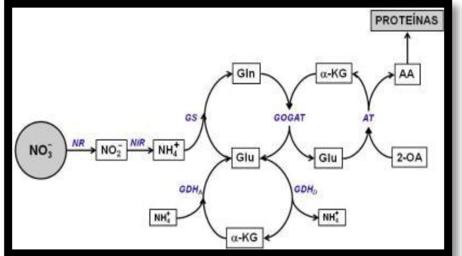
⇩

Produção e qualidade;
Adaptação.

Alterações hormonais e alívio do estresse oxidativo

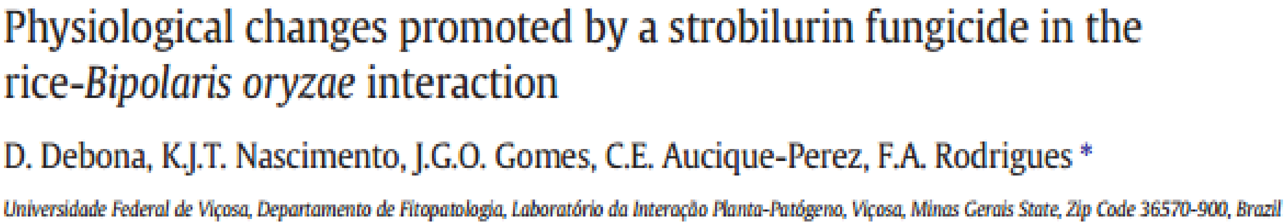


Assimilação e redução de N



Pesticide Biochemistry and Physiology, 2016.

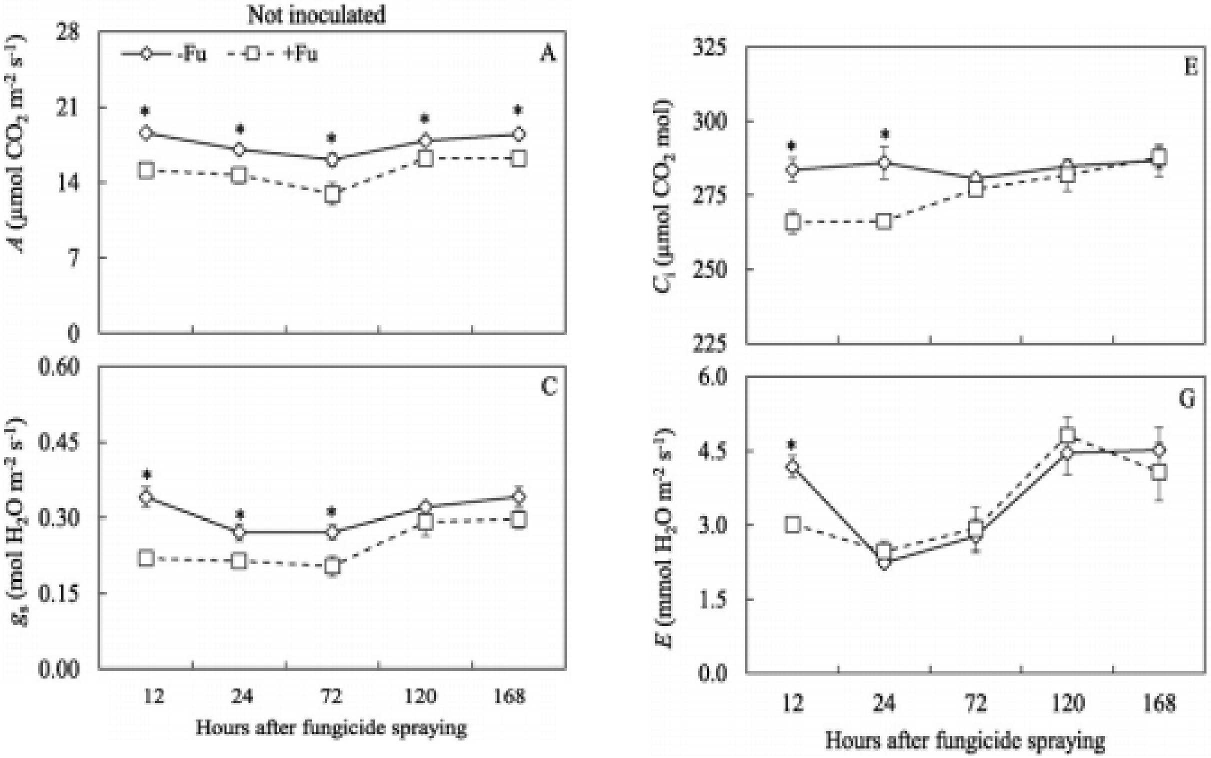
Alterações na fotossíntese



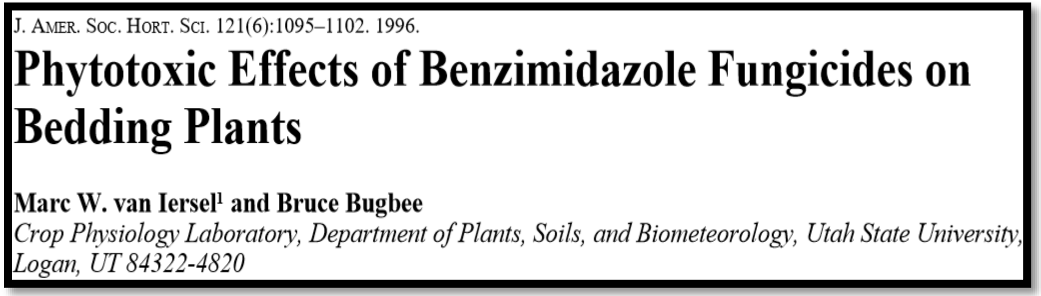
Physiological changes promoted by a strobilurin fungicide in the rice-*Bipolaris oryzae* interaction

D. Debona, K.J.T. Nascimento, J.G.O. Gomes, C.E. Aucique-Perez, F.A. Rodrigues *

Universidade Federal de Viçosa, Departamento de Fitopatologia, Laboratório da Interação Planta-Patógeno, Viçosa, Minas Gerais State, Zip Code 36570-900, Brazil



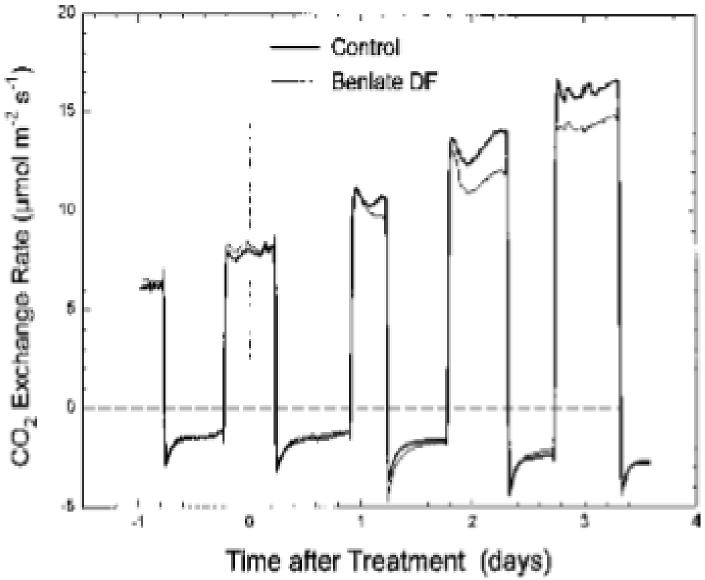
****Azoxistrobina promoveu aumento de ABA.**

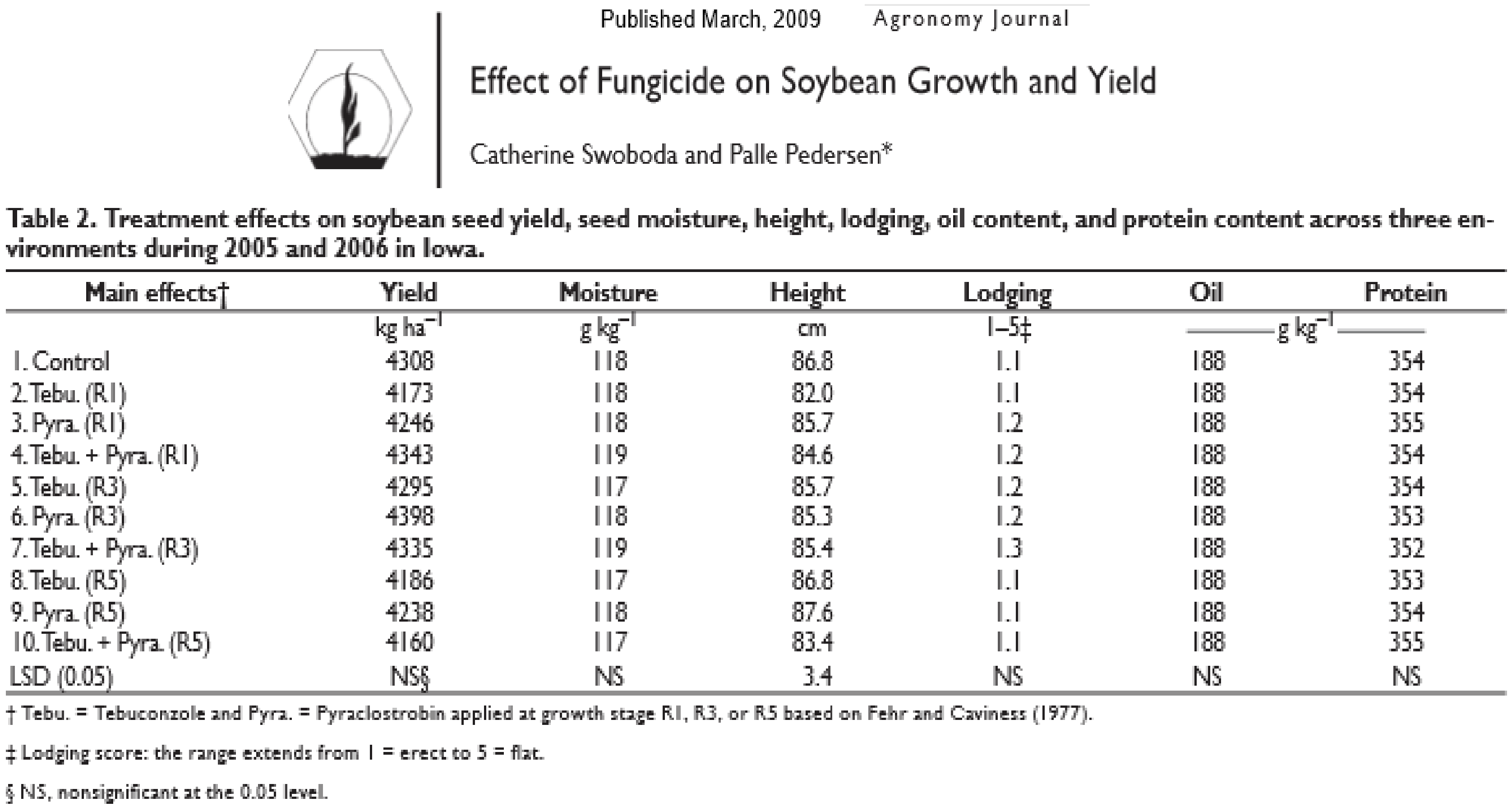


J. AMER. SOC. HORT. SCI. 121(6):1095–1102. 1996.

Phytotoxic Effects of Benzimidazole Fungicides on Bedding Plants

Marc W. van Iersel[1] and Bruce Bugbee
Crop Physiology Laboratory, Department of Plants, Soils, and Biometeorology, Utah State University, Logan, UT 84322-4820





Published March, 2009 Agronomy Journal

Effect of Fungicide on Soybean Growth and Yield

Catherine Swoboda and Palle Pedersen*

Table 2. Treatment effects on soybean seed yield, seed moisture, height, lodging, oil content, and protein content across three environments during 2005 and 2006 in Iowa.

Main effects†	Yield	Moisture	Height	Lodging	Oil	Protein
	kg ha^{-1}	g kg^{-1}	cm	1–5‡	g kg^{-1}	
1. Control	4308	118	86.8	1.1	188	354
2. Tebu. (R1)	4173	118	82.0	1.1	188	354
3. Pyra. (R1)	4246	118	85.7	1.2	188	355
4. Tebu. + Pyra. (R1)	4343	119	84.6	1.2	188	354
5. Tebu. (R3)	4295	117	85.7	1.2	188	354
6. Pyra. (R3)	4398	118	85.3	1.2	188	353
7. Tebu. + Pyra. (R3)	4335	119	85.4	1.3	188	352
8. Tebu. (R5)	4186	117	86.8	1.1	188	353
9. Pyra. (R5)	4238	118	87.6	1.1	188	354
10. Tebu. + Pyra. (R5)	4160	117	83.4	1.1	188	355
LSD (0.05)	NS§	NS	3.4	NS	NS	NS

† Tebu. = Tebuconzole and Pyra. = Pyraclostrobin applied at growth stage R1, R3, or R5 based on Fehr and Caviness (1977).

‡ Lodging score: the range extends from 1 = erect to 5 = flat.

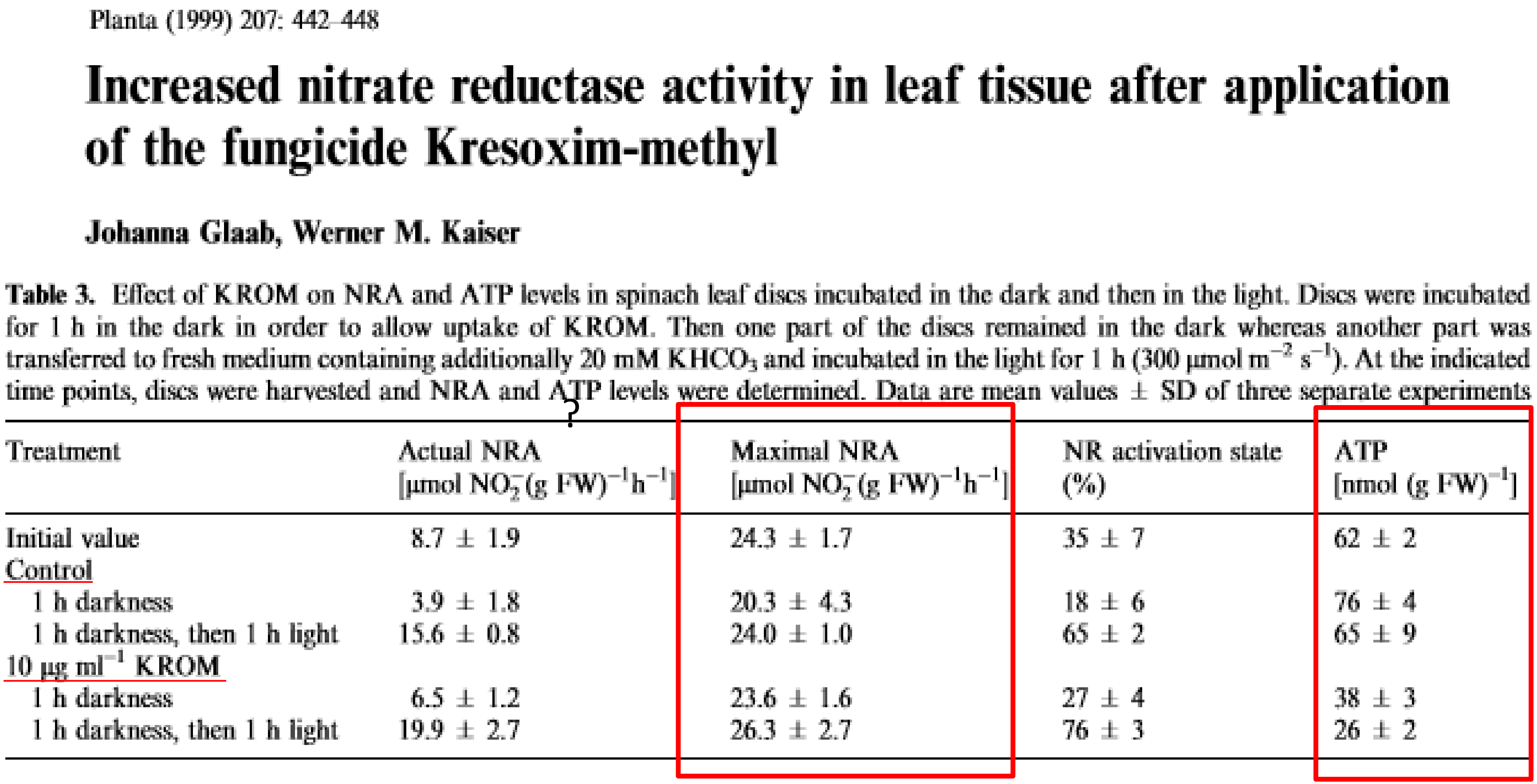
§ NS, nonsignificant at the 0.05 level.

Tebuconazole

Pyraclostrobin

Tebuconazole + Piraclostrobin

Alterações na assimilação e redução de N



Planta (1999) 207: 442–448

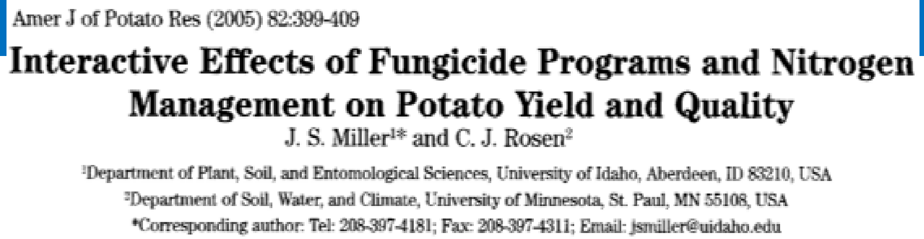
Increased nitrate reductase activity in leaf tissue after application of the fungicide Kresoxim-methyl

Johanna Glaab, Werner M. Kaiser

Table 3. Effect of KROM on NRA and ATP levels in spinach leaf discs incubated in the dark and then in the light. Discs were incubated for 1 h in the dark in order to allow uptake of KROM. Then one part of the discs remained in the dark whereas another part was transferred to fresh medium containing additionally 20 mM $KHCO_3$ and incubated in the light for 1 h (300 μmol m^{-2} s^{-1}). At the indicated time points, discs were harvested and NRA and ATP levels were determined. Data are mean values ± SD of three separate experiments

Treatment	Actual NRA [μmol NO_2^- (g FW)$^{-1}$h^{-1}]	Maximal NRA [μmol NO_2^- (g FW)$^{-1}$h^{-1}]	NR activation state (%)	ATP [nmol (g FW)$^{-1}$]
Initial value	8.7 ± 1.9	24.3 ± 1.7	35 ± 7	62 ± 2
Control				
1 h darkness	3.9 ± 1.8	20.3 ± 4.3	18 ± 6	76 ± 4
1 h darkness, then 1 h light	15.6 ± 0.8	24.0 ± 1.0	65 ± 2	65 ± 9
10 μg ml^{-1} KROM				
1 h darkness	6.5 ± 1.2	23.6 ± 1.6	27 ± 4	38 ± 3
1 h darkness, then 1 h light	19.9 ± 2.7	26.3 ± 2.7	76 ± 3	26 ± 2

- Discos de folha de espinafre.



Amer J of Potato Res (2005) 82:399-409

Interactive Effects of Fungicide Programs and Nitrogen Management on Potato Yield and Quality

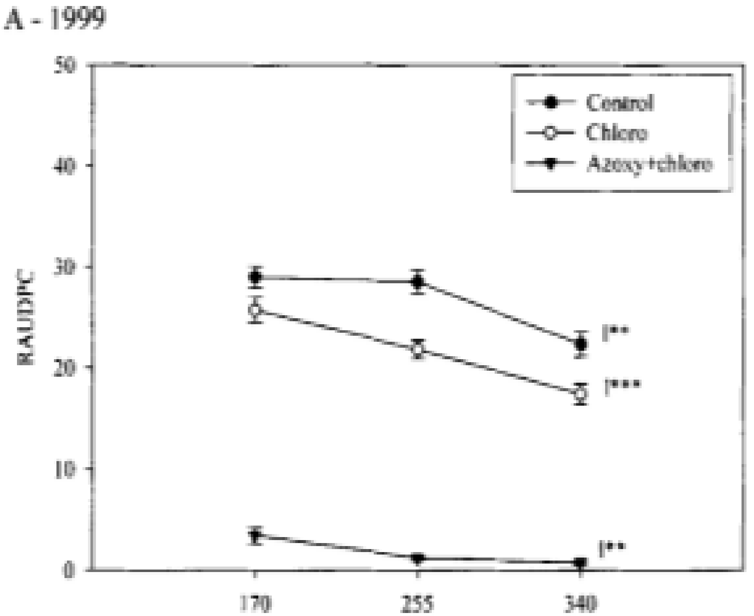
J. S. Miller[1]* and C. J. Rosen[2]

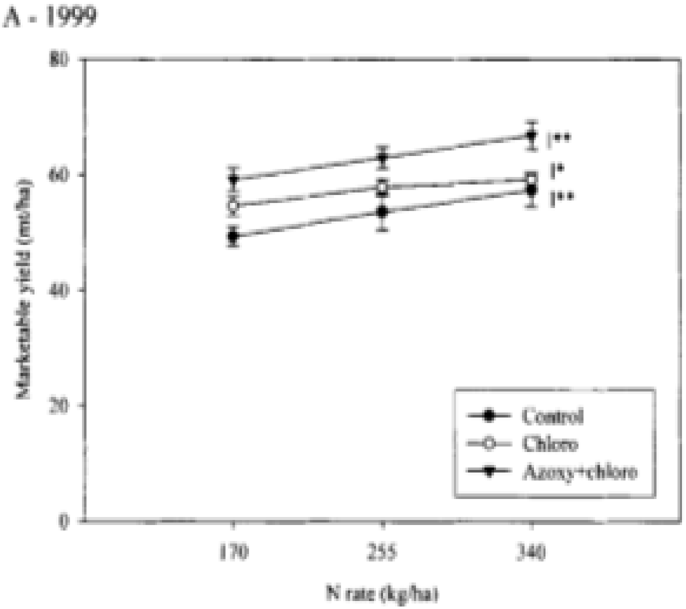
[1]Department of Plant, Soil, and Entomological Sciences, University of Idaho, Aberdeen, ID 83210, USA
[2]Department of Soil, Water, and Climate, University of Minnesota, St. Paul, MN 55108, USA
*Corresponding author: Tel: 208-397-4181; Fax: 208-397-4311; Email: jsmiller@uidaho.edu

Pinta-preta em batata
(*Alternaria solani*)

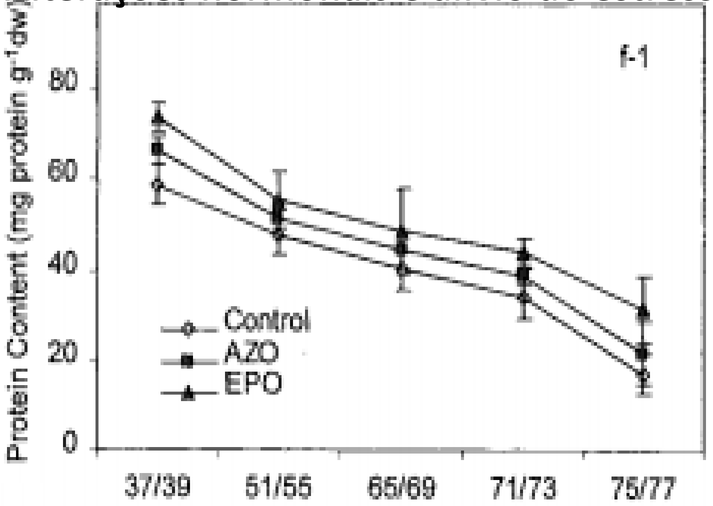
- A pinta-preta é uma doença influenciada pela fertilidade do solo e nutrição da planta;
- Baixas quantidades de P e elevados níveis de fertilizantes nitrogenados reduzem a doença no campo (Barclay et al. 1973; Davis 1985).

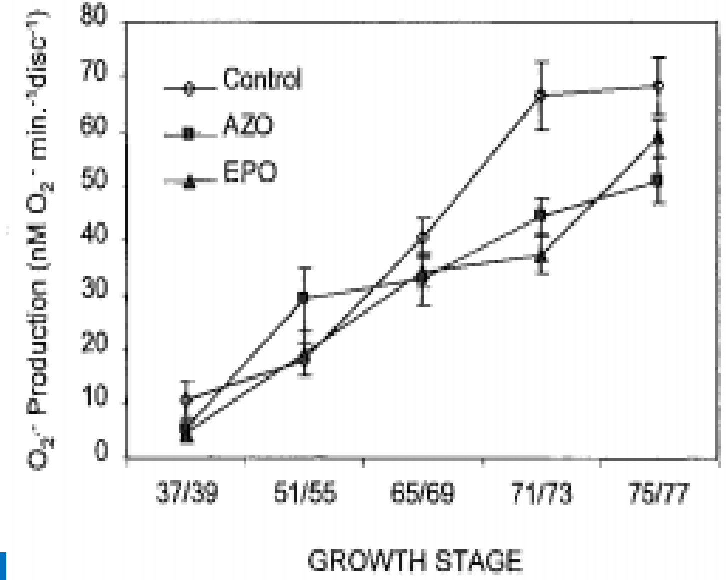
Patógeno é + agressivo em cultivos deficientes em N.





Alterações hormonais e alívio do estresse oxidativo

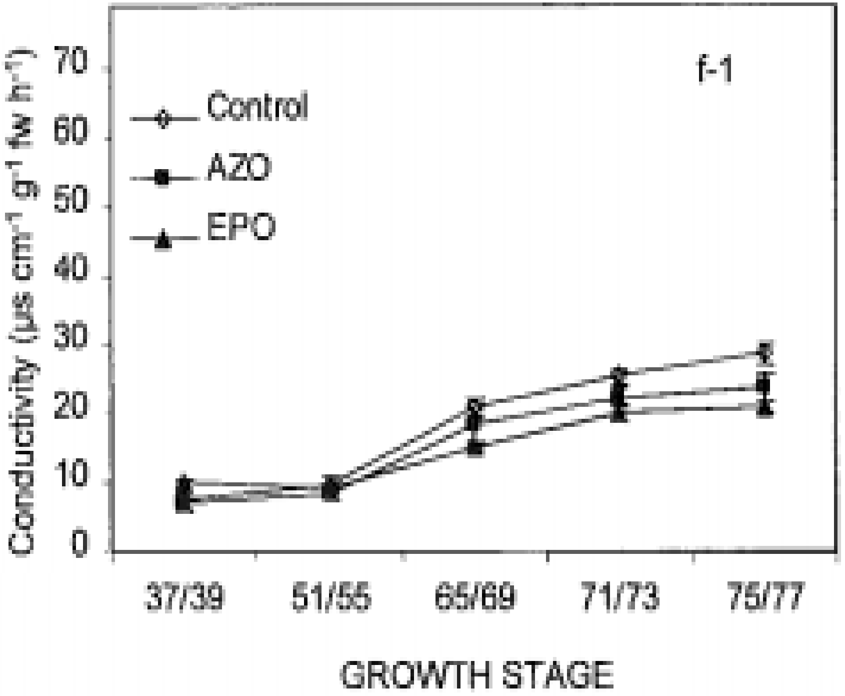




Pesticide Biochemistry and Physiology 71, 1–10 (2001)

Physiological Effects of Azoxystrobin and Epoxiconazole on Senescence and the Oxidative Status of Wheat

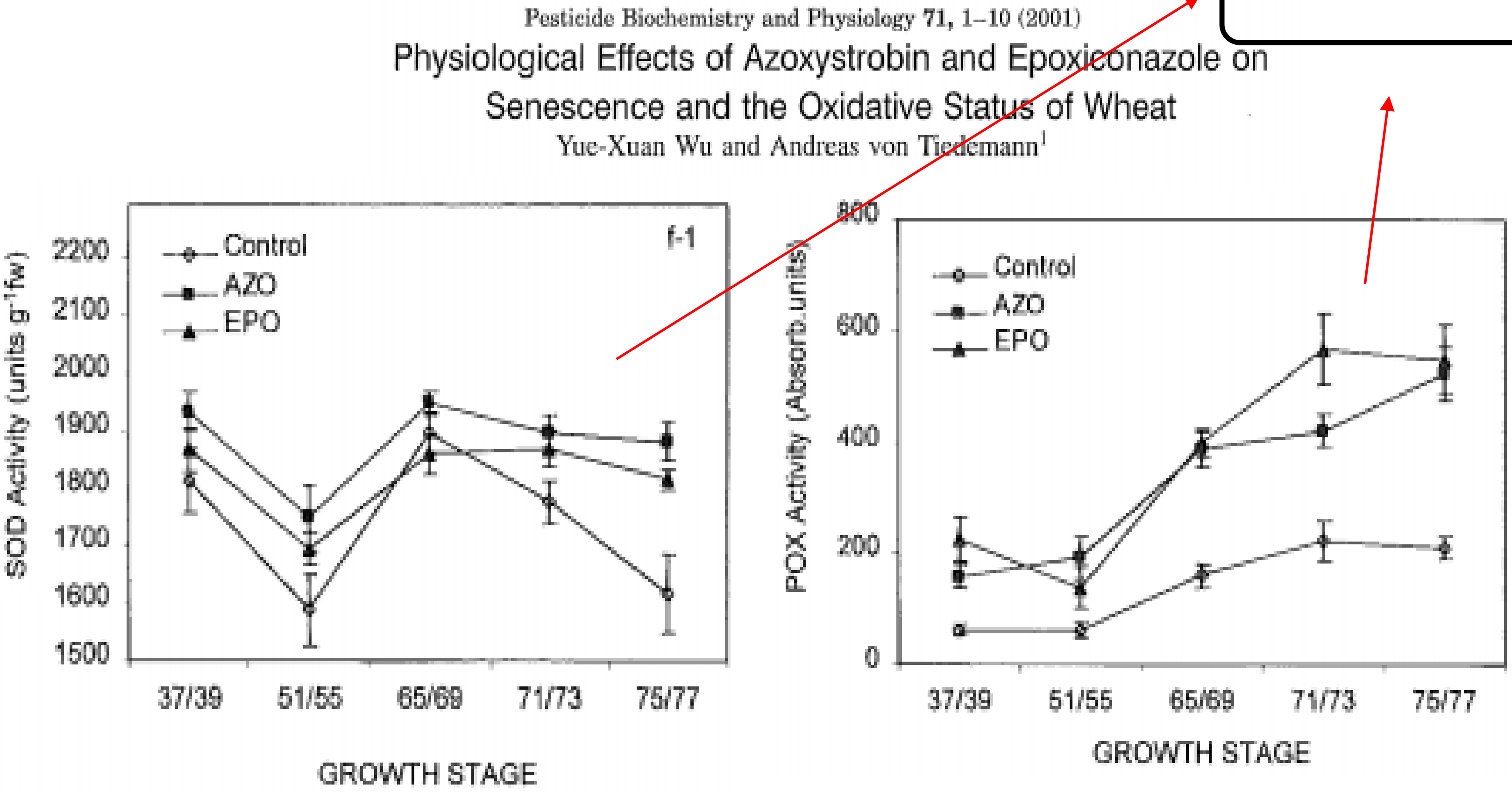
Yue-Xuan Wu and Andreas von Tiedemann[1]



Processos observados na senescência foliar

Alterações hormonais e alívio do estresse oxidativo

Mecanismos antioxidantes



Pesticide Biochemistry and Physiology 71, 1–10 (2001)

Physiological Effects of Azoxystrobin and Epoxiconazole on Senescence and the Oxidative Status of Wheat

Yue-Xuan Wu and Andreas von Tiedemann[1]

Superóxido (O2-) governa a conversão de ACC (ácido 1-aminociclopropano-1-carboxílico) em etileno na célula.

Fatores de transcrição em *Escherichia coli*: OxyR e SoxR atuam como sensores a H2O2 e O2-, respectivamente.

⇩

Ativam a expressão de genes que codificam para enzimas e moléculas antioxidantes

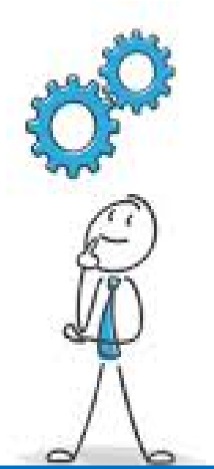
"Efeito verde" das Estrobirulinas

Estresse oxidativo ⇨ <u>envelhecimento das plantas</u>

- Degradação do pigmento;
- Alteração da permeabilidade da membrana
- Degradação das proteínas;
- Metabolismo alterado dos fitohormônios.

<u>Estrobirulinas:</u>
Incrementos
na produção e qualidade
e tolerância a condições
estressantes.

Qual é o real efeito secundário dos fungicidas na produção e qualidade do produto ou na capacidade de resistirem ao estresse?



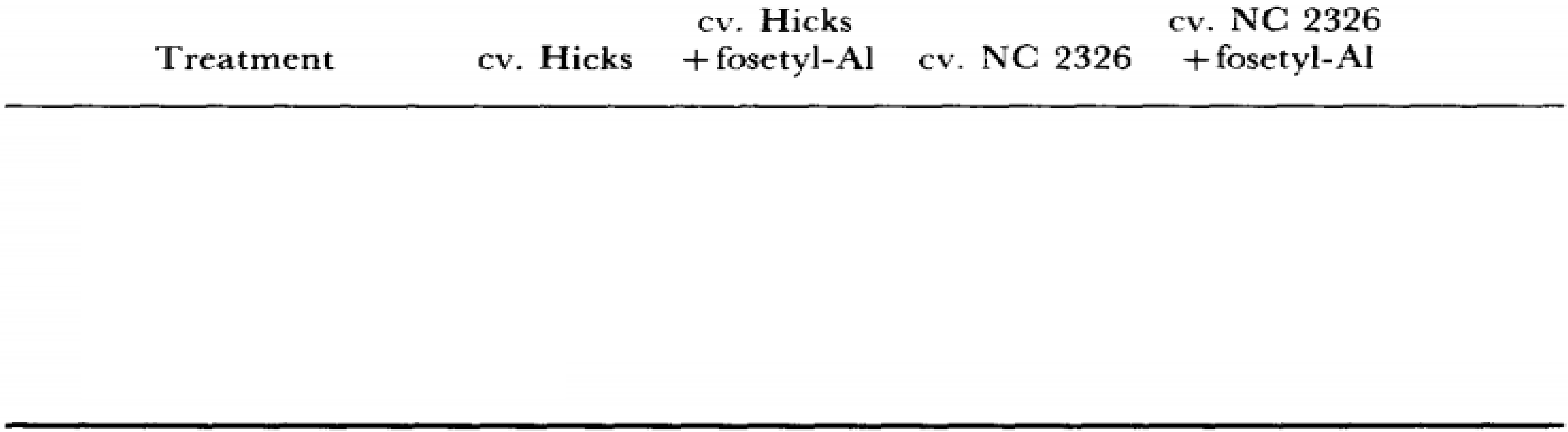
Efeitos de fungicidas no sistema de defensa da planta

1. **Ativação de sistema de defensa**
2. **Resistencia sistêmica adquirida (SAR ou ISR)**

Phytoalexin accumulation, phenylalanine ammonia lyase activity and ethylene biosynthesis in fosetyl-AL treated resistant and susceptible tobacco cultivar infected with *Phytophthora nicotianae* var. nicotianae

1-) NC 2326, resistant to race 0 de *Phytophthora nicotianae* var. nicotianae

2-) Hicks, a susceptible cultivarG.S. Nemestothy. Author links open the author workspace.D.I. Guest. Author links open the author workspace.Opens the author workspace



Treatment	cv. Hicks	cv. Hicks +fosetyl-Al	cv. NC 2326	cv. NC 2326 +fosetyl-Al

1. Mevinolin, a specific inhibitor of sesquiterpenoid biosynthesis
2. Non-specific amino-transferase inhibitor minooxyacetic acid (AOA)
3. Aminohydrazinophenylpropionic acid (AHPP), a specific inhibitor of phenylalanine ammonia lyase activity
4. Aminoethoxyvinylglycine (AVG) inhibitor ofethylene biosynthesis,

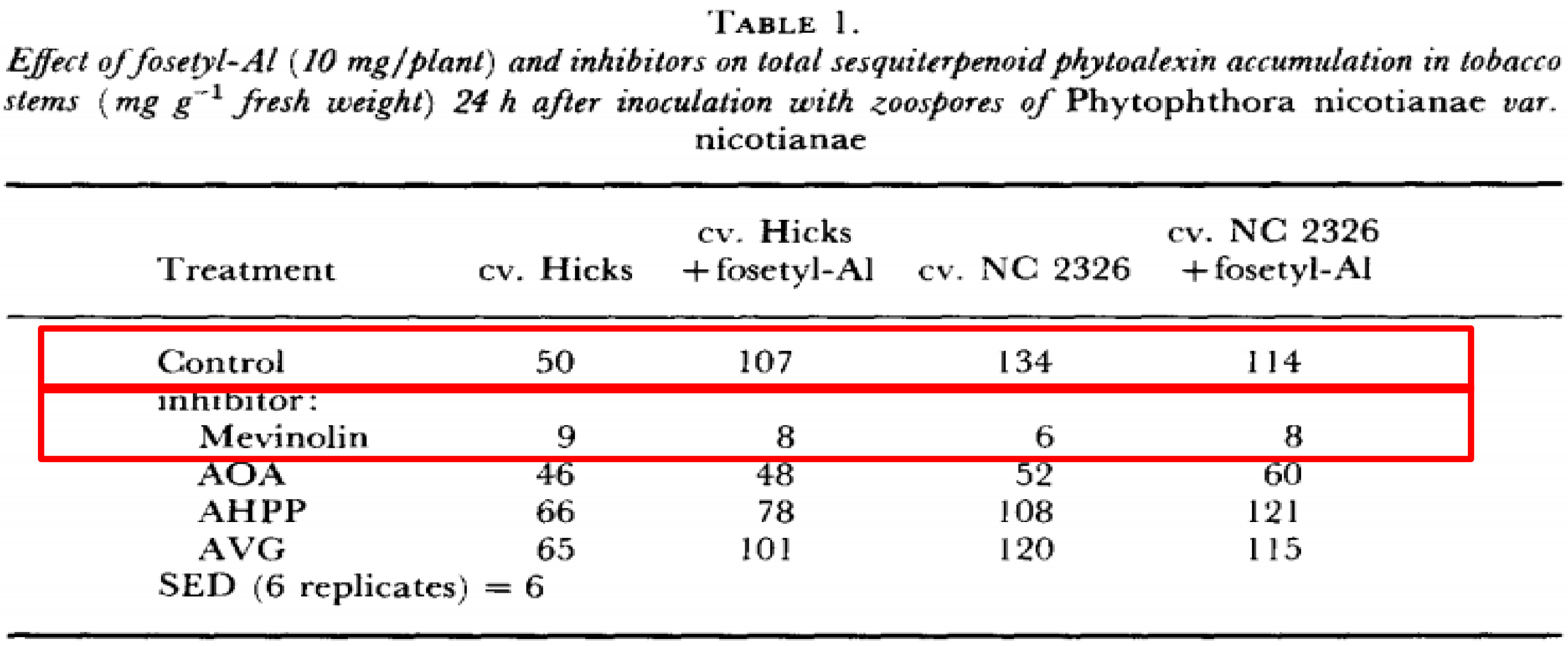


Table 1.

Effect of fosetyl-Al (10 mg/plant) and inhibitors on total sesquiterpenoid phytoalexin accumulation in tobacco stems (mg g^{-1} fresh weight) 24 h after inoculation with zoospores of Phytophthora nicotianae *var.* nicotianae

Treatment	cv. Hicks	cv. Hicks +fosetyl-Al	cv. NC 2326	cv. NC 2326 +fosetyl-Al
Control	50	107	134	114
inhibitor:				
Mevinolin	9	8	6	8
AOA	46	48	52	60
AHPP	66	78	108	121
AVG	65	101	120	115
SED (6 replicates) = 6				

1. Mevinolin, a specific inhibitor of sesquiterpenoid biosynthesis

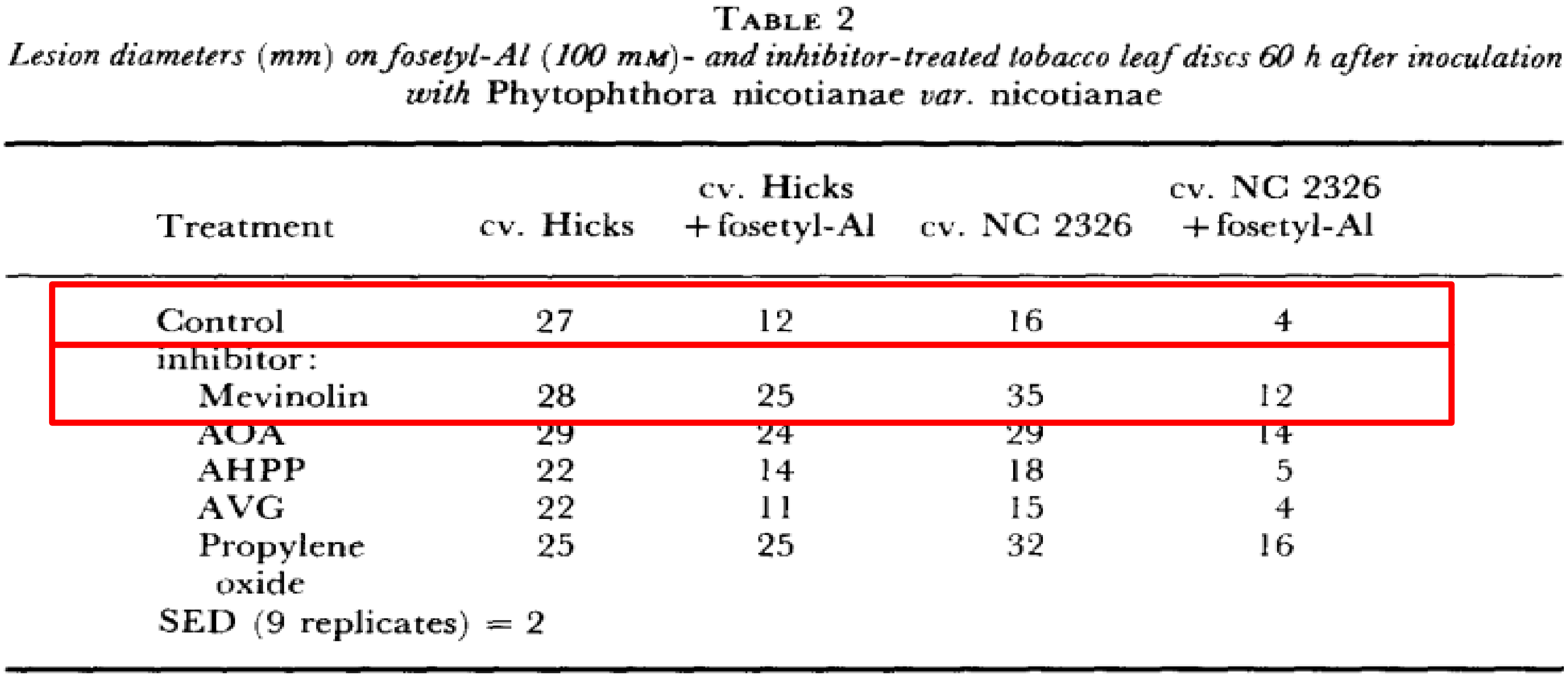


TABLE 2

Lesion diameters (mm) on fosetyl-Al (100 mM)- and inhibitor-treated tobacco leaf discs 60 h after inoculation with Phytophthora nicotianae *var.* nicotianae

Treatment	cv. Hicks	cv. Hicks + fosetyl-Al	cv. NC 2326	cv. NC 2326 + fosetyl-Al
Control	27	12	16	4
inhibitor:				
Mevinolin	28	25	35	12
AOA	29	24	29	14
AHPP	22	14	18	5
AVG	22	11	15	4
Propylene oxide	25	25	32	16
SED (9 replicates) = 2				

1. Mevinolin, a specific inhibitor of sesquiterpenoid biosynthesis

- O sistema de defensa esta sendo ativado...
- Como?
- E na ausência do patógeno?

Azoxystrobin induces lignification-related enzymes and phenolics in rice (Oryza sativa L.) against blast pathogen (Pyricularia grisea).

Sundravadana, S., Alice, D., Kuttalam, S., & Samiyappan, R. (2007).

- Lignification-related enzyme activities
- Assay of Phenylalanine ammonia lyase
- Phenolic content

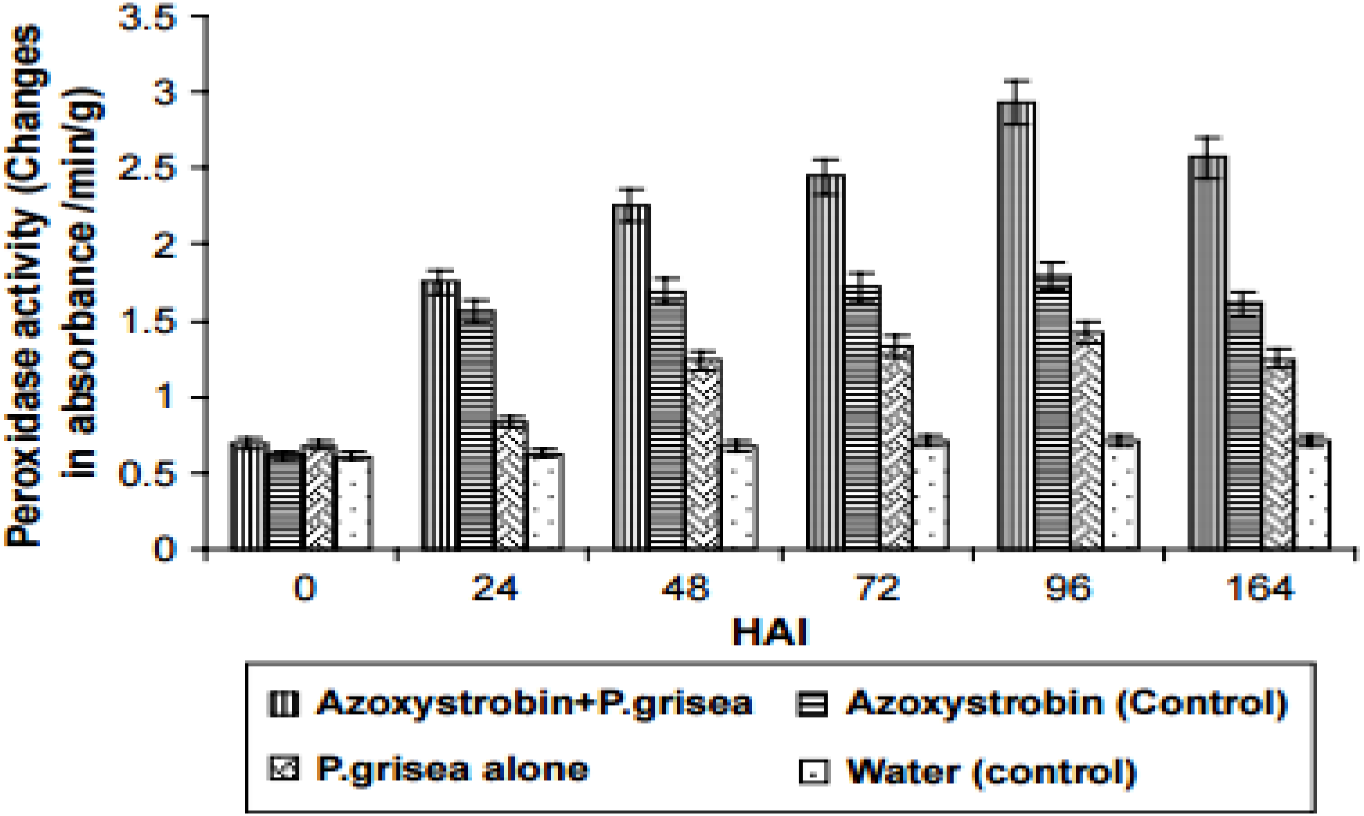


Figure 3. Effect of azoxystrobin on the induction of POD activity in rice leaves.

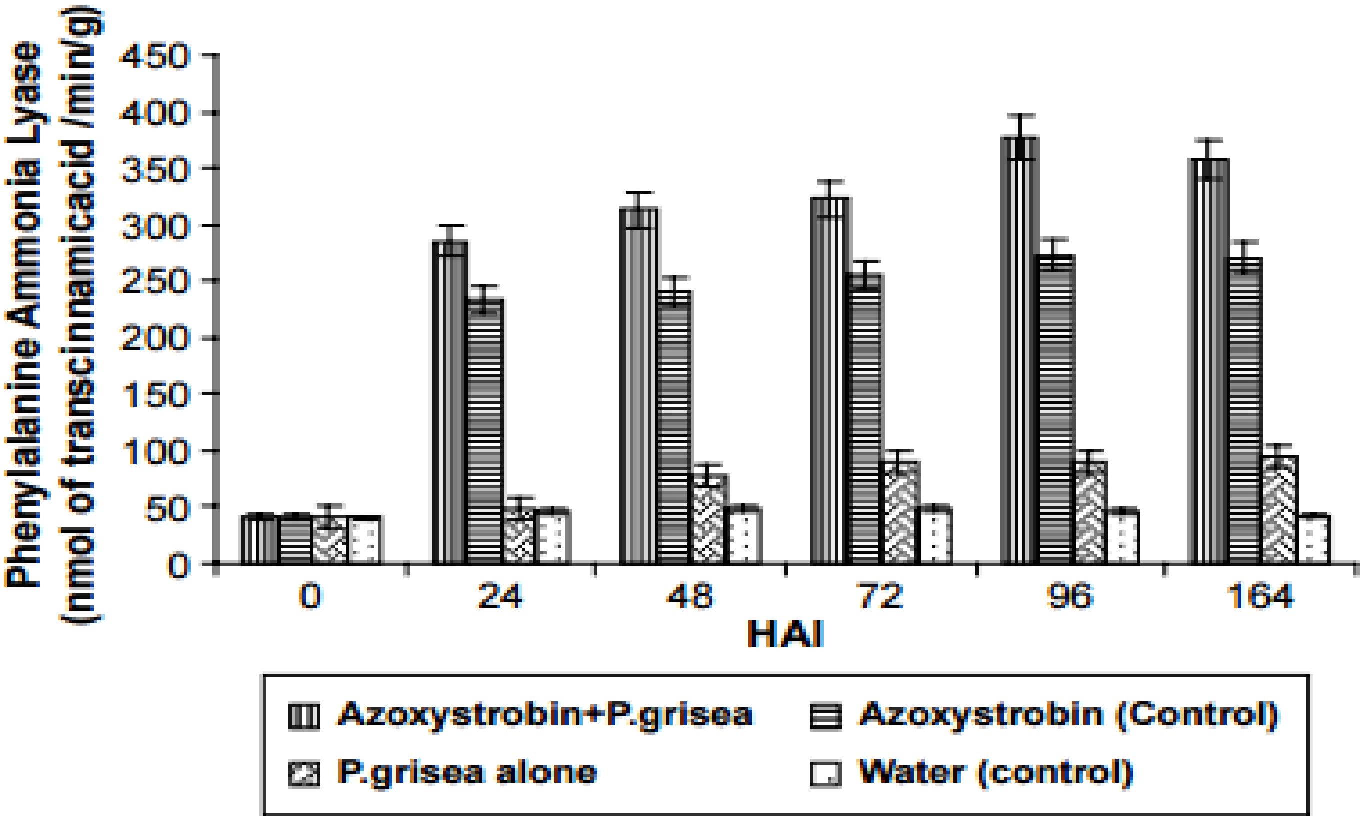


Figure 5. Effect of azoxystrobin on the induction of PAL activity in rice leaves.

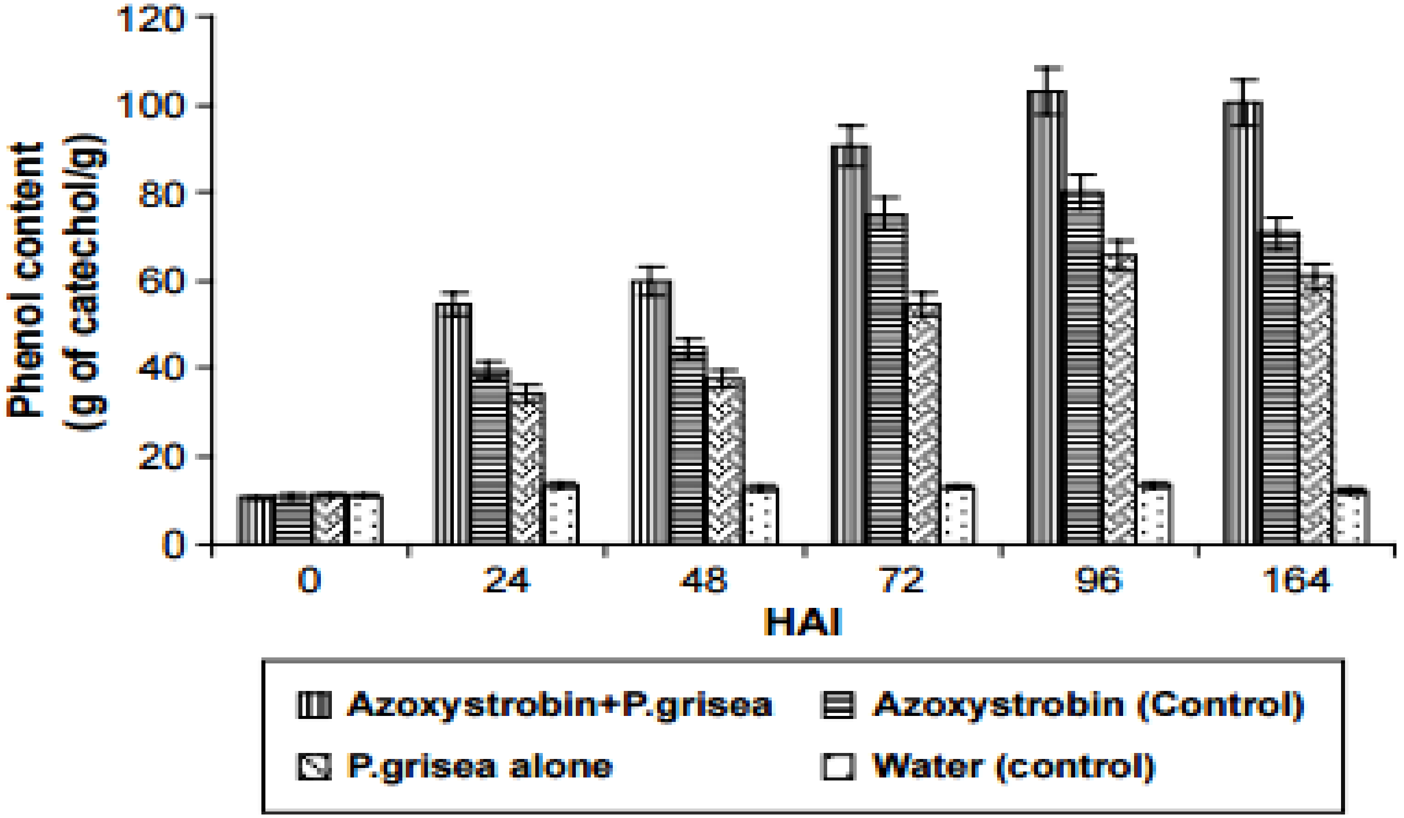


Figure 6. Effect of azoxystrobin on the total phenolics content in rice leaves.

Melhor prevenir

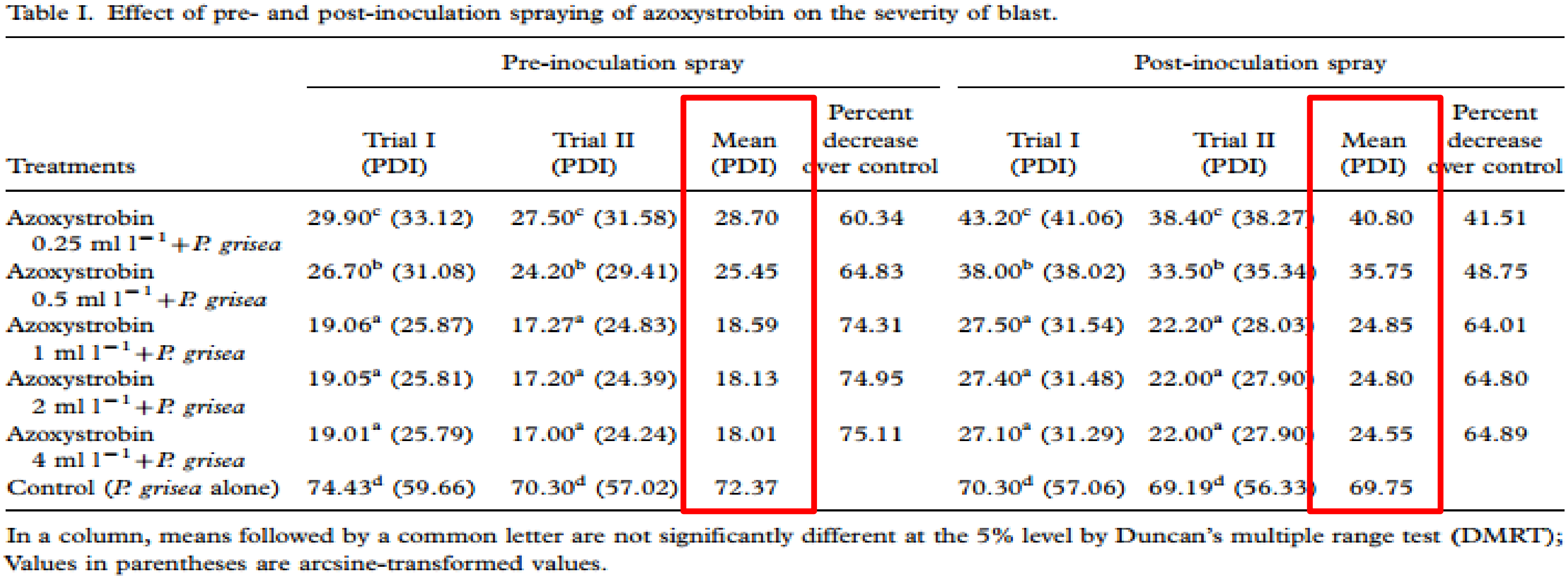


Table I. Effect of pre- and post-inoculation spraying of azoxystrobin on the severity of blast.

Treatments	Pre-inoculation spray				Post-inoculation spray			
	Trial I (PDI)	Trial II (PDI)	Mean (PDI)	Percent decrease over control	Trial I (PDI)	Trial II (PDI)	Mean (PDI)	Percent decrease over control
Azoxystrobin 0.25 ml l^{-1} + *P. grisea*	29.90^{c} (33.12)	27.50^{c} (31.58)	28.70	60.34	43.20^{c} (41.06)	38.40^{c} (38.27)	40.80	41.51
Azoxystrobin 0.5 ml l^{-1} + *P. grisea*	26.70^{b} (31.08)	24.20^{b} (29.41)	25.45	64.83	38.00^{b} (38.02)	33.50^{b} (35.34)	35.75	48.75
Azoxystrobin 1 ml l^{-1} + *P. grisea*	19.06^{a} (25.87)	17.27^{a} (24.83)	18.59	74.31	27.50^{a} (31.54)	22.20^{a} (28.03)	24.85	64.01
Azoxystrobin 2 ml l^{-1} + *P. grisea*	19.05^{a} (25.81)	17.20^{a} (24.39)	18.13	74.95	27.40^{a} (31.48)	22.00^{a} (27.90)	24.80	64.80
Azoxystrobin 4 ml l^{-1} + *P. grisea*	19.01^{a} (25.79)	17.00^{a} (24.24)	18.01	75.11	27.10^{a} (31.29)	22.00^{a} (27.90)	24.55	64.89
Control (*P. grisea* alone)	74.43^{d} (59.66)	70.30^{d} (57.02)	72.37		70.30^{d} (57.06)	69.19^{d} (56.33)	69.75	

In a column, means followed by a common letter are not significantly different at the 5% level by Duncan's multiple range test (DMRT); Values in parentheses are arcsine-transformed values.

SAR

Probenazole induces systemic acquired resistance in Arabidopsis with a novel type of action.

Yoshioka, K., Nakashita, H., Klessig, D. F., & Yamaguchi, I. (2001).

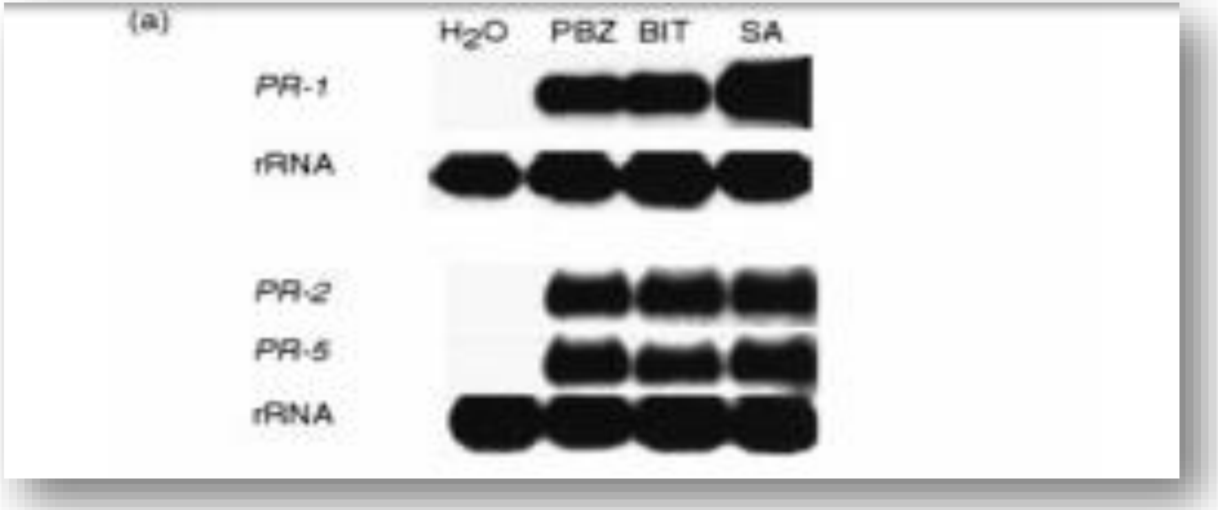
Wild-type Arabidopsis treated with PBZ (Probenazole) or BIT (active metabolite) exhibited:

- increased expression of several pathogenesis-related genes
- increased levels of total salicylic acid (SA)
- and enhanced resistance to the bacterial pathogen

- ***Pseudomonas syringae* pv. tomato**
- ***Peronospora parasitica***

active metabolite:
1, 2-benzisothiazol-3 (2H)-one 1,1-dioxide
(BIT)

RNA extraction and Northern blot analysis



active metabolite:
1, 2-benzisothiazol-3 (2H)-one 1,1-dioxide (BIT)

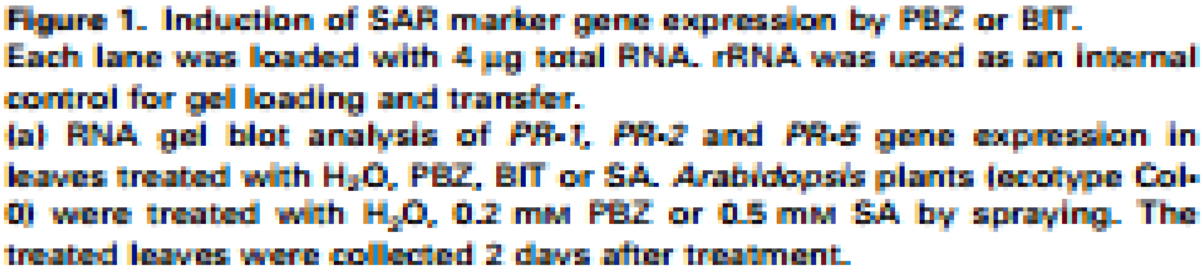
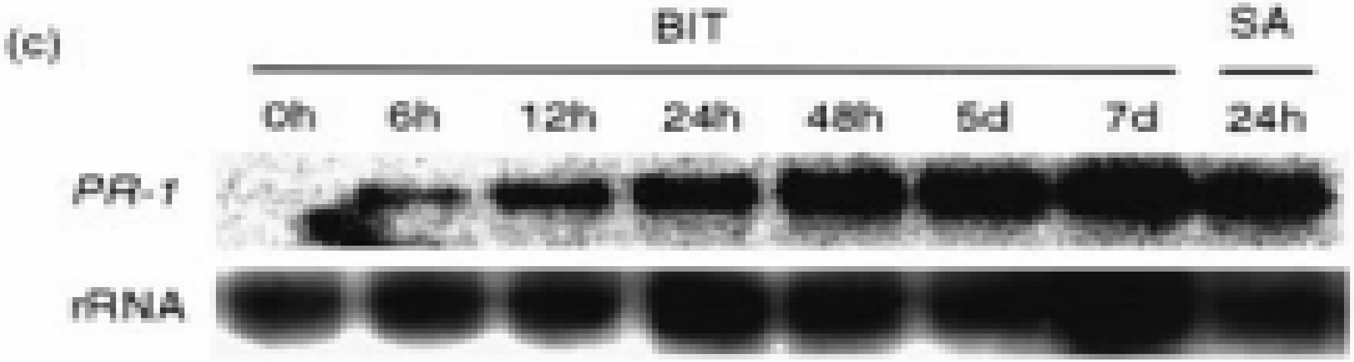


Figure 1. Induction of SAR marker gene expression by PBZ or BIT.
Each lane was loaded with 4 μg total RNA. rRNA was used as an internal control for gel loading and transfer.
(a) RNA gel blot analysis of *PR-1*, *PR-2* and *PR-5* gene expression in leaves treated with H_2O, PBZ, BIT or SA. *Arabidopsis* plants (ecotype Col-0) were treated with H_2O, 0.2 mM PBZ or 0.5 mM SA by spraying. The treated leaves were collected 2 days after treatment.

Expressão de PR-1



(c) Col-0 plants were sprayed with 0.2 mM BIT or 0.5 mM SA and the leaves were harvested at the indicated hours (h) or days (d).

A trifloxystrobin fungicide induces systemic tolerance to abiotic stresses.

Han, S. H., Kang, B. R., Lee, J. H., Lee, S. H., Kim, I. S., Kim, C. H., & Kim, Y. C. (2012).

- Relative water content of the leaves and the survival rate of intact plants indicated that plants acquired systemic tolerance to drought stress following trifloxystrobin pre-treatment.

- Induced drought tolerance activity by trifloxystrobin was sustained for 25 days after initial application.

Seca

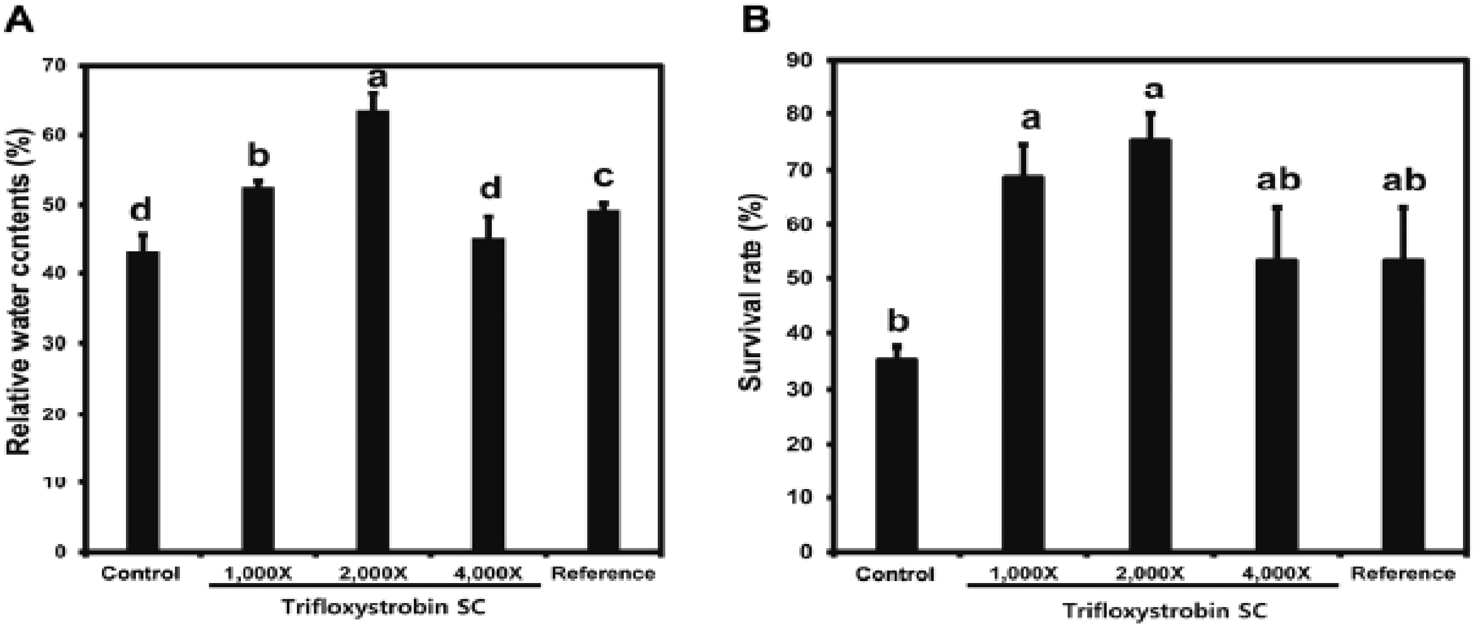
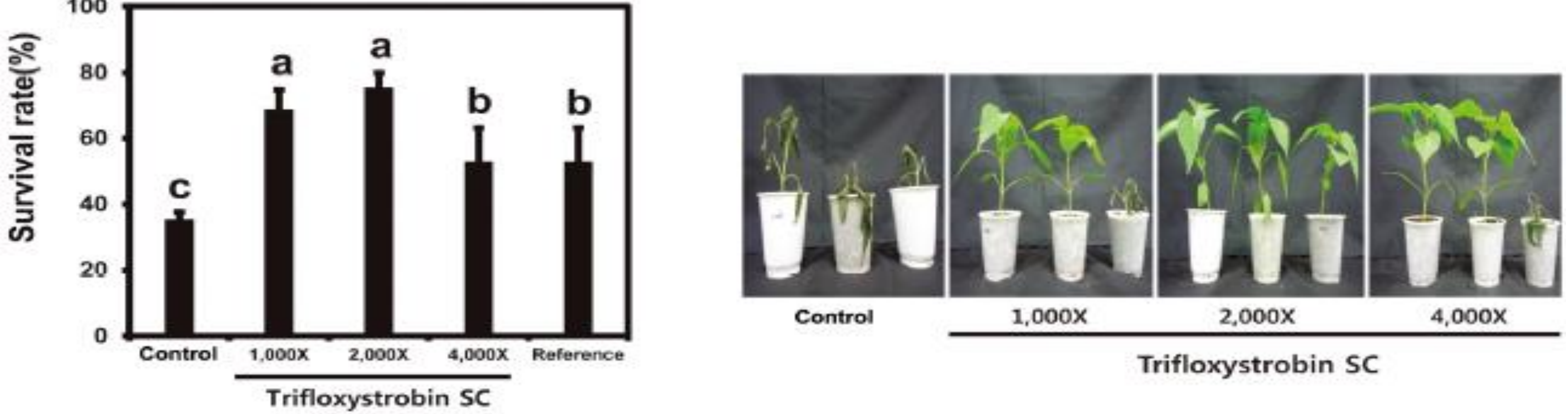


Fig. 2. Effect of trifloxystrobin suspension concentrate (SC) treatment on induction of drought tolerance in red pepper. Pepper plants were grown in pots with soil-less medium and were treated with defined concentrations of trifloxystrobin SC, azoxystrobin SC, or water as a negative control. Five days after treatment, a drought stress was employed by withholding water for ten days, and then relative water content of the red pepper seedlings was measured (A). Two days after rehydration of the drought-stressed red pepper, surviving seedlings were counted to evaluate induced drought tolerance (B). Each bar represents the mean ± standard deviation of three replicate experiments with 15 plants/treatment. Bars with different letter superscripts are statistically different at $P < 0.05$.

FRIO



GEADA

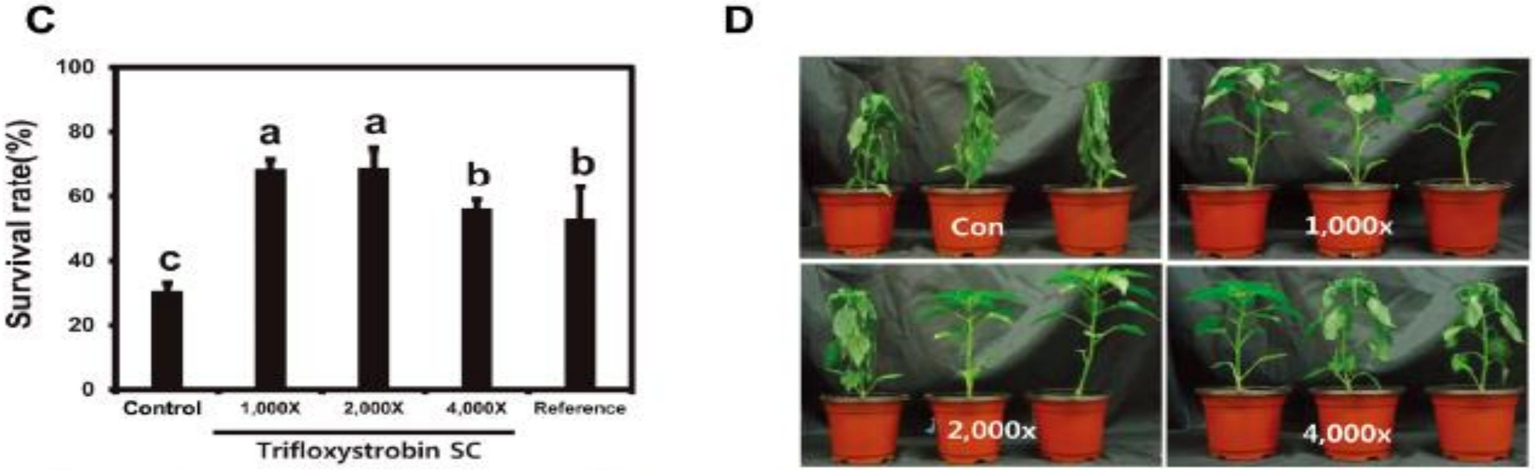
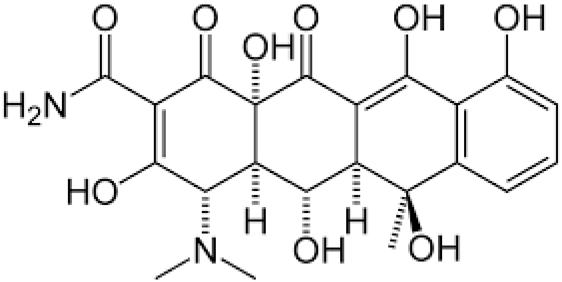
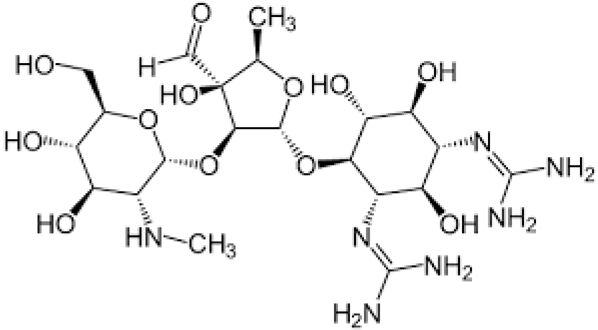


Fig. 3. Induction of cold (A and B) and frost (C and D) stress tolerance in red pepper following foliar application of trifloxystrobin suspension concentrates (SC). Three-week-old red peppers grown in pots were treated with foliar applications of defined concentrations of trifloxystrobin SC, azoxystrobin SC, and water as a negative control. Five days after the application, the plants were exposed to –1℃ for 9 h for cold stress and 30 minutes at –8℃ for freezing stress before returning to room temperature. A and C, Survival rates after cold or frost stresses were measured by counting the number of plants that survived the treatments. B and D. Representative photographic images of red pepper plants following induced cold or frost tolerance by trifloxystrobin SC are shown. Each bar represents the mean ± standard deviation of three replicate experiments with 15 plants/treatment. Bars with different letter superscripts are statistically different at $P < 0.05$.

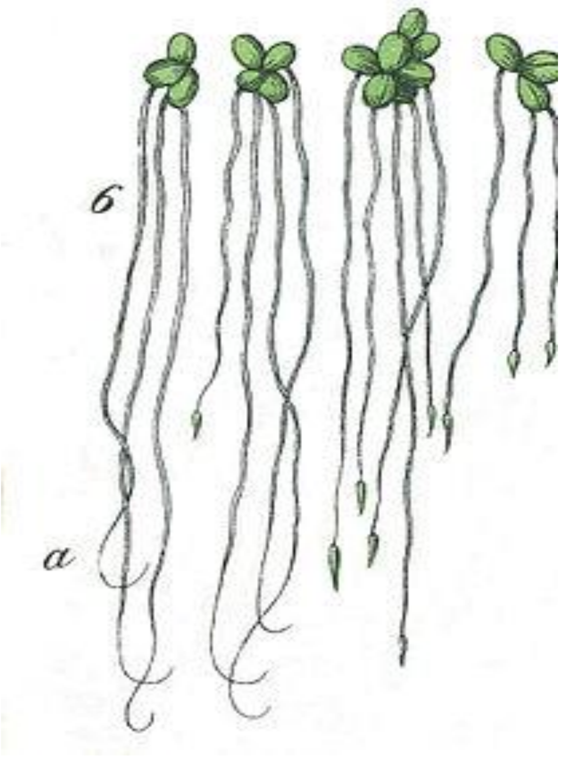


Efeitos dos antibióticos nas plantas



Growth modifiers, antibiotics and their effects on plant growth.

Nickell, L. G., & Finlay, A. C. (1954).



Lemna minor

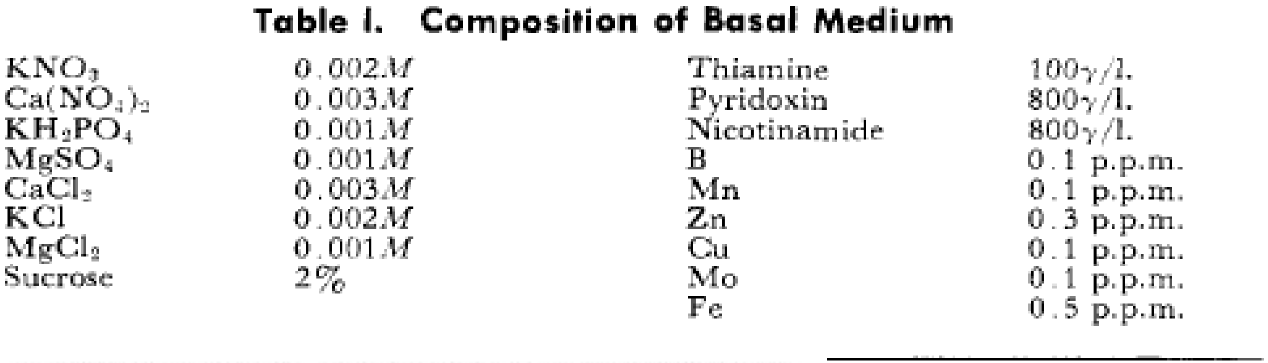


Table I. Composition of Basal Medium

KNO_3	$0.002M$	Thiamine	$100\gamma/l.$
$Ca(NO_3)_2$	$0.003M$	Pyridoxin	$800\gamma/l.$
KH_2PO_4	$0.001M$	Nicotinamide	$800\gamma/l.$
$MgSO_4$	$0.001M$	B	0.1 p.p.m.
$CaCl_2$	$0.003M$	Mn	0.1 p.p.m.
KCl	$0.002M$	Zn	0.3 p.p.m.
$MgCl_2$	$0.001M$	Cu	0.1 p.p.m.
Sucrose	2%	Mo	0.1 p.p.m.
		Fe	0.5 p.p.m.

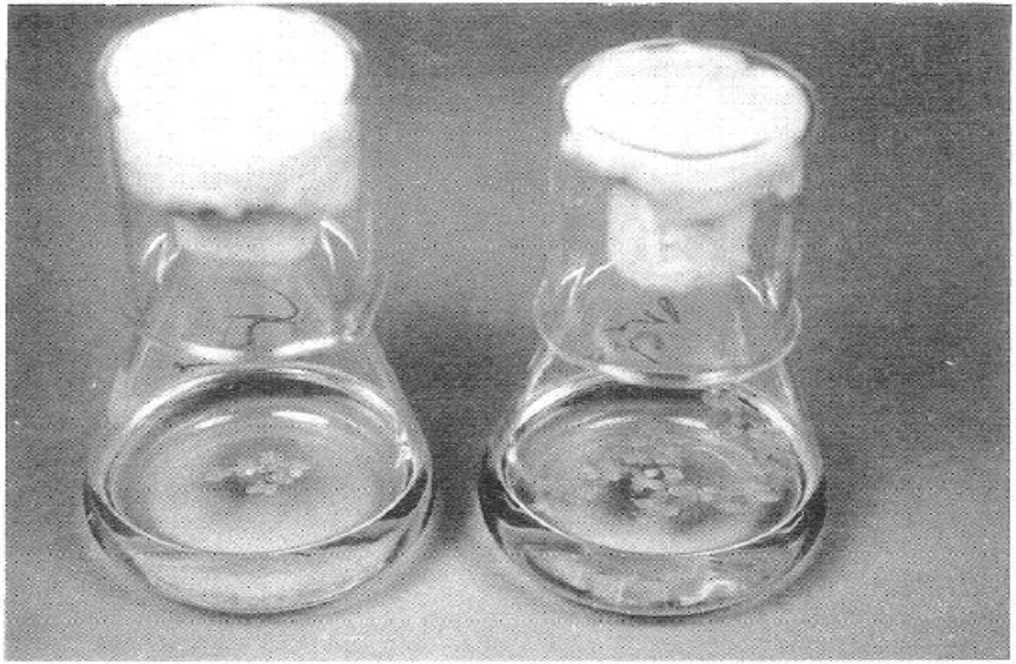


Figure 1. Duckweed (*Lemna minor*) plants growing under aseptic conditions in

1, 5, 10, e 20 ppm

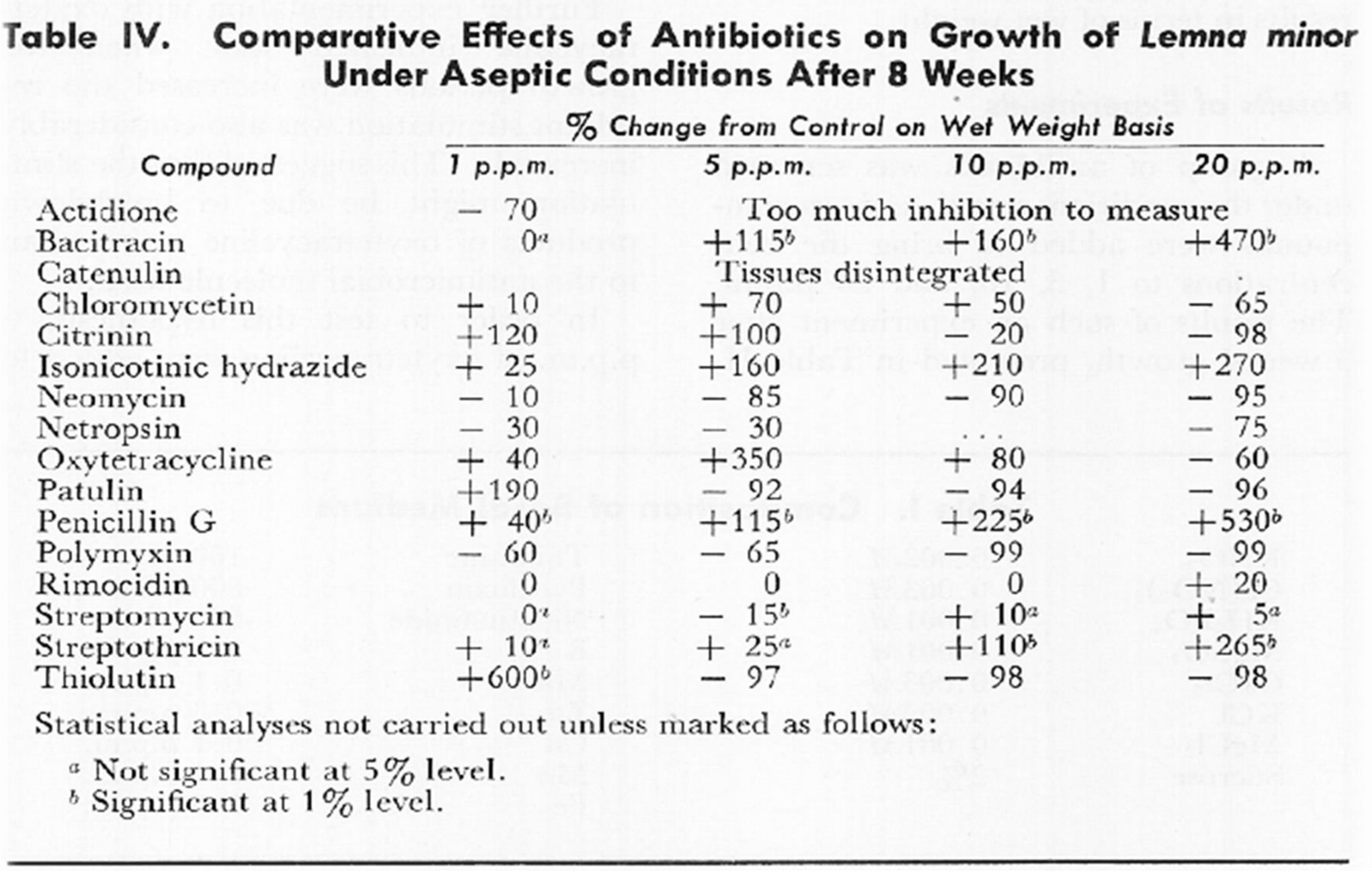


Table IV. Comparative Effects of Antibiotics on Growth of *Lemna minor* Under Aseptic Conditions After 8 Weeks

Compound	% Change from Control on Wet Weight Basis			
	1 p.p.m.	5 p.p.m.	10 p.p.m.	20 p.p.m.
Actidione	−70	Too much inhibition to measure		
Bacitracin	0[a]	+115[b]	+160[b]	+470[b]
Catenulin	Tissues disintegrated			
Chloromycetin	+10	+70	+50	−65
Citrinin	+120	+100	−20	−98
Isonicotinic hydrazide	+25	+160	+210	+270
Neomycin	−10	−85	−90	−95
Netropsin	−30	−30	...	−75
Oxytetracycline	+40	+350	+80	−60
Patulin	+190	−92	−94	−96
Penicillin G	+40[b]	+115[b]	+225[b]	+530[b]
Polymyxin	−60	−65	−99	−99
Rimocidin	0	0	0	+20
Streptomycin	0[a]	−15[b]	+10[a]	+5[a]
Streptothricin	+10[a]	+25[a]	+110[b]	+265[b]
Thiolutin	+600[b]	−97	−98	−98

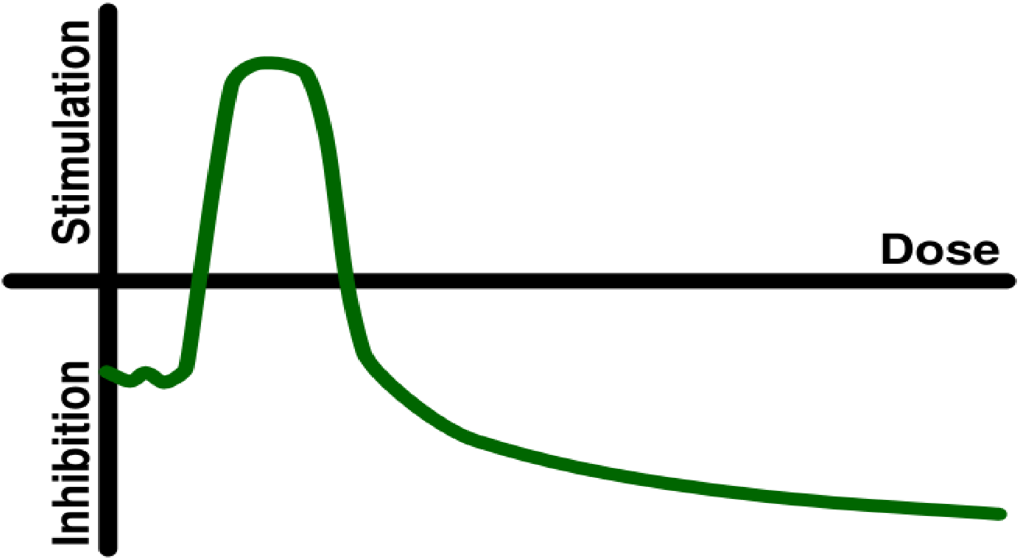
Statistical analyses not carried out unless marked as follows:

[a] Not significant at 5% level.

[b] Significant at 1% level.

Tipos de efeitos

1. Stimulation
2. Inhibition
3. No effects
4. Hormesis



Antibióticos mais usados na agricultura para o controle de doenças de plantas

- Estreptomicina
- Oxitetraciclina
- Penicilina

Efeitos diferentes em diferentes espécies

ESTREPTOMICINA

Maior uso: controle queima bacteriana das rosáceas – pera e maçã, *Erwinia amylovora* (fireblight)

Algum uso: controle de cancro cítrico **-** *X*. *citri* na FL

Streptomycin induced changes in growth and metabolism of etiolated seedlings.

Mukherji, S., Bag, A., & Paul, A. K. (1975).

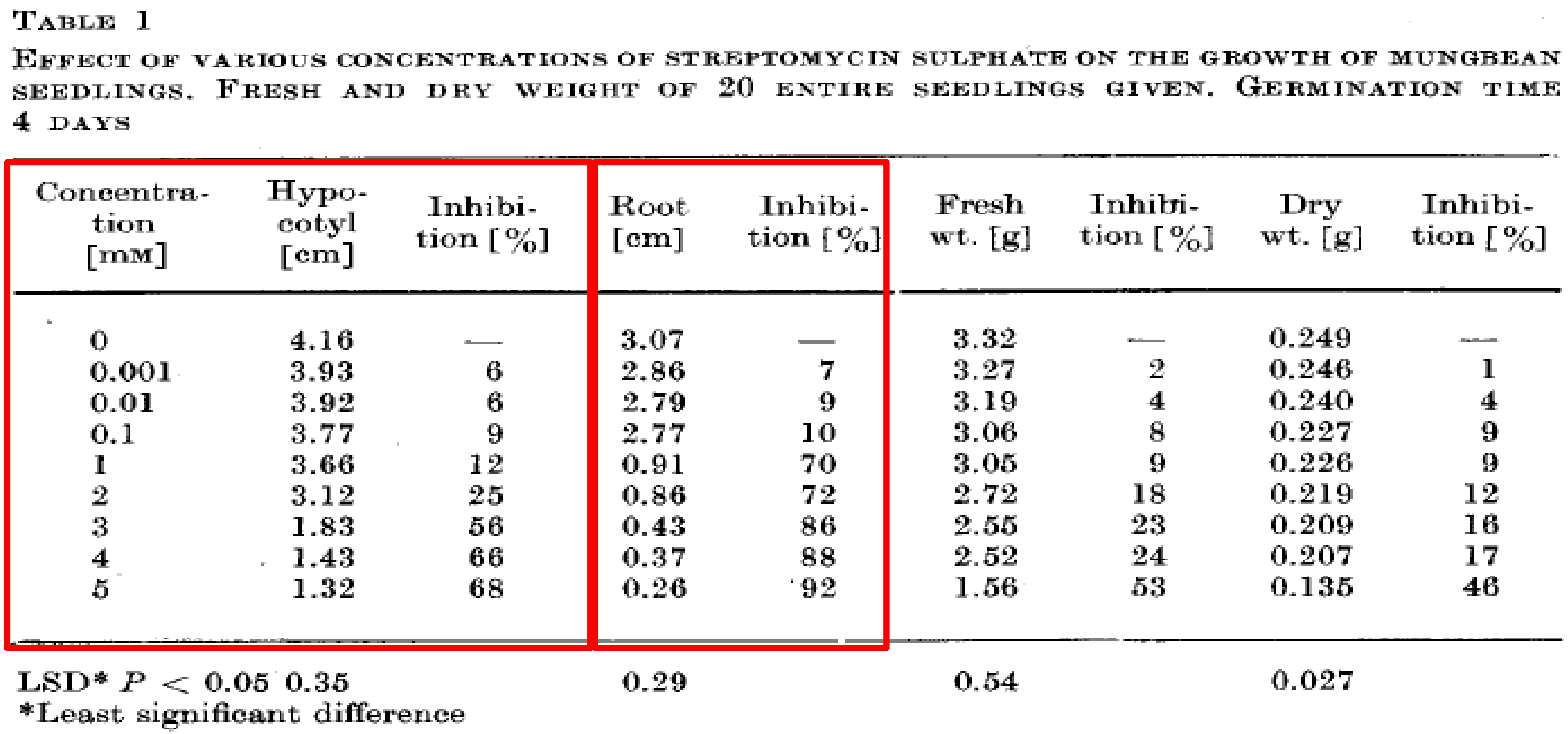


TABLE 1

EFFECT OF VARIOUS CONCENTRATIONS OF STREPTOMYCIN SULPHATE ON THE GROWTH OF MUNGBEAN SEEDLINGS. FRESH AND DRY WEIGHT OF 20 ENTIRE SEEDLINGS GIVEN. GERMINATION TIME 4 DAYS

Concentration [mM]	Hypocotyl [cm]	Inhibition [%]	Root [cm]	Inhibition [%]	Fresh wt. [g]	Inhibition [%]	Dry wt. [g]	Inhibition [%]
0	4.16	—	3.07	—	3.32	—	0.249	—
0.001	3.93	6	2.86	7	3.27	2	0.246	1
0.01	3.92	6	2.79	9	3.19	4	0.240	4
0.1	3.77	9	2.77	10	3.06	8	0.227	9
1	3.66	12	0.91	70	3.05	9	0.226	9
2	3.12	25	0.86	72	2.72	18	0.219	12
3	1.83	56	0.43	86	2.55	23	0.209	16
4	1.43	66	0.37	88	2.52	24	0.207	17
5	1.32	68	0.26	92	1.56	53	0.135	46
LSD* $P < 0.05$	0.35		0.29		0.54		0.027	

*Least significant difference

Phaseolus aureus L.

Oryza sativa L.

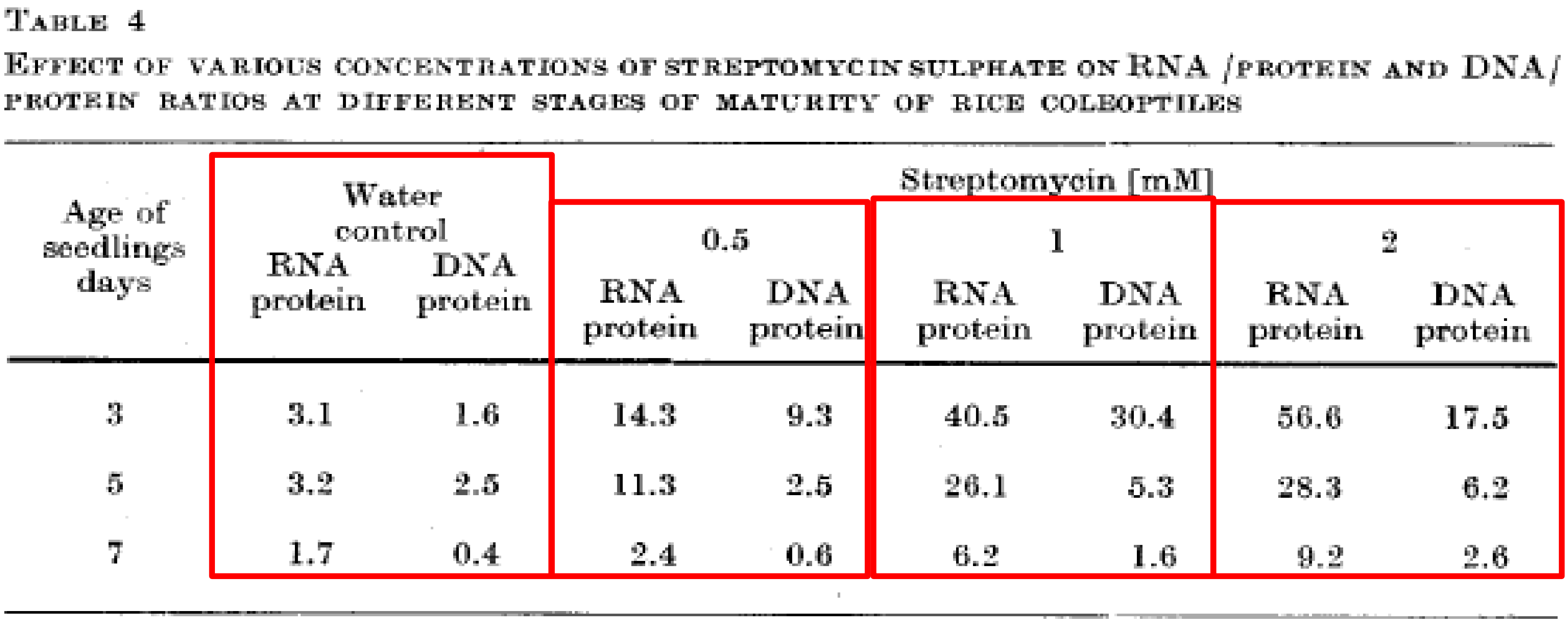


TABLE 4

EFFECT OF VARIOUS CONCENTRATIONS OF STREPTOMYCIN SULPHATE ON RNA/PROTEIN AND DNA/PROTEIN RATIOS AT DIFFERENT STAGES OF MATURITY OF RICE COLEOPTILES

Age of seedlings days	Water control		Streptomycin [mM]					
			0.5		1		2	
	RNA protein	DNA protein	RNA protein	DNA protein	RNA protein	DNA protein	RNA protein	DNA protein
3	3.1	1.6	14.3	9.3	40.5	30.4	56.6	17.5
5	3.2	2.5	11.3	2.5	26.1	5.3	28.3	6.2
7	1.7	0.4	2.4	0.6	6.2	1.6	9.2	2.6

Streptomycin is a protein synthesis inhibitor. It binds to the small 16S rRNA of the 30S subunit of the bacterial ribosome

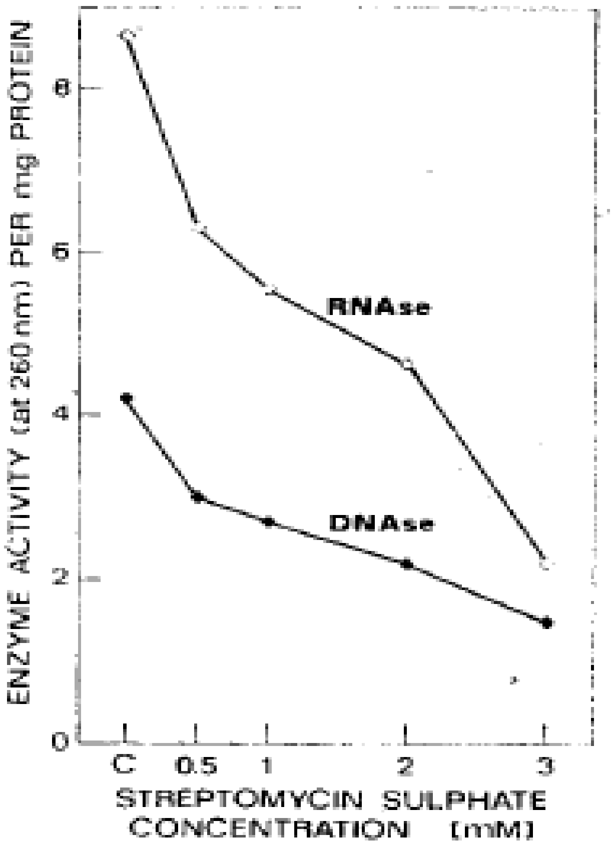


Fig. 1. Effects of various concentrations of streptomycin sulphate on the activities of RNase (□) and DNase (■) in rice coleoptiles. Germination time 5 days.

Oxitetraciclina

Maior uso: controle queima bacteriana das rosáceas – pera e maçã, *Erwinia amylovora* (fireblight)

Algum uso: mancha bacteriana – *Xanthomonas arboricola* pv. *Pruni* em nectarina e pêssego

Negative effects of oxytetracycline on wheat (*Triticum aestivum* L.) growth, root activity, photosynthesis, and chlorophyll contents.

Li, Z. J., XIE, X. Y., ZHANG, S. Q., & LIANG, Y. C. (2011).

Plants were grown in PVC boxes under controlled conditions with a photoperiod of 14 h, a light intensity of 400 µmol m-2 s-1 and temperatures of 25/20°C (day/ night).

↓

After 1 wk, OTC was fed to the plants by amending the fullstrength nutrient solution with 0 (control treatment), 10, 20, 40, and 80 µmol OTC L-1.

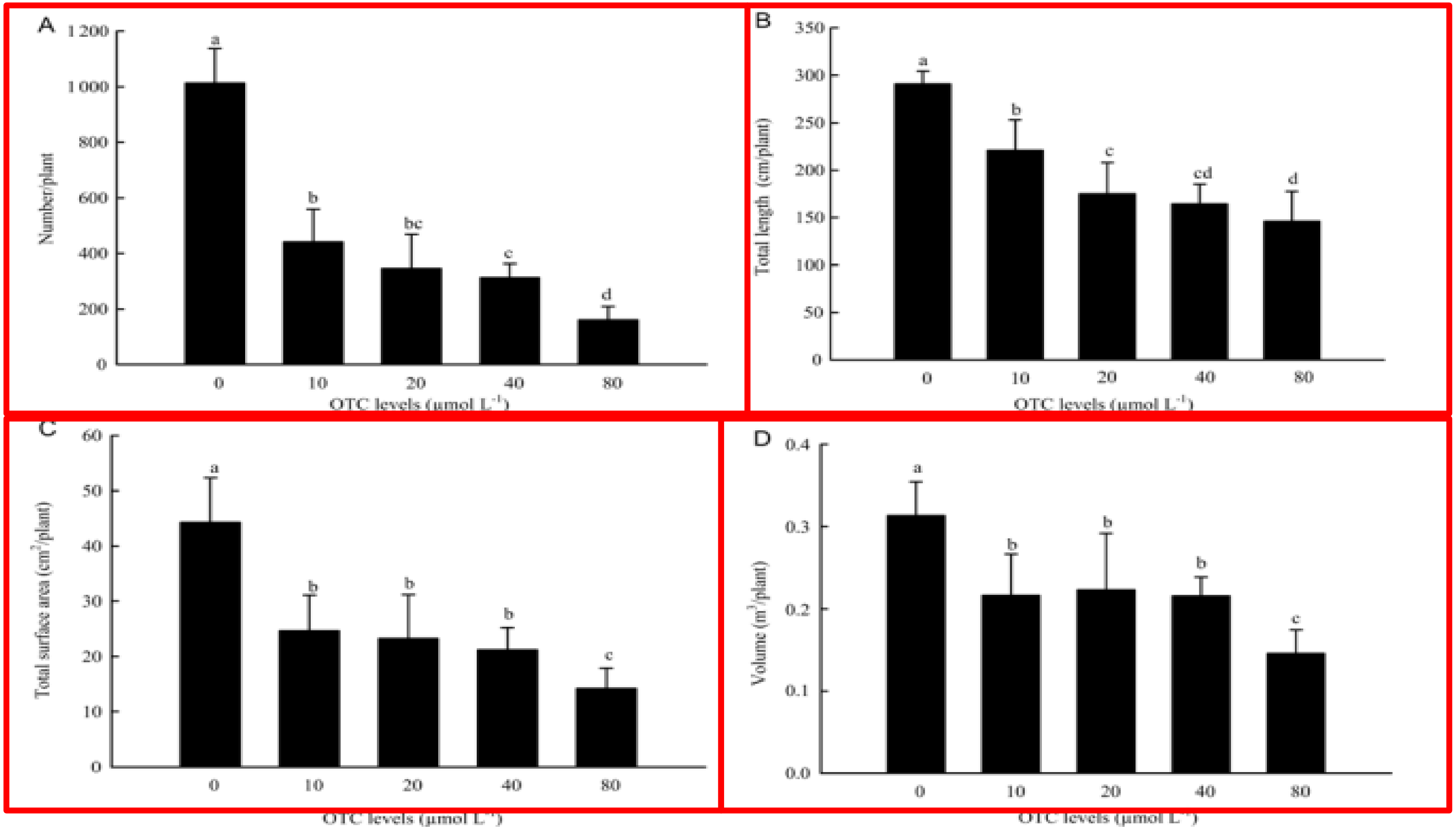


Fig. 1 Effects of OTC on wheat roots number (A), total length (B), total surface area (C), and volume (D). Bars are standard deviations of means of three replicates and lowercase letters indicate level of significance at the 5%. The same as below.

Effects of OTC on wheat leaves contents of chlorophyll a (A), chlorophyll b (B), and total chlorophyll (C).

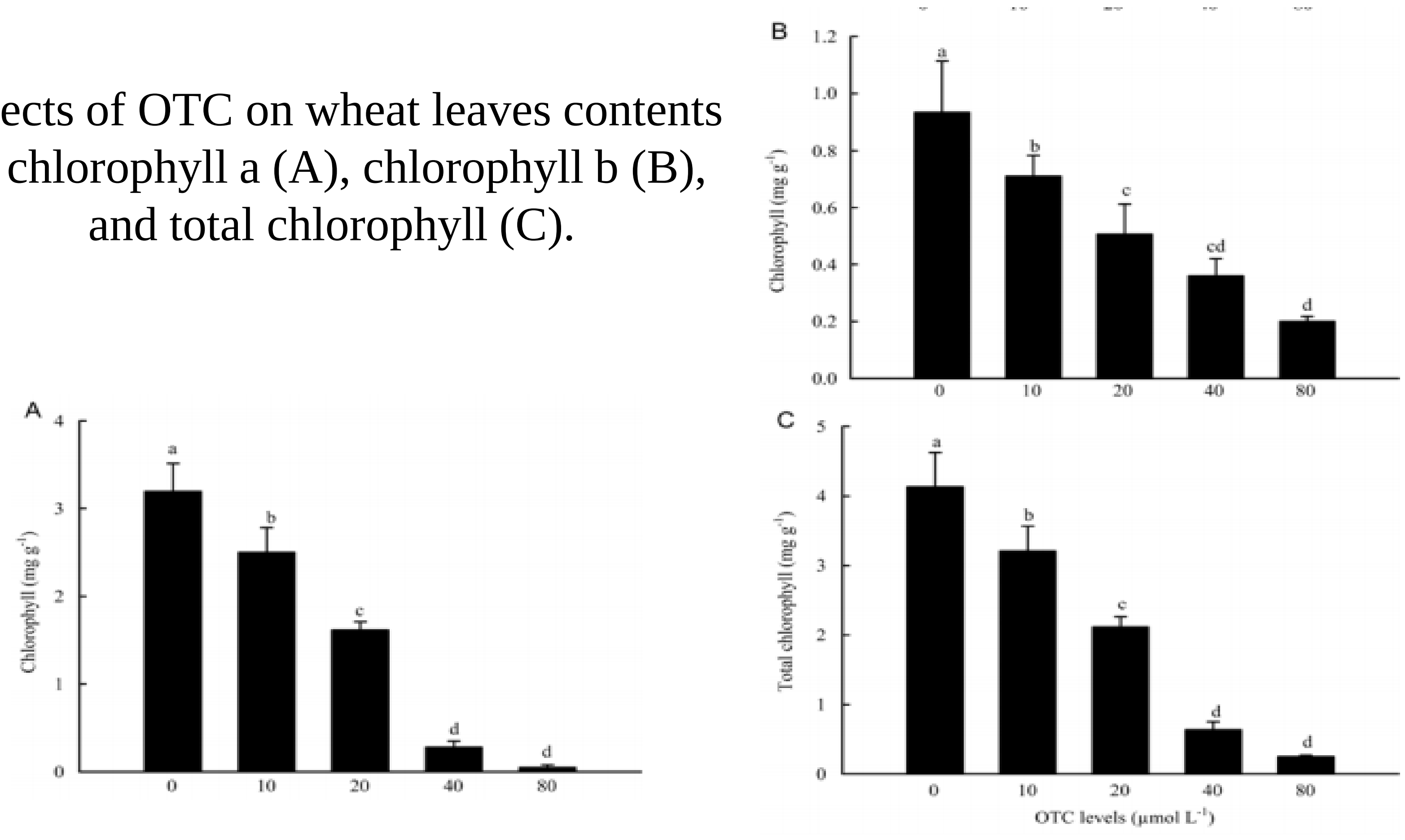


Fig. 3 Effects of OTC on wheat leaves contents of chlorophyll *a* (A), chlorophyll *b* (B), and total chlorophyll (C).

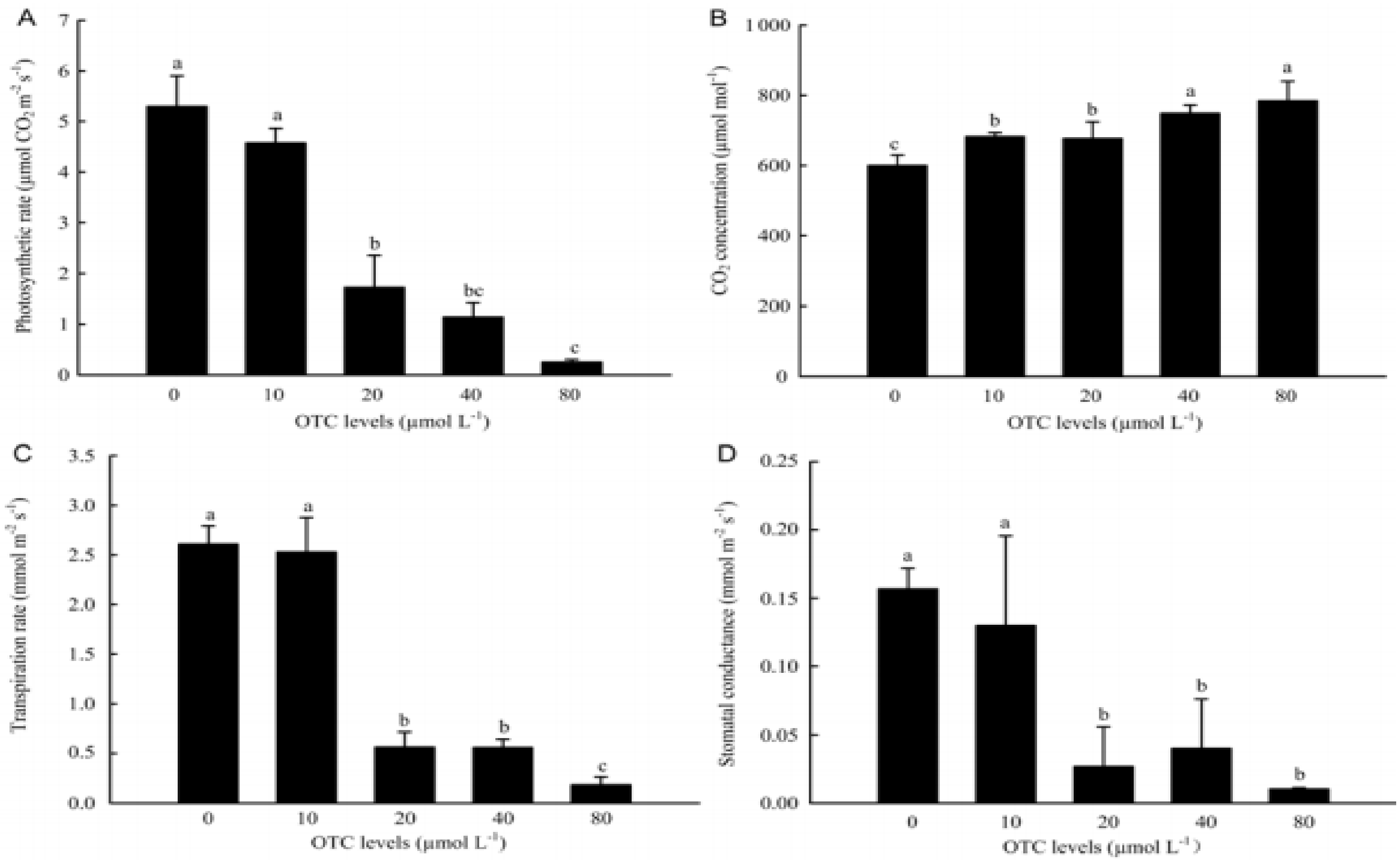
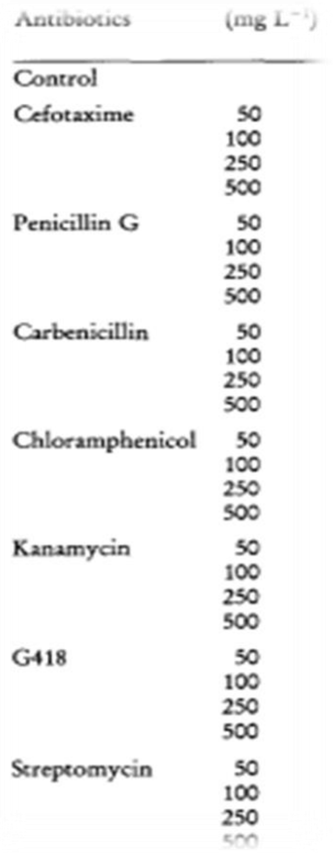


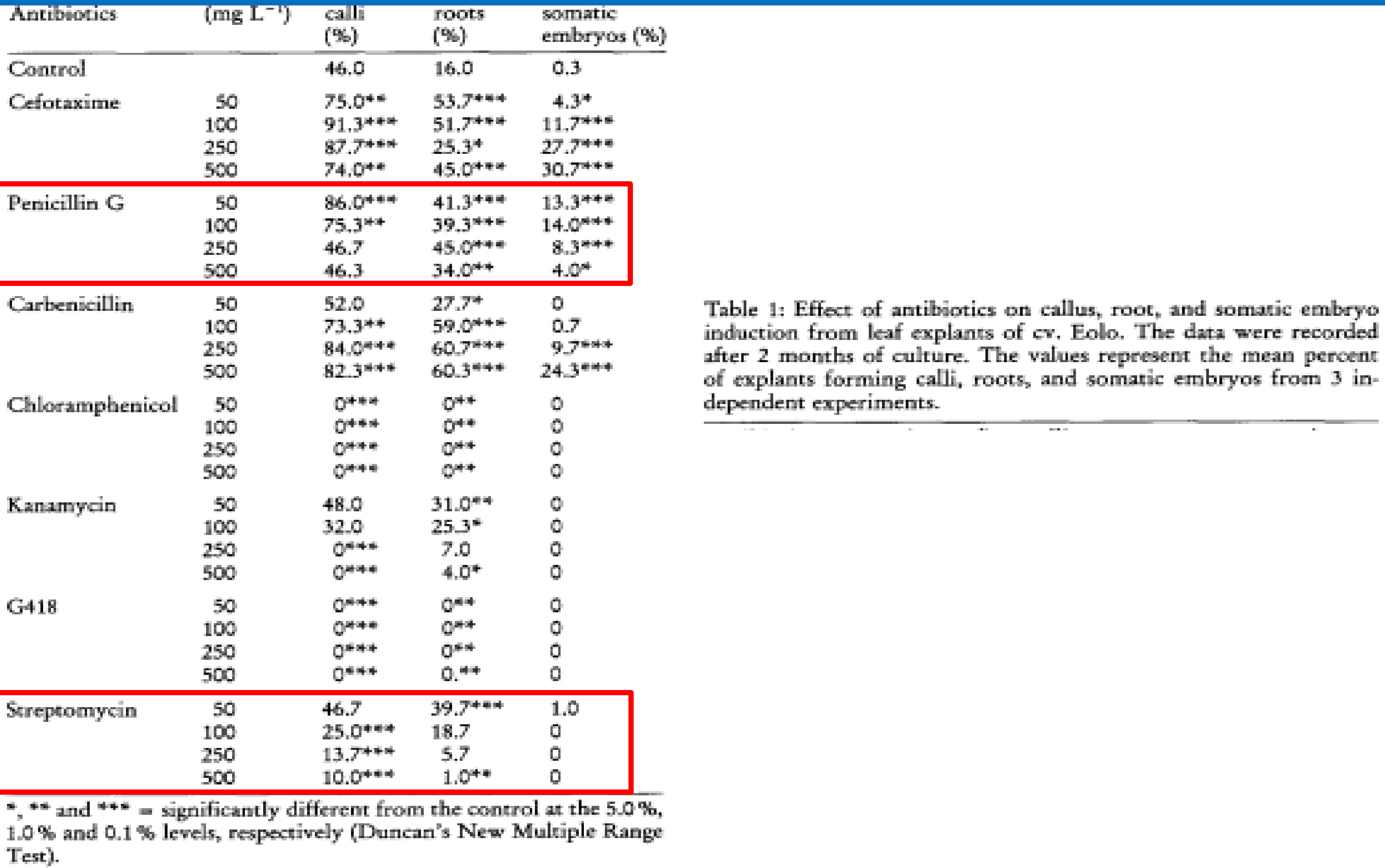
Fig. 4 Effects of OTC on photosynthetic rate (A), intercellular CO_2 concentrations (B), transpiration rate (C), and stomatal conductance (D) in wheat.

Antibiotics stimulate somatic embryogenesis without plant growth in several Dianthus cultivars.

Nakano, M., & Mii, M. (1993).



Antibiotics	(mg L^{-1})
Control	
Cefotaxime	50
	100
	250
	500
Penicillin G	50
	100
	250
	500
Carbenicillin	50
	100
	250
	500
Chloramphenicol	50
	100
	250
	500
Kanamycin	50
	100
	250
	500
G418	50
	100
	250
	500
Streptomycin	50
	100
	250
	500



Antibiotics	(mg L⁻¹)	calli (%)	roots (%)	somatic embryos (%)
Control		46.0	16.0	0.3
Cefotaxime	50	75.0**	53.7***	4.3*
	100	91.3***	51.7***	11.7***
	250	87.7***	25.3*	27.7***
	500	74.0**	45.0***	30.7***
Penicillin G	50	86.0***	41.3***	13.3***
	100	75.3**	39.3***	14.0***
	250	46.7	45.0***	8.3***
	500	46.3	34.0**	4.0*
Carbenicillin	50	52.0	27.7*	0
	100	73.3**	59.0***	0.7
	250	84.0***	60.7***	9.7***
	500	82.3***	60.3***	24.3***
Chloramphenicol	50	0***	0**	0
	100	0***	0**	0
	250	0***	0**	0
	500	0***	0**	0
Kanamycin	50	48.0	31.0**	0
	100	32.0	25.3*	0
	250	0***	7.0	0
	500	0***	4.0*	0
G418	50	0***	0**	0
	100	0***	0**	0
	250	0***	0**	0
	500	0***	0.**	0
Streptomycin	50	46.7	39.7***	1.0
	100	25.0***	18.7	0
	250	13.7***	5.7	0
	500	10.0***	1.0**	0

*, ** and *** = significantly different from the control at the 5.0 %, 1.0 % and 0.1 % levels, respectively (Duncan's New Multiple Range Test).

Table 1: Effect of antibiotics on callus, root, and somatic embryo induction from leaf explants of cv. Eolo. The data were recorded after 2 months of culture. The values represent the mean percent of explants forming calli, roots, and somatic embryos from 3 independent experiments.

Referências

A: Efeitos secundários de fungicidas imóveis

Krofta, K.; Pokorny, J.; Kudrna, T.; Jezek, J.; Pulkrábek, J.; Krivanek, J.; Becka, D **.**(2012**).** The effect of application of copper fungicides on photosynthesis parameters and level of elementary copper in hops. Plant Soil Environ., 58, (2): 91–97.

Vicente, L. C.; Rodrigo, L. C.; João, P. F. C. 2007. Benefícios do cobre na cafeicultura. Empresa de Pesquisa Agropecuária de Minas Gerais, n.3, maio.

Palmer, J. W.; Davies, S . B.; Shaw, P. W.; Wünsche, J. N. 2003. Growth and fruit quality of ‘Braeburn’ apple (*Malus domestica*) trees as influenced by fungicide programmes suitable for organic production. New Zealand Journal of Crop and Horticultural Science, v. 31.

Dias, M.. C.; Figueiredo, P.; Duarte, L. F.; A.M. Gil. A. M..; Santos, C. 2014. Different responses of young and expanded lettuce leaves to fungicide Mancozeb: chlorophyll fluorescence, lipid peroxidation, pigments and proline content.. Photosynthetica 52 (1): 148-151.

Saladin, G.; Magne, C.; Clement, C. 2003. Effects of fludioxonil and pyrimethanil, two fungicides used against *Botrytis cinerea*, on carbohydrate physiology in *Vitis vinifera* L. Pest Manag Sci 59:1083–1092.

B: Efeitos secundários de fungicidas móveis

Han, S. H., Kang, B. R., Lee, J. H., Lee, S. H., Kim, I. S., Kim, C. H., & Kim, Y. C. (2012). A trifloxystrobin fungicide induces systemic tolerance to abiotic stresses. The Plant Pathology Journal, 28(1), 101-106.

Debona, D.K.J.T., Nascimento, J.G.O., Gomes, C.E., Aucique-Perez, F.A.Rodrigues. (2016). Physiological changes promoted by a strobilurin fungicide in the rice Bipolaris oryzae interaction. Pesticide Biochemistry and Physiology, 130, 8–16.

Van, I.M.W., Bugbee, B. (1996). Phytotoxic effects of benzimidazole fungicides on bedding plants. ,121(6),1095-102.

Catherine, S., Palle, P. (2009). Effect of Fungicide on Soybean Growth and Yield. Published in Agron. J. 101:352–356.

Johanna, G., Werner M.K (1999). Increased nitrate reductase activity in leaf tissue after application of the fungicide Kresoxim-methyl. Planta 207:442-448.

Miller J.S., Rosen, C.J. (2005) Interactive Effects of Fungicide Programs and Nitrogen Management on Potato Yield and Quality. Amer J of Potato Res 82:399-409.

Yue-Xuan W., Andreas, V.T. (2001). Physiological Effects of Azoxistrobin and Epoxiconazole on Senescence and the Oxidative Status of Wheat. Pesticide Biochemistry and Physiology 71, 1-10.

C: Efeitos no sistema de defensa e efeitos de antibióticos

Nemestothy, G. S., & Guest, D. I. (1990). Phytoalexin accumulation, phenylalanine ammonia lyase activity and ethylene biosynthesis in fosetyl-Al treated resistant and susceptible tobacco cultivars infected with Phytophthora nicotianae var. nicotianae. *Physiological and Molecular Plant Pathology*, *37*(3), 207-219.

Sundravadana, S., Alice, D., Kuttalam, S., & Samiyappan, R. (2007). Azoxystrobin induces lignification-related enzymes and phenolics in rice (Oryza sativa L.) against blast pathogen (Pyricularia grisea). *Journal of Plant Interactions*, *2*(4), 219-224.

Yoshioka, K., Nakashita, H., Klessig, D. F., & Yamaguchi, I. (2001). Probenazole induces systemic acquired resistance in Arabidopsis with a novel type of action. *The Plant Journal*, *25*(2), 149-157.

Han, S. H., Kang, B. R., Lee, J. H., Lee, S. H., Kim, I. S., Kim, C. H., & Kim, Y. C. (2012). A trifloxystrobin fungicide induces systemic tolerance to abiotic stresses. *The Plant Pathology Journal*, *28*(1), 101-106.

Mukherji, S., Bag, A., & Paul, A. K. (1975). Streptomycin induced changes in growth and metabolism of etiolated seedlings. *Biologia Plantarum*, *17*(1), 60-66.

Li, Z. J., XIE, X. Y., ZHANG, S. Q., & LIANG, Y. C. (2011). Negative effects of oxytetracycline on wheat (Triticum aestivum L.) growth, root activity, photosynthesis, and chlorophyll contents. *Agricultural Sciences in China*, *10*(10), 1545-1553.

Nickell, L. G., & Finlay, A. C. (1954). Growth modifiers, antibiotics and their effects on plant growth. *Journal of Agricultural and Food Chemistry*, *2*(4), 178-182.

Nakano, M., & Mii, M. (1993). Antibiotics stimulate somatic embryogenesis without plant growth in several Dianthus cultivars. *Journal of plant physiology*, *141*(6), 721-725.