III Workshop Latino Americano sobre Biobed

ADVANCES IN BIOPURIFICATION SYSTEM FOR PESTICIDE DEGRADATION - CHILE

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https://lechosbiologicos.wordpress.com/

Factors Affecting the Efficiency of Biobed

Biomixture

- Composition
  - Type of material
  - Proportion
    - Determines microorganisms with specific catabolic activities
- Age of the biomixture
  - Succession of substrates and microorganisms with different catabolic activities
- Moisture
  - Aerobic or Anaerobic conditions
- Temperature
  - Degradation rate
- Homogeneity/ Particle size
  - Sorption capacity
  - Microbial activity

Clay layer

- Moisture (no draining layers under the clay!!)

Grass layer

- A well established grass layer favours the moisture balance and avoids transport of pesticides to the bottom of the biobed.

Some topics that we have addressed

1. Effect of the type of soil. Incubation Temperature. Alternative materials: oat husk, barley, sawdust, biochar

2. Supplementation of NPK nutrients and activating compounds, in the biomix

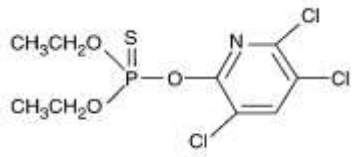
3. Development of supports for the immobilization of ligninolytic fungi and their inoculation in the biomix

4. Isolation, selection and development of bacterial consortia degrading organochlorine, organophosphates and other pesticides

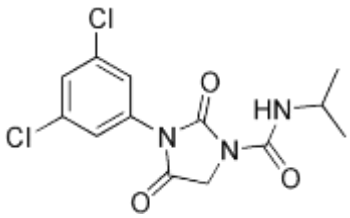
5. Effect of the rhizosphere (columns and ponds) and hydraulic load in the biopurification system (ponds). Single and repeated applications

Pesticides Characteristics

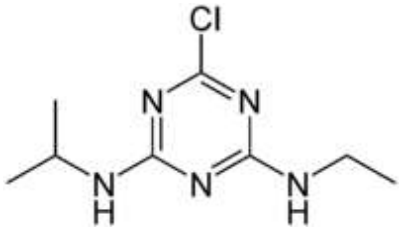
Pesticides	Koc	T1/2 Soils (days)	Water solubility (mg L^{-1})	Mobility class
Chlorpyrifos (I)	6000	7-15	1.4	Non mobile
Iprodione (F)	700	42-80	13	Moderately mobile
Atrazine (H)	40-155	35-50	33	Moderately mobile
Isoproturon (H)	36-240	6-28	65	Moderately mobile



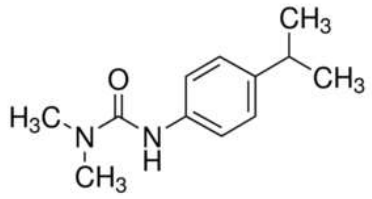
Chlorpyrifos



Iprodione



Atrazine



Isoproturon

1

Soils and Materials Characterization

Parameter	Soils		
	Clay	Sandy	Trumao
N (mg/kg)	13.0 ± 0.4	9.0 ± 0.1	18.6 ± 0.7
P (mg/kg)	4.0 ± 0.3	20.0 ± 0.9	17.1 ± 0.5
K (mg/kg)	43.0 ± 2.4	149.0 ± 8.4	69.0 ± 1.4
pH_w	5.2 ± 0.4	6.0 ± 0.2	5.6 ± 0.1
Organic Matter (%)	3.0 ± 0.2	2.0 ± 0.5	12.7 ± 0.5
Silt (%)	20.1 ± 0.7	32.6 ± 0.9	34.2 ± 0.4
Clay (%)	68.5 ± 0.8	9.1 ± 0.5	28.7 ± 0.8
Sand (%)	11.3 ± 0.5	58.3 ± 0.4	37.1 ± 0,2

Parameter	Wheat Straw	Sawdust	Barley Husk
Dry wheight (%)	91.1 ± 1.8	87.8 ± 1.2	88.8 ± 1.0
Fiber (%)	54.3 ± 1.2	76.6 ± 1.3	12.9 ± 0,5
Lignin (%)	9.9 ± 0.4	20.6 ± 0.6	2.4 ± 0.2
Celullose (%)	41.8 ± 0.7	54.3 ± 0.4	9.6 ± 0.1
Organic Matter (%)	66.1 ± 1.2	61.75 ± 0.6	59.8 ± 0.9
pH	5.9 ± 0.1	4.82 ± 0.1	5.8 ± 0.1
N (mg/kg)	5.6 ± 0.3	2.8 ± 0.1	6.8 ± 0.6

1 Pesticides Degradation (%) (100 mg kg-1)

Biomix	Atrazine	Ioproturon	Iprodione	Chlorpyrifos
CS1	89.8 ± 2.4 a	79.1 ± 0.7 a	24.8 ± 1.7 a	76.1 ± 0.9 ab
CS2	66.2 ± 4.2 c	63.6 ± 0.2 b	25.6 ± 1.2 a	86.8 ± 0.2 a
CS3	77.0 ± 0.2 b	53.2 ± 0.2 c	34.3 ± 0.2 a	57.8 ± 0.2 b
SS1	76.5 ± 0.2 b	77.4 ± 2.2 a	52.9 ± 5.2 b	72.9 ± 0.7 ab
SS2	75.0 ± 4.2 b	63.3 ± 1.4 ab	38.1 ± 0.3 c	77.2 ± 1.1 a
SS3	92.7 ± 0.2 a	52.4 ± 1.7 b	68.4 ± 1.2 a	55.9 ± 1.7 c
TS1	73.4 ± 0.4 b	74.4 ± 0.4 a	32.3 ± 1.2 a	76.1 ± 1.2 a
TS2	71.6 ± 0.3 c	44.3 ± 1.2 b	25.9 ± 1.5 a	55.7± 1.1 c
TS3	92.7 ± 0.5 a	65.0 ± 0.2 a	23.6 ± 1.1 a	63.7 ± 0.4 b

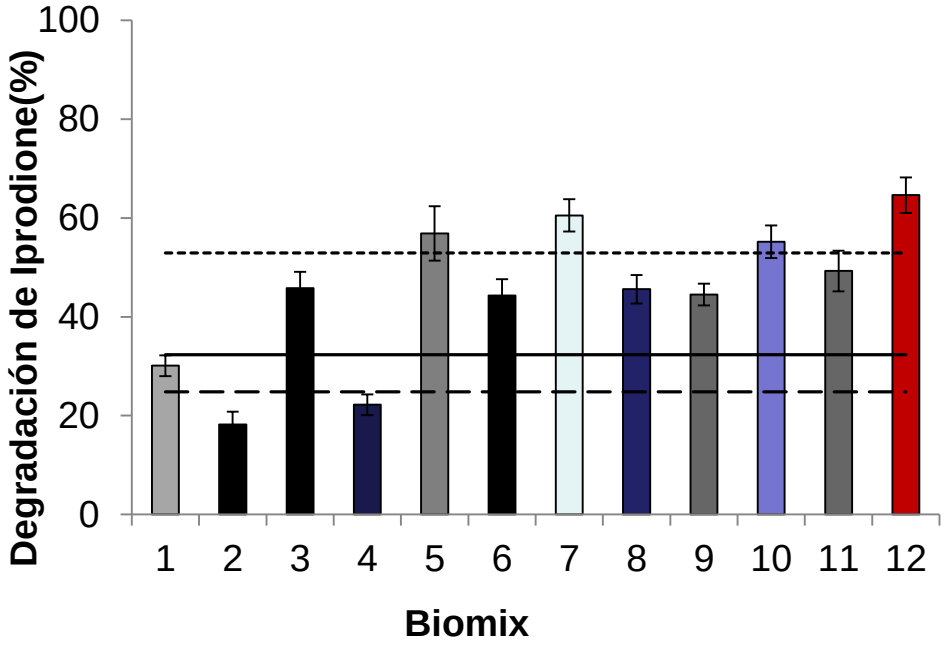
Soils
CS: Clay Soil
SS: Sandy Soil
TS: Trumao Soil

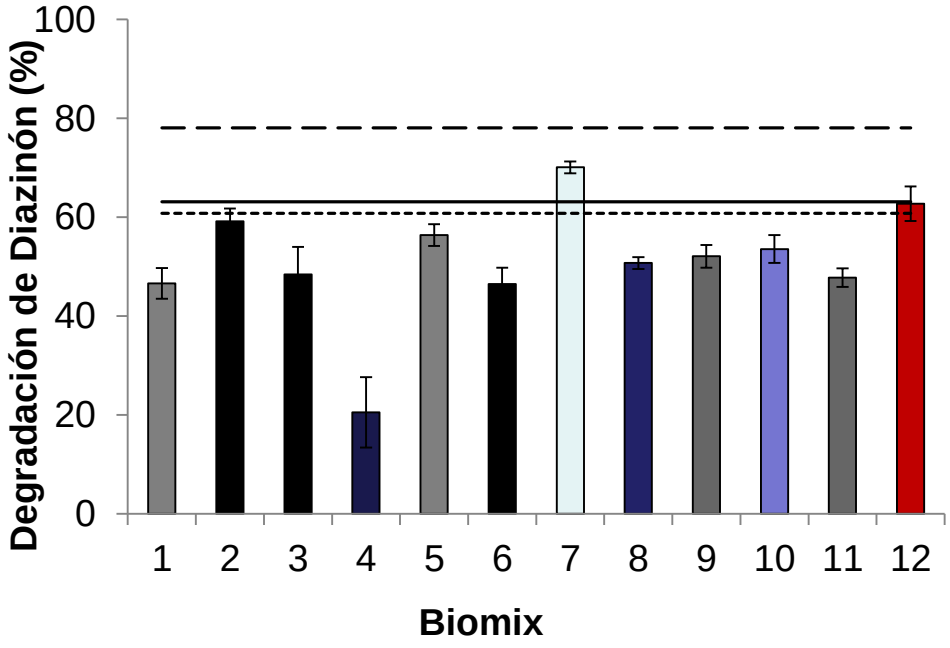
Materials
1 soil:peat:straw (1:1:2)
2 soil:peat:straw:sawdust (1:1:1:1)
3 soil:peat:straw:barley (1:1:1:1)

Diez et al., 2013a

1 Iprodione and Diazinon Degradation (100 Mg Kg^{-1})

	Biomix											
	Clay Soil (25%) Straw (50%)				Trumao Soil (25%) Straw (50%)				Sandy Soil (25%) Straw (50%)			
	1	2	3	4	5	6	7	8	9	10	11	12
Peat (%)	20	15	10	5	20	15	10	5	20	15	10	5
Biochar (%)	5	10	15	20	5	10	15	20	5	10	15	20





Diez et al., 2013b

Electronic Journal of Biotechnology ISSN: 0717-3458
http://www.ejbiotechnology.info
DOI: 10.2225/vol16-issue6-fulltext-17 *RESEARCH ARTICLE*

Influence of novel lignocellulosic residues in a biobed biopurification system on the degradation of pesticides applied in repeatedly high doses

M. Cristina Diez[1] ✉ · Gonzalo R. Tortella[1] · Gabriela Briceño[1] · Maria del Pilar Castillo[2] · Jorge Díaz[3] · Graciela Palma[1] · Carolina Altamirano[1] · Carolina Calderón[1] · Olga Rubilar[1]

Chemosphere 92 (2013) 1361–1366

Contents lists available at SciVerse ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Technical Note

Degradation of pesticide mixture on modified matrix of a biopurification system with alternatives lignocellulosic wastes

C. Urrutia [a], O. Rubilar [b], G.R. Tortella [b], M.C. Diez [b,*]

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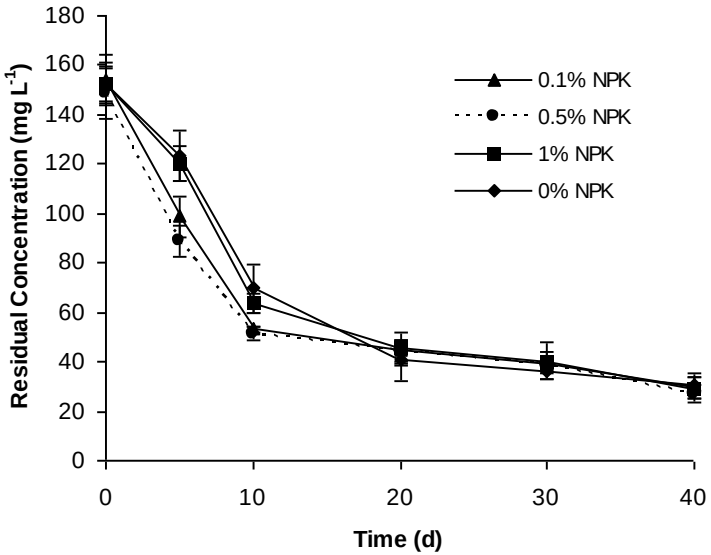
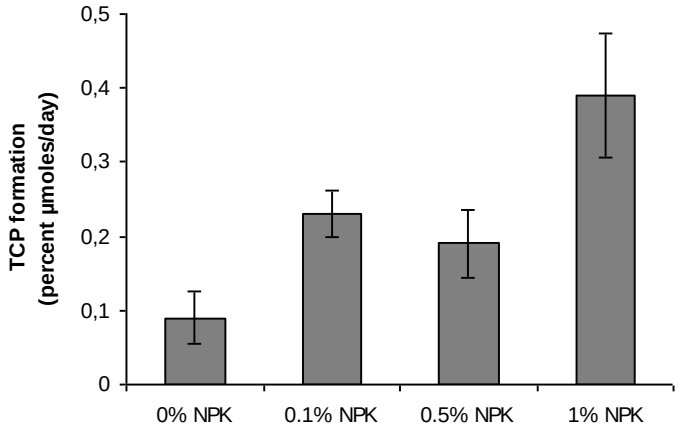
Journal of Biobased Materials and Bioenergy
Vol. 7, 741–747, 2013

Biochar as a Partial Replacement of Peat in Pesticide-Degrading Biomixtures Formulated with Different Soil Types

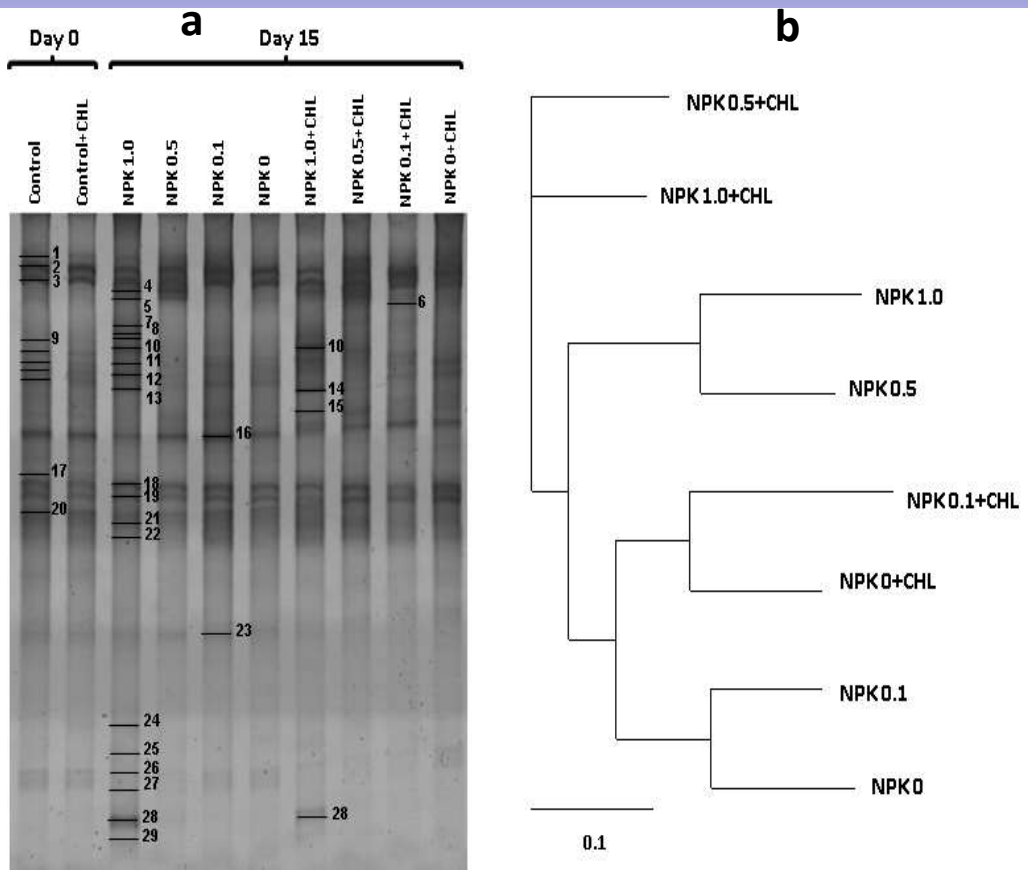
M. Cristina Diez[1,3,*], Marcela Levio[3], Gabriela Briceño[2,3], Olga Rubilar[1,3], Gonzalo Tortella[1,3], and Felipe Gallardo[2,3]

2 NPK Addition - Microbial Diversity Evaluation





Chlorpyrifos degradation and TCP accumulation in a biobed biostimulated with NPK fertilizer after 40 days of incubation. (Initial chlorpyrifos conc. 160 mg kg-1)



DGGE banding pattern (a) and clustering representation (b) of the bacterial 16S rRNA genes amplified with the primers sets EUBf933- GC/ EUBr1387

NPK of 0.5 and 1.0%, modified the bacterial community and affected TCP degradation (Tortella et al., 2010)

Chemosphere 88 (2012) 224–228

Contents lists available at SciVerse ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Technical Note

Chlorpyrifos degradation in a biomixture of biobed at different maturity stages

G.R. Tortella [a,*], O. Rubilar [a], M.d.P. Castillo [b], M. Cea [a], R. Mella-Herrera [a], M.C. Diez [a]

J. Soil Sci. Plant Nutr. 10 (4): 464 - 475 (2010)

BIOSTIMULATION OF AGRICULTURAL BIOBEDS WITH NPK FERTILIZER ON CHLORPYRIFOS DEGRADATION TO AVOID SOIL AND WATER CONTAMINATION

. Tortella[1]*, O. Rubilar[1], M. Cea[1], C. Wulff[1], O. Martínez[1], and M.C. Diez[1,2]

International Biodeterioration & Biodegradation 85 (2013) 8–15

Contents lists available at SciVerse ScienceDirect

International Biodeterioration & Biodegradation

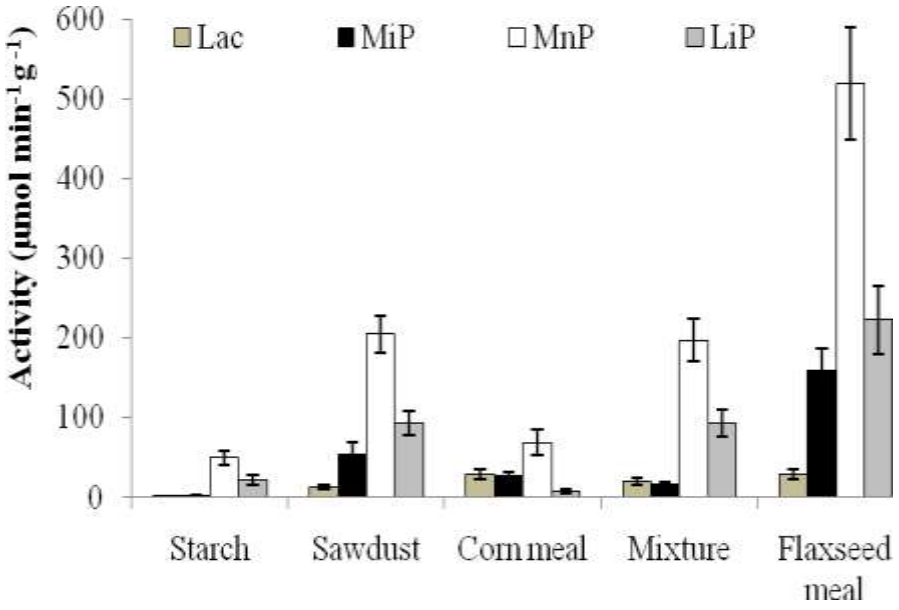
journal homepage: www.elsevier.com/locate/ibiod

Natural wastes rich in terpenes and their relevance in the matrix of an on-farm biopurification system for the biodegradation of atrazine

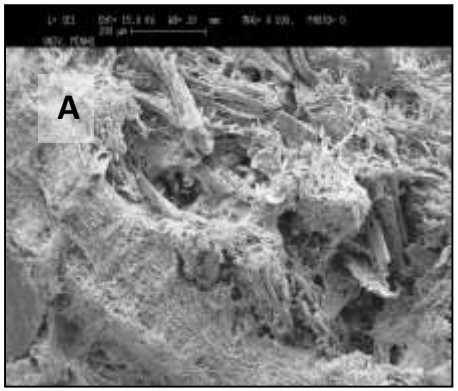
G.R. Tortella [a,b,*], O. Rubilar [a,b], M. Cea [a,b], G. Briceño [a,b], A. Quiroz [b,c], M.C. Diez [a,b], L. Parra [b,c]

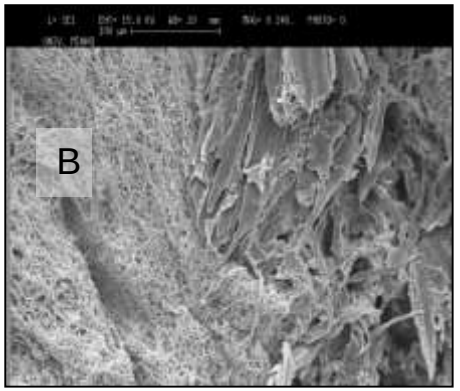
Pellet Formulation for WRF Immobilization

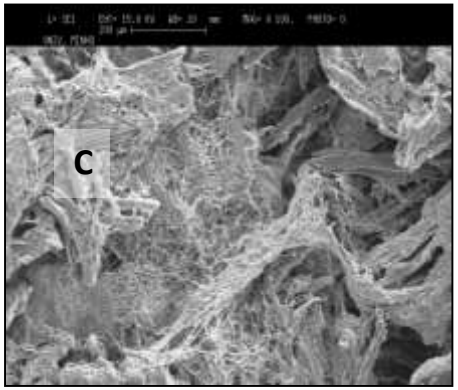
Patent 01395-2013, 16/05/2013.

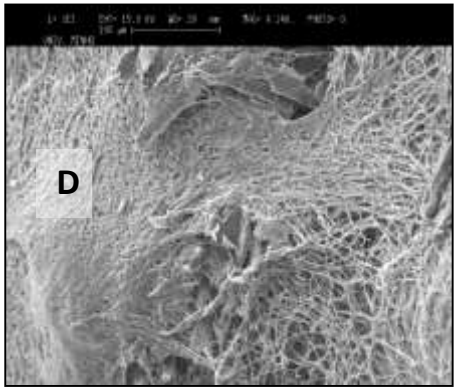


Cumulated ligninolytic activities of *A. discolor* on different materials





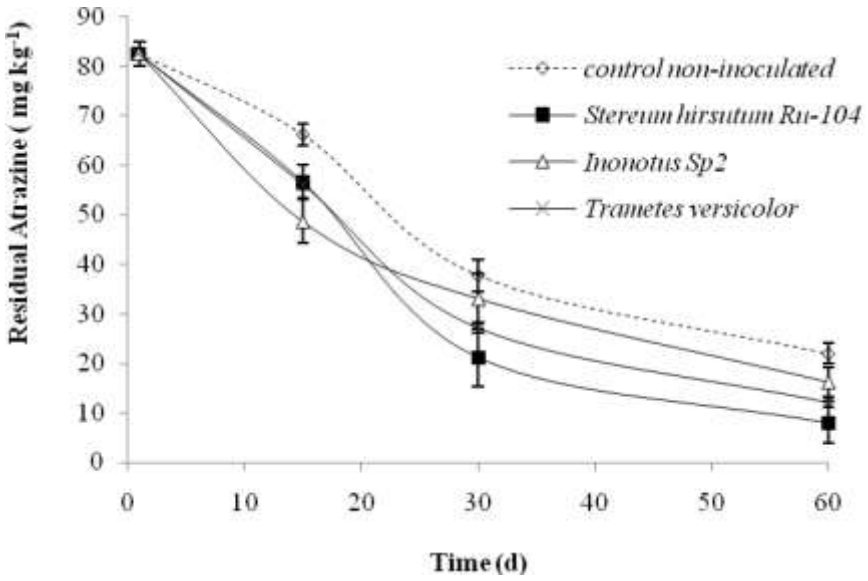


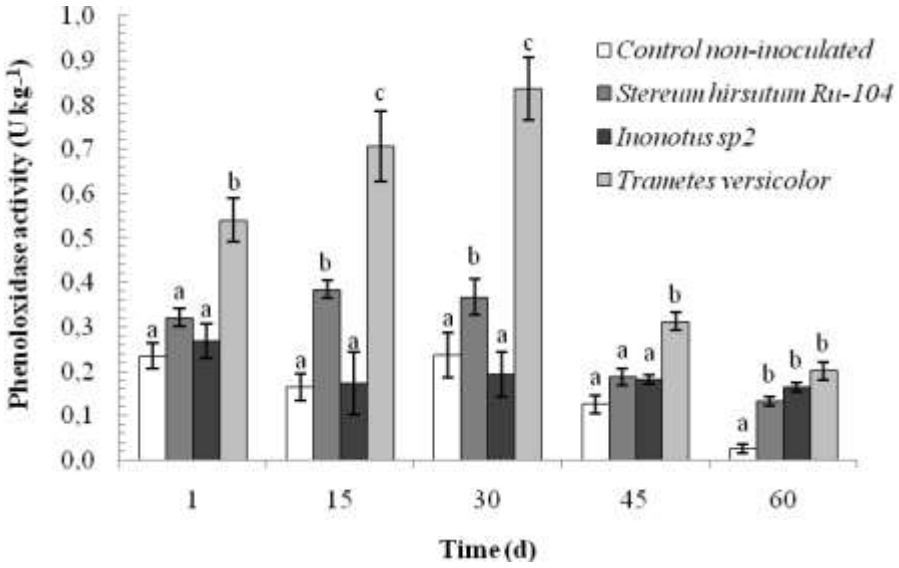


Scanning electron microscopy of *A. discolor* overgrown in the formulation F1, 30 days of storage. Core of F1-CPS at 4 ºC (A), surface F1-CPS at 25 ºC (B), core F1-UPS at 4 ºC (C), surface F1-UPS at 25 ºC (D).

Elgueta et al., 2016

Atrazine Degradation - Immobilized WRF





Residual atrazine (mg kg^{-1}) after 60 days at 20 °C, in a biomixture inoculated with pelletized support of white-rot fungi.

Phenoloxidase activity (U kg^{-1}) after 60 days at 20 °C, in a biomixture inoculated with pelletized support of white-rot fungi.

Elgueta et al., 2016

Elgueta et al. AMB Expr (2016) 6:104
DOI 10.1186/s13568-016-0275-z

AMB Express

ORIGINAL ARTICLE Open Access

Immobilization of the white-rot fungus *Anthracophyllum discolor* to degrade the herbicide atrazine

S. Elgueta[1,2*], C. Santos[2], N. Lima[3] and M. C. Diez[4]

JOURNAL OF ENVIRONMENTAL SCIENCE AND HEALTH, PART B
2017, VOL. 0, NO. 0, 1–7
https://doi.org/10.1080/03601234.2017.1330070

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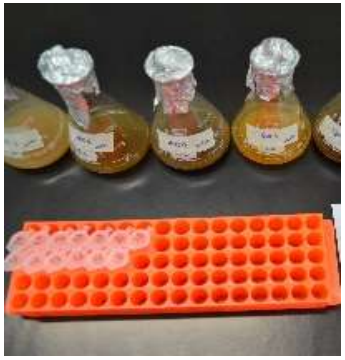
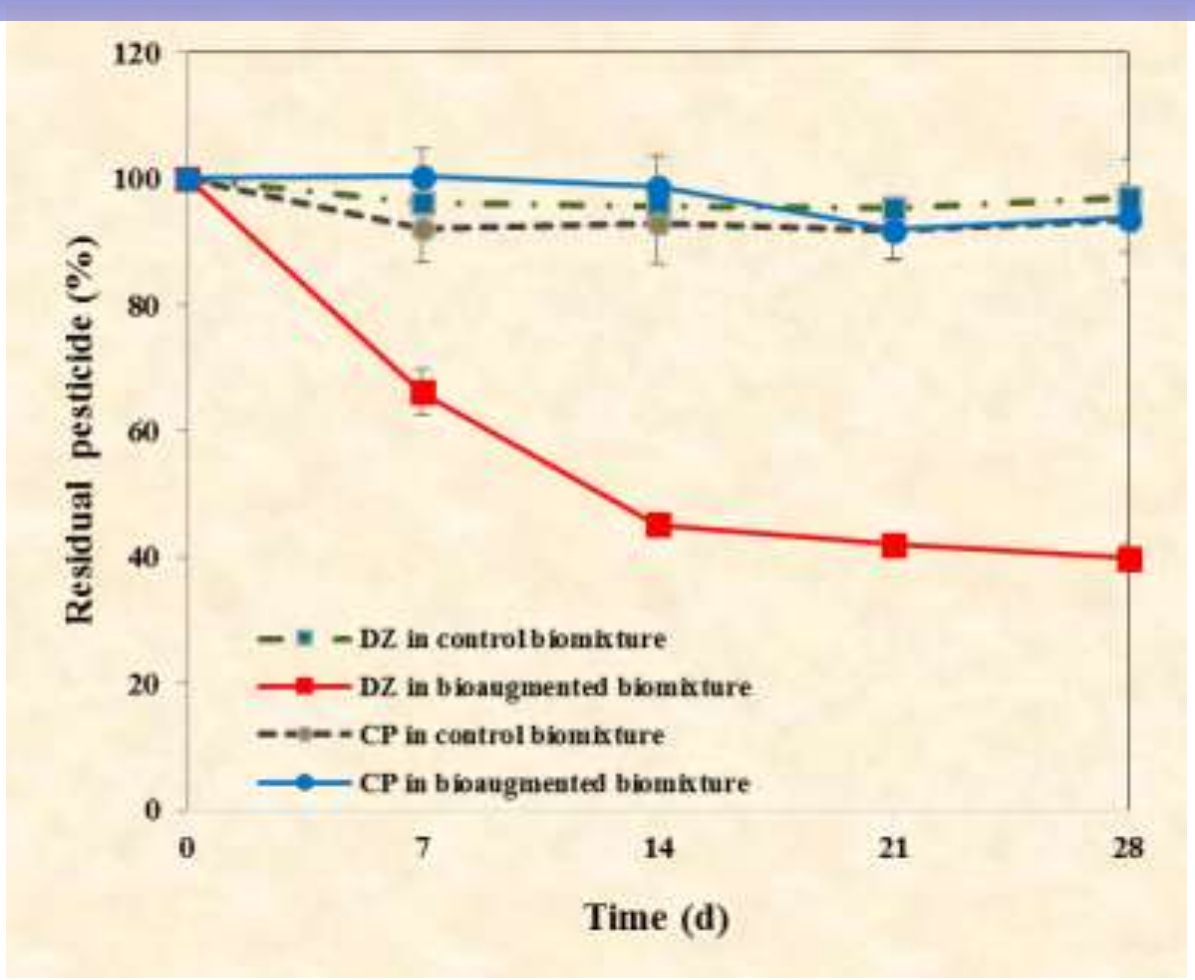
Check for updates

Atrazine, chlorpyrifos, and iprodione effect on the biodiversity of bacteria, actinomycetes, and fungi in a pilot biopurification system with a green cover

Sebastian Elgueta[a,b], Arturo Correa[b], Marco Campo[a], Felipe Gallardo[a], Dimitrios Karpouzas[d], and Maria Cristina Diez[a,c]

Actinobacteria Consortia - Pesticides Degradation





Diazinon and Chlorpyrifos removal from sterilized (control) and inoculated biomixture by the Streptomyces mixed culture during 4 weeks.

Briceño et al., 2016

Environ Sci Pollut Res
DOI 10.1007/s11356-017-9790-y

ADVANCES IN ENVIRONMENTAL BIOTECHNOLOGY AND ENGINEERING 2016

Organophosphorus pesticide mixture removal from environmental matrices by a soil *Streptomyces* mixed culture

Gabriela Briceño[1,2] · Karen Vergara[1] · Heidi Schalchli[1,3] · Graciela Palma[4] · Gonzalo Tortella[1,2] · María Soledad Fuentes[5] · María Cristina Diez[1,3]

International Biodeterioration & Biodegradation 73 (2012) 1–7

Contents lists available at SciVerse ScienceDirect

International Biodeterioration & Biodegradation

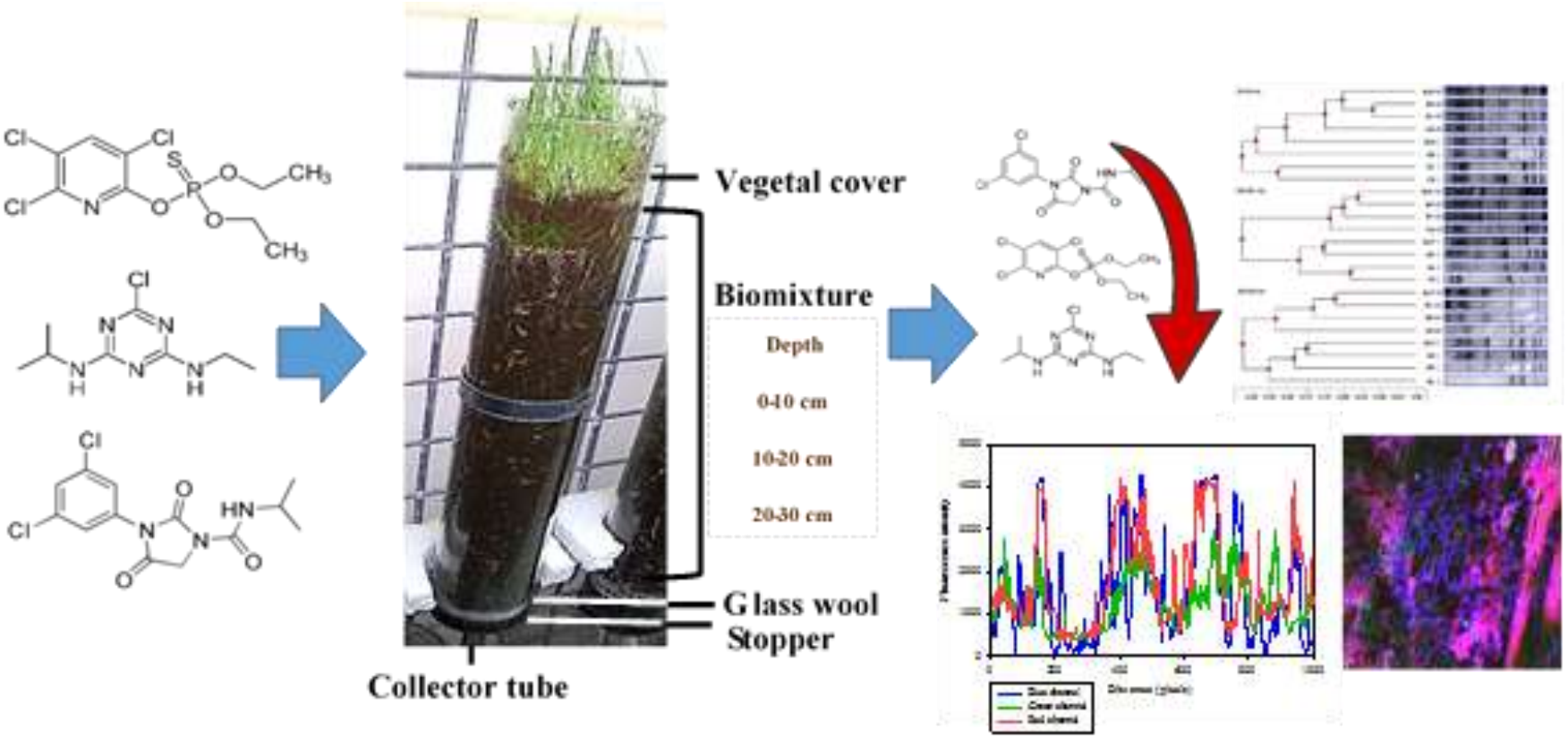
journal homepage: www.elsevier.com/locate/ibiod

Chlorpyrifos biodegradation and 3,5,6-trichloro-2-pyridinol production by actinobacteria isolated from soil

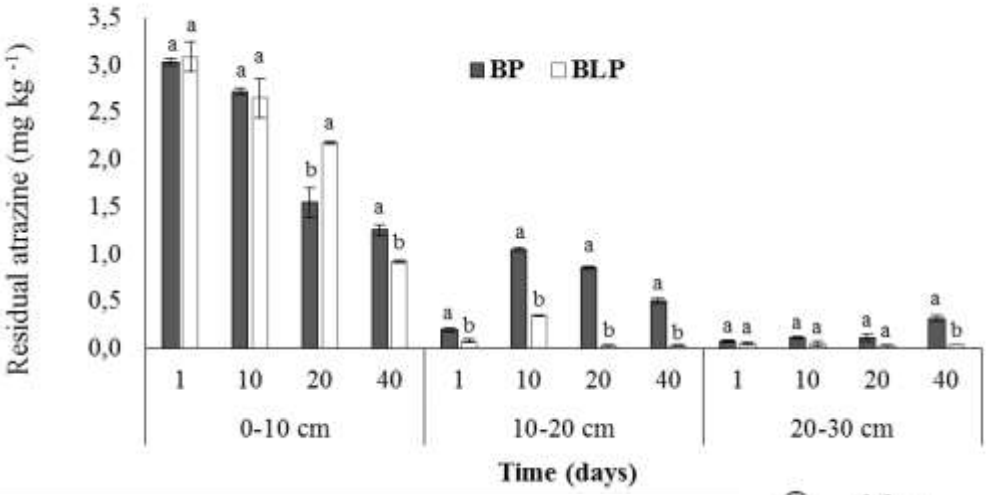
G. Briceño[a,b,c,*], M.S. Fuentes[d], G. Palma[b,c], M.A. Jorquera[b,c], M.J. Amoroso[d,e], M.C. Diez[a,c]

[a] Department of Chemical Engineering, Universidad de La Frontera, P.O. Box 54-D, Temuco, Chile
[b] Department of Chemical Science, Universidad de La Frontera, Temuco, Chile
[c] Scientific and Technological Bioresource Nucleus, Universidad de La Frontera, Temuco, Chile
[d] Planta Piloto de Procesos Industriales Microbiológicos (Proimi-Conicet), Avenida Belgrano y Pasaje Caseros, 4000 Tucumán, Argentina
[e] Facultad de Bioquímica, Química y Farmacia, Universidad Nacional de Tucumán, 4000 Tucumán, Argentina

5 Effect of the Rhizosphere on Pesticides Degradation

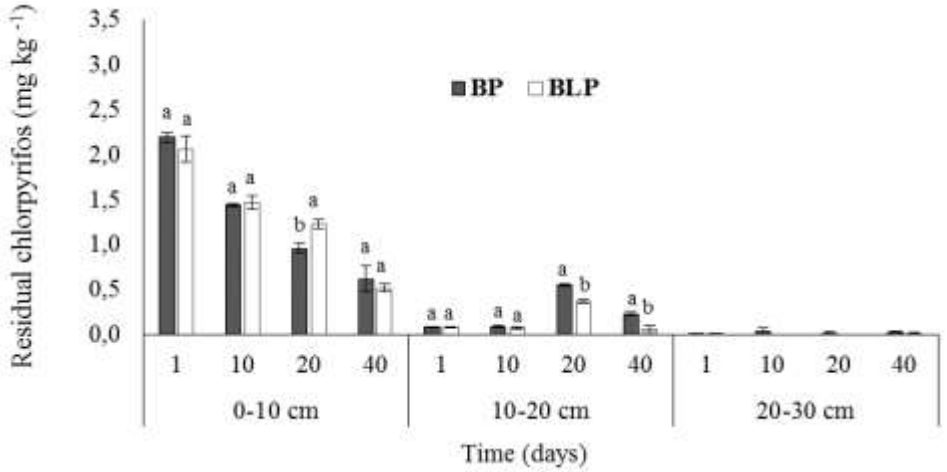


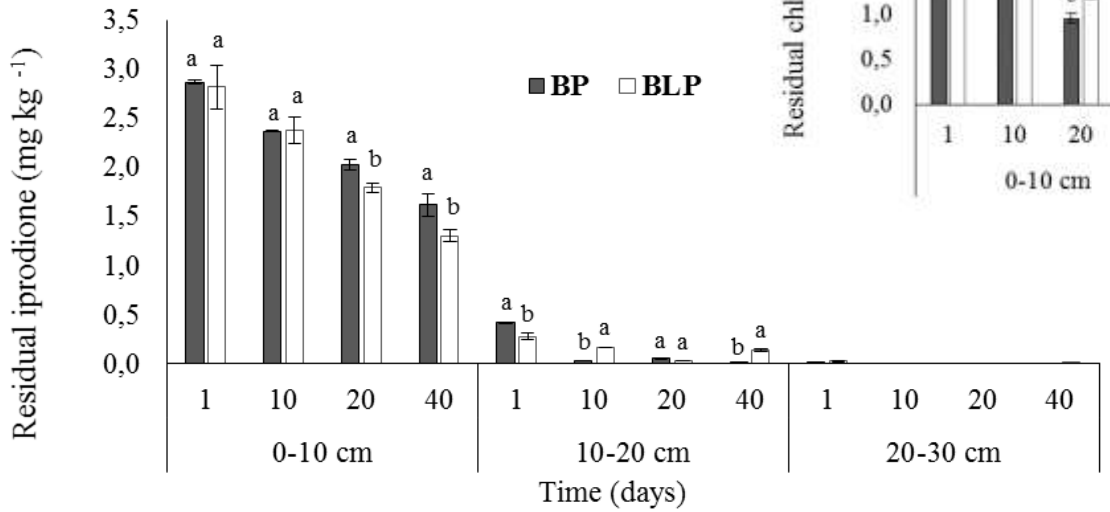
Effect of the Rhizosphere on Pesticides Degradation



Columns Assays

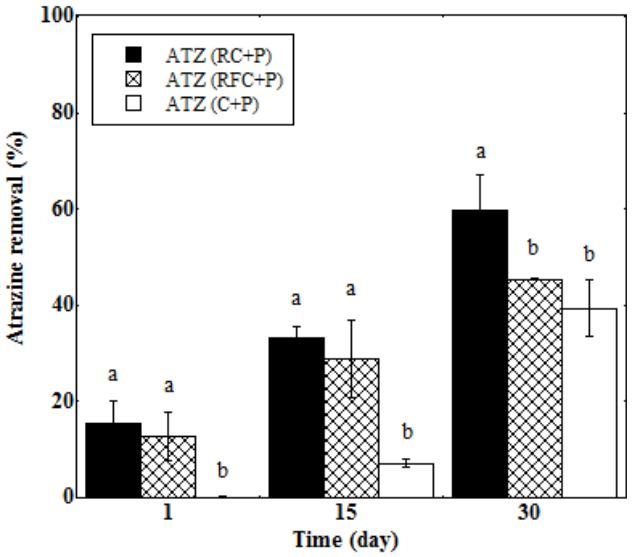
Single application

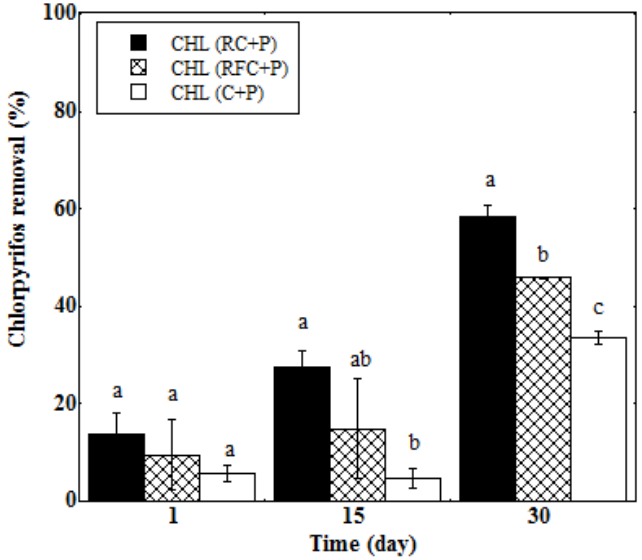


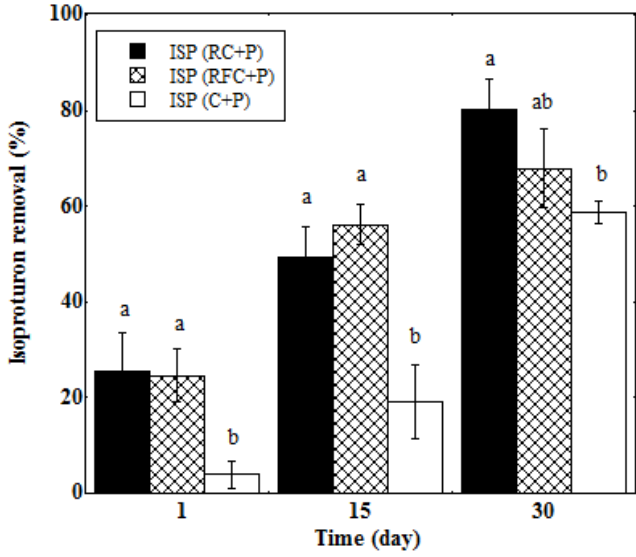


Diez et al., 2017a

PESTICIDES DEGRADATION – RHIZOSPHERE – Lab Scale







Pesticides removal ATZ, CHL and ISP (5 mg kg-1) in the biomixture with roots (RC+P), without roots (RFC+P) and control(C+P).

Biomixture= soil, peat and oat husk (1:1:2)

Urrutia et al. 2015

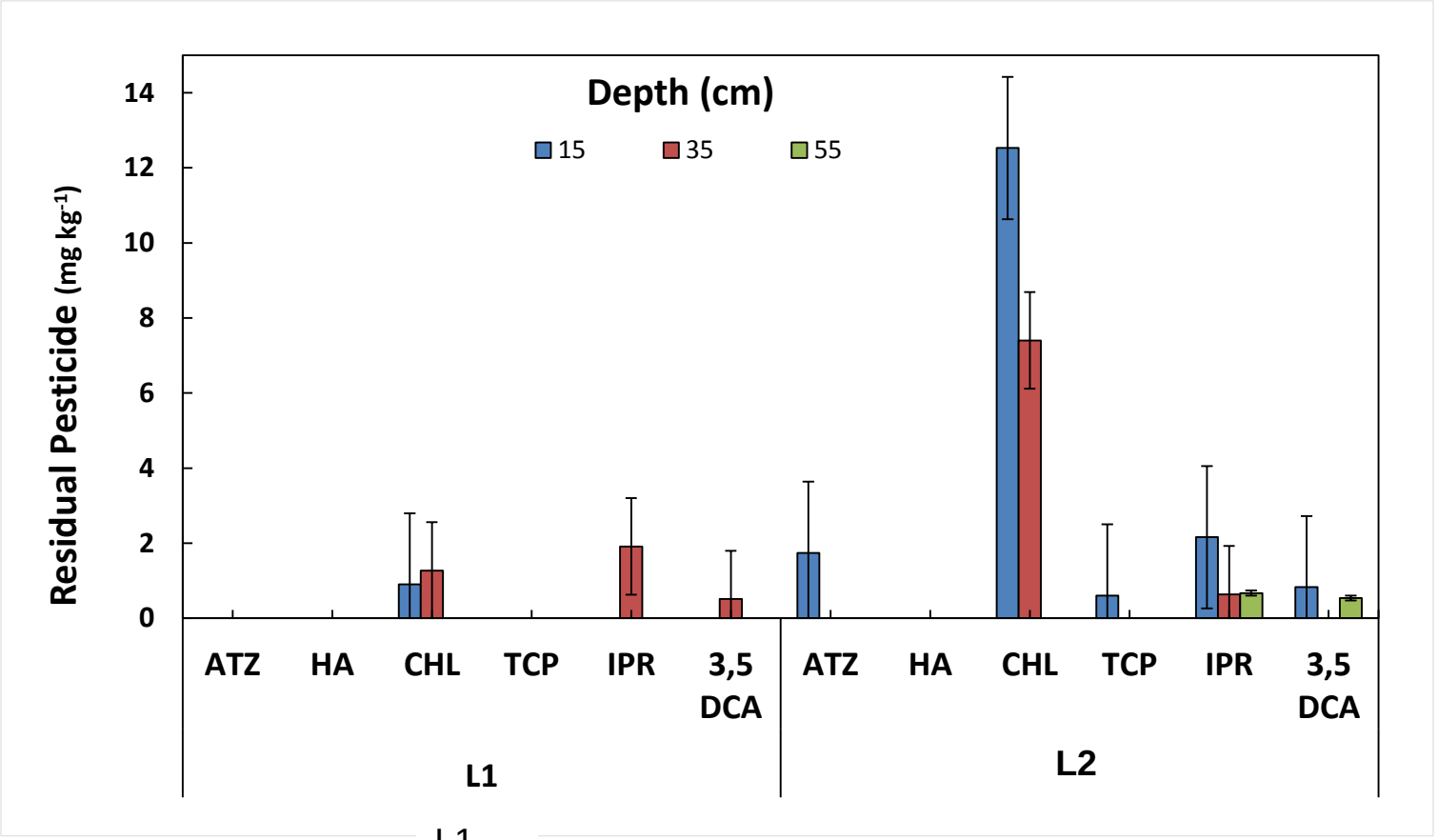
5 Effect of the Rhizosphere on Pesticides Degradation






Units of 1m^3 with and without vegetal cover + control without pesticides

5 RESIDUAL PESTICIDES AND METABOLITES



Pesticides and metabolites concentrations in the biomix after 60 days at three depth of biobed. With pesticides and vegetal cover (L1), With pesticides without vegetal cover. (L2) Single application . Pond Assay

Journal of Environmental Management 187 (2017) 103–110

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Research article

Bioaugmentation and rhizosphere-assisted biodegradation as strategies for optimization of the dissipation capacity of biobeds

M. Campos [a], C. Perruchon [b], P.A. Karas [b], D. Karavasilis [b], M.C. Diez [c], D.G. Karpouzas [b, *]

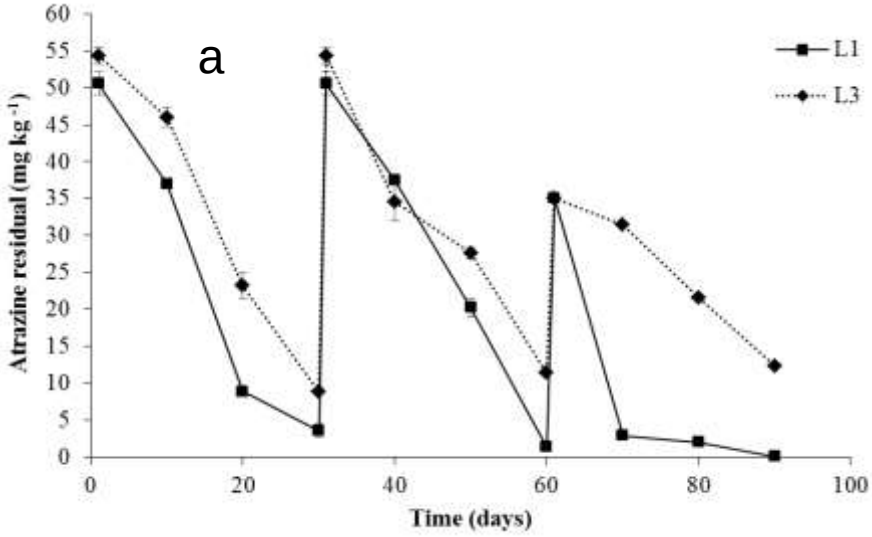
Journal of Soil Science and Plant Nutrition, 2015, 15 (2), 410-421

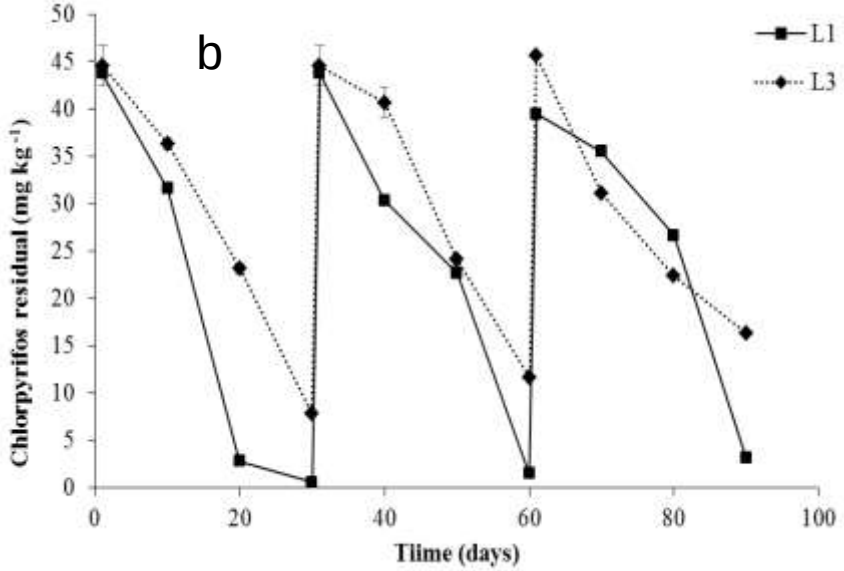
RESEARCH ARTICLE

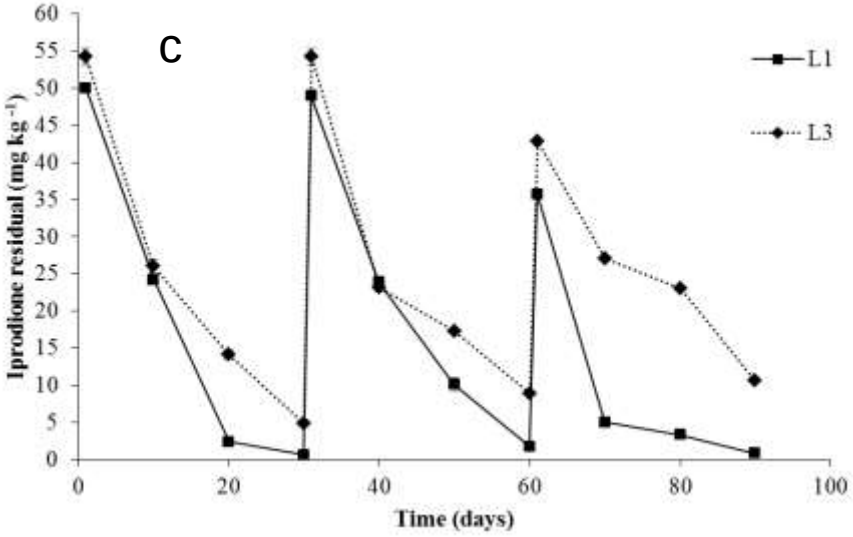
Rhizosphere effect on pesticide degradation in biobeds under different hydraulic loads

M.C. Diez[1,3*], H. Schalchli[1,3], S. Elgueta[3], E. Salgado[3], N. Millahueque[3], O. Rubilar[1,3], G.R. Tortella[3], G. Briceño[3]

Residual Pesticides - Reapplied







Concentración residual de Atrazina (a), Clorpirifos (b) e Iprodiona (c) en la biomezcla (15 cm) con 3 reaplicaciones L1 (con plaguicida con ballica), L3 (con plaguicida sin ballica).

Diez et al 2017b

Pesticides - Reapplied

Plaguicida	Periodo (días)	Disipación (%) Sin Cubierta Vegetal	Disipación (%) Con Cubierta Vegetal
ATZ	1-30	83,7	92,8
	31-60	79,0	97,2
	61-90	64,8	99,6
CHL	1-30	82,4	98,7
	31-60	73,8	96,6
	61-90	64,2	91,9
IPR	1-30	91,2	98,8
	31-60	83,7	96,5
	61-90	75,1	97,8

Disipación (%) de los plaguicidas. Promedio de los tratamientos con y sin cubierta vegetal.

Diez et al 2017b

Pesticides - Reapplied

Plaguicida	Periodo (d)	t 1/2 (d) Sin Cub Vegetal	t 1/2 (d) Con Cub. Vegetal
ATZ	1-30	10,9	7,2
	31-60	13,7	5,9
	61-90	19	4
CHL	1-30	11,8	4,3
	31-60	14,7	6,4
	61-90	19,8	8,5
IPR	1-30	8,5	4,3
	31-60	11,7	6,2
	61-90	15,5	5,7
Promedio		14,0	5,83

Tiempo de vida media (t 1/2) por plaguicida . Promedio de los tratamientos con y sin cubierta vegetal

Diez et al 2017b

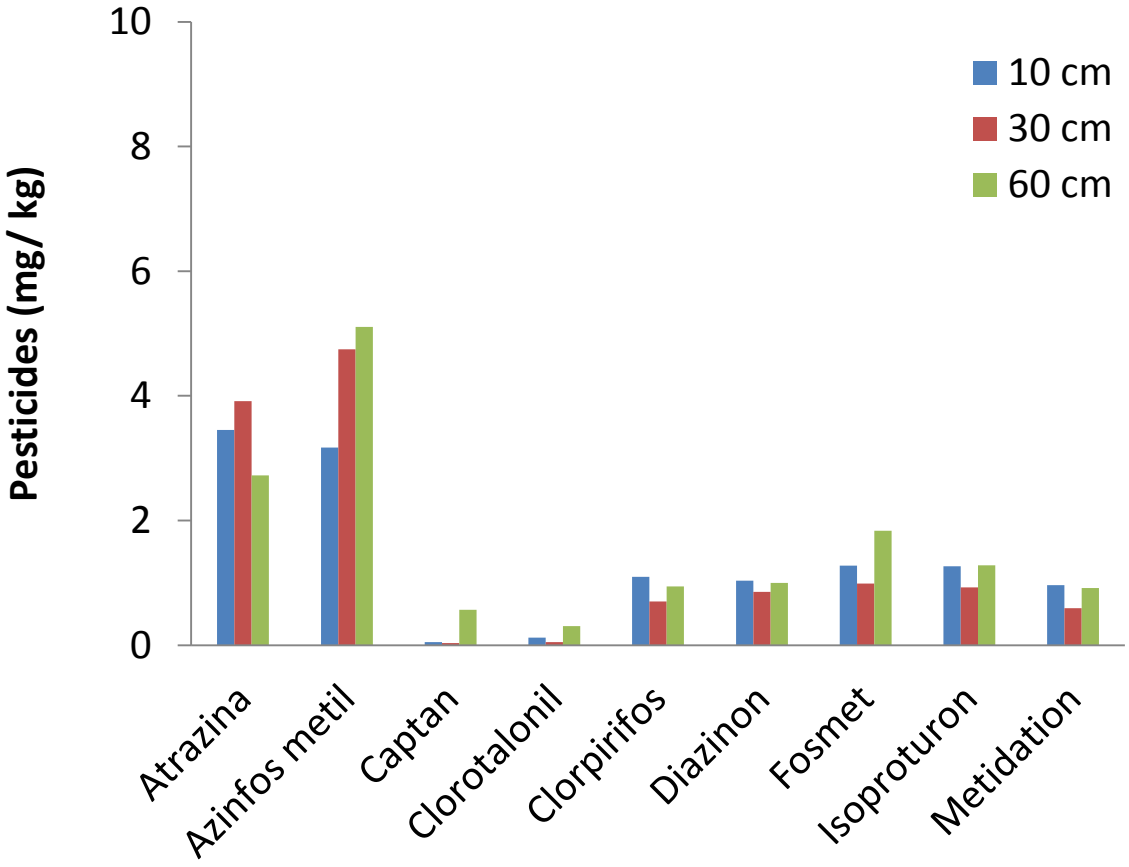
DEGRADATION OF PESTICIDES IN BIOBEDS-FARM SCALE

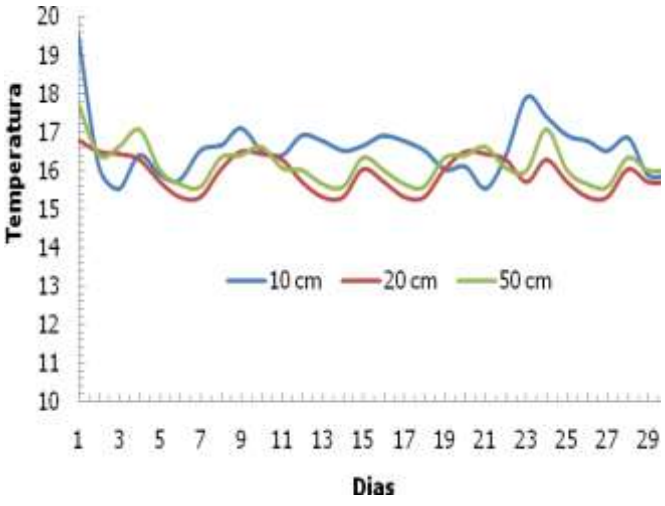
PESTICIDES EVALUATED

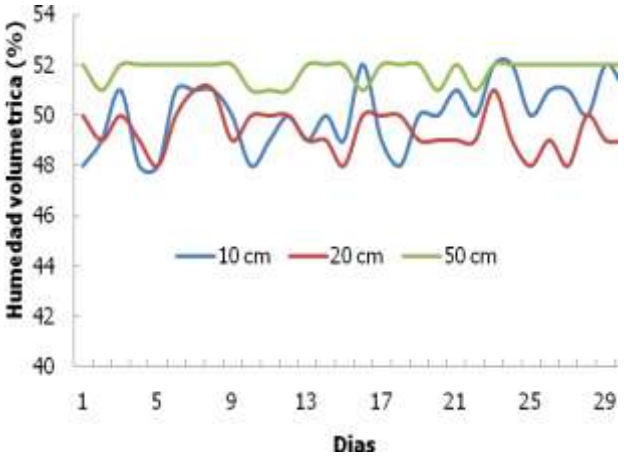
Commercial name	Active ingredient	Type	Concentration a.i.
Pyrinex 48 EC	Clorpirifos	Insecticida	480
Captan 80 WP	Captan	Funguicida	800
Clorotalonil 72 SC	Clorotalonil	Funguicida	720
Imidan 70 WP	Fosmet	Insecticida	700
Supracid 40 WP	Metidation	Insecticida	400
Guzation 35 WP	Azinfosmetil	Insecticida	350
Atrazina 500 SC	Atrazina	Herbicida	500
Diazinon	Diazinon	Insecticida	400
Fuego	Isoproturon	Herbicida	500

*P. C= Producto Comercial

DEGRADATION OF PESTICIDES IN BIOBEDS-FARM SCALE





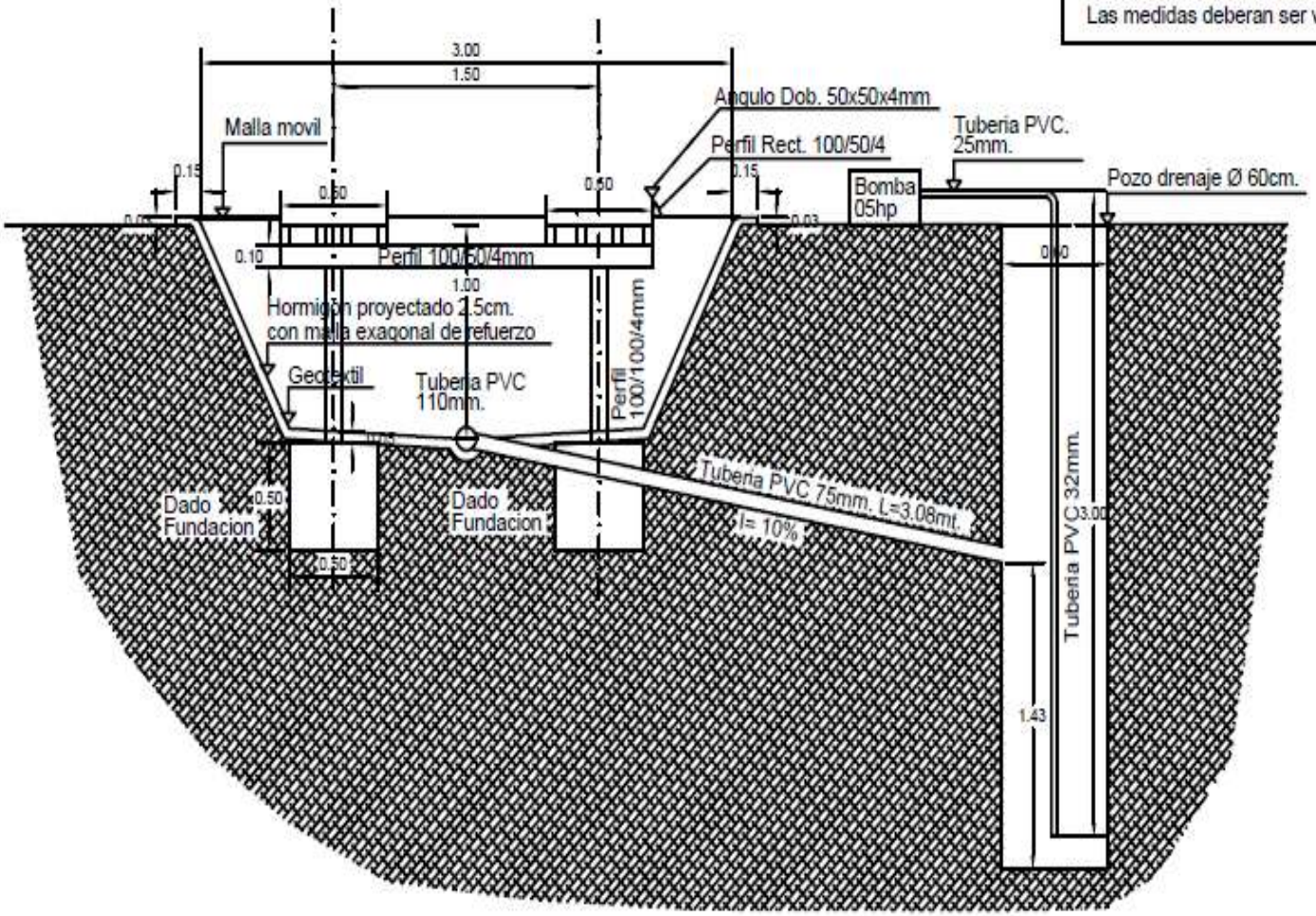


Residual pesticides in the biobed after 120 days of application (inicial concentration 45 mg i.a./kg each)

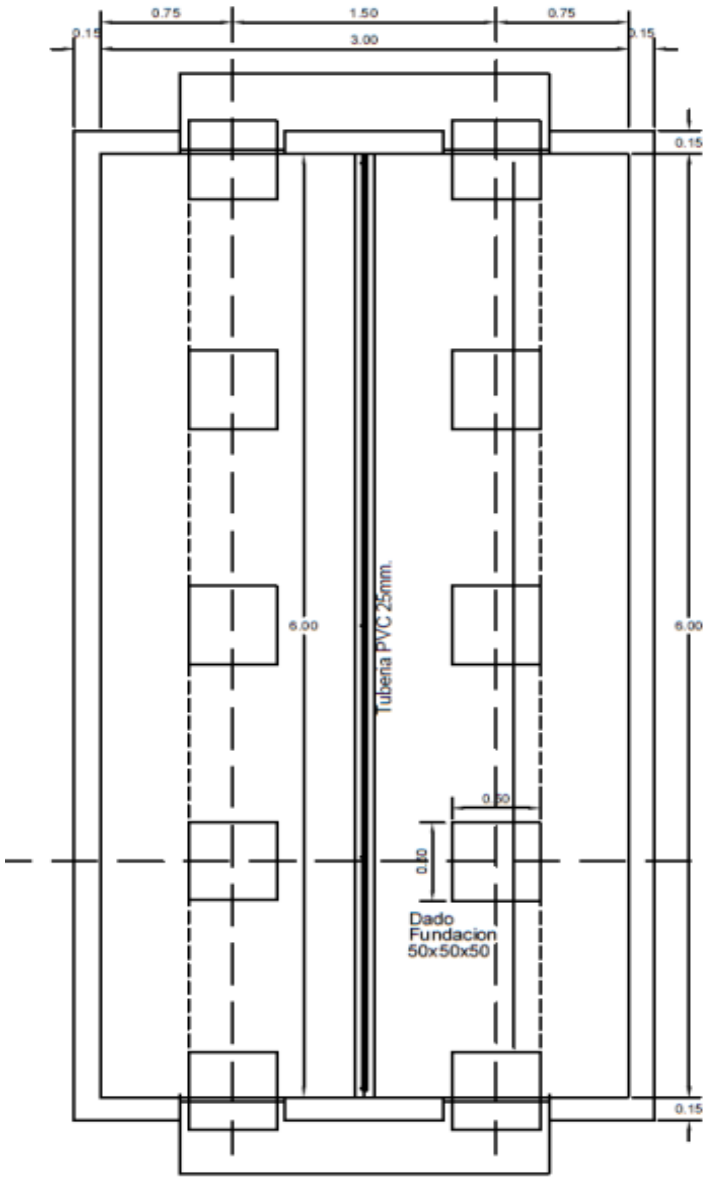
BIOBED CONSTRUCTION

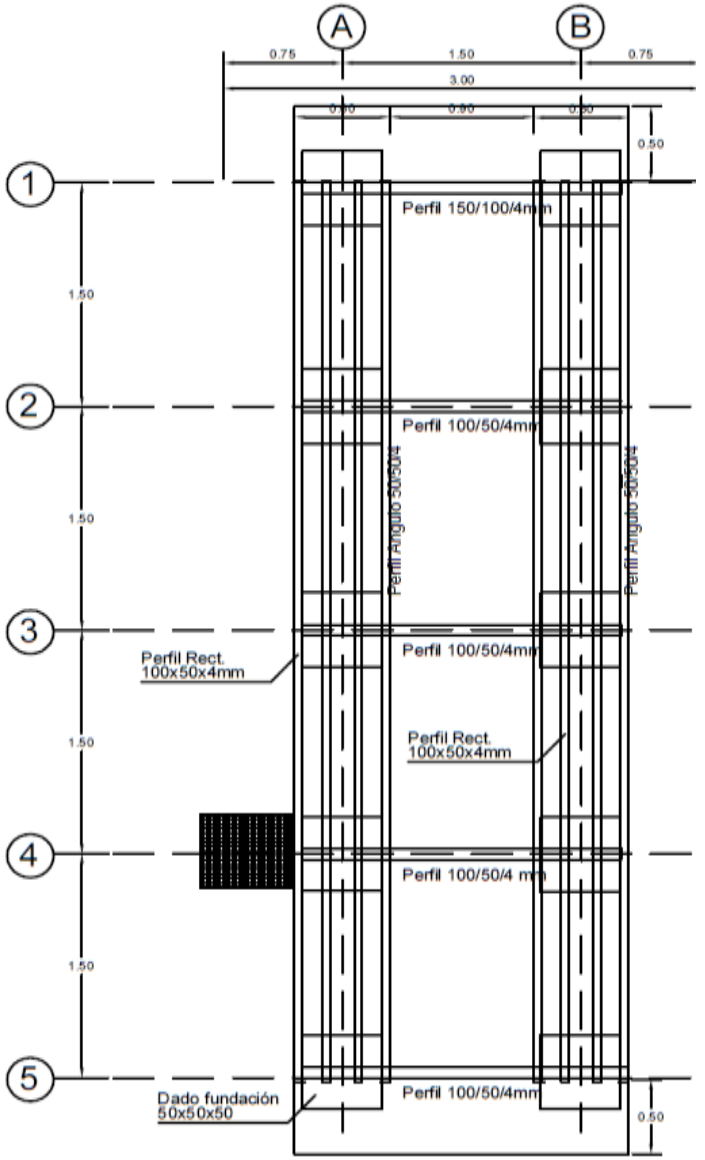
NOTA:
Los materiales a utilizar para la estructura metalica deben ser resistente segun calculo para 5.000 Kg. (Tractor)

Las medidas deberan ser verificadas en obras



BIOBED DESIGN





CONSTRUCTION

Excavación

Instalación de fundaciones

Instalación de malla

Revestimiento con hormigón

Instalación de travesaños

Instalación de rampa

Instalación de geotextil

Bomba y sistema de recirculación

CONSTRUCTION

Incorporación de arena y gravilla

Incorporación de biomezcla

Capa de suelo

Instalación de césped

Lecho biológico

Lecho biológico con techumbre

DIFUSION

MATERIALS


MANUAL DE CONSTRUCCIÓN
Y OPERACIÓN DE
LECHOS BIOLÓGICOS
PROYECTO D09R1006
Manejo Adecuado de Residuos de Plaguicidas en la Producción Frutícola de la Región de La Araucanía a través de la Implementación y Difusión de Lechos Biológicos
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III Workshop Latino Americano sobre Biobed

ADVANCES IN BIOPURIFICATION SYSTEM FOR PESTICIDE DEGRADATION - CHILE

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