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EVALUATION OF THE BEHAVIOUR OF HASS PLANTS GRAFTED IN DIFFERENTROOTSTOCKS UNDER CULTURE CONDITIONS IN COPIAPÓ VALLEY

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There is an important increase in the number of avocado orchards in Chile. Due to this scenario and the incorporation of new adaphoclimatic areas far from their origin zone, a study of behaviour of different rootstocks in saline condition of culture, in Copiapó Valley, in northern Chile was performed.
This investigation was performed for 3 seasons in a block of varieties in lower Copiapó Valley. Irrigation water characteristics are the following: EC 2093 MuS cm^{-1}, 17.02 meq L^{-1} sulphates, 5.44 meq L^{-1} bicarbonates; 4,1 meq L^{-1} chlorides; 14 meq L^{-1} calcium; 6,3 meq L^{-1} magnesium 7.22 meq L^{-1} sodium; and also a concentration of 1.72 mg L^{-1} of boron, which is known to be a phytotoxic for fruit trees culture. Soil characteristics are 8% clay, 10% slime and 82% sand.

EVALUACION DEL COMPORTAMIENTO DE PLANTAS DE HASS INJERTADOS EN DIFERENTES PORTAINJERTOS DE SEMILLA BAJO CONDICION DE CULTIVO EN EL VALLE DE COPIAPO

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El cultivo del palto se ha desarrollado en forma importante en Chile. Debido a esto y a la incorporación de nuevas zonas edafoclimáticas diferentes a su zona de origen, se realizó el estudio de comportamiento de diferentes portainjertos en condición de cultivo salina, en el valle de Copiapó en el norte de Chile. Esta investigación lleva 3 temporadas en un bloque de variedades en la zona baja del valle de Copiapó. Las características del agua de riego son las siguientes: CE 2093 MuS cm^{-1}, 17,02 meq L^{-1} sulfatos; 5,44 meq L^{-1} bicarbonatos; 4,1 meq L^{-1} cloruros; 14 meq L^{-1} calcio; 6,3 meq L^{-1} magnesio; 7,22 meq L^{-1} sodio; siendo la característica más importante la concentración de 1,72 mg L^{-1} de boro, citándose en la literatura como fitotóxica para el cultivo de frutales. Las características de suelo corresponde a 8% arcilla, 10% limo y 82% de arena. Los portainjertos de semilla utilizados corresponden a Nabal, Mexicola, Thomas, Duke 7, Benix, D9, Borchard. Se midió nivel foliar de nutrientes durante 3 temporadas en plantas injertadas con Hass y en portainjertos sin la variedad injertada. Además se midió niveles foliares en plantas inoculadas con micorrizas desde vivero. Se observó que el nivel foliar es diferente para cada portainjerto y así como también de los portainjertos inoculados con micorrizas.

1. Introduction

The avocado (American Persea Mill.) it is one of the species fruit-bearing that major increase has presented as for surface planted during last years in Chile (15.050 you have. In 1996 to 24.000 you have. The year 2003; ODEPA, 2003), where our country occupies the third place worldwide in the surface of avocado of the Californian type (races Guatemalan and hybrids), Mexico and The United States, with a national output estimated in 140.000 annual tons.

According to Webber (1926) mentioned by Ben-Ya'acov and Michelson (2001), one of the most important factors of the industry of the avocado they are the rootset, nevertheless it is known very little of them. The development of the tree, health and productivity in the fruit-bearing cultures are very dependent on the type of rootset.

The avocado is sensitive to the stress of soil; extremely sensitive to the salinity and also to alkaline soils. The principal factor is the toxicity for chlorine, but in some soils one adds the sodium to the problem. The resistant rootset not send sodium towards the foliage, this way can be eliminated the burning of the leaves, but it remains the negative effect on the productivity (Ben-Ya'acov and Michelson, 2001). On the other hand, the mycorrize are mutualism associations that develop in the mayority of the most top plant species and in some fungi of soil. It is one symbiosis catalogued almost universally, so much for the number of capable plants to being colonist for the micorriza and because he is in great quantity of natural habitats (Olive groves and Barea, 1985).

Given the difficulty of absorption of nutriment that appears in soils of saline and alkaline conditions since those of Atacama's region (Copiapó) is possible to wait for a beneficial effect of the mycorrize on plants. For this motive, the aims of the present work are:

General aim:

 To evaluate the behaviour in saline conditions of different rootset belongs of seeds of avocado, inoculated in his roots with mycorrize.

Specific aims:

 To compare the behaviour in conditions of saline soil of plants belongs of seeds of avocado, varieties Mexícola, Benik, Turnip field, Thomas, Duke 7, Borchard and D9 during the first cycle of growth.

 To determine if the inoculation with mycorrize arbusculares Glomus intraradices of the roots of sayings rootset, belongs of seeds of avocado, increases the tolerance to the saline condition during the first cycle of growth.

3. Materials and Method

3.1. Place of the tests

The investigation was composed by two tests, which were effected in the property in the country Bramador, belonging to Uniagri-Copiapó Ltda., located in the Km 9 of the highway north - south, Copiapó, III region.

3.2. Vegetable (plant) material and characteristics of the zone

The investigation was realized in a plantation of 6 bosses of avocado belongs of seeds, correspondent to the varieties Mexícola, Benik, Turnip field, Thomas, Duke 7 and D9. The rootset are grafted with the variety Hass. In case of the first test all the grafts of every variety were inoculated with mycorrize, corresponding to the genre Glomus, species intraradices (Schenck and Smith), that come from a solid way of sand and are developed by the company SYTEN (Substances and natural technologies, España). For the second one I test only the half of the grafts of every variety they are inoculated with micorriza.

3.3. Test I

3.3.1. Materials

24 grafts were in use of avocado of five years of age, which are divided in 3 varieties of rootset belongs of seed, of which 8 grafts belong to each one. In turn they are subdivided in 4 grafts grafted with the variety Hass, and 4 without grafting. On the other hand all the grafts are inoculated with 20 g of mycorrize glomus intraradices.

3.3.2. Methodology

Consisted of the measurement of analysis you will foliate realized on March 2, 2007, together with the evaluation of previous information corresponding to the year 2004 and 2005, that they can determine the behaviour of 3 varieties of rootset grafted with the variety Hass and without grafting, all inoculated with mycorrize.

3.3.3 Treatments I

The treatments (factor A) correspond to each of the bosses, who were in use, are 3:

1. Mexícola
2. Nabal
3. Benik

Each of the treatments were evaluated (factor B or subtreatments):

- with graft
- without graft

3.3.4. Statistical analysis

The test does not constitute in yes an experimental design. Nevertheless, the results of the measurements there were analyzed with a classification factorial 3 X 2.

3.3.5. Variables to measuring

 The foliar analysis, with the purpose of obtaining nutritional information of the plants.

3.4. I test II

3.4.1. Materials

A total of 80 grafts were in use of avocado of five years of age, which are divided in 3 varieties of rootset belongs of seed, of which 16 grafts belong to each one. Each of the different types of rootset is grafted with the variety Hass. In turn they are subdivided in grafts inoculated with 20 grams by plant of mycorrize and without inoculating.

3.4.2. Methodology

This test consisted of a variable realized (fulfilled) on March 2, 2007, that it will be evaluated as a whole with previous information obtained between(among) October, 2002 and May, 2004, April, 2005, which can determine the behaviour of 3 varieties of rootset inoculated and without inoculating with mycorrize.

3.4.3. Treatments test II

The treatments correspond to each of 3 bosses who were in use:

1. Duke 7
2. D9
3. Thomas

Subtreatments

1. With mycorrize
2. Without mycorrize

3.4.4. Statistical design

The statistical used design was that of divided blocks.

3.4.5. Variables to measuring

 The leaf analysis, with the purpose of obtaining nutritional information of the plants.

4. Presentation and Discussion of Results

Immediately result appears in separated form and analyses corresponding to every test. The information has prepared in pictures and graphs to facilitate its comprehension.

4.1. Test I

Square 4.1.2 summary of the averages analysis you will foliate test I for year 2004, 2005 and 2007. (Original document in annexes)

	Factor B	***N (%)***	***Cloruros (mg/kg)***	***P (%)***	***Ca (%)***	***Mg (%)***	***K (%)***	***Na (mg/kg)***	***S (%)***	***B (mg/kg)***	***Fe (mg/kg)***	***Mn (mg/kg)***	***Cu (mg/kg)***	***Zn (mg/kg)***
T 1	*C/injerto*	*1,95*	*3037,3*	*1,145*	*1,625*	*0,44*	*1,11*	*<250*	*0,50*	*91,7*	*116,2*	*39,15*	*11,3*	*24,1*
	S/injerto	1,74	3385,8	0,16	2,24	0,67	1,13	399,8	0,51	142,7	181,5	49,1	14,5	23,02
T 2	*C/injerto*	*1,88*	*2056*	*0,153*	*2,26*	*0,71*	*1,31*	*<250*	*0,50*	*107,7*	*106,3*	*52,26*	*7,26*	*28,6*
	S/injerto	1,81	3625	0,16	1,97	0,63	1,63	<250	0,51	106,9	155	61,9	7,5	23,57
T 3	*C/injerto*	*1,93*	*2579*	*0,143*	*2,24*	*0,77*	*1,28*	*<250*	*0,61*	*83*	*119,1*	*56,20*		*29,5*
	S/injerto	2,03	2874	0,17	1,66	0,54	1,52	<250	0,41	118,6	123,4	36,03	8,9	23,8

T1 = Mexícola
T2 = Nabal
T3 = Benik

4.1.3. Discussions analysis to foliate test I

1. Calcium, Magnesium and Sodium:

a. Treatments: Mexicola is the rootset with major concentration
b. Subtreatments (Factor B): The varieties without grafting in general there present major levels of these elements.

2. Nitrogen:

a. Treatment: it is possible to observe that Benik is the rootset that absorbed more this element.
b. Subtreatments (Factor B): The subtreatments without grafting present a major level of the above mentioned elements.

3. Boron, Iron and Copper:

a. Treatment (Factor A): These elements were absorbed in bigger quantity by the variety Mexicola.
b. Subtreatments (Factor B): The varieties without grafting in general there present bigger levels of these elements.

4. Chlorides:

a. Treatments: Mexicola corresponds to the rootset who presents bigger level of chlorides in his leaves.
b. Subtreatments (Factor B): The varieties without grafting in general there present bigger levels of these elements.

5. Potassium:

a. Treatments (Facto A): In this case it was Nabal who absorbed bigger quantity of this element.
b. Subtreatments (Factor B): The subtreatments without graft present a bigger level of the above mentioned elements.

6. Phosphorus and Zinc:

a. Treatments (Factor A): It Was Benik the variety that absorbed more of these elements. b. Subtreatments (Factor B): The grafted varieties were who presented bigger concentration of Zinc, nevertheless who obtained bigger level of Phosphorus were them without grafting.

7. Manganese:

a. Treatments (Factor A): According to it is observed in the picture, it was Nabal the rootset in to absorb bigger content of the above mentioned element.
b. Subtreatments (Factor B): The grafted varieties presented slightly bigger concentration of manganese.

4.2. Test II

Square 4.2.1. Summary of the averages analysis you will foliate test I for year 2004, 2005 and 2007. (Original document in annexes)

	Factor B	***N (%)***	***Cloruros (mg/kg)***	***P (%)***	***Ca (%)***	***Mg (%)***	***K (%)***	***Na (mg/kg)***	***S (%)***	***B (mg/kg)***	***Fe (mg/kg)***	***Mn (mg/kg)***	***Cu (mg/kg)***	***Zn (mg/kg)***
T 1	*C/micorrizas*	*1,63*	*1,88*	*0,115*	*1,67*	*0,45*	*1,05*	*270*	*0,5*	*98,95*	*92,25*	*143,8*	*9,3*	*15,95*
	S/micorrizas	1,62	1,64	0,15	1,66	0,48	1,405	<250	0,87	134,9	132.3	105,1	13,25	22
T 2	*C/micorrizas*	1,89	*1,64*	*0,14*	*1,99*	*0,50*	*1,27*	*<250*	*0,49*	*122,4*	*89,5*	*140,6*	*9,61*	*18,68*
	S/micorrizas	1,46	1,75	0,13	2,23	0,60	1,15	<250	0,51	120,3	128	100,6	11,12	24,8
T 3	*C/micorrizas*	*1,89*	*1,37*	*0,15*	*1,28*	*0,34*	*1,74*	*<250*	*0,39*	*176,9*	*104,3*	*133,8*	*11,7*	*18,76*
	S/micorrizas	1,81	1,68	0,14	2,03	0,55	0,59	<250	0,52	138,6	120	322,8	11,95	23,9

T1 = Duke 7
T2 = D9
T3 = Thomas

4.2.3. Discussions analysis to foliate test II

1. Nitrogen:

a. Treatments (Factor B): Thomas I turn out to be the rootset with bigger concentration of Nitrogen.
b. Subtreatments (with without mycorrize): The varieties with mycorrize presented more.

2. Chlorides, Calcium, Magnesium and Sodium:

a. Treatments (Factor A): The bigger concentration I present in the mycorrize D7. b. Subtreatments (with and without mycorrize): In general the varieties without mycorrize presented bigger concentration of the mentioned elements.

3. Phosphorus and Potassium:

a. Treatments: It Was D9 the variety of rootset that absorbed more P and K

b. Subtreatments (with and without mycorrize): Bigger concentration of Potassium in inoculated.

4. Boron, Iron and Manganese:

a. Treatment (Factor A): I observe bigger level of these elements in Thomas.
b. Subtreatments (with and without mycorrize): In general the bigger concentrations were in the subtreatments without mycorrize.

5. Copper :

a. Treatment (Factor A): The variety D7 I present the broad more level of is you element.
b. Subtreatments (with and without mycorrize): In general the varieties without mycorrize presented bigger concentration.

6. Zinc and Sulphur:

a. Treatments (Factor A): It Was D9 the variety of rootset that absorbed more.
b. Subtreatments (with and without mycorrize): The grafts without mycorrize absorbed a bigger concentration.

5. CONCLUSIONS

Test I

The analysis of the evaluated Treatments demonstrated that undoubtedly it is Mexícola that rootset that concentrate the bigger quantity in his leaves, this reflects then its low tolerance to you go out due to its origin, on the contrary who if it possesses tolerance to these, and good behaviour since rootset it was Benik.

With regard to the Subtreatments was observe that those varieties without grafting were possessing bigger concentration of almost the totality of the elements evaluated especially of them you go out, which indicates a positive effect of the graft of variety Hass, which can indicate that Hass has a good behaviour opposite to them you go out, characteristic that probably it transfers to the finished plant.

Test II

The subtreatments with mycorrize and without mycorrize they did not present a significance level of statistics for any variable of growth, nevertheless the size obtained and observed in field it was always major for the inoculated grafts.

In spite of that a marked effect is not observed, the subtreatment inoculated with mycorrize a bigger tolerance presented to the salinity, reflected in a minor damage to foliate the being compared with the subtreatment without mycorrize. Also it appreciates an effect of them you go out on the plants without grafting,

D7 I present the bigger concentration of you go out, in comparison with other treatments.

5. REFERENS

ABELSON, P. 1985. Plant fungal simbiosis. Science 229 (4714): 617.

AZCON, C., BAREA, J. 1997. Applying mycorrhiza biotechnology to horticulture significance and potentials. Scientia Horticulturae, 68, p. 1- 24.

BAREA, J. 1988. Las micorrizas y la protección de cultivos. Jornadas de fitopatología. El suelo en la patología vegetal. Serie de jornadas técnicas. Consejería de agricultura. Junta de comunidades de Castilla la mancha. Dirección general de promoción y desarrollo agrario. Toledo, España.

_____. 2001. Las micorrizas arbusculares, componente clave en la productividad y estabilidad de agroecosistemas. *http://www.csi.es/asociaciones/api/boletines.htm* 19/06/2004

BARRIENTOS-PRIEGO, A., MUÑOZ PEREZ, R., BORYS, M. y MARTINEZ-DAMIAN, M. 2000. Cultivares y portainjertos del aguacate. In*:* El aguacate y su Manejo Integral. Daniel Téliz (coord.). Ediciones Mundi Prensa, SA. de CV., D.F., México. p 35-54.

BENAVIDES, C. 1996. Requisitos del suelo y susceptibilidad a cloruros. In: Cultivo del palto y perspectivas de mercado. Universidad de Chile. Depto. de Producción Agrícola. Publicaciones misceláneas agrícolas nº 45. Santiago de Chile. p 61 - 75.

BEN-YA´ACOV, A. 1976 Avocado rootstocks in use in Israel. California Avocado Society Yearbook. 59: 66-58.

_____ y MICHELSON, E. 2001. Selección y uso de portainjertos y nuevas variedades de palto. Seminario internacional. Universidad católica de Valparaíso. Facultad de agronomía. 113 p.

BOLAN, N. y ABBOTT, L. 1983. Seasonal variation in infectivity of vesicular arbuscular mycorrhizal fungi relation to plant response to applied phosphorus. Aust. J. Soil Res. 21:297.

CALABRESE, F. 1992. El aguacate. Mundi prensa ediciones, Madrid. 249 p.

CASTRO, M. 1996. Técnicas de propagación para la obtención de plantas de palto de óptima calidad. In: Cultivo del palto y perspectivas de mercado. Universidad de Chile. Depto. de Producción Agrícola. Publicaciones misceláneas agrícolas nº 45. Santiago de Chile. p 31-34.

_____. 2001. Situación nacional de portainjertos de palto y su relación con factores de productividad y precocidad. In: Selección y uso de portainjertos y nuevas variedades de palto. Universidad católica de Valparaíso. Facultad de agronomía. Seminario internacional. Quillota, Chile. p 62-75.

CAUTIN, R. 1996. Nuevos antecedentes sobre requerimientos de polinización y variedades. In: Cultivo del palto y perspectivas de mercado. Universidad de Chile. Facultad de agronomía. Publicaciones misceláneas agrícolas nº 45. Santiago de Chile. p 15-29.

DAVID, S. 1994. Vesicular arbuscular mycorrhizal fungi. En: R.W. Weaver et al (Eds.). Methods of soil análisis, Part 2. Microbiological and bochemical properties. Soil Science Society of America, Madison, WI. p 351-358.

DOMINGUEZ, A. 1984. Tratado de fertilización. Ediciones Mundi-Prensa Madrid. 579 p.

FICHET, T. 1996. Portainjertos, una nueva alternativa para Chile. In: Cultivo del palto y perspectivas de mercado. Universidad de Chile. Depto. de Producción Agrícola. Publicaciones misceláneas agrícolas nº 45. Santiago de Chile. p 35 - 41.

FRANCL, L. 1993. Interactions of nematodes with mycorrhizae and mycorrhizal fungi. En: Nematode interactions. M.W. Khan. Chapman and Hall (Eds.). London, UK: 203-216.

GARDIAZABAL, F y ROSENBERG, G. 1991. Cultivo del Palto. Quillota, Universidad Católica de Valparaíso, Facultad de Agronomía. 201 p.

_____. 2001. Paltos. In: Agenda del salitre. Ediciones SQM. Nº 11. Santiago de Chile. p 887-902

GAZIT, S. and KADMAN, A. 1976. Growing avocados in areas of high salinity. En proc. First international tropical fruit short course - The avocado. Sauls J.W., R.L. Phillips and L.K. Jackson (Ed.) University of Florida. Grinessille: p. 58-60.

GERDEMANN, J.W. 1968. Vesicular arbuscular mycorrhiza and plant growth. Annual Review of Phytopathology 6: 396-418.

GIL, F. 1995. Las micorrizas y la nutrición mineral. In: Elementos de fisiología vegetal. Relaciones hídricas. Nutrición mineral. Transporte. Metabolismo. Ediciones Mundi-Prensa. España. p 281-283.

HERNANDEZ - DORREGO, M. 1999. Las micorrizas. *http://www.cdeea.com/micorrizas.htm* 15/04/2004

HERNANDEZ, R. 2001. Nutrición mineral de las plantas – Libro botánica on line. *http://www.forest.ula.ve/~rubenhg/nutricionmineral.htm* 19/07/2001.

INTERNATIONAL CULTURE COLLECTION OF ARBUSCULAR AND VESICULAR ARBUSCULAR MYCORRHIZAL FUNGI (INVAM), 2000. *http://www.invam.caf.wvu.edu/Myc_info/Taxonomy/Glomaceae/glomaceae.htm* 09/12/2003.

JIMENEZ, M. y GALLO, P. 1993. Micorrizas vesículo arbuscular asociadas con cítricos en el valle de Azapa, I región (Chile). Revista IDESIA (Chile), vol. 12. p. 63-69.

LAHAV, E. 1998. Nutrición en paltos. Sociedad Gardiazábal y Magdahl Ltda. Seminario internacional de paltos, Viña del Mar, Chile. p 43-49.

MATTAR, M., HERNANDEZ, C. y CASTRO, M. 2003. Efecto de la inoculación de micorrizas (*Glomus intraradices* Schenck & Smith) en vivero sobre plantones de aguacate. In: V Congreso mundial del aguacate. Libro de resúmenes. Junta de Andalucía. Consejería de agricultura y pesca. Viceconsejería, servicio de publicaciones y divulgación. Granada-Málaga, España. p 396-397.

MENDOZA, H. 2002. Alcalinidad y salinidad: Diagnóstico, efecto sobre la producción y soluciones. In: Primer simposium internacional de Fertirrigación y control en frutales y viñas. Publicación de Bioamérica.

MORURA, J. 1983. Aguacate. Centro Agronómico Tropical de Investigación y Enseñanza (CATIE). Turrialba, Costa Rica 37 p.

MORTON, J. 1987. Avocado. In: Fruits of warm climates. Miami, FL. p. 91-102.

OFICINA DE ESTUDIOS Y PLANIFICACION AGRARIA (ODEPA), 2002. Estadísticas productivas. Frutales: superficie total país. *http://www.odepa.gob.cl/base-datos/* 01/03/2005.

OLIVARES, J y BAREA, J. 1985. Micorrizas. Nutrición vegetal, algunos aspectos químicos y biológicos. Editores La chica G. y C. González O. UNESCO, España: 167-196.

POMARES, F. 1986. La salinidad del suelo en los cítricos. Instituto Valenciano de Investigaciones Agrarias. Valencia. 24 p.

RAZETO, B. 1992. Para entender la fruticultura. Santiago de Chile, Vivarium. 303 p.

_____. 1996. Situación actual del palto en Chile. In: Cultivo del palto y perspectivas de mercado. Universidad de Chile. Depto. de Producción Agrícola. Publicaciones misceláneas agrícolas nº 45. Santiago de Chile. p 9-14.

ROMAN, S. 2001. Libro azul. Manual básico de fertirriego. Segunda edición. Soquimich comercial S. A. 177 p.

SALAZAR – GARCIA 2002. Nutrición del aguacate. Principios y aplicaciones. Instituto Nacional de Investigaciones Forestales, Agrícolas y Peruanas. Campo experimental Santiago Ixcuintla, Nayarit, México. 192 p.

SALISBURY, F. y ROSS, C. 1992 Fisiología vegetal. México. Grupo editorial iberoamericana. 759 p.

SIERRA, C., CESPED, R. y OSORIO, A. 2001. Caracterización de la salinidad de los suelos y aguas del valle del río Copiapó. Gobierno regional de Atacama e Instituto de investigaciones agropecuarias (Chile). Centro regional de investigación Intihuasi (La Serena), oficina técnica Copiapó. Boletín INIA Nº 70. 32 p.

SILVA, H. y RODRIGUEZ, S. 1995. Fertilización de plantaciones frutales. Publicación de la Facultad de Agronomía. Pontificia Universidad Católica de Chile. Departamento de Ciencias vegetales. 519 p.

SOTOMAYOR, C. 1996. El palto (III). Revista Chile agrícola. Santiago de Chile. Nº 220. Noviembre 1996. p 397-40.