VOL V

AGRÁRIAS

PESQUISA E INOVAÇÃO NAS CIÊNCIAS QUE ALIMENTAM O MUNDO

EDUARDO EUGÊNIO SPERS
(Organizador)

EDITORA ARTEMIS
2021

VOL V

AGRÁRIAS

PESQUISA E INOVAÇÃO NAS CIÊNCIAS QUE ALIMENTAM O MUNDO

EDUARDO EUGÊNIO SPERS
(Organizador)

EDITORA ARTEMIS
2021

Editora Chefe	Profª Drª Antonella Carvalho de Oliveira
Editora Executiva	M.ª Viviane Carvalho Mocellin
Direção de Arte	M.ª Bruna Bejarano
Diagramação	Elisangela Abreu
Organizadora	Prof. Dr. Eduardo Eugênio Spers
Imagem da Capa	Shutterstock
Bibliotecário	Maurício Amormino Júnior – CRB6/2422

EDITORA ARTEMIS
2021

Editora Artemis
Curitiba-PR Brasil
www.editoraartemis.com.br
e-mail:publicar@editoraartemis.com.br

Dados Internacionais de Catalogação na Publicação (CIP)
(eDOC BRASIL, Belo Horizonte/MG)

A277 Agrárias [livro eletrônico] : pesquisa e inovação nas ciências que alimentam o mundo V / Organizador Eduardo Eugênio Spers. – Curitiba, PR: Artemis, 2021.

Formato: PDF
Requisitos de sistema: Adobe Acrobat Reader
Modo de acesso: World Wide Web
Edição bilíngue
ISBN 978-65-87396-34-7
DOI 10.37572/EdArt_290421347

1. Ciências agrárias – Pesquisa. 2. Agronegócio. 3. Sustentabilidade. I. Spers, Eduardo Eugênio.

CDD 630

Elaborado por Maurício Amormino Júnior – CRB6/2422

EDITORA ARTEMIS
2021

Editora Artemis
Curitiba-PR Brasil
www.editoraartemis.com.br
e-mail:publicar@editoraartemis.com.br

APRESENTAÇÃO

As Ciências Agrárias são um campo de estudo multidisciplinar por excelência, e um dos mais profícuos em termos de pesquisas e aprimoramento técnico. A demanda mundial por alimentos e a crescente degradação ambiental impulsionam a busca constante por soluções sustentáveis de produção e por medidas visando à preservação e recuperação dos recursos naturais.

A obra **Agrárias: Pesquisa e Inovação nas Ciências que Alimentam o Mundo** compila pesquisas atuais e extremamente relevantes, apresentadas em linguagem científica de fácil entendimento. Na coletânea, o leitor encontrará textos que tratam dos sistemas produtivos em seus diversos aspectos, além de estudos que exploram diferentes perspectivas ou abordagens sobre a planta, o meio ambiente, o animal, o homem, o social e sobre a gestão.

Este Volume V traz 28 artigos de estudiosos de diversos países: são 18 trabalhos de autores da Argentina, Canadá, Colômbia, Cuba, Espanha, México e Portugal e dez trabalhos de pesquisadores brasileiros, divididos em três eixos temáticos.

Os dez trabalhos organizados sob o eixo temático **Clima, Solo e Água** desenvolvem temas relativos à importância desses elementos para a manutenção dos ecossistemas. Os 14 títulos que compõem o eixo temático **Agroecologia e Desenvolvimento Sustentável**, por outro lado, apresentam estudos sobre diferentes formas de se diminuir, reverter ou harmonizar as consequências da atividade humana sobre o meio ambiente. Seguindo a mesma linha, o eixo **Resíduos Agrícolas e Logística Reversa** traz quatro trabalhos que finalizam este importante volume.

Desejo a todos uma proveitosa leitura!

Eduardo Eugênio Spers

SUMÁRIO

CAPÍTULO 2

SALT AFFECTED SOILS IN PROTECTED PRODUCTIVE SYSTEMS. IRRIGATION WATER AND PRODUCTIVE MANAGEMENT

Data de submissão: 05/02/2021
Data de aceite: 04/03/2021

Margarita M. Alconada Magliano
Edafología,
Facultad de Ciencias Agrarias y Forestales,
Universidad Nacional de La Plata,
Calle 60 y 119 s/N (1900)
La Plata, Argentina
margaalconada@yahoo.com.ar

Luciano Juan
Edafología,
Facultad de Ciencias Agrarias y Forestales,
Universidad Nacional de La Plata,
Calle 60 y 119 s/N (1900)
La Plata, Argentina
lulajuan83@yahoo.com.ar

ABSTRACT: Horticultural Belts throughout the country present common productive, environmental, social, and economic problems. In all cases, an analysis of the causes of the negative effects of these production systems is required in order to obtain sustainable productions. In this paper, some soil, irrigation water and productive management relationships in greenhouses of the Horticultural Belt of Gran La Plata, Buenos Aires, Argentina, are analyzed to promote reflective thinking about a state of actions and inactions that, in all cases, lead to degradation and contamination of soil, water and crop products, with social and economic consequences, which begins with the salinization and sodification of soils. Possible origins of diagnostic errors, that are part of the problem, are exposed. Holistic procedures and visions are needed to modify the way in which soil, irrigation water, and the procedures that help prevent salinization and sodification are studied and analyzed, and associated degradations are established. Several practices (organic amendments, solarization, biofumigation, drains) that are intended to improve soil original conditions and degradations are proposed. It is necessary to know the single and combined effects of a very high number of natural and anthropic variables that interact in intensive productive schemes in order to decide with scientific and technological rigor, possible actions for effectively sustainable productions.

KEY WORDS: Salinization and sodification. Permeability. Irrigation water. Sustainable management.

SUELOS AFECTADOS POR SALES EN SISTEMAS PRODUCTIVOS PROTEGIDOS. AGUA DE RIEGO Y MANEJO PRODUCTIVO

RESUMEN: Los Cinturones Hortícolas de todo el país presentan problemas productivos, ambientales, sociales y

económicos comunes. En todos los casos, a fin de obtener producciones sustentables, se requiere un análisis del origen de los efectos negativos que se generan en estos sistemas productivos, En este trabajo se analizan algunas relaciones entre el suelo, el agua de riego y el manejo productivo en invernaderos del Cinturón Hortícola del Gran La Plata, provincia de Buenos Aires, Argentina, con el objetivo de promover un pensamiento reflexivo sobre un estado de acciones e inacciones que, en todos los casos, conducen a la degradación y contaminación del suelo, agua y productos de cosecha, con consecuencias sociales y económicas, que comienzan con la salinización y sodificación del suelo. Se exponen posibles orígenes de estos procesos degradativos, y errores de diagnóstico, que son parte del problema. Se plantea la necesidad de modificar la forma en que se estudia el suelo y agua de riego, debiendo incorporarse visiones holísticas y procedimientos que contribuyan a prevenir la salinización y sodificación, y degradaciones asociadas. Se proponen diversas prácticas (enmiendas orgánicas, solarización, biofumigación, drenajes) que tienen como finalidad mejorar las condiciones originales y degradaciones del suelo. Es necesario conocer los efectos individuales y combinados de un muy elevado número de variables naturales y antrópicas que interactúan en estos esquemas productivos intensivos con la finalidad de decidir, con rigor científico y tecnológico, posibles acciones que efectivamente generen producciones sustentables.
PALABRAS CLAVE: Salinización y sodificación. Permeabilidad. Agua de riego. Manejo sustentable.

1 INTRODUCTION

Intensive production, unsolved problems_. The technological level and management practices that are implemented in the so-called Horticultural Belts (HB) that surround the main cities of Argentina, depend on variables such as: surface of the establishments, form of land tenure, social components, labor and capital availability, technology access, production system and environmental characteristics. Some of these variables are shared by all HB, from the technological to the social, economic, productive and environmental consequences. They are characterized by high use of inputs, very high costs, varied productivity and profitability, with negative consequences on the environment in all cases. With the current production schemes, soils degradation, water and crop pollution, as well as damage to human health are widely denounced processes for different technical, scientific, and social fields, for more than 50 years. However, the persistence of some of the problems and even their exacerbation is alarming. It seems that some inescapable evidence cannot modify "immovable certainties" in the way to produce. The soils management in intensive crops is frequently carried out using procedures that are generally repeated year after year for decades. Although promising modifications that include agroecological management, biological control and aspects related to crop ecophysiology are introduced, the production criterion is similar and could be erroneous when considering that the observed yield decreases and/or degradations are reversed with the use of more inputs, in type and quantity (Alconada-Magliano et al., 2018). On the other hand, from the scientific and technological fields, it is not possible to fill "the gap" of knowledge or inadequate transmissions to the productive sector, which is frequently occupied by commercial companies that promise solutions that should at least be more carefully analyzed. This lack of control is proof of an absent Argentine State in a dangerously autonomous food production scheme. Also, on occasion, research studies are carried out, which, although valuable, are not always part of a sequence of advances aimed at reversing environmental degradation and pollution. The reasons for insisting on some ways of producing and/or analyzing the problems that occur as a result of these operations are similar to that indicated by Pla Sentis (2014) for irrigated agriculture in other parts of the world: The cause-effect relationships of soil salinization-sodification and other degradation problems are not considered, as they are not addressed as hydrological processes that can be controlled at least in part.

In this paper, we analyze some relationships between soil, irrigation water and productive management of crops in greenhouses of the Horticultural Belt of Gran La Plata, to promote reflective thinking about a state of actions and inactions that in all cases lead to degradation and contamination of soils, water, and crop products, with social and economic consequences, which begins with the salinization and sodification of soils. The possible origins of the diagnostic errors that are part of the unsolved problem are analyzed. We would like to point out that it is possible to find solutions, if causes and effects, alone and in combination, of a very large number of variables which interact in intensive productive schemes are thoroughly analysed, without insisting on what is evidently not the right path to follow for solutions to be achieved.

2 ORIGEN AND CONSEQUENCES OF INTENSIVE PRODUCTION DEGRADATIONS OF GRAN LA PLATA HB

Intensive production under plastic coverings generates, in all cases, soil degradation due to salinization, sodification, alkalization, organic matter decreases and structure and permeability loss that generate waterlogging, and associated with this, diseases and pests development. Attempts to revert this are made with the addition of fertilizers, organic fertilizers (manures), biocides in plants and in the soil, and more recently through the application of a significant number of products whose origin and effectiveness has not been properly proven, such as are generically referred to as “biostimulants”, which include products marketed as “humic acids”. Although, under certain circumstances, beneficial effects are obtained, in general, it is difficult to attribute it to a particular practice, not being the effects permanent. Also, they do not solve the situation posed by not addressing the main problem (Alconada-Magliano et al. 2018). On the contrary, the greater use of uncontrolled inputs increases costs, decreases economic benefit, and contaminate harvest products, environment and mainly human consumption water (Auge, 2005).

2.1 ORIGIN OF THE PROBLEM

The origin of the problem starts by not considering the natural peculiarities of the soil and irrigation water which, although they vary within the region of Gran La Plata, have general physical-chemical characteristics that condition management. However, it is common to apply “recipes” that were generated for other regions of the world and productive schemes (hydroponics, sanded), and / or follow recommendations of commercial companies. Consequently, inorganic and organic fertilizers are added in excess. These are a source of nutrients, salts, and even pollutants, contributing to the salinization and sodification of soils and deficiencies of other nutrients. In the region is frequent the Ca deficiency in tomato and pepper fruits (Blossom end rot) still with very rich Ca values in soils. It should be noted that even some practices that try to improve drainage can incorporate salts and especially Na^*, such as gypsum depending on its quality (Magra and Ausilio, 2004). Regarding organic fertilizers, salinity-sodicity-alkalinity is very variable, and very high doses are used (approx. 40 tn. ha^{-1}. $year^{-1}$). For example, in a recent trial 23.6 dS.m-1 and 13.5 $dS.m^{-1}$ were measured in uncomposted and composted rice husk chicken manure respectively (Larrieu et al. 2019). On products marketed as “humic acids”, it can be indicated that salinity, sodicity and alkalinity are also very variable. In a recent test carried out with a product that is marketed in the region, it was measured 58.4 $dS.m^{-1}$ of EC, while the label indicates EC 2.53 $dS.m^{-1}$. with no yield improvements (unpublished).

Although in some cases soil nutrition is analyzed prior to the management, this is usually done on the superficial horizon without considering that it works as part of a much deeper soil that is linked to groundwater and other soil and landscape elements. Consequently, everything that is done on the surface has a deep impact and determines that the soil continues to be suitable for crops, as well as the groundwater continues to be potable for human consumption.

2.2 SOILS AND WATER IN THEIR NATURAL CONDITION

Figure 1 shows the soils where mainly the horticultural production of the region is developed, classified as *Vertic Argiudoll* (Seguí and Estancia Chica Series), and *Typic Hapludert* (Gorina Serie) (Soil Survey Staff, 1999 in Hurtado et al. 2006). In their natural condition their main limitation is a restricted permeability due to the presence of a large number of expansive type clays from the surface, mainly in the Gorina Serie, and a low phosphorus content. The rest of the chemical variables are at adequate levels. However, after the addition of P to improve the limiting natural condition, phosphoric acid continues to be added for pH control and because it is part of the disseminated "recipes". The phosphoric acid results inconducent and P hyperfertilization is confirmed in many region studies (Alconada et al. 2000).

The irrigation water comes from two aquifers, the Pampeano and the Puelche, and they are characterized by a similar chemical composition due to the hydraulic communication that exists between them (Auge, 2005). This author indicates that Ca and Na bicarbonate type waters prevail in the Pampeano, and sodium in the Puelche, with saline levels between 0.5 and 1.0 g / l. The average chemical composition of water in the High Plain environment (intensive production area) is as follows: HCO_3^- 7.6 me.l^{-1} (89%); Cl^{-1} me.l^{-1} (11%) and similar in NO_3^- and SO_4^{-2} 0.4-0.45 me.l^{-1}, (4-5%); Na^+ 7.7 me.l^{-1} (77%); Ca^{+2} 1 me.l^{-1} (11%); Mg^+ 20.7 me.l^{-1} (9%) and K^+ 0.25 me.l^{-1} (3%) (Auge, 2005). As an example, Table 1 shows the water composition that irrigate soils in Figure 1 and in Table 2, ions participation in percentage terms.

Figure 1. Main soils horticultural production is carried out in Gran La Plata, Buenos Aires, Argentina

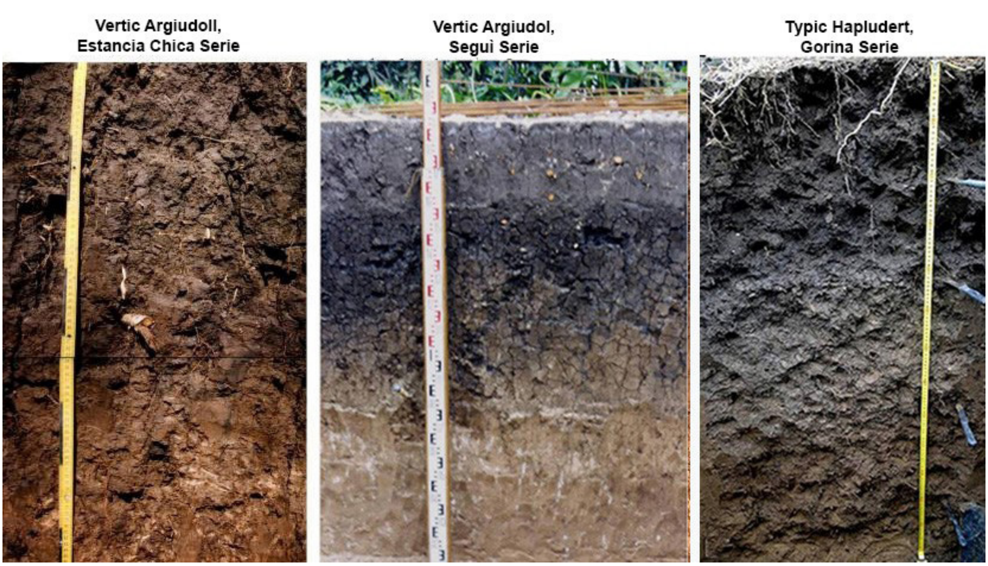


Table 1. Water chemical composition from different productive sites of Gran La Plata: pH, electric conductivity (EC in µS- m-1, cations and anions (me. l´1), sodium adsorption ratio (SAR) (modified from Alconada and Zembo, 2000)

Water well	pH	EC	HCO_3	TSS	Cl	SO_4	Ca	Mg	Na	K	$CaCO_3$	SAR
A	7,8	700	8,63	758	0,79	0,21	0,82	7,10	1,88	1,26	396	0,94
B	7,8	700	7,53	655	0,62	0,04	3,05	0,91	3,91	0,25	198	2,78
C	7,9	550	6,03	538	0,45	0,08	3,20	3,05	1,61	0,33	313	0,91
D	7,6	570	7,10	743	0,80	1,40	0,40	1,00	8,10	0,20	70	9,68
E	7,3	758	6,74	591	0,42	0,35	3,40	1,89	1,91	0,34	265	1,17

An important variability is appreciated mainly in the cation content that significantly modify the effect on the soil (Pla Sentis, 2015). This author points out the need to incorporate classic measurements of SAR (Soil Adsorption Ratio) and ESP (Percent Exchangeable Sodium), using the CROSS index (Cations Ratio of Soil Structural Stability, CROOS = Na. 0,56. K / [(Ca + 0,6Mg) 2] ½meq/1 ½) in order to consider the dispersing effect of Mg^{+2} because in some circumstances this adds to the effect of the high Na^+ level.

2.3 WATER QUALITY INTERPRETATION PROCEDURES

The US Lab. Staff (USDA, 1954) is the most widespread interpretation criteria in many laboratories in Argentina (Handbook N°60) which is currently in disuse in the world because it qualifies water in the opposite way to what happens in the soil. Thus, the dispersive effects that a high SAR would favor can be controlled with a higher salinity by allowing some flocculation (Porta et al. 1994). This is considered in the FAO criterion (Ayres and Wescott, 1987) where the combined effect of the SAR and EC is analyzed, as well as the effect of specific ions. However, greater precision in the calculation of the contributions or losses of dissolved or precipitated salts in the soil and in the composition of the drainage water, is presented in the SALSODIMAR Model (Pla Sentis, 1997, 1998, 2006, 2015). This model estimates the salinization and sodification processes of soils based on the associated hydrological processes. It calculates the salts balance and the interactions between the ions present in the irrigation water, groundwater and soil solution. It also considers the evapotranspiration (EVT), the hydrological properties of the soil, and foresees the needs of irrigation and washing, as well as the excesses that sharpen the degradations, for a particular climate and crop. It is a simple and fast calculation program (Excel sheet), and even when all the edaphic variables that are requested are not available, an estimation of them obtains better approximations than with other interpretation procedures (Alconada and Zembo, 2000).

Some examples are set out to incorporate considerations when interpreting water quality. In all cases, the waters presented in Table 1 produce a gradual increase in soil Na^+ and pH, which is modified according to management. Figure 2 shows different handling of wet drip irrigation bulbs with D water in the *Typic Hapludert* (Table 1). In Figure 3 this soil is compared in its natural condition and degraded.

Figure 2. Wet irrigation bulbs: a) mishandling with saline halo (left); b) mishandling with salts, compaction and waterlogging (center); and c) management adjusted to soil condition without salts (right)

Figure 3. *Typic Hapludert* soil profile in its natural field condition, with granular structure (right), same soil under greenhouse, with surface cracking (left)

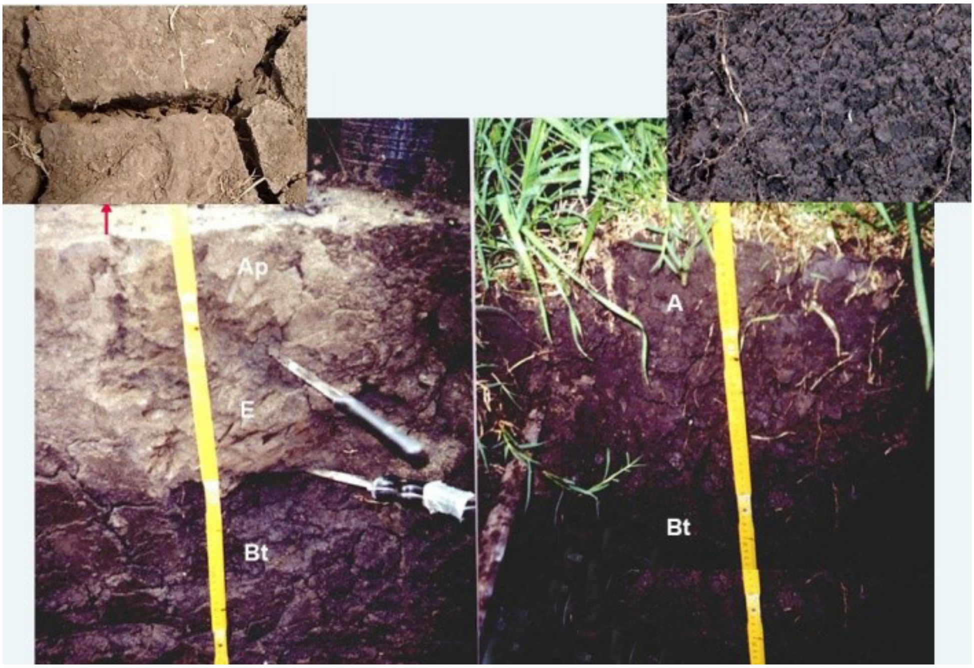


Figure 4 compares the *Vertic Argiudoll* in adjacent greenhouses with two management: type, traditional in the region (soil pulverization by tillage and indiscriminate handling of inputs) vs. good practices (crop rotation, green manures, chisel tillage, fertigation adjusted to the needs of the crop, etc). The waters correspond to those of type A, B or C (Table 1). The degradations produced are a result of the management implemented and do not arise only from the water quality.

Figure 4. *Typic Argiudoll*: traditional management with soil pulverization (left) vs. good practices (right)

3 MANAGEMENT PRACTICES

3.1 USE OF ORGANIC AMENDMENTS

Compost is the result of the transformation process of animal and plant remains due to its use as food for different soil organisms (bacteria, fungi, worms, mites, insects, etc) (Romàn et al. 2013). In recent years, the volume of waste and the amount of organic matter that has been disposed has progressively increased. This poses a serious problem of waste disposal for society and on environmental conservation. Therefore, the elimination, reduction or reuse of biodegradable waste should be a priority of environmental policies. Composting is defined as a process of controlled aerobic transformation of organic materials contained in waste through the activity of microorganisms. This process takes place in a variable time of approximately 3 to 4 months, fulfilling three phases depending on the temperature each acquires: mesophilic (15 to 45°C), thermophilic (45 to 70°C) and maturation (at room temperature, 16°C), obtaining the transformation from an organic residue into a stable product, which can be free of pathogens and applied to the soil (Sztern and Pravia.1999; Romàn et al. 2013).

Composting gives the possibility of safely transforming organic waste into an input for agricultural production if the thermal cycle is reached. Reaching high temperatures reduces the presence of pathogens in the soil and weed seeds. If not, negative effects may occur. The compost can be a substrate, amendment or organic fertilizer for the soil, because it improves soil conditions since it can increase water storage; the porosity of the soil and provide a greater number of nutrients than traditional fertilizers. It is also a way to reduce garbage in large quantities. An important feature of compost is the capability to influence soil microflora by suppressing many soil borned pathogens diseases such as *Pythium sp*, *Phytophthora sp*, *Fusarium sp* (Szczech and Smolińska, 2001; Borrero et al. 2004).

It should be noted that the mentioned advantages may not be achieved unless all aspects related to the quality of the waste and appropriate procedures to achieve a human health safe product are considered. As said before, use of organic amendments is very common in this area although is not clear for the farmers the reason of its use. Table 2 shows an analitical evaluation of organic amendments (modificated from Costa et al. 1991in Soler, 1998). This evaluation, like others present in literature and also the laws on the use and handling of hazardous waste, are not considered. In general, non-composted manure of varied origins are applied. This could bring different types of problems of degradation and contamination of soil, water and crop products.

In the *Typic Hapludert* (Figure 1) of the Gran La Plata region, studies were carried out comparing the effect on the soil and the crops of the aggregate of chicken bed manure without composting and the same material but composted. The doses were the most used in the region, 40 t-1. ha^{-1}. year for non-composted chicken manure, and equivalent dose considering the organic carbon content of the same material but composted, a double dose of compost and a control without any application (Alconada et al. 2018, Larrieu, et al. 2019).

Figure 5 shows the materials used in this test with respect to a vermicompost (not tested this time). The crop management was the usual in the region but without the addition of inorganic fertilizers in irrigation carried out by drip system. No salinity was observed in any of the treatments with the lowest doses or in the witness. With the highest dose of compost, a slight salinization is appreciated. The absence of inorganic fertilizers avoided the salinization that is commonly observed with the traditional crop management, as shown in Figure 6. It is concluded in this study, that adjusted doses of composted manure can be used in replacement of synthetic fertilizers. It is noteworthy that the improvements in the physical properties of these soils due to the addition of these amendments were not conclusive, requiring further studies (Alconada-Magliano et al. 2018; Larrieu et al. 2019). Another result was a general increase in beneficial microbial population, having assured the elimination of pathogens by composting the materials. There was no significant nematode population in any case (Alconada-Magliano et al. 2018)

Table 2. Evaluation criterion of the chemical composition of organic amendments (compost) (modificated from Costa *et al.* 1991 in Soler 1998)

		Low	Medium	High
macronutrients %	N	0.5-1.5	1.5-3	3
	P	0.5-1	1-2	2
	K	0.02-0.16	0.15-0.3	0.3
	Ca	0.6-1.5	1.5-3.5	3.5
	Mg	0.1-0.25	0.25-0.4	0.4
	S	0.5-1.0	1-1.5	1.5
micronutrients ppm	Fe	1000-8000	8000-13000	15000
	Mn	20-150	150-400	400
heavy metals ppm	Pb	100-400	400-1000	1000
	Zn	100-1200	1200-2000	2000
	Cu	100-600	600-1200	1200
	Ni	20-100	100-200	200
	Cd	1-15	15-35	35
Electrical conductivity $mS.cm^{-1}$		0-1	1-2	2
Humidity %		10-25	25-50	50
Organic matter %		35-50	50-65	65-80

Figure 5. Uncomposted (left) and composted (center) rice husk chicken manure and vermicompost (right)

Figure 6. Wet bulb from drip irrigation. Treatment with low dose compost (left), with high dose compost (center), and in traditional management with salinity and sodicity problems (righ)

3.2 PHYSICAL METHODS FOR SOIL DISINFECTION: EXPERIENCES IN SOLARIZATION AND BIOFUMIGATION

The lack of crop rotation generates problems in the effectiveness of soil disinfection methods Crop damage causes yield losses. According to this, it is increasingly important to look for management alternatives that allow facing various adversities. Soil disinfection is done in order to eliminate or reduce the presence of pathogens that may be present in the soil. There are chemical methods, such as the use of different types of fumigants, and physical methods, among which are the use of water vapor, solarization, biofumigation and biosolarization (Alconada, 2004; Alconada-Magliano et al. 2018).

- *Biofumigation:* consists of incorporating some type of organic matter into the soil (plant remains, manure), at a rate of 5 $kg.m^{-2}$ of soil, and then covering it with transparent polyethylene to cause the temperature to rise. It should be noted that the use of manure carries other risks as previously discussed. The decomposition of the incorporated organic matter releases toxic gases that serve to control pests and soil diseases, and may also have some effect on the weed seed. Among the plant species whose remains are more effective for good biofumigation are crucifers such as cabbage, broccoli, cauliflower, which, when decomposed, release a large amount of toxic compounds (methylisothiosyanate and ammonium). The good practices mentioned, with crucifers incorporation included were carried out in the photo in Figure 4. Figure 7 shows soil covered with transparent polyethylene that is being biofumigated.

Local biofumigation experiences were carried out in soil that had nematodes, incorporating traces of chopped broccoli (5 $kg.m^2$ of soil) (April 2011), leaving the soil covered with transparent polyethylene for 90 days. The practice was also tested in October 2012, comparing the effect of incorporating chicken bed and chopped broccoli (5 $kg.m^2$ of soil in both cases). The soil was covered with transparent polyethylene for 15 days (Figure.7), reaching average temperatures of 22.3°C in the biofumigation with chicken bed and 23.1°C when broccoli was incorporated. In all situations, after biofumigation, the presence of nematodes in the soil was significantly reduced although they were not completely eliminated. (Alconada-Magliano et al. 2018).

It is important to remember that for the biofumigation to be carried out correctly, it is necessary to take into account to incorporate organic matter into the soil, preferably well chopped cruciferous; that the soil is well tilled and humid, not flooded; to place the transparent polyethylene making good contact with the soil and that the site is exposed for several days, depending how many on the time of the year, to solar radiation.

Figure 7. Soil covered with polyethylene after organic matter incorporation for Biofumigation (photo M Cuellas)

3.3 SOIL DRAINAGE IMPROVEMENTS

As practices tested in the region with success to increase the rooting depth (effective depth) and improve water circulation are indicated: subsurface drains, tillage with subsoiled and to a lesser extent with chisel (Alconada Magliano et al, 2018).

Tillage with chisel or subsoiler_. Regarding the use of chisels and subsoilder these are vertical tillage that allowed to increase the effective depth of the soil by decreasing the apparent density, improving water storage, and increasing productivity. In the region the use of subsoiler was more effective than chisel (Cerisola in Alconada Magliano et al. 2018).

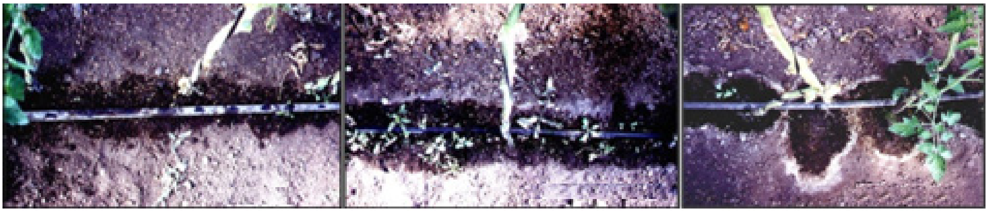
Gypsum_. The use of gypsum on soils is also a frequent practice in the region, and although it may produce temporary improvements (Cuellas, 2015), in general, the doses are insufficient for the proposed objective of replacing Na^{+} with Ca^{+2} and improving the soil structure. In soils such as those present in the region (Figure 1), it is necessary to improve subsurface permeability.

Use of subsurface drains _. In cases where salts accumulation has occurred and / or soil conditions favor the accumulation of salts due to intensive management systems (Figure 1), subsurface drains can be installed in the most clayey horizon (Btss). In the region of the study, at approximately 20-30 cm depth was instated (Figure 8). These drains prevent the accumulation of surface water and the rise of salts when the soil dries between two consecutive irrigations.

Figure 9 shows the effect of drains over the surface of the *Typic Hapludert* soil (Figure 1). Figure 9 compares drains (without accumulation of salts), drains plus gypsum addition (slight accumulation of salts attributed to gypsum), soil with traditional management without drains (highly salinized). In Alconada-Magliano et al. (2018), Cuellas (2015) and Cuellas (2019), the installation details of these drains and the promising results obtained when they are properly installed (slope, depth, filtering material) are presented.

Figure 8. PVC drains installed on top of the Btss horizon covered with granite stone and detail of the drain with use of level to maintain slope

Figure 9. Effect of the drains on soil´s surface: only drain (left), drains plus gypsum (center) and greenhouse with traditional management without drains



4 CONCLUSIONS

Salinization, sodicity, and/or alkalization, with loss of structure and permeability, is produced by inappropriate management practices for the natural conditions of soil and water of the region studied.

The water evaluation criteria of U.S. Salinity Lab.Staff (USDA, 1954) is not adequate. Procedures that consider the salt balance that results from the involved hydrological processes, depending on the soil, crop, climate, and management should be used. Productive and water management practices determine the magnitude of the observed degradations. Taking this to consideration it is possible to obtain sustainable productions with lower costs. Control depends mainly on handling.

The use of tillage tools that pulverize the soil should be avoided. Use of chisel or subsoil tillage (subsoiler), and subsurface drains, are suitable alternatives for poor drainage soils.

Use of organic amendments such as composted rice husk chicken manure, and other residue available composted, could be a good tool to improve poor or degraded soil conditions. But it is important to determine salinity and composition in order to evaluate the overall impact over the soil.

Composted manure application, controlled in quality and quantity, could replace the use of synthetic fertilizers in soils such as those of Gran La Plata.

In the same way, physical methods for soil disinfection could be used to decrease crop cost and chemicals use but it does not seem to be a definitive solution for plague and weed control.

The use of excess fertilizers and other commercial products not adequately known in their quality and purpose, exacerbate the problems of degradation and contamination of the soil, water and crop products.

REFERENCES

Alconada, M ; L Giuffre; L Huergo y C Pascale. 2000. Hiperfertilización con fósforo de suelos Vertisoles y Molisoles en cultivo de tomate protegido. In; Avances en Ingeniería Agrícola 1998-2000, Ed. Facultad de Agronomía, UBA. 343-347p.

Alconada-Magliano, M. 2004. Desinfección del suelo con vapor. Efectos sobre la nutrición de los cultivos. Ediciones, INTA. 123p. https://agris.fao.org/agris-search/search.do?recordID=AR2004000072

Alconada M and J Zembo. 2000. Influencia cualitativa del riego con aguas subterráneas en suelos con producciones intensivas a campo y en invernáculo. 1er Joint World Congress on Groundwater. Brasil.

Alconada-Magliano M, SB Martínez and M Garbi (Ed). 2018. Producción intensiva flori-horticola sustentable en el Gran La Plata, 61 p. http://sedici.unlp.edu.ar/handle/10915/73390.

Ayers RS and DW Westcot (1987). Calidad del agua en la agricultura. FAO. 174p.

Auge MP. 2005. Hidrogeología de La Plata, Argentina. En RE de Barrio, RO Etcheverry, MF Caballe & E Llambias (Ed.) Geología y Recursos Minerales de la Provincia de Bs As. Relatorio del XVI Congreso Geológico Argentino, La Plata: Pp 293-312.

Borrero, C, Trillas, MI, Ordovás, J, Tello, JC, Avilés, M. 2004. Predictive factors for the suppression of Fusarium wilt of tomato in plant growth media. Phytopathology. 94, 1094-1101.

Hurtado M, J Giménez and M Cabral. 2006. Análisis Ambiental del partido de La Plata. Aportes al Ordenamiento territorial. Ed. 1ra. Buenos Aires: CFI.134p.

Cuellas, MV. 2015. Control de la salinización del suelo mediante sistemas de drenes en producciones intensivas de cultivos bajo cubierta. Tesis de Magister Sc en Ciencias del Suelo, UBA, 159 p http://ri.agro.uba.ar/files/download/tesis/maestria/2015cuellasmarisol.pdf

Cuellas, MV. 2019. Problemáticas de los suelos en producciones bajo cubierta del periurbano AMBA. VI Congreso de la RAS (Red Argentina de la Sallinidad) de la AACS, FAUBA, Buenos Aires, Actas: 140 a 145. http://share.agro.uba.ar/d/XhzRkgJe2Sb

Larrieu, L; M Cuellas, AE Pellegrini y MM Alconada-Magliano. 2019. Enmiendas orgánicas sobre el suelo y cultivos hortícolas protegidos. VI Congreso de la RAS (Red Argentina de la Salinidad) de la AACS. FAUBA. Buenos Aires. 303-308.

Magra G y A Ausilio. 2004. Yeso agrícola: algunas características de diferentes productos existentes en el mercado. Facultad de Ciencias Agrarias. UNR.

Pla Sentis I. 1997. Evaluación de los procesos de salinización de suelos bajo riego. Edafología SECS (Spain): 241-267

Pla Sentis I. 1998. Modelling the processes of dissolution and precipitation of salts in soils as related to management of irrigation and drainage. Proc. 16th World Congress of Soil Science ISSS Montpellier (France) I: 98-104

Pla Sentis I. 2006. Hydrological approach for assessing desertification processes in the Mediterranean region. In: Kepner et al., Eds.) “Desertification in the Mediterranean Region: A Security Issue”, Springer: 579-600.

Pla Sentis I. 2015. Advances in the prognosis of soil sodicity under dryland and irrigated conditions. International Soil and Water Conservation Research WASWAC (China) 2(4): 50-63.

Porta JG; M López-Acevedo and C Roquero, 1994. Edafología para la agricultura y elmedio ambiente. Ed. Mundi Prensa. 807 p.

Soil Survey Staff. 1999. Soil taxonomy. A basic system of soil classification for making and interpreting soil surveys. United States Department of Agriculture. Agriculture Handbook Nº 436, 869 p.

Román, P, MM Martínez and A Pantoja. 2013. FAO Manual de compostaje del agricultor. 112p. http://www.fao.org/docrep/019/i3388s/i3388s.pdf

Soler Rovira, PA. 1998. Evaluación del impacto ambiental y riesgo de contaminación producidos por la aplicación agrícola de lodos de depuradora. Universidad Autónoma de Madrid. Facultad de Ciencia. Tesis Doctoral. 276 p.

Sztern D, and M Pravia. 1999. Manual para la elaboración de compost bases conceptuales y procedimientos. Organización Panamericana de la Salud Organización Mundial de la Salud 69 p. http://www.ingenieroambiental.com/newinformes/compost.pdf

Szczech, M., Smolińska, U. 2001. Comparison of suppressiveness of vermicomposts produced from animal manures and sewage sludge against *Phytophthora nicotianae* Breda de Haan var. *nicotianae*. J. Phytopathol. 149, 77-82.

USDA, US Salinity Lab. Staff. 1954. Diagnosis and improvement of saline and alkaline soils. 166p. https://www.ars.usda.gov/ARSUserFiles/20360500/hb60_pdf/hb60complete.

SOBRE O ORGANIZADOR

EDUARDO EUGENIO SPERS realizou pós-doutorado na Wageningen University (WUR), Holanda, e especialização no IGIA, França. Possui doutorado em Administração pela Universidade de São Paulo (USP). Foi Professor do Programa de Mestrado e Doutorado em Administração e do Mestrado Profissional em Comportamento do Consumidor da ESPM. Líder do tema Teoria, Epistemologia e Métodos de Pesquisa em Marketing na Associação Nacional de Pós-Graduação e Pesquisa em Administração (ANPAD). Participou de diversos projetos de consultoria e pesquisa coordenados pelo PENSA e Markestrat. É Professor Titular no Departamento de Economia, Administração e Sociologia, docente do Mestrado em Administração e Coordenador do Grupo de Extensão MarkEsalq no campus da USP/Esalq. Proferiu palestras em diversos eventos acadêmicos e profissionais, com diversos artigos publicados em periódicos nacionais e internacionais, livros e capítulos de livros sobre agronegócios, com foco no marketing e no comportamento do produtor rural e do consumidor de alimentos.

Índice Remissivo

A

B

C

G

H

I

J

L

M

T

V

Z

EDITORA
ARTEMIS