

Summary

M. Ofek, S. Ruppel and Y. Waisel

Effects of salinity on rhizosphere bacterial communities associated with different root types of *Vicia faba* L.

Differences between various inherent physiological characteristics of lateral and taproots of faba bean plants (*Vicia faba* L.) were described and related to the root tissues per se. As the rhizosphere constitutes an "extension" of the root tissues, the question was asked if distinct bacterial communities inhabit the rhizosphere of different roots and how is it affected by salinity. Plants were grown with their root systems in aeroponics. Samples were taken from roots of the same age and developmental stage. Metabolic fingerprints of rhizosphere bacterial communities were analyzed using the Biolog® assay. Rhizosphere bacterial communities produced distinct metabolic fingerprints for lateral and for taproots. Specific association between *Herbaspirillum* and lateral roots was found both under saline and under non-saline growth conditions. It can be concluded that the bacterial communities of the rhizosphere are determined by the different root types as well as by the salinity of the environment.

Key words: rhizosphere, root type, bacterial community, aeroponics, Biolog®

Summary

Muhammad Ashraf

Tolerance of some potential forage grasses from arid regions of Pakistan to salinity and drought

In some areas of Pakistan crop production is not possible because of scarcity of sweet water and very low annual rainfall. However, the vast area can be economically utilized provided if plant species, which possess co-tolerance to both drought and salinity are grown under irrigation with subsoil saline water. Keeping this in mind the present study was undertaken to identify grass species, which possess co-tolerance to drought and salinity.

In the first experiment, salinity tolerance of five grass species, *Cenchrus pennisetiformis* Hochst & Steud., *Leptochloa fusca* (L.) Kunth, *Panicum turgidum* Forsk., *Pennisetum divisum* (Gmel.) Henr. and *Puccinellia distans* (L.) Parl. was assessed after 6 weeks growth in salinized sand culture. The salt treatments used were 0, 8, 16, and 24 dS m⁻¹ that were prepared by mixing four salts NaHCO₃, MgSO₄·7H₂O, CaCl₂·2H₂O, NaCl in 1:5:10:30 ratio in half strength Hoagland's nutrient solution. *Leptochloa fusca* and *P. distans* produced significantly greater fresh and dry matter than the other species at all salinity treatments. *Pennisetum divisum* had the lowest fresh and dry matter of all the species, whereas *C. pennisetiformis* and *P. turgidum* were intermediate in biomass production. *Leptochloa fusca* accumulated relatively high concentrations of Na⁺, Cl⁻, K⁺ and Ca²⁺ in the shoots compared with the other species. In contrast, *P. distans* contained relatively high Cl⁻, but had low Na⁺ and K⁺ in the shoot. *Cenchrus pennisetiformis* absorbed relatively greater amount of Na⁺ and Ca²⁺ in the shoots, but restricted the uptake of Cl⁻ into the shoots and had moderate shoot K⁺ concentration. *Panicum turgidum* was relatively intermediate in Na⁺ and Cl⁻ accumulation in the shoots, but was highest in Cl⁻, Na⁺ and K⁺ accumulation in the roots. *Pennisetum divisum*, which was the poorest in biomass production, contained relatively moderate amount of Na⁺ in the shoots, but had high K⁺ and Cl⁻ at different salt treatments.

In the second experiment, tolerance of four grass species, *C. pennisetiformis*, *L. fusca*, *P. turgidum*, and *P. divisum* to water deficit was assessed. *Cenchrus pennisetiformis* and *P. turgidum* produced significantly greater fresh and dry matter, whereas *P. divisum* was

intermediate in biomass production at all drought treatments. *Leptochloa fusca* had the lowest fresh and dry matter compared with the other species. *Leptochloa fusca* had the lowest and *P. divisum* highest osmotic potential compared with the species at both drought treatments. Osmotic adjustment was relatively highest in *L. fusca*.

On the basis of the results of the salt and drought experiments, it was established that *C. pennisetiformis* and *P. turgidum* were relatively tolerant to drought, but were intermediate in tolerance to salinity, whereas *P. divisum* was sensitive to both the stresses. *Leptochloa fusca*, which was found highly salt tolerant, showed the lowest tolerance to water deficit. Thus, *P. turgidum* and *C. pennisetiformis* could be grown on drylands by irrigating them with subsoil saline water having moderate salt concentration.

Key words: desert grasses, salinity tolerance, drought tolerance, physiology

Summary

Abdallah Atia, Karim Ben Hamed, Ahmed Debez and Chedly Abdelly
Salt and seawater effects on the germination of *Crithmum maritimum*

Salt tolerance during the germination stage is critical for the establishment of plants that grow in saline soils. The objective of this investigation was to determine the effect of NaCl (50, 100, 150, 200, and 300 mM) and sea water (5, 10, 20, and 30 %) as major salinity agents, on the germination of the halophyte *Crithmum maritimum* distilled water or saline solution (NaCl or sea water). *C. maritimum* showed drastic reduction in germination when subjected to salinities above 150 mM NaCl solutions or 20 % seawater dilution. Further increasing salt concentrations delayed the germination process. When the non germinated seeds were transferred to distilled water, germination recovery (%) reached values close to the controls (untreated seeds), indicating that high NaCl concentrations suppressed germination via an osmotic effect. The recovery response of *C. maritimum* likely reflects the plant ability to withstand long periods of high salinity at the germination step, while preserving seed viability. This is of selective advantage, since soil salinity concentrations fluctuate considerably in the natural habitats of *C. maritimum*.

Summary

Muhammad Y. Ashraf, Ghulam Sarwar, Muhammad Ashraf, Faqir Hussain, Riaz A. Wahed and Muhammad M. Iqbal
Growth performance and nutritional value of salt tolerant plants growing under saline environments

Salinity is the major abiotic stress, which severely affects crop yields. It is more acute in the arid and semi-arid regions of the world. Unfortunately, most of the developing and less developed countries happen to fall in these regions. The population load in these countries is also very high and agricultural lands fail to fulfill the food, feed, fodder and industrial raw material needs of their ever-growing population. The new lands are not available for cultivation of crops and permanent solution of salinity problem is not possible due to poor economic status of these countries. Therefore, it is necessary to exploit salt tolerant plants for food, feed, fodder and industrial raw materials. In Pakistan, severe shortage of fodder for livestock is observed during winter so the introduction of salt tolerant plants having palatability and food values and that can be grown on salt-affected marginal lands, is necessary. The present work is a step in this direction and is aimed at providing information on how the salt tolerant plants can be utilized for fodder

purpose.

The present studies were conducted at the Biosaline Research Station-II of the Nuclear Institute for Agriculture and Biology, Faisalabad, Pakistan with the collaboration of Dept. of Botany, University of Agriculture, Faisalabad, Pakistan to evaluate biomass production and nutritive value of some salt tolerant grasses and bushes like *Leptochloa fusca*, *Sporobolus arabicus*, *Suaeda fruticosa*, *Kochia indica* and *Atriplex lentiformis*. The soil salinity of the experimental site ranged from 4.8 to 28.6 dS m⁻¹ having pH values of 7.82 to 8.92 and RSC of 21.6. The plants were irrigated with underground brackish water with EC of 4.78 dS m⁻¹ and pH 8.2. The plants were raised from root stocks in the selected plots and side by side naturally growing plants of these species of the same age were also selected to compare the growth and nutritional values. When the plants were of reasonable size (the stage when these species can be used for fodder), samples were collected from the experimental plots and naturally growing forage species at BSRS-II. The plants were tested for their biomass and analyzed for protein, total carbohydrates, Na⁺, K⁺, Ca²⁺, Mg²⁺, P and total nitrogen. The results indicated that *Atriplex lentiformis* produced the highest biomass followed by *Kochia indica*, *Leptochloa fusca*, *Sporobolus arabicus* and *Suaeda fruticosa*. Plant yield was significantly higher in the experimental plots than that growing under natural environmental conditions.

The chemical analyses for protein and carbohydrates indicated that *Suaeda fruticosa* contained maximum protein followed by *Kochia indica*, *Atriplex lentiformis*, *Sporobolus arabicus* and *Leptochloa fusca*. On the other hand, the highest carbohydrates were recorded in *Sporobolus arabicus*, closely followed by *Leptochloa fusca* and minimum were in *Atriplex lentiformis*. Maximum Na⁺ was recorded in *Atriplex lentiformis*, closely followed by *Suaeda fruticosa* while minimum was in *Sporobolus arabicus* grass. The highest K⁺ was maintained by *Kochia indica* closely followed by *Atriplex* while *Leptochloa* grass contained the least amount of K⁺. The highest amount of Ca²⁺ was recorded in *Atriplex*, followed by *Kochia*, *Suaeda fruticosa*, *Leptochloa* and *Sporobolus*. On the other hand, maximum Mg²⁺ was accumulated in *Suaeda fruticosa* and *Kochia* and minimum in *Leptochloa* grass and trend was similar for P. Total nitrogen was higher in *Suaeda fruticosa*, followed by *Kochia indica* and *Atriplex lentiformis* than in the other species.

Summary

Xiaojing Liu, Hailong Qiao, Weiqiang Li, Toshiaki Tadano and M. Ajmal Khan
Comparative effect of NaCl and seawater on seed germination
of *Suaeda salsa* and *Atriplex centralasiatica*

The *Suaeda salsa*, a leaf succulent annual plant, and *Atriplex centralasiatica*, a secreting annual plant, are the common halophytes from the family Chenopodiaceae that are widely distributed in China. Seeds of *S. salsa* and *A. centralasiatica* were collected from the coastal salt flats in Haixing County, and experiments were conducted to determine the effect of NaCl and seawater on seed germination under a 12 h light/dark photoperiod in 0, 5, 10, 20, 30, 40, 50 dS m⁻¹ seawater and NaCl solutions at 15/25 °C temperature regimes. Results showed that *S. salsa* and *A. centralasiatica* are good salt tolerant halophyte species. *S. salsa* is more salt tolerant than *A. centralasiatica*. Seed germination decreased with the increase in salinities above 20 dS m⁻¹ salinity levels, especially in *A. centralasiatica*. Only few seeds germinated in 50 dS m⁻¹ of NaCl and seawater in *A. centralasiatica*, but there was more than 50% seeds germinated at that salinity in *S. salsa*. Rate of germination in *S. salsa* was also higher than in *A. centralasiatica*. Seed germination was inhibited more by NaCl than seawater. Both species has the ability to

survive under extreme conditions, the un-germinated seeds can recover completely when salinity stress was removed. Seawater appears to reduce the viability of *A. centralasiatica* seeds. These two species can be grown in saline soils and *S. salsa* even can survive full strength seawater.

Key words: Germination, recovery, NaCl, seawater, *Suaeda salsa*, *Atriplex centralasiatica*

Summary

Ahmed Debez, Wael Taamalli, Dhouha Saadou, Zeineb Ouerghi, Mokhtar Zarrouk, Bernhard Huchzermeyer, Chedly Abdelly

Salt effect on growth, photosynthesis, seed yield and oil composition of the potential crop halophyte *Cakile maritima*

Cakile maritima is a local halophyte widely distributed along the sandy beaches of Tunisia. Moderate salt levels (50-100 mM NaCl) were optimal for the plant, since stimulating the plant growth. This typical halophytic response at 100 mM NaCl was associated with the improvement of photosynthetic activity. The plant seemed able to sequester Na⁺ in the leaf vacuoles. Indeed, leaf V (vacuolar) H⁺-ATPase activity was enhanced up to 300 mM NaCl, while leaf P (plasmalemma) H⁺-ATPase activity increased at salinities higher than 200 mM NaCl. Seed yield was also improved at 100 mM NaCl. Seeds of plants cultivated at salt concentrations above 200 mM NaCl showed altered viability. Salt treatment did not affect seed oil content, but increased erucic acid (22:1) percentage at the expense of that of oleic acid (18:1). Taken together, our data suggest the utilisation of *C. maritima* as a potential seed-oil crop halophyte under mild salinities. Effect of nitrogen deficiency, salinity and drought on proline metabolism in *Sesuvium portulacastrum*

Summary

Dorsaf Messedi, Ines Slama, Nahla Laabidi, Tahar Ghnaya, Arnould Savoure, Abdelaziz Soltani and Chedly Abdelly

Effects of nitrogen deficiency, salinity and drought on proline metabolism in *Sesuvium portulacastrum*

Sesuvium portulacastrum is a perennial halophyte belonging to the Aizoaceae family with potential utility for saline soil stabilisation and desalinisation, as well as for landscaping activities. It is an obligatory halophyte that shows maximal growth potentialities in the presence of 100-400 mM NaCl. Under severe salinity (1000 mM NaCl), growth is impeded, without the development of toxic symptoms in the leaves or the loss of their hydration. This growth reduction resulted essentially from a nutritional disruption induced by salt. *S. portulacastrum* response to nitrogen availability under salinity or drought stresses was investigated in the present study. A particular interest was granted to proline accumulation. In response to salt or hydric stress, proline accumulation was dependent on the availability of nitrogen. Under adequate nitrogen, this trait was concomitant with an increase in ornithine- δ -aminotransferase (δ -OAT EC 2.6.1.13) activity and a reduction in proline dehydrogenase, (ProDH EC 1.5.1.2). Under limiting nitrogen supply and osmotic stress, the decrease of proline accumulation was concomitant with an enhancement of the δ -OAT and ProDH activity and a decrease in leaf proline concentration suggesting that δ -OAT plays also an important role in proline catabolism when plants were subjected to

nitrogen deficiency.

Kristina N. Toderich, Victoria V. Li, Clanton C. Black, Temur R. Yunusov, Elena V. Shuiskay, Gulnara K. Mardonova and Lilya G. Gismatullina

Linkage studies of structure, isoenzymatic diversity and some biotechnological procedures for *Salsola* species under desert saline environments

(no summary available)

Summary

Nader Ben Amor, Karim Ben Hamed, Annamaria Ranieri and Chedly Abdelly
Kinetics of the antioxidant response to salinity in *Crithmum maritimum*

In the present work, we investigated the kinetics of metabolic reactions representative of NaCl-induced oxidative damage and the antioxidant activity in the roots and shoots of the halophyte *Crithmum maritimum*. We focused on the enzymes responsible for the elimination of H₂O₂. CAT activity increased progressively in roots and shoots of 50 mM NaCl-treated plants and attained their maximal values after 60 days of salt treatment. These enzyme activities showed important fluctuations in the roots and shoots of 200 mM NaCl-treated and in control plants. POD activity increased regularly, especially in roots of treated and non-treated plants. The effect of salt treatment on POD activity was significant at the end of salt treatment (60 days). Taken together, our results demonstrate that the ability of tissues to express important antioxidant activities at 50 mM NaCl may constitute an important part of the metabolic salt tolerance in *C. maritimum*.

Summary

Münir Öztürk, Aykut Güvensen, Çiğdem Görk and Güven Görk

An overview of the coastal one plant diversity and management strategies in the mediterranean region of Turkey

The coastline in the Mediterranean phytogeographical region of Turkey is 5191 kilometres long, including the Aegean and the Mediterranean Seas. It is highly indented, embodying numerous bays and coves that have been inhabited by humans since historic times. A total of 213 plant taxa from 37 families are distributed all along this coast, 26 belonging to Poaceae, 23 to Fabaceae, 21 to Asteraceae and 19 to Chenopodiaceae. The major genera are *Limonium*, *Plantago*, *Tamarix*, *Chenopodium*, *Juncus*, *Bromus* and *Astragalus*. The distribution of different ecological forms was as follows; Psammophytes (67 taxa), Halophytes (85 taxa), Xerophytes (47 taxa) and Ruderals (14 taxa). Out of the 213 taxa 13 are endemics. These endemics together with 10 nonendemics are included in the list of endangered taxa. The physico-chemical characteristics of the ground water and soils show that EC, boron and pH in the soils varies between 3.95-67.95 dS/m, 0.57 -5.3 ppm and 7.46-9.10, whereas sodium and chloride contents vary between 38.7-714.3, 25.0-871.67 me/l respectively. In the ground water values of pH, EC and boron lie between 7.02 - 8.28, 7.36 - 93.59 dS/m, 0.88 - 5.02 ppm, whereas sodium and chloride lie between 70.2-1147.2, 61.2-1223.12 me/l respectively. A large percentage of the soils and ground waters are face to face with boron toxicity. The biotic pressures effective in the area are land degradation due to salinity alkalinity problems, summer houses, sand extraction, city and industrial effluents and tourism. In this paper

ecological features like plant cover, soil and groundwater characteristics vis-a-vis biotic pressures are presented for a sustainable planning of these areas.

Summary

Shahina A. Ghazanfar

Aline and alkaline vegetation of NE Africa and the Arabian peninsula: an overview

The saline, hyper saline and alkaline areas of NE and E Africa and Arabia are vegetated by some 200 species of flowering plants belonging mainly to the families Acanthaceae, Asteraceae, Chenopodiaceae, Fabaceae, Poaceae, Polygonaceae and Zygophyllaceae. The species belong to three phytochoria, the Saharo-Sindian, Somalia-Masai and Zanzibar-Inhambane occupying Arabia, NE and E Africa and the coastal region of east Africa respectively. The typical and the dominant perennial halophytic species in these phytochoria are diverse with little overlap, Vicariance is present in several groups of halophytes in the Arabian Peninsula

The saline areas of NE & E Africa are dominated by the grass *Drake-Brockmania somalensis*, subshrubs *Duosperma eremophilum* (Acanthaceae) and *Indigofera spinosa*; the alkaline swamps by *Diplacne fusca*, and the alkaline flats by *Sporobolus spicatus* and *Psilolemma jaegeri*; gypsophilous soils are dominated by *Volkensinia prostrata* (Amaranthaceae). In Arabia the main species in saline habitats are mostly perennial succulents, subshrubs and stoloniferous hemicryptophytes. Amongst the annuals, succulents species such as *Bienertia cycloptera* and *Zygophyllum simplex* are rare. The most common coastal and salt tolerant species are *Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Halopeplis perfoliata*, *Limonium* spp., *Salsola* spp., *Salicornia europaea*, *Seidlitzia rosmarinus*, *Zygophyllum* spp.; the grasses and sedges *Aeluropus lagopoides*, *Juncus rigidus*, *Odyssea mucronata*, *Sporobolus spicatus*, *S. condimilis*, and mangroves *Avicennia marina*.

Key words: Tropical East Africa, Arabia, halophytes, saline, alkaline, arid

Summary

A. Aksoy and E. Hamzaoglu

Vegetation zones in the salty marshes of Central Anatolia and natural borders of agricultural usage (Turkey)

Edaphic factors that cause vegetation zones seen in the salty marshes of Central Anatolia were observed in terms of floristic characters. Samples were taken from the halosere which is in aggregation phase found in the dried base part of Yay Lake (Sultansazlığı-Kayseri), and the role of the Mg^{+2} , Na^{+} , Ca^{+2} , K^{+} , Cl^{-} , SO_4^{-2} and total CO_3^{-2} values on shaping of these zones was determined. Halophytic vegetation zones of Tuz Lake, Seyfe Lake and the marshes of Sultansazlığı were analyzed in terms of physiognomy, floristic composition and endemism. It is emphasized that the most outer part of salty marshes which is characterized by *Artemisia santonicum* L. should be accepted as “natural border” for agricultural.

Key words: Central Anatolia, salty marshes, vegetation zones, agriculture

Summary

Hassan M. El Shaer

Halophytes as cash crops for animal feeds in arid and semi- arid regions

Salinity and drought are responsible for substantial losses of agriculture yield, deterioration of vegetation cover and erosion of soils worldwide. Optimum and sustainable utilization of halophytes would play an important role to cope with the reduction of yield due to drought and salinity by providing different raw materials for food, feed, chemical industry, medicinal purposes, in addition to elimination of soil and wind erosion. This article is aimed at drawing attention on the potential of halophytes, focusing mainly on their capability to supply animal and poultry feed materials in arid and semi- arid regions. It seems that many halophytic species can be used successfully with economic benefit for several purposes such as: rehabilitation of marginal lands, animal feed and human food production, soil protection and sand dune fixation. Utilization of halophytes as feed materials is discussed in the following article. It tackles the possibilities for halophytes utilization, nutritive value of common halophytes, possible enhancement of the use of halophytes as feed materials, their utilization by various species of animals (small ruminants, camels, poultry) and on the impact of salinity on animal physiological responses. It is indicated that several halophytic species, mainly *Atriplex* spp., *Tamarix* spp., *Suaeda* spp., *Nitraria retusa*, *Juncus* spp., *Salsola* spp. could have a great role in feeding livestock and poultry under arid and saline conditions. Some of such halophytic plants, particularly the palatable ones, could be fed directly, while the less or un – palatable plants, should be processed through proper treatment methods to enhance their nutritive value and to maximize their utilization. Halophytic feed materials could provide additional good quality feed resources with reasonable economic advantages for livestock and poultry production on the rangelands particularly in such countries that suffer from fresh water and animal feed shortage.

Key words: Halophytes, salinity, drought, sheep, goats, camels, poultry, feed

Summary

Fatih Konukcu

Potential of dry drainage as a sustainable solution to waterlogging and salinisation

Some 80 million hectares cultivated land around the world are affected by salinity while about 20 million hectares suffer from severe irrigation-induced waterlogging and salinity problem. This could not be overcome by applying conventional drainage methods due to the high cost and to environmental restrictions. “Dry-drainage” has recently been considered as an alternative method to control waterlogging and salinity. It involves the creation of sink areas of fallow land, which operate as evaporation basin drawing a stable flux of water and salt from irrigated cropped area. What is lacking is a serious technical and economic appraisal of dry-drainage, that may be reduced to three key questions: (i) what is the limiting crop intensity? (ii) what is the limiting watertable depth? (iii) what is the long-term impact of salt accumulation in the drainage sink area. A simulation model was developed to investigate the above questions. In addition a field-scale assessment of a dry-drainage system with wheat-cotton cropping pattern was established for the Lower Indus Basin in Pakistan, where shallow saline watertables, intensive irrigation, high evaporative demand and natural dry-drainage co-exist. The simulation results showed that the dry-drainage have satisfied the necessary water and salt balance when the cropping intensity was about 50% and watertable depth was around 1.5 m. However the design criteria may be significantly influenced under other climatic conditions, by soil properties, by the practiced crop and by economic factors.

Key words: Salinity, waterlogging, drainage, evaporation, watertable depth, leaching, simulation model

Summary

M. Qadir, J.D. Oster, S. Schubert and G. Murtaza

Vegetative bioremediation of sodic and saline-sodic soils for productivity enhancement and environment conservation

Nearly 20% of irrigated area in the world is salt-affected, which contains excess levels of soluble salts in soil solution (salinity) and/or sodium ions (Na^+) in soil solution and on cation exchange complex (sodicity). Saline-sodic and sodic soils are a major category of salt-affected soils. Amelioration of these soils is driven by providing a soluble source of calcium (Ca^{2+}) to replace excess Na^+ on the cation exchange complex. Chemical amendments have long been used to ameliorate saline-sodic and sodic soils for enhancing productivity. During the last two decades, there is growing evidence from researchers and farmers in many developing countries that these soils can be brought back to a highly productive state by a plant-assisted amelioration approach rather than cost-intensive chemical amelioration. This amelioration strategy, termed vegetative bioremediation, involves the cultivation of certain plant species resistant to ambient levels of soil salinity and sodicity coupled with appropriate soil and irrigation management practices. Without relying on chemical amendments, vegetative bioremediation enhances the dissolution rate of inherent or precipitated calcite (CaCO_3), which has negligible solubility under natural conditions and commonly occurs in sodic and saline-sodic soils. It is driven by the partial pressure of CO_2 (PCO_2) within the root zone, the release of protons (H^+) by roots of certain plant species, and, to a much smaller extent, the Na^+ uptake by plants and its subsequent removal from the field at harvest. Enhanced levels of PCO_2 and H^+ assist in increasing calcite dissolution. This results in the added benefit of improved soil physical properties within the root zone, enhancing the hydraulic conductivity and allowing the leaching of Na^+ below the effective rooting depth. This chapter documents the information on different aspects of vegetative bioremediation.

Summary

V.P.S. Shekhawat, Ashwani Kumar and K.H. Neumann

Bio-reclamation of secondary salinized soils using halophytes

The feasibility of three halophyte plant species, *Haloxylon recurvum*, *Suaeda nudiflora*, *Salsola baryosma*, of the *Chenopodiaceae* were tested for their suitability for bioremediation of a secondary salinized soil. Effects of plantation of these three species on soil pH, EC, exchangeable calcium and exchangeable sodium was studied. *Haloxylon recurvum*, accumulated maximum amount of sodium in the aerial shoot on dry weight basis. Smaller concentrations were found for *Suaeda nudiflora* and *Salsola baryosma*. A considerable reduction in soil EC at all the tested depths was recorded in *Suaeda nudiflora* and *Haloxylon recurvum* stands. Soil pH was also modulated by these plant treatments. The most prominent reduction in soil exchangeable sodium was recorded in *Haloxylon recurvum* stands. Soil calcium content was also affected by halophyte plantation. In *Suaeda nudiflora* and *Haloxylon recurvum* plots increase in calcium concentration was recorded in all the depth levels. Soil exchangeable sodium percentage (ESP) in *Suaeda nudiflora* grown field plots declined in 0 - 40 cm soil layers. In *Haloxylon recurvum* plots it decreased at all the depth levels. Based on the present results we propose the use of these plants as 'primer plants' for the remediation of

salt contaminated soils. Results clearly indicate that beside biomass production, these three plant species may enhance the process of reclamation of problematic soils.

Summary

Halil Kirnak

Effects of irrigation water salinity on yield and evapotranspiration of drip irrigated cucumber in a semiarid environment

A field study was conducted to determine a short term effects of saline irrigation on yield and evapotranspiration (ET) of drip irrigated cucumber in Sanliurfa-Harran Plain, Turkey in 2001. Four irrigation water salinity levels ($EC_i = 0.45, 3, 6, \text{ and } 9 \text{ dS m}^{-1}$) along with 100 of crop evapotranspiration were used in a completely randomized design with 3 replications. Model for relation between yield and ET proposed by Stewart et al. for drought conditions was checked for cucumber under saline conditions and yield estimation of the model was quite good. The salinity levels affected the yield of cucumber severely at $EC_i = 9 \text{ dS m}^{-1}$. The highest yield (3187 kg da^{-1}) was produced by plants irrigated with good quality water. Irrigation with saline water tended to decrease ET and plant growth. Cucumber tolerated greater levels of irrigation salinity than previously reported. The used irrigation method, drip irrigation system, likely moderated the water use of cucumber.

Key words: salinity stress, plant growth, fruit yield, transpiration, cucumber, salinity

Summary

Chedly Abdelly, Zouhaier Barhoumi, Tahar Ghnaya, Ahmed Debez, Karim Ben Hamed, Riadh Ksouri, Ons Talbi, Fethia Zribi, Zeineb Ouerghi, Abderrazzak Smaoui, Bernhard Huchzermeyer and Claude Grignon

Potential utilisation of halophytes for the rehabilitation and valorisation of salt-affected areas in Tunisia

The areas suffering from a salt excess reach approximately 1 billion ha throughout the world. In Tunisia, 1.5 million ha (10 % of the whole territory and 18 % of the arable lands) are affected by salt. The selection of salt tolerant varieties or the improvement of plant salt tolerance by genetic engineering would allow the extension of the cultivated areas with an increase in their productivity. However, the contribution of this approach remains limited, taking into account the complexity of the mechanisms involved in the plant salt tolerance. The alternative approach consists in using halophytes which have already acquired the necessary characteristics to tolerate salt, and express a high productivity under these constraining conditions. Within the framework of this approach, we showed that some halophytes are able to desalinise and fertilise soil, thus creating micro-habitats favourable for the development of several salt-sensitive annual plants, mainly represented by *Medicago* species, highly appreciated by the livestock. Other halophytes are well grazed and contribute directly to the pastoral value of the marginal zones. The majority of these species are able to maintain high growth potentialities under a wide range of salinities and to produce biomass (case of the *Poaceae*) with low salt concentration in tissues. Some species are potentially useful for the production of oil, since their seeds are particularly rich in lipids (32 to 42% of seed DW). Extracted oil can be used either for human consumption or in industrial applications. Other halophytes have promising characteristics for the rehabilitation of marginal zones, through soil desalination and stabilisation, as well as heavy metal phytoextraction (phytoremediation).

Summary

Muhammad Y. Ashraf, Faqir Hussain, Muhammad M. Iqbal, Wolfgang Maibaum and Marcus Ross

Interactive effect of potash and organic manures on growth and nutrient uptake of sugarcane grown under saline conditions

Salinity is a major problem of irrigated agriculture of Pakistan, which is becoming more acute with time and as a result, many lands are becoming infertile and barren. The proper reclamation of these soils is very expensive. However, good production of salt tolerant crops on these soil is possible through proper nutrient management. Sugarcane is an industrial and cash crop in Pakistan as well as in many countries of the world. So proper nutrient management technology for sugarcane crop to grow it in salt-affected soils is necessary. The present study is a step in this direction.

The interactive effect of potash SOP or MOP and two organic fertilizers on the growth and nutrient uptake in two sugarcane varieties, SPSG-26 (salt tolerant) and CP-77-400 (salt sensitive), was studied at three selected sites in Pakistan, normal and salt-affected. Experiment on each site consisted of three treatments of organic manure (without manure, farmyard manure and sugarcane press mud) in main plots and five treatments of potassium as SOP and MOP (without K, 100, 200 kg K₂O ha⁻¹ as SOP and 100 and 200 kg K₂O ha⁻¹ as MOP) in sub-plots with three replications. The results indicated that growth and cane yield were increased with the application of potash (SOP or MOP) and organic manure under saline as well as normal conditions, however, it was more pronounced in the plants treated with SOP and farmyard manure in both the varieties, at all the selected sites. The performance of salt tolerant variety SPSG-26 was far better than sensitive one. The Na⁺ uptake was reduced in those plants, which were treated with potash, either in the form of SOP or MOP, but it enhanced where organic manures and sugarcane press mud were applied. The uptake of Ca²⁺, K⁺, P and N also increased with the application of potash and organic manures both under saline as well as normal conditions, however, effect of SOP was more pronounced than MOP in all the cases. From the results it can be concluded that proper dose of potash and organic manure is necessary to have optimum growth and better nutrient uptake by sugarcane under salt affected soils.

Summary

H. Hüsni Kayolçioğlu and Bülent Okur

The effects of saline irrigation water by drip irrigation on salt distribution in soil

An ongoing field trial was established in 1996 at the experimental site of Ege University Faculty of Agriculture, Department of Horticulture. In the study, two different rootstocks (*Poncirus trifoliata* and Troyer citrange) were budded onto Satsuma mandarins (cv. Owari) which are irrigated with 5 different levels 0.65 (fresh water-I0); 2.00 (I1); 3.50 (I2); 5.00 (I3) and 6.50 (I4) dS m⁻¹ of saline water by drip irrigation. The aim of the study was to examine the horizontal and vertical distribution of salt in the soil at two different dates of irrigation season, mid and end. In the mid period samples, salt accumulation was in the horizontal direction on rows and decreased with the increased distance from the drippers. On the other hand, in the samples taken at the end of the season salt accumulation was towards between rows with an increasing trend. Soil at the rooting zone of *Poncirus trifoliata* rootstock contained less Na and Cl ions than the Troyer citrange plots.

Key words: Salinity, drip irrigation, *Poncirus trifoliata*, troyer citrange

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