VALUATION OF NOT CONVENTIONAL SALT WATERS IN DRY CULTURE

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Abstract. In the dry and semi-arid zones, the water requirements of the cultures are raised while the available water presents a strong unfavorable mineralization in irrigation. Our study concerned the culture of tomato, variety "**Saint Peter**" averagely sensitive to the salinity. Plants were Subdued to two series of solutions (series 1: natural salt waters T1, T2, T3 and series 2: T1C, T2C and T3C corrected salt waters) and a standard nourishing solution noted T4. The addition in nutriments in natural salt waters improved considerably the growth of the plants of tomato which was translated by a smooth running of the photosynthetic processes, and a production of important fresh and dry biomass. So, there is a more important accumulation of proline and soluble sugars in the various parts of the plant which is made in the sense: root stalk-leaf.

Keyword: Dry zones, salt waters, tomato, salinity, proline, soluble sugars

INTRODUCTION

The excessive salinity affects the rhizosphere and limits the distribution of plants in their natural housing middle. The strong illumination and the rare rains in the semi-arid and dry regions which represent a third of the surface of the globe, stress the salinisation of the irrigated perimeters and make them unfit for the cultures (Denden, and al, 2005).

The water is an indispensable resource for vegetables. Its presence in a major condition for development of any plant, can and assure its vital physiological functions. Plants present in dry zones and semi dry is going to find to expose to a salt stress (Calu, 2006).

The salinity is a very important middle factor which limits the growth and the productivity of plants (Parida and Das, 2005). The development of plants is the result of the integration and the regulation of the physiological processes and the most dominating is the photosynthesis

Indeed, according to the degree of salinity in the middle, glycophytes in particular is exposed to modifications of their morpho-physiological behavior (Bennaceur and al, 2001), biochemical (Grennan, 2006) and mineral (Martinez and al, 2007). Indeed, the tolerance, in the case of a reduction in the hydric potential, expresses himself by a preservation of the turgescence (Garg and al, 2002; Moinuddin and al, 2005) due to the phenomenon of osmotic adjustment.

Within the framework of this approach, we proceeded to biometric measures fresh and dry biomass of the air part, and in the dosages of some biochemical parameters (proline, soluble sugars and chlorophyll) on plants of tomato.

MATERIAL AND METHOD

1. Objective of experiment.

The physiological and biochemical mechanisms involved during the salt stress will be identify on the plants of tomato irrigated by a natural then corrected salt water and it after its reconstruction on the experimental site.

2. Composition of the various treatments

Table 1

Composition of the various treatments

E.S.N*: Natural saline water

References water	pH	CE	NO_3^-	NH_4^+	$PO_4^{-}{}_3$	Cl^-	$S0_4^{-2}$	Na^+	Ca^{+2}	Mg^{+2}	K^+
Water of Blida natural	7,20	0,59	0,35	1,80	0,00	0,60	0,80	1,30	2,80	1,80	0,00
T1 E.S.N*	7,80	2,87	0,35	0,00	0,00	14,45	9,40	9,90	9,25	9,20	0,00
T1C T1 rectified	5,50	3,58	10,20	1,80	3,30	14,45	9,40	9,90	9,25	9,20	5.85
T2 E.S.N*	7,80	2,87	0,35	0,00	0,00	15,65	8,20	9,90	9,25	9,20	0,00
T2C T2 rectified	5,80	3,58	10,20	1,80	3,30	15,65	8,20	9,90	9,25	9,20	5.85
T3 E.S.N*	7,80	2,87	0,35	0,00	0,00	14,45	9,40	9,90	9,25	9,20	0,00
T3C T3 rectified	5,80	3,58	10,20	1,80	3,30	14,45	9,40	9,90	9,25	9,20	5,85
Water of Blida rectified (T4)	5,80	1,56	10,20	1,80	3,30	0,60	1,50	1,30	5,10	1,80	4,25

3. Plant material

The used species during our experiment is the tomato *(Solanum lycopersicum*), variety Saint-Peter. After the seeding of seeds in the steam room in 25°C, a transplanting of the young germs of ready definitive tomato in jars of 2 liter capacity; tucks of gravel rolled by oued 3 in 8 mm in diameter beforehand disinfected and rinsed abundantly was operated. The watering was realized by a standard nourishing solution.

From the appearance of the fifth leaf, we proceeded with care of the various treatments

Our experimental study was led according to an experimental total plan in randomization, in a studied factor "solution of irrigation " with 8 repetitions, with 56 plants by cutting and 168 plants in all.

4. Studied parameters

The tested parameters were measured according to the destructive method according to three different periods respectively:

- First cutting: in 13 days of salt stress (Stage of vegetative development).

- The second cutting: in 26 days of salt stress (stage of the beginning-bloom).
- The third cutting: in 126 days of salt stress (Final stage).

4.1 Biometric measures

At the time of every realized cutting, the air part of every plant was collected, and weighed.

4.2 Biochemical dosages

The made biochemical analyses concerned the content in chlorophyll, in proline and in soluble sugars at the level of the organs of plants.

4.2.1 Dosage of the proline

The proline is measured according to the technique used by Troll and simplified by Lindesly (1955) and finalized by Dreier and Goring (1974) and modified by Monneveux and Nemmar (1986). The principle is the quantification of the reaction proline-ninhydrine by spectrophotometric measure. The proline couples with the ninhydrine by forming a colored complex. The intensity of the coloring is proportional in the quantity of proline in the sample. The optical density is read to 528 nm in the spectrophotometer.

4.2.2 Dosage of soluble sugars

The dosage of soluble sugars is realized according to the method of Dubois, (1965); and the reading was made with the spectrophotometer in the wavelength of 490 nm.

4.2.3 Dosage of the chlorophyll

The extraction of the chlorophyll has and b is realized according to the method of Francis and al (1970 in Bouzid, 2010). After 48 hours, we proceed to the reading of the optical densities of the solutions with a spectrophotometer with two wavelengths: (645 and 663 nm).

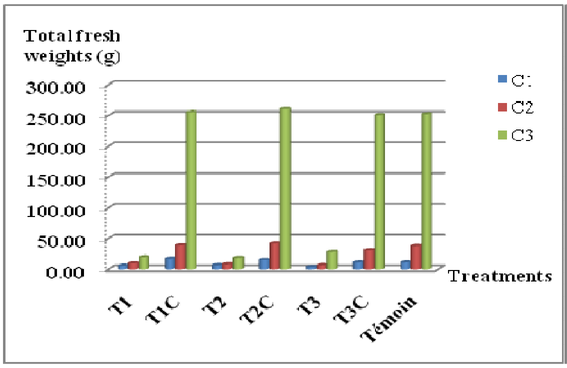
5. Statistical analysis

To determine the meaning of the effect treatment on the studied parameters, we proceeded to analyses of the variance and in comparison with the averages according to the method of Newman and Keuls, based on the smallest significant difference, by means of the test of Ficher with $\alpha = 5$ %.

RESULTS AND DISCUSSION

1. Effect of the salinity on the biomass of fresh and dry air part:

The influence of treatments applied to the variety of tested tomato revealed that the natural salt treatments (T1, T2 and T3) led significant decreases of the total biomasses of fresh and dry air parts compared with level of 5 % for three realized cuttings and this held account the Ionic imbalance of the food circles and the bad hydro mineral supply of plants and its translated by a production of weak biomass.



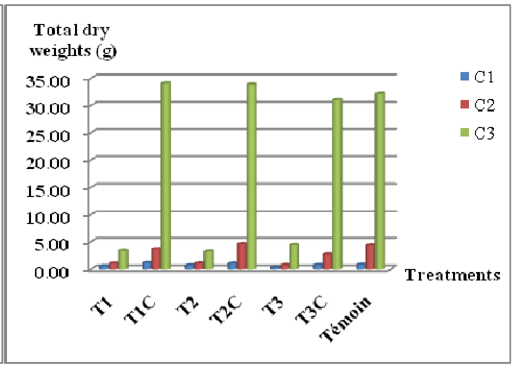


Fig. 1. total fresh biomass of the air part (g)

Fig. 2. total dry biomass of the air part (g)

Generally, we notice that plants irrigated by the treatment (T3) where the sodium is connected partially with chlorides and partially with sulfates show that the production in material is lowest in fresh and dry parts with reductions of (65.84 %, 82.74 %) during the cutting 1, and (60.49 %, 83.06 %) during the cutting 2 and compared with the witness (T4) respectively. While during the last cutting, we noticed that all the natural salt treatments are statistically classified in the same homogeneous group (b).

The young organs of plants growing in natural salt waters (T1, T2, T3) necrotize and the terminal leaves fade ending in a decrease of the biomass fresh and dry organs of plants. The works of Warne and al, (1990) showed in this respect that the most obvious signs of stress at the level of the vegetation watered by waters charged in salt are the ones of a physiological drought showing itself by a general aspect stunted by the plant, by a decrease of the foliar surface and by the roots mass and by a partial drying of the vegetation.

On the other hand, plants fed by the salt corrected solutions (T1C, T2C, T3C) present a high hydro mineral absorption this because of the perfect Ionic balance, the adequate quantities in nourishing elements and a favorable pH to the absorption to know 5,5 and 5,8 translating by important fresh and dry biomasses.

2. Effect of the salinity on the production of proline and soluble sugars in the various organs of the plant:

According to the results presented in the table 2, we notice that these osmolytes both accumulate rather in the leaves where we register the highest concentrations in particular at the level of plants fed by the corrected salt solutions in particular at the level of T2C. It was previously noticed that plants irrigated by the salt corrected solutions (T1C, T2C and T3C) grew better compared with plants watered by the same natural salty treatments.

Plants stemming from corrected salt solutions produced more of proline and soluble sugars. The corrected middle creates a stronger outside osmotic potential; the osmotic stress perceived by plants leads an answer of defense which is a production of proline and total sugars to adjust the internal osmolarity. Indeed, the correction of salt waters improves the hydro mineral absorption of plants what shows good that the nourishing middle is not toxic anymore and does not constitute any more an obstacle for the growth of the plant. In other words, plants not presenting mineral deficiency, do not present physiological drought compared with plants stemming from natural salt treatments T1, T2 and T3.

Table 2

Effect of the salinity on the production of proline and soluble sugars in the various organs of the plant during three cuttings.

		cutting 1			cutting 2			cutting 3		
		leaves	**stalks**	**roots**	**leaves**	**stalks**	**roots**	**leaves**	**stalks**	**roots**
T1	**P**	0,022 ±0,001 d	0,013 ±0,001 e	0,010 ±0,002 ef	0,025 ±0,002 e	0,015 ±0,002 e	0,014 ±0,002 e	0,038 ±0,002 e	0,031 ±0,002 ef	0,023 ±0,004 e
	S	0,161 ±0,009 f	0,159 ±0,009 e	0,086 ±0,006 f	0,219 ±0,010 e	0,188 ±0,007 f	0,129 ±0,008 e	0,374 ±0,091 e	0,216 ±0,004 f	0,140 ±0,004 f
T1C	**P**	0,085 ±0,004 b	0,054 ±0,005 b	0,051 ±0,003 b	0,194 ±0,006 b	0,131 ±0,007 b	0,123 ±0,005 b	0,421 ±0,014 b	0,259 ±0,011 b	0,185 ±0,007 b
	S	0,437 ±0,020 b	0,311 ±0,011 b	0,246 ±0,007 b	0,512 ±0,017 b	0,359 ±0,019 b	0,280 ±0,004 b	0,768 ±0,011 b	0,391 ±0,006 b	0,315 ±0,004 b
T2	**P**	0,026 ±0,004 d	0,020 ±0,002 d	0,016 ±0,001 d	0,039 ±0,002 d	0,023 ±0,003 d	0,021 ±0,002 d	0,062 ±0,007 d	0,042 ±0,002 d	0,035 ±0,002 d
	S	0,329 ±0,020 c	0,206 ±0,006 c	0,176 ±0,012 d	0,407 ±0,017 c	0,237 ±0,009 d	0,211 ±0,014 d	0,444 ±0,024 d	0,253 ±0,004 d	0,250 ±0,003 d
T2C	**P**	0,090 ±0,007 a	0,073 ±0,003 a	0,065 ±0,003 a	0,385 ±0,010 a	0,307 ±0,005 a	0,238 ±0,007 a	0,524 ±0,010 a	0,315 ±0,007 a	0,280 ±0,007 a
	S	0,742 ±0,032 a	0,356 ±0,012 a	0,320 ±0,011 a	0,821 ±0,006 a	0,555 ±0,006 a	0,428 ±0,010 a	0,924 ±0,005 a	0,595 ±0,009 a	0,460 ±0,004 a
T3	**P**	0,021 ±0,002 d	0,016 ±0,001 e	0,012 ±0,001 e	0,029 ±0,002 e	0,022 ±0,002 d	0,018 ±0,001 de	0,054 ±0,003 d	0,036 ±0,003 de	0,032 ±0,003 d
	S	0,277 ±0,011 e	0,183 ±0,010 d	0,114 ±0,010 e	0,305 ±0,012 d	0,215 ±0,005 e	0,141 ±0,014 e	0,441 ±0,036 d	0,240 ±0,006 e	0,151 ±0,002 e
T3C	**P**	0,046 0,006 c	0,037 ±0,006 c	0,033 ±0,007 c	0,169 ±0,004 c	0,103 ±0,006 c	0,083 ±0,006 c	0,318 ±0,026 c	0,187 ±0,009 c	0,153 ±0,004 c
	S	0,307 ±0,010 d	0,190 ±0,013 d	0,224 ±0,013 c	0,406 ±0,010 c	0,334 ±0,015 c	0,262 ±0,010 c	0,505 ±0,007 c	0,353 ±0,004 c	0,290 ±0,002 c
T4	**P**	0,014 ±0,002 e	0,013 ±0,003 e	0,007 ±0,001 f	0,016 ±0,001 f	0,014 ±0,002 e	0,014 ±0,002 e	0,033 ±0,002 e	0,025 ±0,003 f	0,020 ±0,002 e
	S	0,080 ±0,010 g	0,066 ±0,004 f	0,064 ±0,009 g	0,142 ±0,006 f	0,076 ±0,007 g	0,083 ±0,011 f	0,176 ±0,003 f	0,095 ±0,005 g	0,088 ±0,003 g

P: Proline **S:** soluble sugars

These corrected treatments (T1C, T2C and T3C) present a concentration osmolytes stronger than in natural salt waters (T1, T2 and T3). For that purpose, the external osmolarity is thus stronger what requires an adjustment of the internal even stronger osmolarity (not to dehydrate because the water passes of the middle the least concentrated towards the most concentrated middle what is translated by a greater production Of these osmoregulaters both in the organs of plants watered by the corrected salt treatments.

On the other hand, plants fed by natural salt waters accumulate less of osmoprotectors in all the tested vegetable parts, this is due to the fact that the circles are loaded with unbalanced salts thus create a stronger external osmotic potential not allowing a perfect and regular hydro mineral absorption.

The comparison between three organs of plant shows that the accumulation of the proline and the soluble sugars is more important in the leaves than in the stalks and the roots.

3. Effect of the salinity on the chlorophyllous pigments:

The results presented in figures 3, 4 and 5 shows that the salinity exercises a remarkable effect on three natural salt treatments by reducing significantly the formation of the chlorophyllous pigments during three periods of the applied stress.

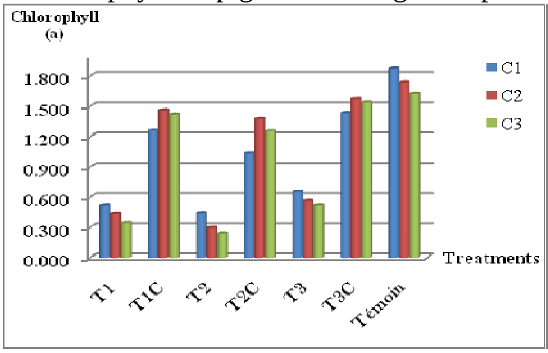


Fig. 3. Quantity of chlorophyll (µg/g MF) (a)

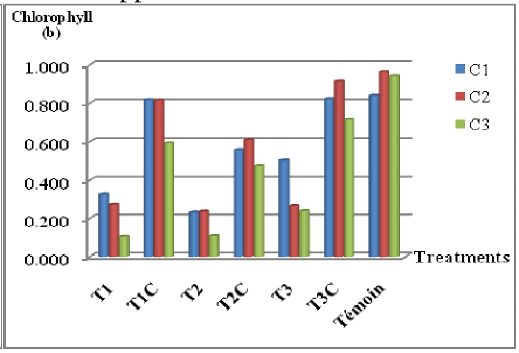


Fig. 4. Quantity of chlorophyll (b) (µg/g MF)

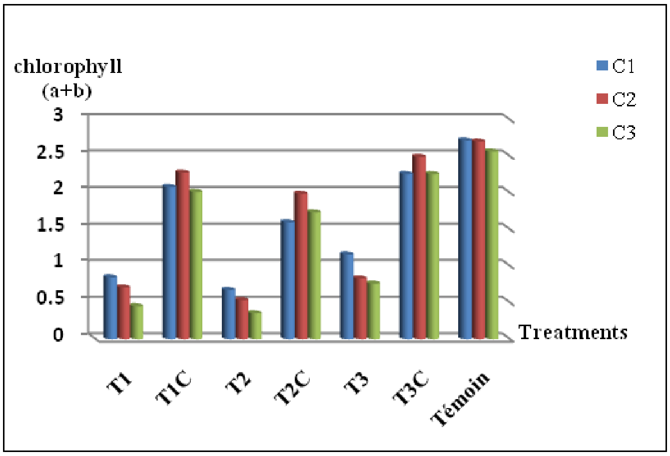


Fig. 5. Quantity of the chlorophyll (a+b) (µg / g MF)

We notice, according to these three figures that the treatment T2 always shows the most lowest values of the chlorophyll has and some chlorophyll b with rates of reductions of (76,64 %, 72,5 %,), during the cutting 1, (83 % and 75,51 %) during the cutting2 finally (85,14 % and 88,42 %) during the cutting 3 and it compared with the witness respectively.

In the same context, Denden and al. (2005 in Lepengue and al, 2012), shows that lower them chlorophyllous contents could be variants of the physiology of this chemical stress.

The salt toxicity would cause in that case, damages of chlorophyll proportionally in the salt concentrations. Such phenomena were also already reported by Lepengue and al. (2010) on the corn (***Zea mays, L***), Symaraytis and al. (1992) on ***Nicotiana plumba ginifolia***, and Piri (1991) on the wheat (***Triticum aestivum, L***.), in answer to the salt toxicity.

Furthermore, three varieties of ***Lycopersicum esculentum*** and a variety of ***Lycopersicum sheesmanii*** were studied under various diets of irrigation in the salt water. The contents in chlorophyll (a), (b) and total were reduced under the influence of a salt stress (El Iklil and al, 2002 in Bouchoukh, 2010).

The correction of natural salt waters, allowed to increase the quantity of these two parameters during the first two cuttings. This can be explained by the perfect Ionic balance of the food circles as well as the hydric potential adequate which allowed the plants of grow and to develop with a similar rhythm to that of plants fed by the witness (standard nourishing solution) and to escape the fatal effect of the salinity.

We also noticed a low regression of the parameter measured to plants watered by the salt solutions corrected during the third cutting, this because of the physiological senescence of plants. Besides, plants watered by the treatment witness always show the highest values.

The reduction of the photosynthesis depends on two aspects of the salinisation to know, the concentration and the Ionic composition of the salt solution. Indeed, a strong concentration in salt reduces the water available on the plant, and creates an osmotic stress which makes the electrochemical transport photosynthetic inactive (Allakhverdiev and al, 2000).

So according to Walker and al. (1981), a loss of turgescence in salty middle would be responsible for a decrease of the photosynthetic capacity and, consequently, for a growth.

CONCLUSIONS

The irrigation with salt waters drives to the increase of the salinity in the root's middle. The Ionic imbalance of natural salt tested waters (T1, T2 and T3) stresses the effect of the salinity of the food circles what limits the growth of the plants of tomato and reduces as a consequence of the hydric consumption and the mineral which is in connection with the evapo-transpiration. On the other hand, the high concentration of salt in the corrected nourishing middle and the Ionic balance of which is completed favors the vegetative development of the plants of the variety Saint Peter.

The decreases of the parameters of growth and the biochemical parameters are in direct relation with the concentrations in salt in natural salt waters.

The addition of major and minor nourishing elements in natural salt waters drove to a significant increase of the growth of the tested plants and this fact in a better use of the fert-irrigation compared with plants treated with natural salt waters. There are then some differences between both series of solutions. Concerning the fresh biomass and dry total, the natural salinity of the middle, acts on the growth one decreasing the total biomass by bringing down the leaves which affect the threshold of toxic accumulation of Na^+. This toxicity is observed at the level of the plants of treatments (T1, T2 and T3) foliar characteristics of the state of senescence.

The weakness of production of fresh and dry biomass is registered at the level of natural salt waters can be explained first of all by a strong osmotic pressure because of a particularly high salinity which inhibits the absorption of the water. She can be also explained by a high concentration of chloride compared with sulfate and by a concentration abnormally high in Na + having unfavorable effects on the development of some culture in particular to tomato.

The salinity entailed physiological modifications which expressed themselves, by an accumulation of some osmoticum studied (proline, soluble sugars) and by a reduction of content in chlorophylls [Chl has, Chl b and Chl (a+b)]. The accumulations of solutions as well as the reductions of the contents in chlorophylls were more important at the level of the corrected salt solutions than in the natural salt treatments.

The accumulation of the proline was demonstrated at numerous species and in various situations of stress (osmotic, hydric, and thermal) (Tahri and al, 1998), some authors (Singh and al, on 1973) think that the accumulated quantities could be connected at the level of tolerance in stress. The accumulated proline could play a role of osmoticum. She could, also, intervene in the regulation of the cytoplasmic pH or to constitute a reserve of nitrogen used by the plant after the period of the stress (Hadjadj and al, 2010).

To the variety of tomato studied "Saint-Peter", the accumulation both osmolytes are made in the direction: root-stalk-leaf as well to witness plants as those irrigated by natural salt waters or corrected with a more important accumulation at the level of the corrected salt solutions and more particularly for the treatment T2C.

We can also note that the corrected salt circles are not toxic for plants because they do not show signs of mineral deficiency for dehydration and thus plants grow suitably. However, these corrected salt solutions present a concentration osmolytes stronger than in natural salt waters. The external osmolarity is thus stronger what requires for plants an even stronger internal adjustment not to dehydrate, what is translated by a greater production of proline and soluble sugars. Plants fed by the treatment of witness present a rate of proline least the raised further to the absence of osmotic stress

Contrary to this increase of contents it proline and of soluble sugars in the corrected salt treatments under the influence of the stress, we noticed a reduction in contents in chlorophyllous pigments [Chlorophylls (a), (b) and (a+b)] to plants fed by salt waters.

According to Roudani, (1996), the morpho-physiological disturbances inferred by various typical of salts contained in the solutions are explained by the direct toxicity and the nutritional competition.

The direct toxicity is connected to the excessive accumulation in some plants of the sodium ions (Na +) and chlorides (Cl^-) in the foliar organs which perturb the photosynthetic processes of leaves and reduce the quantities of synthesized organic matters.

As regards the nutritional competition, the absorption of the ions Na + limit the entry of the other ions (Ca^{2+} and K^+, Mg^+, NO^{3-}, PO^{4-}.) by the phenomena of mineral competition of apoplasmic fixation. This situation drives to the mineral deficiency of plants, and to the general reduction of their growth (Soltani, 1988).

The corrected salt solutions allowed the preservation of a smooth running of the photosynthetic process. We deduct from it that we optimizing the fert-irrigation in natural salt waters, it are possible to obtain plants of characteristics equivalents or less neighbors of a standard middle.

The plants of tomato of the variety "Saint-Peter" manage at grow and to develop in the conditions of high salinity due to the osmotic mechanisms of adjustment. They also adopt, the same strategy face has the salt constraint one tolerating a higher accumulation of ions Mg^{+2}, Na^{+}, Cl^{-} and SO_4^{-2} mainly in foliar tissues.

The correction of the natural salt treatments causes on one hand a better morphological growth of plants being translated by an important fresh and dry biomass; and by, an increase of the contents of the protein compounds (Proline), the carbohydrates (soluble Sugar) and the chlorophyllous pigments (a and b).

On the other hand, the natural salt treatments lead chlorophyllous losses at the level of plants, morphological disorders of and physiological disturbances of numerous primary and secondary metabolic compounds.

Finally, the obtained results will be of a mattering contribution to participate in a better conduct of the culture of tomato in the dry and semi-arid zones where supplied waters of irrigation are of inferior quality.

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