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Assess the effects of irrigation water sources on the growth of faba bean (Vicia faba L.) seedlings

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الملخص:

أجريت تجربة في معمل كلية الموارد الطبيعية وعلوم البيئة بجامعة طبرق لتقييم جودة مصادر الري المختلفة من خلال دراسة الصفات المورفولوجية لشتلات الفول ، حيث تم إستخدام مصدرين لمياه الري (المياه الجوفية ، مياه الصرف الصناعي) مقارنة بمياه الري الطبيعية (المجموعة الضابطة). تم زراعة بذور الفول في صناديق بإستخدام التصميم العشوائي التام في ثلاثة مكررات، بحيث تحتوي كل مكررة على 50 بذرة. بعد 30 يوم من الزراعة تم تقدير الخصائص المورفولوجية للشتلات (إرتفاع النبات، طول وعدد الجذور، الوزن الرطب والجاف للشتلات، عدد ومساحة الأوراق). أظهرت النتائج التأثير السلبي للمياه الجوفية المستخدمة، وكذلك استخدام مياه الصرف الصناعي مقارنة بـ ماء الصنبور على خصائص نمو شتلات الفول المصري، وأظهرت نتائج تحليل التباين وجود فروق معنوية واضحة بين مصادر الري المختلفة، حيث نجد إنه عند إستخدام المياه الجوفية بتركيز 3٪ و 5٪ أدي إلي إنخفاض في إرتفاع النبات بنسبة تراوحت من 9.7٪ إلى 252.5٪، وتراوح الإنخفاض في طول الجذر من 37.1٪ إلى 154.3٪، على التوالي مقارنة بالمجموعة الضابطة (ماء الصنبور). بالإضافة إلى ذلك كانت مساحة الورقة 9.8سم2 عند استخدام ماء الصنبور وإنخفضت إلي 6.5سم2 و 5.2 سم2 لتركيزي المياه الجوفية علي التوالي وبلغت 8.7 سم2 و 1.1 سم2 عند استخدام مياه الصرف الصناعي المخلوطة بمياه الصنبور بنسبة (1: 1) و (2: 1) على التوالي. لذلك يراعي عند إستخدام المياه الجوفية في ري المحاصيل نسبة ملوحة البئر وتجنب إستخدام الآبار ذات الملوحة المرتفعة، وكذلك ينبغي خلط مياه الصرف الصناعي بالمياه الطبيعة عند إستخدامها في الري بنسبة لا تقل عن 50%.

الكلمات المفتاحية: الفول البلدي (Vicia faba L.)، المياه الجوفية، مياه الصرف الصناعي، الخصائص المورفولوجية للشتلات

Abstract:

An experiment was conducted in the laboratory of the Faculty of Natural Resources and Environmental Sciences at the University of Tobruk to assess the quality of the irrigation sources on growth and development faba bean seedlings, using (groundwater and industrial wastewater) compared to tap water (as control). The experiment was conducted in a completely randomized design in three replicates, each replicate including 50 seeds. The morphological

characteristics of the seedlings (plant height, root length, fresh and dry weight, and leaves area, were estimated 30 days after sowing. The results showed the negative impact of using groundwater, as well as the use of industrial wastewater compared to tap water, on the growth characteristics of faba bean seedlings. There was significant reduction in plant height ranged from 9.7% to 252.5%, and in root length ranged from 37.1% to 154.3%. In addition, the leaf area when using tap water was 9.8 cm2, and it was 6.5 cm2 and 5.2 cm2, when using groundwater at a concentration of 3% and 5%, respectively, and 8.7 cm2 and 1.1 cm2, when applying mixed industrial wastewater with a percentage of (1:1) and (2:1) respectively. Therefore, it should avoid using underground wells with high salinity to irrigate crops, and industrial wastewater must be mixed with natural water when used for irrigation at a rate of not less than 50%.
Keywords: Faba bean, groundwater, industrial wastewater, seedlings

1.Introduction

Faba bean, or the so-called broad bean (*Vicia faba* L.) is one of the most important major leguminous crops in the world, which ranks fourth after peas, chickpeas, and lentils (according to FAO 2018). Although the total cultivated area decreased from 3.7 to 2.1 million hectares between 1980 and 2014, (FAO, 2017), productivity per region tends to increase, due to reduced exposure to abiotic and biotic stresses (Link *et al*., 2010; Silero *et al*., 2010; Singh *et al*., 2012). Fresh and dry bean seeds are used for human consumption. It is highly nutritious because it has a high protein content (up to 35% in dry seeds) (Lizarazo *et al*., 2015; Longobardi *et al*., 2015; Neme *et al*., 2015). On the other hand, it is considered the most important leguminous crop in Libya, the Middle East, North Africa, the Mediterranean region, the Nile Valley, and Ethiopia, where it is considered one of the basic food crops, whether for human nutrition or as fodder for livestock due to its high protein content, which ranges between 20 and 40% (According to FAOSTAT, 2018).

Recently, in the severe climatic changes that the world is exposed to, and the challenges facing plant production and then securing food. Libya is located within the range of arid and semi-arid lands, which are the most vulnerable to these challenges. The severe shortage of water resources and go toward findings other sources and solutions alternative to that shortage of arable water. The trend and motivation were towards the possibility of tapping into groundwater as well as sewage, industrial, and agricultural wastewater.

Groundwater in Libya is a major source of irrigation water, which is used in various agricultural activities and crop production, where contributes 95% of the water used (according to CEDARE, 2014, LIAS, 2022). Libya is considered one of the top 36 countries in the world facing water stress which a score of 4.84 (World Resources Institute, 2016 a, b). As water consumption rates have increased, where has exacerbated the water crisis facing the country, just like the rest of the countries that fall within the range of arid and semi-arid lands. Libya has been ranked as one of the most water-insecure places in the world (World Resources Institute, 2016 a, b). Libya depends almost entirely on limited surface groundwater, and its exploitation needs careful management and proper planning to preserve it. Therefore, it was necessary to evaluate the quality of that water for use in the production of strategic crops within the country to find out the best use of water resources in light of the constant shortage and deficit in those resources, which is reflected in the provision and security of food. Therefore,

in our study, we evaluated the effects of available non-conventional irrigation water sources and the quality of each of them to face the severe shortage of natural irrigation water and the extent of its impact on sowing field crops.

Material and methods:

Experiment description:

The experiment was conducted in the Department of Environmental Sciences, Faculty of Natural Resources and Environmental Sciences, University of Tobruk, Libya. The experiment was conducted with the aim of evaluate the quality of the irrigation water used for the growth of faba bean seedlings. Two different types of irrigation water (groundwater) were used, with two different salt concentrations (3% and 5%), industrial wastewater was also used as another source with a mixing ratio with tap water (1:1), (2:1), and natural water (tap water, control) for comparison.

The sowing was done in October 2021, under normal conditions (open weather) in clay soil with plastic pots using a completely random design in 3 replicates, each replicate contains 50 seeds.

Measurements:

During the growing season five plants were taken, randomly from each experimental pot, to determine, plant height and root length (cm), according to **AOSA (1983),** leaf area (cm^2/plant) was calculated using the equation (A= W*L*C), Where (W) is the maximum leaf width, (L) is the maximum leaf length, C (constant=0.75) according to **Thomas, 1975**, number of roots/plant, total dry weight per plant.

30 days after seed germination. The shoot of samples were used to the fresh weight; Dry weights were recorded after those samples were oven-dried at 70 C for 72 h or until weights were constant**.**

Irrigation source:

1- Tap water (control).
2- Ground water (The first well has 3% salinity).
3- Ground water (The second well has 5% salinity).
4- Industrial wastewater: tap water (1:1).
5- Industrial wastewater: tap water (2:1).

Statistical analysis:

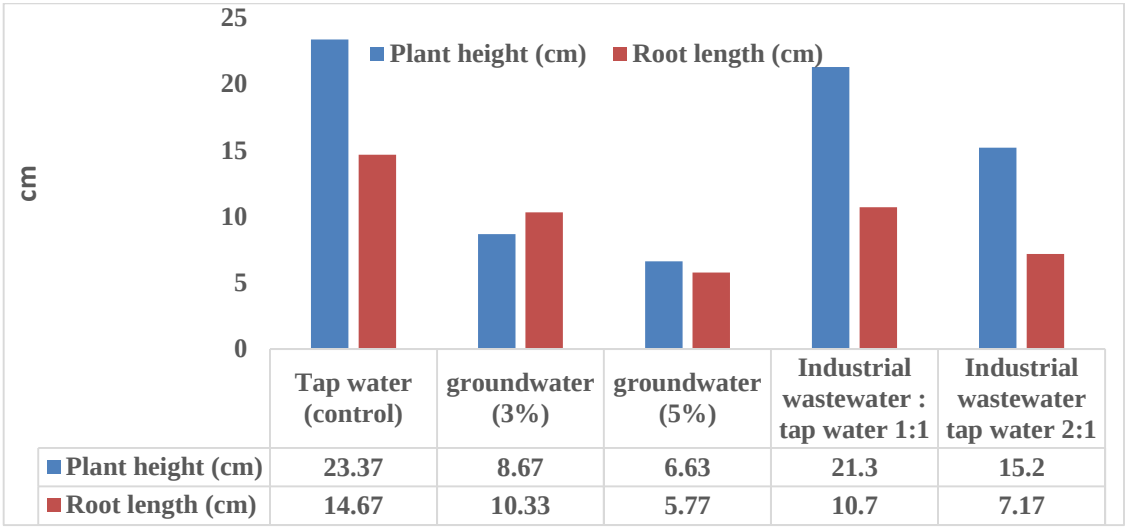
The responses to the treatments were statistically analyzed according to Gomez and Gomez 1982, by analysis of variance (ANOVA), using L.S.D at 5% for comparison between the different treatments by using SPSS software programme.

Results and discussion:

Figure (1) Shows the effect of the irrigation source used on both plant height as well as the spread of the root system (root length) of faba bean plants. The results showed that there are significant differences between irrigation water sources, where the negative impact of groundwater appears as a result of its high salinity. The use of groundwater led to a decrease in plant heights by 14.7 cm and 16.7 cm for the first and second wells, respectively, compared to control. This results agree with what **FILIPOVIĆ** *et al.,* (2020) who found that irrigation

with saline water led to a statistically significant decrease in the height of faba bean plant. The root length also decreased by approximately 42% and 154% for the same two wells, respectively, compared to control (14.7 cm). This may be due to the physiological effects of drought on plants, which are caused reduction in vegetative growth, according to (**Beltagi M.S. *et al.*, 2006, Mahajan S. and Tuteja N., 2005**), also agree with **Mustard J. and Renault S. 2006** who observed a relation between decreased plant height and increased salinity concentration.

On the other hand, the negative effect was less pronounced when using industrial wastewater mixed with natural irrigation water at a ratio of 1:1 or 2:1 than when using saline groundwater, as plant height decreased by 2.1 cm and 8.2 cm, compared to control. Root length was also decreased by 37% and 101% for the two mixing ratios, respectively, compared to the control. A lot of studies reported that reduction in root growth may be due to decrease in cell division and disorder in the activity and content of phytohormones in the roots exposed to heavy metals that may be present in wastewater used for irrigation (**El-Gamal, *et al.*, 2022**).



	Tap water (control)	groundwater (3%)	groundwater (5%)	Industrial wastewater : tap water 1:1	Industrial wastewater tap water 2:1
Plant height (cm)	23.37	8.67	6.63	21.3	15.2
Root length (cm)	14.67	10.33	5.77	10.7	7.17

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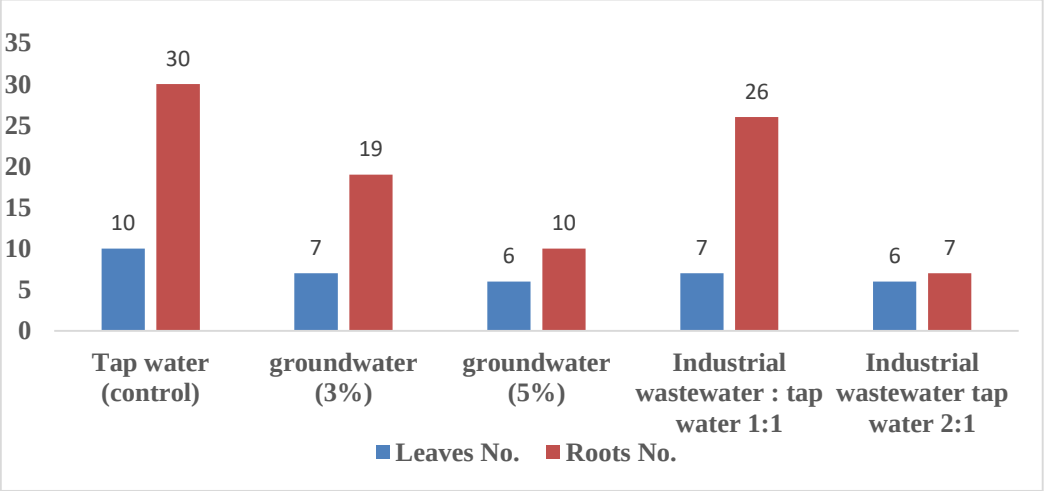
Figure (1) Effect of irrigation water sources used to irrigate the faba bean plant on plant height (cm), and root length (cm)

The data in Figure (2) shows the effect of irrigation water sources used on the number of leaves/plant and number of roots/plant. The obtained results show that there are no significant differences in leaves, and roots number per plant between all irrigation water sources used. Contrary, there were significant differences appeared when comparing all irrigation water sources with tap water (control), where the number of leaves/plant decreased as varied between 42.9% and 66.7%

The results showed highly significant differences effect of irrigation water sources on developing roots. When using tap water, the number of roots reached 30 roots/plant, comparing to 19 and 10 roots/plant when using groundwater, wells, (3% and 5% salinity), respectively. On the other hand, when applying the synthetic wastewater mixture led to a decrease of the

roots number by 4, 23 when mixing in a ratio of 1:1 and 2:1, respectively, which negatively affected the growth and spread of the roots of faba bean seedlings



. Figure (2) Impact of water irrigation sources on a number of leaves/plant, and roots number/plant

Figure (3) showed that there were significant differences in the wet and dry weight of seedlings, depending on the irrigation source used. The use of tap water (control) recorded the best results compared to other sources. The average of seedling fresh weight was 5.67 g/seedling, and the dry weight was 1.34 g/seedling. contrary, the use of mixed industrial wastewater in a ratio of 2:1 recorded the lowest fresh and dry weight of the seedlings, which was 1.1 and 0.57 g/seedling, respectively. Other authors came to similar conclusions (**Lauter, and Munns, 1987; Zahran, and Sprent, 1986).**

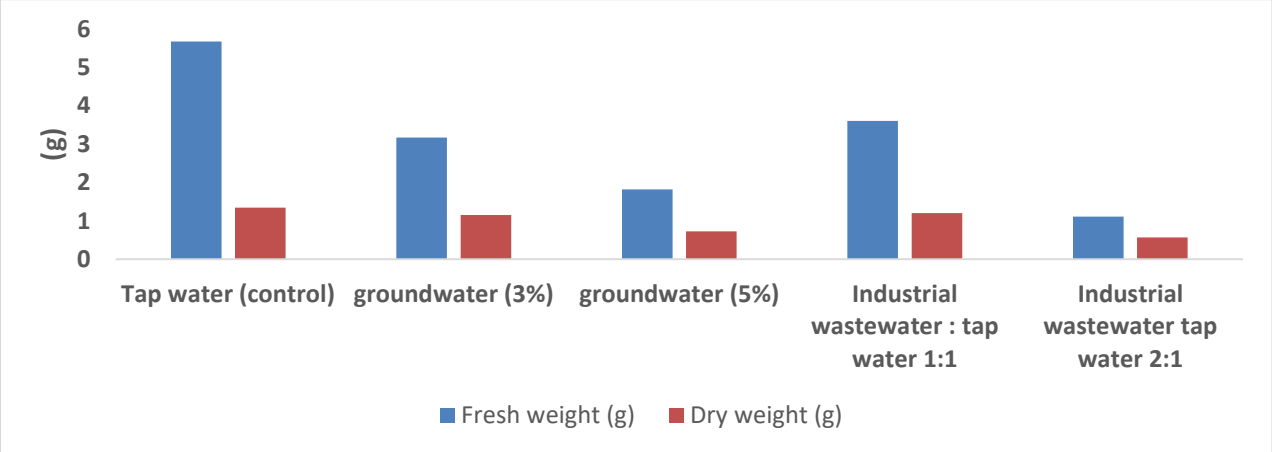


Figure (3) Influence of water irrigation sources on fresh, and dry weight (g)

The results in figure (4) shows the effect of the irrigation water source on the leaves area (cm / plant), which indicated that there was a significant difference among the leaves area

for each irrigation source. The use of tap water resulted in the highest surface area of the leaves 98 cm^2. 0n the other hand it decreased by 53 % when using the first source of groundwater with 3% salinity, and decreased by 68% when using the second source of groundwater with a salt concentration of 5%. Similar results were reported by (**Marwan, and Anan, 2022; Mathur, *et al.*, 2006**; **Neumann**, ***et al.*, 1988**), On the other hand, when mixing industrial wastewater with tap water at a ratio of 1:1, leaves area decreased only by 38%, compare with tap water (control), however, when the mixing ratio was increased to 2:1, the surface area of the plant leaves reached 6.5 cm^2, which was 93% lower than the control. The negative impact of the use of wastewater may be due to, heavy metals or its high salinity (**Nja, *et al.*, 2018**), which improved its quality when mixed with tap water in a ratio of 2:1.

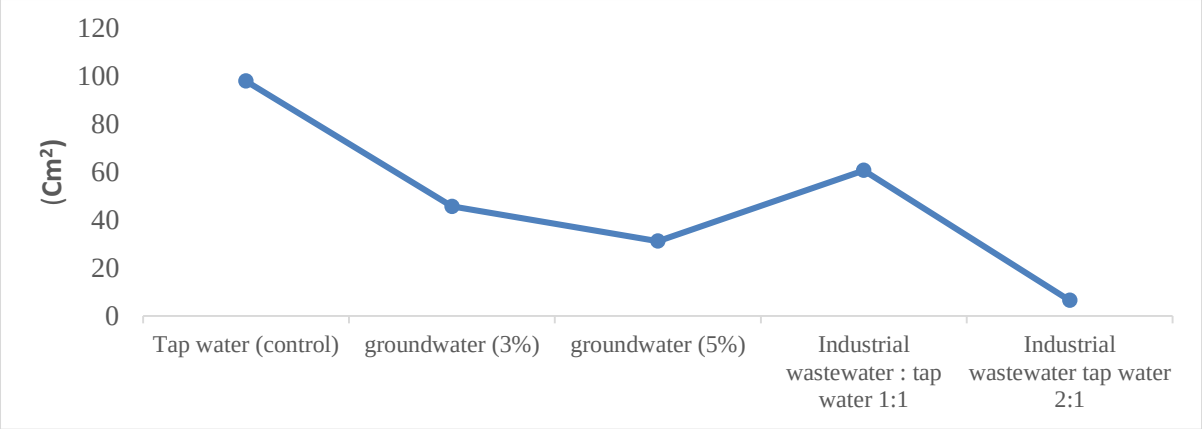


Figure (4) Effect of water irrigation sources on leaf area cm^2/plant

Conclusion

The results indicate that, in light of the challenges facing agriculture in Libya, especially the water shortage challenges. The possibility of benefiting from groundwater in irrigating field crops, but according to the salinity of the water used. Industrial wastewater may also contribute to providing good quantities of irrigation water by mixing it with natural water, but when using it, the mixing ratio should not exceed 50%. These sources are one of the current trends to address the shortage of irrigation water necessary to meet the large gap between food production and consumption in Libya.

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References

Association of Official Seed Analysts [AOSA]. 1983. Seed Vigor Testing Handbook. AOSA, Ithaca, NY, USA. (Contribution to the Handbook on Seed Testing, 32(

Beltagi M.S., Ismail M.A., Mohamed F.H. (2006). Induced salt tolerance in common bean (Phaseolus vulgaris L.) by gamma irradiation. Pak. J. Biol. Sci, 6:1143–1148

CEDARE, 2014.Libya Water Sector M&E Rapid Assessment Report. Monitoring and Evaluation for Water in North Africa (MEWINA) project, Water Resources Management Program, CEDARE

El-Gamal A.M.I., El-Sheikh Aly M.M., El-Emary F.A.A. (2022). Effect of wastewater irrigation on anatomical structure of faba bean plant (Vicia faba L.), Archives of agriculture sciences journal., 5(2):9-20

FAO (2017). FAOSTAT Database. Food and Agriculture Organization of the United Nations. Available at: www.fao.org/faostat/ [accessed June 11, 2017[

FAOSTAT 2018. Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/ faostat/en/#data/ QC

Filipović, L., Romić, D., Ondrašek, G., Mustać, I., & Filipović, V. (2020). The effects of irrigation water salinity level on faba bean (Vicia faba L.) productivity. Journal of Central European Agriculture, 21(3), 537-542

General Water Authority, 2014, Water and Energy for Life in Libya (WELL), Project funded by the European Commission No. 295143, FP7, Libya

Lauter D.J., and Munns R. (1987). Salt sensitivity of chickpeas during vegetative growth and at different humidity's, Australian Journal of Plant Physiology;14:171-180

Libya Institute for Advanced Studies (LIAS), 2022. Water Resources and Water Supply Assessment in Libya,

Lizarazo, C. I., Lampi, A. M., Sontag-Strohm, T., Liu, J., Piironen, V., and Stoddard, F. L. (2015). Nutritive quality and protein production from grain legumes in a boreal climate. J. Sci. Food Agric. 95, 2053–2064. doi: 10.1002/jsfa.6920

.Longobardi, F., Sacco, D., Casiello, G., Ventrella, A., and Sacco, A. (2015). Chemical profile of the carpino broad bean by conventional and innovative physicochemical analyses. J. Food Qual. 38, 273–284. doi: 10.1111/jfq.12143

Mahajan S. and Tuteja N. (2005). Cold, salinity, and drought stresses: an overview. Archives of Biochemistry and Biophysics, 444:139–158

.Marwan N. Haddad and Anan S. Abahri (2022). Effects of Nutrients and Salinity on Yields, Growth, and Nutrients distribution of Faba Beans Grown in Hydroponics System, European Journal of Agriculture and Food Sciences, 4(3) | 40-49, www.ejfood.org, DOI: 10.24018/ejfood.2022.4.3.497 ,

.Mathur N., Singh J., Bohra S., Bohra A., Vyas A. (2006). Biomass production, productivity, and physiological changes in moth bean genotypes at different salinity levels. Am. J. Plant Physiol., 1(2):210–213

Mustard J., Renault S. (2006). Response of red-osier dogwood (Cornus sericea) seedling to NaCl during the onset of bud break. Can. J. Bot. 84(5):844–851

.Neme, K., Bultosa, G., and Bussa, N. (2015). Nutrient and functional properties of composite flours processed from pregelatinised barley, sprouted faba bean and carrot flours. Int. J. Food Sci. Technol. 50, 2375–2382. doi: 10.1111/ijfs.12903

Neumann P. M., Van Volkenburgh E., ClelandR. E.Salinity (1988). stress inhibits bean leaf expansion by reducing turgor, not wall extensibility. Plant Physiol, ;88:233-237

Nja R.B., Merceron B., Faucher M., Fleurat-Lessard P., Béré E. (2018) NaCl – Changes stem morphology, anatomy and phloem structure in Lucerne (Medicago sativa cv. Gabès): Comparison of upper and lower internodes. Micron. 105: 70–81

Sillero, J. C., Villegas-Fernandez, A. M., Thomas, J., Rojas-Molina, M. M., Emeran, A. A., Fernandez-Aparicio, M., et al. (2010). Faba bean breeding for disease resistance. Field Crop Res. 115, 297–307. doi: 10.1016/j.fcr.2009.09.012

.Singh, A. K., Bhatt, B. P., Upadhyaya, A., Kumar, S., Sundaram, P. K., Singh, B. K., et al. (2012). Improvement of faba bean (Vicia faba L.) yield and quality through biotechnological approach: a review. Afr. J. Biotechnol. 11, 15264–15271

Thomas, H. 1975. The growth response of weather of simulated vegetative swards of single genotype of Lolium perenne. J. Agric. Sci. Camb. 84: 333-343

World Resources Institute. Available online: http://www.wri.org/blog/2013/12/world's-36-most-water-stressedcountries (accessed on 28 July 2016 a(

World Resources Institute. Available online: http://www.wri.org/blog/2015/08/ranking-world%E2%80%99smostwater-stressed-countries-2040 (accessed on 28 July 2016 b (

Zahran H.H., Sprent J.I. (1986). Effects of sodium chloride and polyethylene glycol on root-hair and nodulation of Vicia faba L. plants by Rhizobium leguminosarum. Planta, 167:303-309