FEASIBILITY OF PRODUCING INDOOR AND OUTDOOR CROPS USING SOLAR-POWERED DESALINATED WATER: PROSPECTS FOR MENA REGION

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EXTENDED ABSTRACT

Introduction

Employing solar-powered desalination systems to produce food crops is a novel approach to cope with water scarcity, particularly under the current abrupt global climate change. The present study aims at assessing the feasibility of applying desalinated saltwater for growing indoor and outdoor crops to increase water efficiency. Under greenhouse conditions, all environmental variables (temperature, light, humidity, radiation, and carbon dioxide level) are controlled to optimize plant growth. Accordingly, crop quantity and quality are considerably higher than open-field conditions which also leads to substantial amount of saving in irrigation water. Vegetables and horticultural crops are more suitable under these conditions than other field crops. On the other hand, intensive field crops can be cultivated as outdoor crops in open-field adjacent to the greenhouse and irrigated using desalinated saltwater by solar energy. In the present study tomato and pepper are proposed as indoor crops under greenhouse conditions while quinoa and rapeseedfor open-field conditions.

Indoor Crops (Feasibility, Productivity, Water Requirements)

Tomato

Tomato (*Solanum lycopersicum*) is an important source of the antioxidant lycopene, vitamin C, potassium, folate, and vitamin K. On average, it produces in the outdoor system about 71 tonnes/ha tomato fruits. However, a greenhouse (6-m × 40-m) can produce 14 tonnes which is considered as a form of vertical expansion. Following appropriate agriculture practices can contribute to maximizing production quality and quantity. Accordingly, the greenhouse production of tomato has increased recently in the Mediterranean region. Tomato is considered a partially salt-tolerant crop, it tolerates salinity in irrigation water up to 1088 ppm, and soil salinity of up to 1600 ppm [1]. Utilizing solar desalination for producing tomato is an effective solution to reduce the consumption of freshwater and increase tomato production in arid regions. This makes desalinating water increasingly vital to quench global thirst. The square meter contains about 4-5 plants, each plant requires 3/4 liters of irrigation water twice in its first phase of growth and it increases with growth of the plant to reach 3 liters starting from the ninth week after the transplanting. In general, its water requirement per square meter is about 1800 liters in indoor and 1200 liters in outdoor over the growing season. Karami et al., [2] manifested that tomato production using desalinated water improved the farmers' income due to the higher production than using conventional water irrigation systems. In the desalinated water system, the cost of agricultural inputs (except energy) was lower while yield and quality of produced tomato were higher, thereupon more profitable.

Bell pepper

Bell pepper (*Capsicum annuum*) contains protein, carbohydrates, fibers, potassium, vitamin C, and it is considered one of the best sources of antioxidants. Bell pepper is a popular greenhouse crop because its yield and quality are higher in the greenhouse system than in open-field cultivation. Pepper produces 19-25 tonnes of pepper fruits per hectare on average. The production quantity and quality increase significantly under greenhouse conditions. Pepper tolerates salinity in irrigation water of up to 2000 ppm. Consequently, utilizing solar desalination for producing pepper is beneficial in increasing its production and reducing its consumption of freshwater, particularly under current

water scarcity in arid regions. Its water requirement is about 2400 liters per square meter over the growing season [3]. Fallik et al., [4] disclosed that increasing water salinity to 1800 ppm declined paper total yield, but the export-quality yield was not significantly impacted. But, there was a 30–35% reduction in export-quality yield under water salinity of 2900 ppm.

Outdoor Crops (Feasibility, Productivity, Water Requirements)

Quinoa

Quinoa (*Chenopodium quinoa*) is a new field crop that grows in less favorable environments under abiotic stresses with low nutrients content better than the other field crops [5]. It has an important purpose as new highly digestible human food and can contribute to livestock feeds. It tolerates high salinity levels in irrigation water up to 15000 ppm. Thus, it can be cultivated in open-field adjacent to the greenhouse and irrigated by desalinated saltwater using solar energy. It is an important grain crop for human and animal food due to its high-protein and essential amino acids, vitamins (A, B, E), and minerals (Ca, Fe, Cu, Mg, Zn). Its flour can be mixed with wheat flour and used to make bread with high nutritional value and contribute to reducing the production-consumption gap in bread in developing countries. A square meter cultivated by quinoa requires 240 liters and produces 0.29 kg seeds. Yazar et al., [6] elucidated that quinoa grain and biomass yield were slightly reduced by irrigation water salinity up to 19000 ppm compared with freshwater irrigation. Yield parameters suggested a good adaptation of quinoa to salinity conditions in Mediterranean environments.

Rapeseed

Rapeseed (*Brassica napus*) is a globally important oil crop that can help in reducing the gap for oil in MENA region. It contains omega-3 and omega-6, which have highly vital health benefits. The most important rapeseed genotypes have high oil content and are free of Erucic acid. It tolerates adverse environmental conditions and salinity in irrigation water of up to 7000 ppm [7]. Thus, it can be grown and irrigated by desalinated saltwater using solar energy. A square meter cultivated by rapeseed requires 330 liters and produces 0.31 kg seeds. Francois [8] deduced that rapeseed yields were unaffected by salinity up to 6200 ppm and the growth up to 6400 while each unit increase in salinity above these levels reduced seed yield and growth by14 and 11.2% respectively. Moreover, increased salinity did not significantly affect the oil or protein content of the oil-free seed meal. These results place rapeseed in the salt-tolerant category.

Conclusion

It is vital to use solar-powered desalination system in producing vegetable crops, and horticultural crops to save freshwater and increase food production, particularly under current climate changes. Tomato and pepper can be used as indoor crops under greenhouse conditions and irrigated by desalinated saltwater using solar energy. Furthermore, quinoa and rapeseed can be cultivated in open-field adjacent to the greenhouse and irrigated using desalinated saltwater.

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