Effect of seawater on growth of four vegetable crops - Lettuce, leaf perilla, red pepper, cucumber -

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Abstract

The effects of seawater on growth of lettuce(Lactuca sativa L.), leaf perilla(Perilla frutescens var. japonica Hara), red pepper(Capsicum annuum L.) and cucumber(Cucumis sativus L.) seedlings were investigated in the glass greenhouse. These effects were studied on seedlings, and diluted seawater (1%, 5%, 10%, 20%, 50%, 100% v/v) was sprayed enough on leaves. The tested four vegetable crops have well grown up to 10% diluted seawater, but the tested vegetable crops were damaged from increasing salt levels. Of these, lettuce was provided salt-tolerant vegetable crop and red pepper was considered salt-sensitive vegetable crop. The salt tolerance of vegetable crops is different between crops and complicated because of additional detrimental effects caused by accumulated ions or specific ion toxicities in their leaves. These results show that agricultural use of seawater may be benefit crop cultivation in organic farming system as well as in conventional farming system.

Keywords: Organic agriculture, seawater, salt tolerance, salinity, vegetable crops

Introduction

Since 2000, Korean government was planned to achieve environmental-friendly agricultural production goal of 10% by 2015. Organic farmers utilized also a various harmless natural resources for all natural organisms in all kind of environments. Of all natural resources on earth, seawater does not reduce and it is also easily available anywhere around the world. More than 70% of the earth surface is covered by seawater (Natasa et al., 2008). Saline water was previously considered unusable for plant cultivation, but new research during the past two decades has helped bringing into practice some irrigation (Hamdy et al., 1993; Qadir et al., 2001). There are many plants such as rice and other halophytes that grow under saline conditions. In seawater, sulphur (S), magnesium (Mg), kalium (K), calcium (Ca) and many other trace elements with biological significance are highly contained. These nutrients are essential to plant growth. Korean farmers were used salt and seawater to improve quality of agricultural products and to control weed especially in orchard. In recent, agricultural use of seawater or solid is rapidly increased for crop growth regulation and pest control. The experimental research work in Korea was started in 2010. We will here discuss the results of first year's experiments about effects of seawater on growth of major four vegetable crops in Korea – Lettuce, leaf perilla, red pepper and cucumber.

Materials and methods

This experiment was conducted from September to October 2010 under glass greenhouse at the National Academy of Agricultural Sciences. The seawater used in this experiment was sampled from the Yellow Sea. The properties of seawater have been presented in Table 1. Seawater from Yellow Sea was diluted at six different concentrations of 1%, 5%, 10%, 20%, 50% and 100% in v/v. The diluted seawater was prepared direct before the start of seawater treatment. These diluted seawater was sprayed 3 times to four vegetable crops - lettuce (*Lactuca sativa* L.), leaf perilla(*Perilla frutescens var. japonica* Hara), red pepper(*Capsicum annuum* L.) and cucumber(*Cucumis sativus* L.) - on leaves in every 7 days interval. The seedlings are prepared in the greenhouse. They are grown in plastic pots for 2 ~3 weeks to obtain 2 leaves.

Table 1. Chemical properties of seawater in March 2010 (unit: ㎎/ℓ)

Sample site	pH	EC ($dS \cdot m^{-1}$)	T-N	NH_4-N	NO_3-N	T-P	PO_4-P	Na^+	Cl^-	SO_4^{2-}
Seosan	7.92	44.7	1.9	N.d*	0.99	0.121	0.044	10,174	16,696	2,440

*N. d : non detected

Four vegetable crops were harvested by cutting down after 1 weeks treated with 3 times spray on leaves, and then we observed crop damage and measured plant height(cm) and fresh weight(g $plant^{-1}$) as a impact factor on crop growth.

Results and discussion

The plant height and fresh weight yields are shown in Table 2. There are six different levels to utilizing seawater. Growing vegetable crops with diluted seawater are depending on the salt levels.

Seawater dilution	Plant height (cm)				Fresh weight (g $plant^{-1}$)			
	lettuce	Perilla	Red pepper	Cucumber	lettuce	Perilla	Red pepper	Cucumber
0%	14.0	9.8	16.0	21.3	9.07	4.26	3.95	7.87
1%	13.7	11.5	11.5	17.4	9.41	6.41	2.68	10.09
5%	14.3	10.3	13.5	21.2	10.16	5.53	3.38	11.27
10%	14.3	9.2	15.3	18.2	9.38	3.75	4.22	10.13
20%	14.2	7.5	15.5	21.2	8.85	3.35	4.06	10.77
50%	14.0	-	12.0	19.5	7.25	-	3.62	5.93
100%	14.3	-	8.5	-	6.06	-	1.95	-

Table 2. Effect on the growth of four vegetables treated with four dilutions of seawater

Lettuce(*Lactuca sativa* L.) has high salinity tolerance. This crop in the 100% seawater treatment reached a height of 14.3cm better than a height of 14.0cm by control plot. The fresh weight yield, however, results in an increase up to 10% diluted seawater, but in a reduction from over 20% diluted seawater. Leaf perilla(*Perilla frutescens var. japonica* Hara) was an increase in the growth and yield up to 5% seawater concentration, and then decreased with increasing salt levels. Leaf perilla seedlings were died over 50% seawater concentrations. The plant growth of red pepper(*Capsicum annuum* L.) and cucumber(*Cucumis sativus* L.) seedlings are decreased in all diluted seawater concentration, whereas the fresh weight yield was increased up to 20% seawater levels. The use of water with still higher salt levels and even exceeding that of seawater for irrigation of various food and crops has been reported by many scientists including Aronson(1989), Shahida and Naghma(1989), Yensen(1988), and others. Salinity generally affects the growth of plants by either by producing an ion excess or by water deficits in the expanded leaves(Greenway and Munns, 1980).

Conclusion

Organic vegetable cultivation using seawater should be considered that for diluted concentration. Salt tolerance is different depending on vegetable crops. High significant interaction between vegetable growth and seawater concentrations was observed. Crop growths are generally inhibited by extreme high concentration of seawater, but promote crop growth by optimal range of diluted seawater.

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