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A Research on Production of Rocket and Parsley in Floating System

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Abstract

In this research, the possibility of the production of rocket and parsley which have short production cycle and baby leaf vegetable, in floating system to reduce the concentration of nutrient solution; determination of the effects of yield, quality and leaf nutrient content was aimed. Research was carried out during the autumn and spring production seasons of 2010-2011. Standard nutrient solution ((mM) 12 N-NO_3, 3.8 N-NH_4, 2.8 P, 8.4 K, 3.5 Ca, 1.4 Mg, 9.5 Na, 8.0 Cl, 2.7 S, 0.04 Fe) was used as full dose (control treatment) and compared to half dose (1/2 dose) Hoagland nutrient solution. Both of the seasons in total yield were changed between rocket 975.81-1612.15 g m^{-2} and parsley 875.50-1093.50 g m^{-2} respectively. The results showed that using of floating system in Rocket and Parsley cultivation was successful and reduced the concentration of nutrient solution; variety and growing season at rates ranging from 13.7% to 24.8% compared to have showed reduce the yield. In this study, the effect of treatments to some quality parameters (dry weight, vitamin C, nitrate, pH ve EC) and nutrients removed by plant were determined. In addition, it was found that these values increased with increasing with the concentration of nutrient solution; however, vitamin C decreased in Parsley cultivation. When the results evaluated as a whole, it was concluded that using ½ doses decreased yield, some savings could be achieved in terms of nutrient solution consumed by the plant with the negative impact on the environment.

Keywords: floating system, hoagland nutrient solution, yield, quality

1. Introduction

Hydroponic systems are cultivation technologies that use nutrient solutions rather than soil substrates. They also offer a number of benefits, including: the ability to reuse water and nutrients, easy environmental control, and prevention of soil-borne diseases and pests (S. Lee & L. Lee, 2015). Hydroponic systems are originally derived from the water culture system (Harris, 1988). The water culture systems a simple model, composed of a reservoir, an air stone, a tubing system, an air pump, and a floating systems (Hoagland & Arnon, 1950). With improvement of aeration methods to keep dissolved oxygen, the deep water culture system is developed so that plants can be grown with roots constantly suspended in water.

Rocket and parsley, which are the two types of leaves edible vegetables whose usage is ever-increasing in our country, are grown in Mediterranean and Southern European countries. These vegetables whose fresh leaves can be used for consuming as salad and garnish (Vernieri et al., 2006; Rodriguez-Hidalgo et al., 2010) can be grown all year round (Vural et al., 2000). These vegetables are rich in vitamins and minerals, Vitamin C among which is especially effective on many biological activities in human body (Conesa et al., 2009). The only worrisome thing about these vegetables is the content of nitrate (Kara 1993). 5% of the nitrate taken with these vegetables is converted into toxic nitrate by bacteria (Conesa et al., 2009). Nitrate accumulation can be effected by other factors such as the light intensity. High nitrate density in the vegetables which is due to the low light intensity can cause morphological and biochemical changes on the plant (Franco et al., 2011). Therefore, cultivation techniques and plant nutrient of the vegetables whose leafs are consumed bears an extreme importance.

In this study, searching the possibilities of using floating water culture, which is an easy and cost-effective technique for small-scale and valuable vegetable species, for rocket and parsley breeding in autumn and spring months under the unheated greenhouse conditions and determining the effects of decreasing the nutrient solution concentration according to the growth periods are the main goals.

2. Materials and Methods

The research has been conducted in an 18 × 40 m sized PE greenhouse belonging to Ege University Bayindir Vocational Training School (27°40′D, 38°11′K) in the growing periods of spring and autumn in 2010-2011.

Rocket (*Eruca vesicaria* subsp. *sativa* Mill. *cv.* Bengi) and parsley (*Petroselinum crispum* cv. Italian Giant) have been used as the vegetal material in the test. The desks covered with polyethylene covering which is at a high of 1 meter from the ground and made of galvanized steel in the size of 2.40 × 1.40 × 0.30 m and the viols of 53.5 × 34 cm which have been placed inside these desks have been utilized in the study. Two big pearlites which have been expanded as growing area have been used (İzotar, 2008). The seeds have been planted manually as 1.5 g seeds per m^2.

Cultivation has been the start for planting seeds and after 7 days from the seed planting, viols have been placed into the pools. In the study, nutrient solution is applied as (1) full and (2) half doses. The prescription for the half dose treatment and the content of the Hoagland solution used in the full dose treatment which is the control is given in Table 1. The pH of nutrient solution is kept between 5.5-6.0 and the electrical conductivity is between 1.8-2.2 dS m^{-1}. The test is established as 4 times replication according to the color of the randomized blocks test patterns.

Table 1. Standard nutrient solution (mM)

	N-NO$_3$	*N-NH$_4$*	*P*	*K*	*Mg*	*Na*	*Cl*	*S*	*Fe*
Full dose	12	3.8	2.8	8.4	1.4	9.5	8.0	2.7	0.04
1/2 dose	6	1.9	1.4	4.2	0.7	4.75	4.0	1.35	0.02

In addition to its changing depending on the types, the vegetables have reached the harvest maturity in 50-65 days in autumn period and 30-40 days in spring period. The total weight of the crops harvested is calculated as the (g) value. The production values have been given as g m^{-2}.

Vitamin C (mg 100 ml^{-1}) (Pearson, 1970) and nitrate (mg kg^{-1}) (Cataldo et al., 1975) values have been specified related to the characteristics of leaf quality in December 3, 2010 and April 20, 2011.

After the vegetable samples are dried and grinded at 65°C, total N, available P and available K contents have been specified. In the samples taken from the extract obtained with the method of nitrogen modification macro Kjeldahl (Kacar, 1972) and the method of potassium wet digestion (HNO_3+$HClO_4$ in the ratio 1/3), phosphorus Vanadomolibdophosphoric is detected as colorimetric with the method of yellow color and in the K flame photometry. The results for N, P, and K have been determined as% (Pratt, 1965).

During the study period, the water budget technique has been utilized for calculating the vegetable water consumption values related to the topics. Seasonal vegetable water consumption has been decided by subtracting the nutrient solution volume filled in the pools at the beginning of the production period and the nutrient solution volume remaining in the pools at the end of the production period and by dividing them into vegetable cultivation area. The results have been presented as the consumed nutrient solution amount (mm) (Gregory, 2004; Howell, 2006).

The variance analysis is implemented to the data obtained in the study by using the ANOVA statistical analysis packaged software in the computer. To determine the differences between the replications LSD test has been conducted in the 95% significance level.

3. Results and Discussion

3.1 Production Characteristics

The total yield values belonging to the growing periods have been given in Table 2. It has been detected that the single and interaction effects of growing period and nutrient solution on the total yield in rocket growing are important. 36% more total yield has been attained in spring growing period when compared to the autumn period and 22% more total yield has been attained according to the ½ dosage implementation. With the decrease in the concentration of nutrient solution, the production decrease in spring and autumn periods have been 22% and 19% in sequence (Table 2).

Table 2. Treatments effect on total yield (g m^{-2})

		Rocket	Parsley
2010 Fall		1070.64 b	1007.50
2011Spring		1452.72 a	984.25
$Lsd_{0.05}$		*26.00*	*ns*
Full dose		1388.81 a	1082.50 a
1/2 dose		1134.55 b	909.25 b
$Lsd_{0.05}$		*26.00*	*46.917*
2010 Fall	*Full dose*	1165.00 a	1072.00 a
	1/2 dose	975.81 b	943.00 b
2011 Spring	*Full dose*	1612.15 a	1093.00 a
	1/2 dose	1293.29 b	875.50 b
$Lsd_{0.05}$		*36.99*	*66.35*

Note. Means in the same column followed by different small letters are significantly different ($p \leq 0.05$).

The single effect of growing period has not statistically been found as important in the growing of parsley; however, the dosage of nutrient solution and the effect of nutrient solution × growing period interaction on the total yield have come out as significant with 95% trust. While 19% higher total yield is attained according to the full dosage and ½ dosage treatments, 14% and 25% in sequence higher total yield has been seen in autumn and spring growing periods according to the ½ dosage implementation in the full dosage implementation (Table 2).

The total yield values which have been attained in vegetable production change depending on many factors like type (Alberici et al., 2008), growing period (Gonnela et al., 2003; Frezza et al., 2004; Alberici et al., 2008; Fallovo et al., 2009), climate conditions (Franko et al., 2011) and type of producing (Cros et al., 2007; Fallovo et al., 2009). The total yield values that have been attained in the study are in convenience with the ones of former studies in rocket (Carrasco et al., 2012) and parsley (Pokluda 2003; Cros et al., 2007; Franco et al., 2011); and the decrease in the production has occurred in because of the decrease in nutrient solution concentration (Alberici et al., 2008).

3.2 Quality Values

In the growing of rocket, with the increase in the nutrient solution concentration, the changes of quality parameters like dry weigh, vitamin C and the nitrate content of the leaves have been found statistically important. While the dry weight change shows difference depending on the single and interaction effects of nutrient solution concentrations and growing periods, the single and interaction effect of vitamin C and the nitrate content of the leaves at the nutrient solution concentration have been seen as important. The changes of parameters like color, pH and EC have not been seen as significant (Table 3).

Table 3. Effects on the rocket quality parameters of the concentration of nutrient solution

Rocket		*Color*			*DW*	*Vit C*	*Nitrate*	*pH*	*EC*
		L	*Hue*	*Chroma*	*(%)*	*(mg g^{-1})*	*(mg kg^{-1})*		*(ds m^{-1})*
2010 Fall		44.47	130.07	30.86	19.30 a	0.14	60.83	6.26	2.92
2011Spring		45.46	129.54	32.30	16.33 b	0.13	64.06	6.25	3.03
$Lsd_{0.05}$		*ns*	*ns*	*ns*	*0.449*	*ns*	*Ns*	*ns*	*ns*
Full dose		44.20	130.43	30.10	19.79 a	0.15a	66.93 a	6.25	2.81
1/2 dose		45.78	129.18	33.07	15.85 b	0.12 b	57.96 b	6.26	3.14
$Lsd_{0.05}$		*ns*	*ns*	*ns*	*0.449*	*0.225*	*3.971*	*ns*	*ns*
2010 Fall	*Full dose*	43.89	130.08	29.68	21.93 a	0.11 b	70.14 a	6.25	2.82
	1/2 dose	45.14	129.36	32.05	16.68 b	0.17 a	51.52 b	6.25	3.02
2011 spring	*Full dose*	44.51	130.06	30.52	17.66 a	0.18 a	63.71	6.25	2.80
	1/2 dose	46.41	129.07	34.09	15.01 b	0.08 b	64.40	6.27	3.26
$Lsd_{0.05}$		*ns*	*ns*	*ns*	*0.634*	*0.318*	*5.617*	*ns*	*ns*

Note. Means in the same column followed by different small letters are significantly different ($p \leq 0.05$).

In parsley growing, the single and interaction effects of growing periods and nutrient solution concentration on dry weight, vitamin C, the nitrate content of the leaves, pH and EC have been found as significant –except the single effect of growing period on vitamin C. While the quality characteristics increase with the determined full dosage treatment, the vitamin C content has decreased with the increase in the nutrient solution dosage in growing parsley (Table 4).

Especially the nitrate content of the leaves in the ones whose leaves are consumed among the quality parameters in vegetables is important. Because the highness of the nitrate concentration that is taken via feeding either cause the termination of the intestinal membranes or prevent the oxygen movement in the blood by transforming into nitrite (Kara, 1993).

In the study, the effects of the treatment in the analysis related to the nitrate content in rocket and parsley leaves have been found significant; however, the attained mean values have been under the limit that stands as a danger in terms of human health so much (Kara, 1993). It is under the effect of many factors like nitrate content, producer, production system, different organs of the plant, fertilization program and growing period (Guadagnin et al., 2005); and the nutrient solution has been affected from the change of concentration in the study. The change of nutrient solution concentration has also been efficient in the other quality parameters (Alberici et al., 2008).

Table 4. The effects of concentration of nutrient solution on the quality parameters of parsley

Parsley		*Color*			*DW (%)*	*Vit C (mg g^{-1})*	*Nitrate (mg kg^{-1})*	*pH*	*EC (ds m^{-1})*
		L	Hue	Chroma					
2010 Fall		45.77	129.18	32.81	17.64 a	0.15	54.50 a	6.13 a	2.77 a
2011Spring		46.26	129.12	32.87	14.30 b	0.17	44.16 b	5.96 b	2.56 b
$Lsd_{0.05}$		*ns*	*ns*	*ns*	*1.11*	*Ns*	*4.38*	*0.033*	*0.119*
Full dose		45.75	129.18	31.77 b	17.53 a	0.13 b	51.94 a	6.08 a	2.38 b
1/2 dose		46.28	129.12	33.91 a	14.41 b	0.18 a	46.72 b	6.01 b	2.95 a
$Lsd_{0.05}$		*ns*	*ns*	*1.890*	*1.11*	*0.034*	*4.38*	*0.033*	*0.119*
2010 Fall	*Tam doz*	46.05	128.98	31.86	21.11 a	0.12 b	56.50	6.25 a	2.50 b
	1/2 doz	45.49	129.39	33.78	14.18 b	0.18 a	52.50	6.01 b	3.03 a
2011 ilkbahar	*Tam doz*	47.07	129.39	31.69	14.64	0.15	47.38 a	5.91 b	2.26 b
	1/2 doz	45.45	128.86	34.05	13.96	0.19	40.94 b	6.01 a	2.87 a
$Lsd_{0.05}$		*ns*	*ns*	*ns*	*1.57*	*0.049*	*6.19*	*0.046*	*0.168*

Note. Means in the same column followed by different small letters are significantly different ($p \leq 0.05$).

3.3 The Nutrient Contents of the Uptake Plant

In the spring growing period, only the change of K content of parsley among N, P, and K values of plants in rocket and parsley growing has been statistically found as important (95%) (Table 5). K has been identified as 15% more according to the ½ dosage treatment in full dosage treatment in parsley leaves.

Table 5. Some of the nutrient content of Rocket and Parsley (%)

	Dose	*N*	*P*	*K*
Rocket	Full dose	2.30	0.24	4.20
	½ dose	2.03	0.19	4.03
	$LSD_{0.05}$	*ns*	*Ns*	*ns*
Parsley	Full dose	4.70	0.13	5.98 a
	½ dose	3.62	0.10	5.20 b
	$LSD_{0.05}$	*0.39*	*0.007*	*1.25*

Note. Means in the same column followed by different small letters are significantly different ($p \leq 0.05$).

It is stated that for a sufficient feeding, the nutrient material contents whose leaves are consumed should be among the following ranges: nitrogen 2.61-4.95% (deficiency 2.18%), phosphorus 0.5-0.75% (deficiency 0.21%), potassium 3.16-5.39% (deficiency 1.64%), magnesium 0.37-0.84% (deficiency 0.09%) (Eşiyok et al., 2006). Depending on the implementations in the study, it has been determined that N, P and K contents of plants are among 2.03-2.30, 0.19-0.24 and 4.03-4.2% in sequence and N, P and K contents are at a sufficient level also in ½ dosage.

3.4 The Water Consumption of the Plants

The nutrient solution amounts that are consumed by the plant related to the floating water culture system have been given in Figure 1 and 2 according to their growing periods. In autumn and spring periods, at full dosage treatment, the nutrient solution amounts that are consumed by the plant have been determined as 23.81 and 34.33 mm; and as 25.30 and 35.71 mm in ½ dosage treatments.

In spring period, when compared to the autumn period, more nutrient solution has been consumed together with the high temperature and steam pressure opening in the greenhouse (Meriç, 2006)

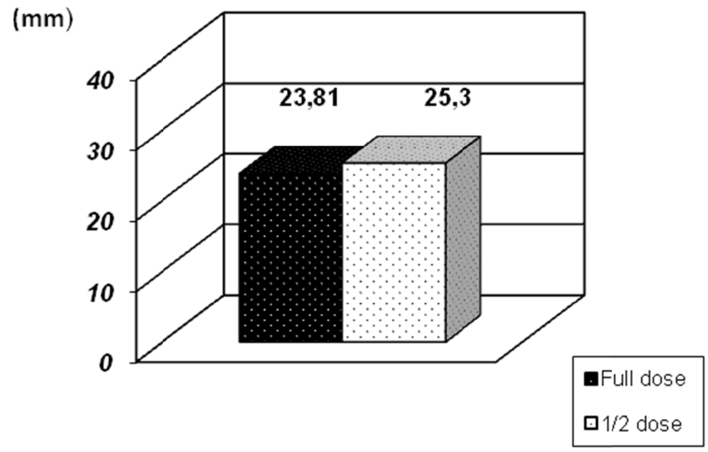

Figure 1. The amount of plant nutrient solution consumed by the plant (2010 Fall)

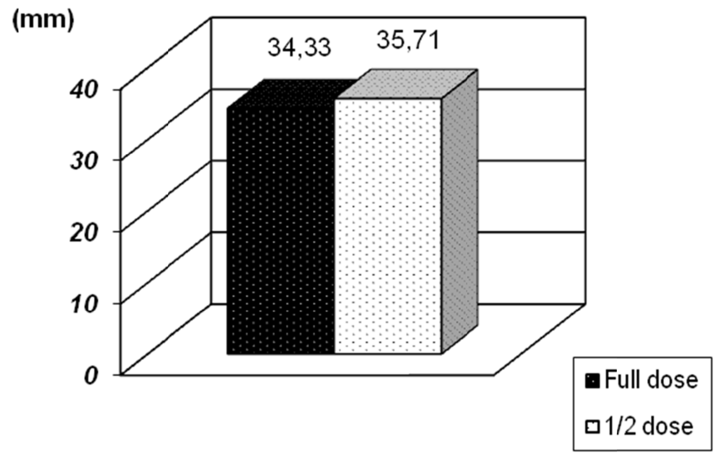

Figure 2. The amount of plant nutrient solution consumed by the plant (mm) (2011 Spring)

4. Conclusion

It is concluded that the vegetable types whose leaves are consumed in greenhouse conditions without heating can be successfully grown in both growing periods; It is also concluded that decreasing the nutrient solution concentration may decrease the negative effect to the environment by providing water and nutrient savings.

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