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EFFECTS OF FOLIAR SPRAYING WITH MARINE PLANT *Ascophyllum nodosum* EXTRACT AND NANO IRON CHELATE FERTILIZER ON FRUIT YIELD AND SEVERAL ATTRIBUTES OF EGGPLANT (*Solanum melongena* L.)

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ABSTRACT

For study effects of foliar spraying with *Ascophyllum nodosum* extract and nano iron chelate fertilizer on fruit yield and several attributes of eggplant, an experiment in factorial format based on randomized complete block design with three replications in Astaneh Ashrafiyeh Township (north of Iran) in 2011 was conducted. Factors of experiment was consist of *Ascophyllum nodosum* extract (A_1: 0 g/l (control), A_2: 1 g/l, A_3: 2 g/l foliar spraying) and nano iron chelate fertilizer (I_1: 0 g/l (control), I_2: 1 g/l, I_3: 2 g/l foliar spraying). In maturity time, fruit yield, number of fruits per plant, number of branches per plant, fruit length and fruit width were measured. Data analysis results showed that, the *A. nodosum* extract and nano iron chelate fertilizer application had significant effect on all studied traits. Also, interaction effect of *A. nodosum* extract and nano iron chelate showed significant differences on fruit yield, number of fruits per plant and fruit length. The highest fruit yield among *A. nodosum* extract levels was recorded from foliar spraying of 2 g/l with 37.89 ton/ha. Also, among nano iron chelate fertilizer treatments spraying of 2 g/l with 37.11 ton/ha was recorded the maximum amount of fruit yield. The highest fruit yield between interaction levels with 46.28 ton/ha was obtained by A_3I_3 level (2 g/l foliar spraying of *A. nodosum* extract and nano iron chelate fertilizer).

Keywords: eggplant, *Ascophyllum nodosum*, nano iron chelate fertilizer, yield, Iran.

INTRODUCTION

Eggplant (*Solanum melongena* L.), also known as Aubergine, Brinjal or Guinea squash is one of the non-tuberous species of the night shade family Solananceae (Kantharajah and Golegaonkar., 2004). The varieties of *Solanum melongena* L. show a wide range of fruit shapes and colors, ranging from oval or egg-shaped to long club-shaped; and from white, yellow, green through degrees of purple pigmentation to almost black. It is an economically important crop in Asia, Africa and the sub-tropics (India, Central America) and it is also cultivated in some warm temperate regions of the Mediterranean and South America (Sihachkr *et al*., 1993). Eggplant fruits are known for being low in calories and having a mineral composition beneficial for human health. They are also a rich source of potassium, magnesium, calcium and iron (Zenia and Halina, 2008). The yield depends upon several production factors. Among these proper, balanced nutrition plays a significant role. Ascophyllum nodosum (rockweed) is brown seaweed known to grow abundantly in temperate countries such as Canada, France, Iceland, Ireland, Norway, and the United Kingdom. This seaweed is usually replaced or mixed with other related species such as Fucus sp. in the most exposed or iced scoured areas (Sharp, 1986). It is sustainably harvested by hand cutter rake in the Maritimes, Canada (Ugarte and Sharp, 2001; Sharp *et al*., 2006; Ugarte *et al*., 2006) with an estimated 7, 500 WT in 2004. *Ascophyllum nodosum* is the most important commercial seaweed in Canada and it is the dominant perennial seaweed in the intertidal zone along the Atlantic coastline of the Maritimes where it forms extensive beds. The extract products of *A. nodosum*, both liquid concentrate and soluble powder, are traded globally for agricultural farming purposes (Anicia *et al*., 2009). Foliar and soil applications of *A. nodosum* extracts have been demonstrated to increase endogenous antioxidant activity and subsequent stress tolerance of several turfgrasses (Zhang and Ervin, 2004). Application of *A. nodosum* extracts has been shown to increase the yield of cauliflower, lettuce, and maize (Abetz and Young, 1983; Jeannin *et al*., 1991). In plant, micronutrients play an important role in the production and productivity. Among micronutrients, Iron (Fe) is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions (Brittenham, 1994). Hence, iron fills many essential roles in plant growth and development, including chlorophyll synthesis, thylakoid synthesis and chloroplast development (Miller *et al*., 1995). Iron is required at several steps in the biosynthetic pathways. (Singh and Dayal, 1992) concluded that spraying iron would cause a 38-42% increase in the peanut yield in alkaline soils. (Zareie *et al*., 2011), with study effect of nitrogen and iron fertilizers on seed yield and yield components of safflower genotypes was reported that, use of foliar spraying of iron fertilizer (sulphate of iron) had significant effect on seeds per head and seed yield of safflower genotypes. (Abdzad Gohari and Noorhosseini Niyaki, 2010), with study effects of iron foliar spraying in four levels (0, 1.5, 3 and 4.5 g/l per plot) and nitrogen fertilizers in four levels (0, 30, 60 and 90 Kg/ha on yield and yield components of Peanut (*Arachis hypogaea* L.) was reported that among iron fertilizer treatments, maximum pod yield with 2916 kg/ha

and seed yield with 1828 kg/ha were recorded from the 4.5 g/l iron foliar spraying treatment. The aim of this study was evaluated the effect of *Ascophyllum nodosum* extract and nano iron chelate fertilizer on fruit yield and several attributes of eggplant in Iran.

MATERIALS AND METHODS

In order to study effects of *Ascophyllum nodosum* extract and nano iron chelate fertilizer foliar spraying application on fruit yield and several attributes of eggplant, an experiment in factorial format based on randomized complete block design with three replications in Astaneh Ashrafiyeh Township located in 37° 16' latitude and 49° 56' longitude (north of Iran) in 2011 was conducted. Soil analysis results show that (Table-1), the soil texture was loam clay and pH, 7.2. Factors of experiment was consist of *Ascophyllum nodosum* extract (A_1: 0 g/l (control), A_2: 1 g/l, A_3: 2 g/l foliar spraying) and nano iron chelate fertilizer (I_1: 0 g/l (control), I_2: 1 g/l, I_3: 2 g/l foliar spraying). Foliar spraying with *Ascophyllum nodosum* extract and also nano iron chelate fertilizer was done twice at vegetative stage (20 days after transplanting) and at blooming period. The experimental field was cleared, ploughed, harrowed and divided into plots, with 10 m^2 areas. Six-week-old eggplant plants were hand-transplanted into well-prepared beds in the field. The spacing between rows was 80 cm and plants were 50 cm. Nitrogen (from source of urea 46% pure nitrogen) was applied 60 kg/ha. Half of nitrogen before planting and the remaining were used 40 days after plantation. Also, Phosphorus (P_2O_5) and potassium (K_2O_5) were applied 100 and 50 kg/ha before planting. All practical managements included; mulching, weeding and other agronomic treatments were done mechanically. Irrigation was done based on plant requirements. In maturity time, fruit yield, number of fruits per plant, number of branches per plant, fruit length and fruit width were measured. The data was analyzed using MSTATC software. Also, the Figures were drawing by EXCEL software. The Duncan's multiple range tests (DMRT) was used to compare the means at 5% of significant.

RESULTS AND DISCUSSIONS

Effect of *Ascophyllum nodosum* extract

With attention to variance analysis results (Table-2), effect of *Ascophyllum nodosum* extract application on fruit yield, number of fruits per plant, fruit length and fruit width at 1% probability level and on number of branches per plant at 5% probability level was significant. Comparison of mean between *Ascophyllum nodosum* extract application levels showed that (Table-3), the highest amounts of fruit yield with 37.89 ton/ha, number of fruits per plant with 5.86 fruits, number of branches per plant with 3.02 branches, fruit length with 34.42 cm and fruit width with 5.47 cm was recorded from 2 g/l *A. nodosum* extract foliar spraying application per hectare. The lowest amounts of fruit yield, number of fruits per plant, number of branches per plant, fruit length and fruit width was recorded from A_1 level (without spraying of *Ascophyllum nodosum* extract), respectively with 20.55 ton/ha, 2.71 fruits, 2.75 branches, 20.09 cm and 2.70 cm. Similar results about different plants were reported by Little and Spann 2010; Neily *et al*., 2010; Ross and Holden, 2010 and Nahed *et al*., 2011.

Effect of nano iron chelate fertilizer

Results of variance analysis showed that (Table-2), the effect of nano iron chelate fertilizer on fruit yield, number of fruits per plant, fruit length and fruit width was significant at 1% probability level. Also, showed a significant difference at 5% probability level on number of branches per plant. Comparison of mean between nano iron chelate fertilizer levels showed that (Table-3), the highest amounts of fruit yield with 37.11 ton/ha, number of fruits per plant with 4.60 fruits, number of branches per plant with 3 branches, fruit length with 29.89 cm and fruit width with 4.38 cm was recorded from 2 g/l foliar spraying of nano iron chelate fertilizer per hectare. On the other hand, the I_2 level (1 g/l spraying of nano iron chelate fertilizer) with 2.95 branches statistically was placed in same level with I_1 treatment. The lowest amounts of fruit yield with 25.45 ton/ha, number of fruits per plant with 3.51 fruits, number of branches per plant 2.73 branches, fruit length with 23.28 cm and fruit width with 3.74 cm was recorded from I_1 level (without spraying of nano iron chelate fertilizer). Similar results about different plants were reported by Horesh and Levy, 1981; Abbas *et al*., 2009; Abdzad Gohari and Noorhosseini Niyaki, 2010; Sheykhbaglou *et al*., 2010.

Interaction effect of *A. nodosum* and nano iron chelate foliar application

With attention to variance analysis results (Table-2), the interaction effect of *A. nodosum* and nano iron chelate fertilizer application showed significant influence at 1% probability level on fruit yield. Also, interaction effect on number of fruits per plant and fruit length showed significant differences at 5% probability level. But, on number of branches per plant and fruit width was non significant. Among interaction levels, the highest amounts of fruit yield with 46.28 ton/ha, number of fruits per plant with 6.60 fruits and fruit length with 38.86 cm was recorded from A_3I_3 level (2 g/l foliar spraying of *A. nodosum* extract and nano iron chelate fertilizer). The lowest amounts of fruit yield with 13.89 ton/ha and fruit length with 17.10 cm was recorded from A_1I_1 (without spraying of *A. nodosum* extract and nano iron chelate fertilizer) level. Also, the minimum amounts of number of fruits per plant with 2.40 fruits was found from A_1I_2 (without spraying of *A. nodosum* extract and 1 g/l foliar spraying of nano iron chelate fertilizer) level (Figure 1, 2 and 3). Similar results about different plants were reported by Chakralhoseini *et al*., 2002; Ghasemi Fasaei *et al*., 2006; Zhu *et al*., 2008 and Nahed *et al*., 2011.

Table-1. Some physical and chemical properties of experimental filed soil.

Depth	**0-30 cm**	**Soil texture**	**Loam clay**
Clay (%)	46.58	E.C.(mmhos/cm)	1.32
Silt (%)	29.97	Total nitrogen (%)	0.194
Sand (%)	23.45	P (ppm)	9.1
pH	7.2	K (ppm)	197

Table-2. Analysis of variance studied traits of eggplant under foliar spraying of *A. nodosum* extract and nano iron chelate.

Source of variance	**df**	**Fruit yield** (ton/ha)	**No. of fruits** (per plant)	**No. of branches** (per plant)	**Fruit length** (cm)	**Fruit width** (cm)
	MS					
A. nodosum extract (A)	2	745.216**	24.433**	0.161*	463.348**	17.414**
Nano iron chelate (I)	2	311.476**	2.713**	0.184*	103.932**	0.948**
A×I	4	25.510**	0.326*	0.068^{ns}	11.079*	0.107^{ns}
Error	16	2.213	0.101	0.039	3.672	0.121
CV%		4.83	7.90	6.79	7.09	8.59

Ns, ** and * respectively: non significant, significant in 1% and 5% area.

Table-3. Comparison of mean effect of foliar spraying of *A. nodosum* extract and nano iron chelate fertilizer.

Treatments	**Fruit yield** (ton/ha)	**No. of fruits** (per plant)	**No. of branches** (per plant)	**Fruit length** (cm)	**Fruit width** (cm)
***A. nodosum* extract** (A)					
A1	20.55 c	2.71 c	2.75 b	20.09 c	2.70 c
A2	34.02 b	3.46 b	2.91 ab	26.61 b	3.95 b
A3	37.89 a	5.86 a	3.02 a	34.42 a	5.47 a
Nano iron chelate (I)					
I1	25.45 c	3.51 c	2.73 b	23.28 c	3.74 b
I2	29.91 b	3.93 b	2.95 a	27.96 b	4 b
I3	37.11 a	4.60 a	3 a	29.89 a	4.38 a

Within each column, means followed by the same letter do not differ significantly at P<0.05

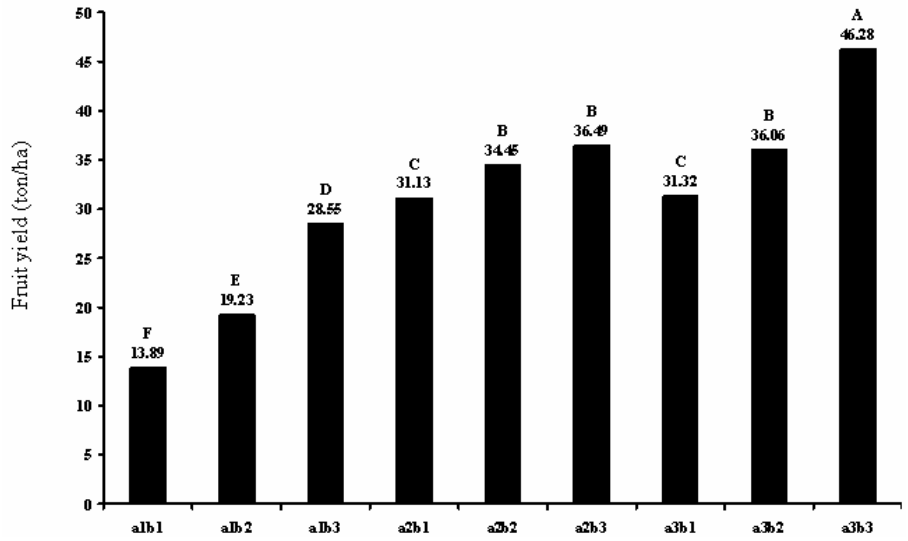

Figure-1. Interaction effect of *A. nodosum* and nano iron chelate fertilizer application on fruit yield.

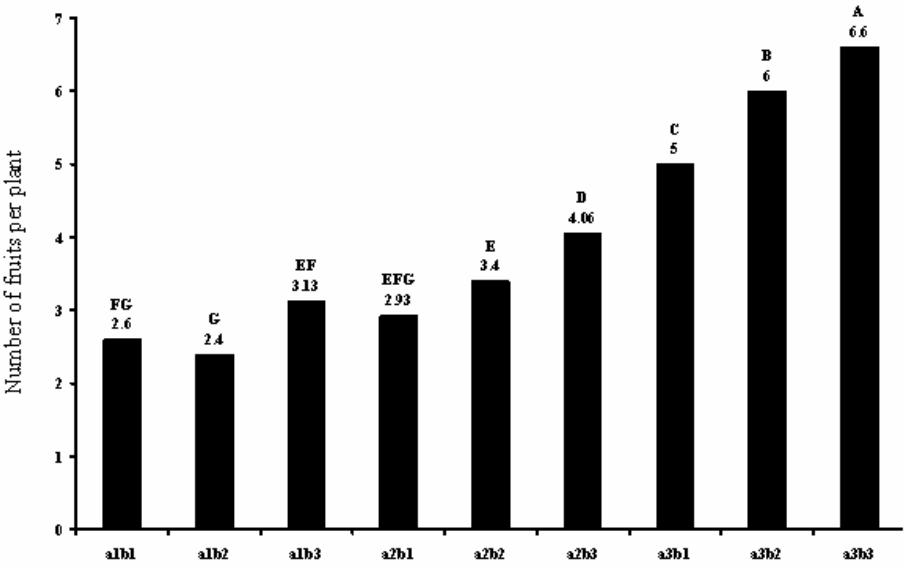

Figure-2. Interaction effect of *A. nodosum* and nano iron chelate fertilizer application on number of fruits per plant.

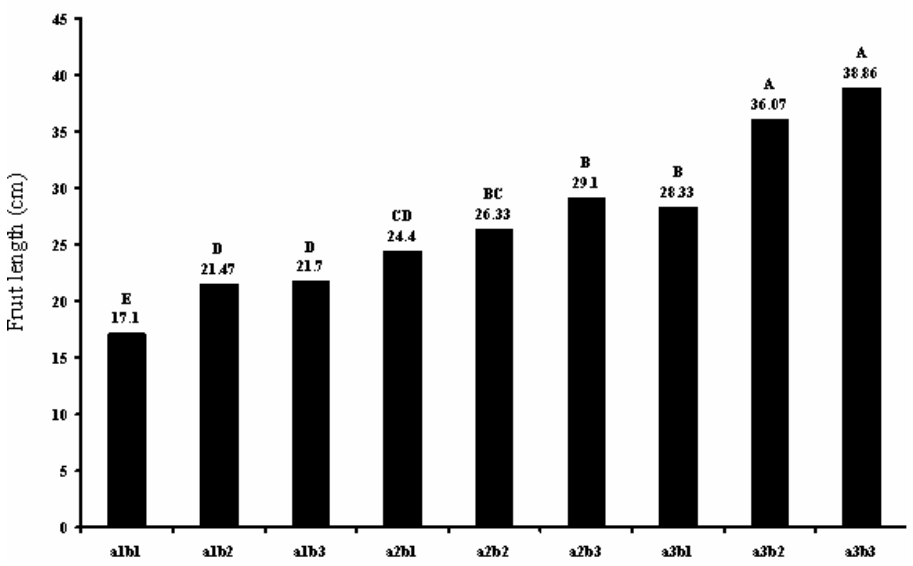

Figure-3. Interaction effect of *A. nodosum* and nano iron chelate fertilizer application on fruit length.

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