Effect of brown algae and vermicompost application on some cherry tomato traits in hydroponic system

Agroecology Journal
Vol. 10, No. 4 (77-83)
Winter 2015

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Received: 6 December, 2014 **Accepter:** 27 February, 2015

ABSTRACT To study the effect of brown algae *Ascophyllum nodosum* and vermicompost extracts on yield and yield components of cherry tomato, a pot experiment based on a completely randomized design in factorial with three replications was conducted in greenhouse condition in Mashhad during 2013-2014 as hydroponic system. Experimental treatments were brown algae and vermicompost extract in 0, 2, 4, 6 per thousand concentrations. Cherry tomato used seeds were soaked in mentioned concentration of each treatments immediately put in cultivation tray. To prepare container seeds field a mixed containing 50% peatmoss and 50% perlite was used. After the tomato seedlings became in the form of 4 to 5 leaves, they were transferred into peat moss and perlite hydroponic system. Growth factors include the number of leaves and plant height, stem diameter, wet and dry weight of stem and quality traits including fruit vitamin C and pH were evaluated at the end of the experiment. Both biofertilizers improved quantitative and qualitative characteristics of plant compared to control. All parameters were increased specially using higher level of biofertilizers. On the whole, using both of fertilizers in 6 per thousand level can be recommended for cherry tomato quality and quantity improvement

Keywords:
- *Ascophyllum nodosum*
- biofertilizer
- bioaminopalis
- ecological production
- Marmarin fertilizer

Introduction Nowadays, reliability on safe agriculture productions and keeping environment as risk-free gain researchers' attentions. In last decades, agricultural pest managements and crop improvements were relied on chemical productions imposing environmental pollutions.[27] Using green non-chemicals in agricultural systems can be considered as an appropriate alternative for current traditional systems which makes the ecosystems to be more stabilized.[39] In recent years, the production of tomato has been increased as a higher demand for its various products. Tomato is a rich source of antioxidants as well as vitamins, carotenoids and lycopene and other nutrient elements which have important role in society health.[3,13,19] The increment of tomato cultivation has resulted in growing application of chemical fertilizers which has negative impacts on ecosystem. A remarkable step in ecological production of tomato is using of non-chemicals such as natural and organic fertilizers.

Biological fertilizers have ability to supply for plants the main nutrient elements from unavailable form to available ones during biological processes and provide favorable conditions for seed germination and seedling initial growth.[38] Plant stimulants have widely used in modern agriculture.[30] *Ascophyllum nodosum* brown algae is known to be as a plant growth stimulant[16,37] having about 15% of protein, 17 kinds of amino acids, 1.56% fat and 57% carbohydrate.[29] It is dominant brown algae in pacific regions used in commercial extract products[26,33] and possess hormonal compounds such as auxin, gibberellin, phenyl-acetic acid, cytokinin as well as macro and micro minerals and so on.[36] Forness *et al.(*2002*)* reported increasing of plant defense system against mycosis using algae fertilizers in potato and showed resistance against viral diseases such as twisted leaves.[16] Also, improvement of corn, rice, potato, pepper, orange and pineapple yield by these growth stimulants has been reported.[11] Blunden *et al.* (1986) and Mancuso *et al.* (2006) said that some of the plants sprayed by *Ascophyllum* exhibit high resistance to salinity and chilling stress due to betaines such as gamma-amino butyric acid.[12,23] Vermicompost extract application as an organic fertilizer in agriculture results in better plant growth and development.[5] The sticky commercial product named Vermiwash contains waste materials of earthworms, macro- and micronutrient elements as well as humic and folic acids and plant growth stimulants compounds.[17] Vermiwash acts not only as a fertilizer but also as a mild pesticide. There are different ways of vermicompost extract production. In all methods during the extraction, dissolved in organic nutrients, beneficial microorganisms, humic acid, folic acid, and plant growth regulators as important factors in plant growth were added to the extract.[4] Also, there are plant growth regulators in vermicompost extract which makes it to improve plant growth.[7] Soltan Esmaiel *(*1996*)* showed effectives of vermiwash as a food solution on plants such as tomato, beans and orchids.[18] It seems that growth stimulant organic compounds such as brown algae and vermicompost extract can provide a good condition for cherry tomato growth and development.

Tthe present study aimed to focus on the effects of these organic fertilizers on yield and yield components of cherry tomato in hydroponic system in green house conditions.

Materials and methods To investigate the effects of brown algae (Marmarin®) and vermicompost (Vermiwash®) extracts in concentrations of 2, 4 and 6 per thousand in different concentrations on cherry tomato growth and development, a greenhouse hydroponic experiment was carried out based on randomized completely design as factorial in three replications during 2013-2014. Cherry tomato seeds were sterilized with sodium hypochlorite 1% solution for 5 minutes then washed with distilled water and 48 seeds were placed in a cultivation tray in sterile conditions. The container of seed included peat moss and perlite (1:1) and in substrate moisture of field capacity. Tomato seedlings with 4 to 5 leaves with 10-12 cm height were transferred to 24 pots in dimensions of 48 × 14 × 30 filled with peat moss, perlite and palm fiber (1:1:1). The temperature of the greenhouse over the six mounts of growth period was kept at 24 ℃ and 19 ℃ during days and nights, respectively. Drip irrigation method was used with an irrigated water circulative system. Two tomato seedlings were planted in each pot. No chemicals were used during the experiment. To control the insects, eucalyptus leaves put in each pot and peppermint 10 ml oil essence diluted in 100 ml of water and sprayed once a week on plants. Over the experiment most of growth parameters were measured such as plant height, stem diameter, total leaves number, stem dry and fresh weight, fruit extract vitamin C and pH. The analysis of variance was done by SAS ver. 9.1 software and mean comparison was done by Tukey test at $p \leq 5\%$ probability level.

Results and discussion

Plant height

The analysis of variance revealed significant effects of treatments on plant height at 5% probability level (Table 1). Elevating fertilizer concentrations increased the plant height; however, between 4 and 6 per thousand concentrations no significant differences were observed in both fertilizers. Increasing in plant height was seen in both fertilizers specially in 6 per thousand concentration (Figure 1a). The effect of plant growth regulators in assimilate distribution over the growing period of plants reflects much more in foliage growth than in roots[30] which is in accordance to obtained results. According to Arankon *et al.* (2005) the organic acids such as humic and fuloic acid in vermicompost have stimulant effects on plant growth.[6]

Muscolo *et al.* (1999) believed that the stimulant effect of vermicompost on auxin production in plant can improve plant height.[25] Vermicompost has positive effect on plant growth by improving physical, chemical and microbial conditions of substrate[9] and regulating the acidity of substrate and increasing water maintenance capacity of cultivation environment.[24] Mahfouz and Sharaf Aldin (2007) reported that organic fertilizers causes significant increase in fennel height.[22] Brown and Burlingham (1968) reported that applying plant growth stimulant bacteria increased wheat and barley height.[14] Obtained results are in consistent with the results observed by Solatan Esmaile (1996) on the effect of using vermiwash on the growth of tomatoes beans and orchids.[18]

Number of leaves

There was an increment in different biofertilizers concentrations which raised the number of leaves in cherry tomato. The highest number of leaves was found at 4 and 6 per thousand of fertilizers (Figure 1b). Probably, both fertilizers acted by providing micro- and macroelements total elements absorbed additionally by root volume increasing which can be effective on growth period and surface and leaves number. Algae extraction as a plant growth stimulant[37,16] leads to the increasing of chlorophyll and photosynthesis rate in leaves.[40] Parker and About (1981) reported that vermicompost nutrition elements are more available for plant and may increase plant growth in this way[1]. Therefore, would be expected that vermicompost causes rapid and direct absorbing of nutrients by foliage and consequently increasing of yield by plant growth factors enhancement such as the number of leaves.

Stem diameter

Adding different concentrations of both boifertilizer extracts increased stem diameter (Figure 1c). Increasing in stem diameter was seen at all concentrations of fertilizers compared to the control. The highest effect was observed in 4 and 6 per thousand concentrations of algae and 2 and 4 per thousand of Vermiwash. Humic acid chemical and physical properties in vermicompost and its extract can increase the preservation capacity of nutrition elements and plant hormones which can increase nitrogen in plant, thereby augmenting the nitrogen growth factor such as height, stem diameter and leaf surface.[34,6] According to Atieh *et al.* (2001) remarkable increasing in activities of vermicompost microorganisms can convert ammonium nitrogen to nitrate which may lead to higher stem diameter.[9]

Stem fresh and dry weight

By increasing of concentration rate, stem fresh weight has been increased. The highest stem fresh weight in stem has been observed in 6 per thousand of both fertilizes, while between 2 and 4 per thousand there were no significant difference statically. Between 4 and 6 per thousand concentrations of Marmarin fertilizer there was no significant difference, statically (Figure 1d). Growth regulator and micronutrients existence in Marmarin and Palis compounds can be the reason of aerial organs fresh weight increment. Stem dry weight was increased, significantly in both fertilizers. The highest stem dry weight seen in 6 per thousand concentrations of both fertilizers; however, no significant difference was observed between 4 and 2 per thousand concentrations (Figure 1e). Probably existence of humic acid in vermicompost and also increasing capacity of nutrition maintenance and growth regulators hormones increased plant growth and fresh weight of plant growth organs.[6] Using biofertiliozers in addition to providing of plant nutritions, increases moisture maintenance in soil, root better development and increases root weight and height. Kling *et al* (2003) reported that vermicompost extract increases plant root growth in various rapeseeds.[20] They reported that regulators or separated hormones extracted from vermicompost may have positive effect on root and plant growth. Pritma and Garg (2010) reported Marigold growth responses biomass increase in the presence of vermicompost boifertilizer.[28]

Table1 - Variance analysis of measured characteristics in cherry tomato affected by different concentrations of brown algae and vermicompost as biological fertilizers

Sources of variation	mean squares							
	df	fruit pH	plant height	stem wet weight	number of leaves	vitamin C	stem diameter	stem dry weight
Concentrations	3	*0.2032	*6092.787	*8928.471	*10442.41	*0.286	*17.4256	*273.7401
Treatment	1	^{ns}0.4160	^{ns} 1335.788	^{ns} 5130.450	^{ns}16939.96	^{ns}1.09226	^{ns}47.912	^{ns} 226.1362
Concentrations* treatment	3	0.0173*	*367.800	*222.733	*471.40	^{ns}0.075	*1.273	*3.416
Error	16	0.001	118.24	153.39	81	0.002	1.4034	6.631

ns and * are lack of significant difference and significant in 5% contingency level, respectively.

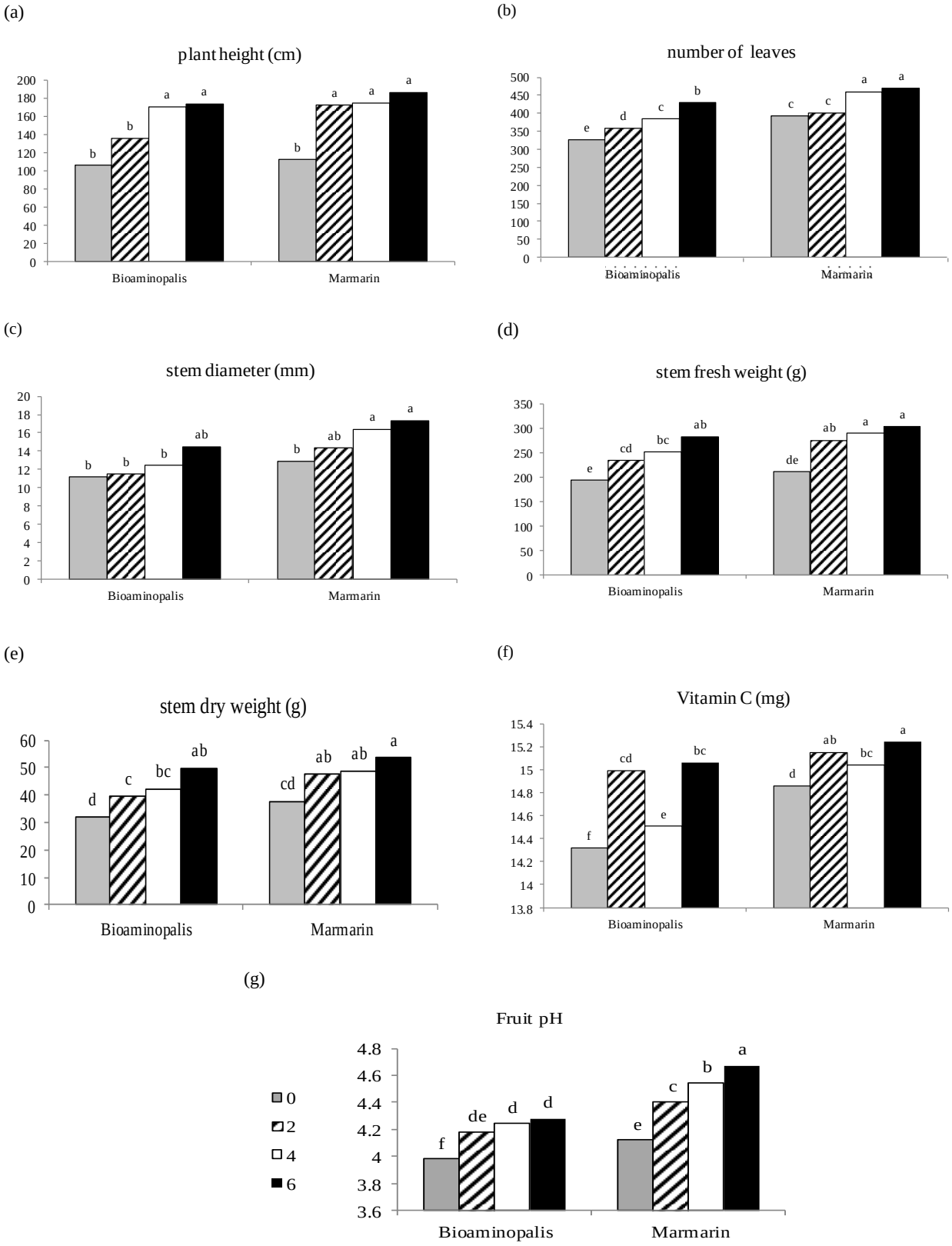

Figure 1- Different concentrations of biological fertilizers in per thousand effects on plant height (a), number of leaves (b), stem diameter (c), stem wet weight (d), stem dry weight (e), vitamin C (f) and fruit pH of cherry tomato

Vitamin C

The analysis of variance revealed significant differences at P ≤ 5% between different fertilizers concentrations in vitamin C amounts in cherry tomato fruit extract (Table1); however, the main effect of fertilizers and their interaction in 5% level had no significant effect on vitamin C (Figure 1f). The results were not in consistent with the results obtained by Tezorazkiss *et al.* (2008).[35] Lee *et al.* (2000) showed that applying chemical fertilizers results in reducing vitamin C in products[21]. Babik *et al.* (2001)[10] and Sorensen *et al.* (1999) [32] reported reducing vitamin C in Broccoli and kale by using chemical fertilizers. Sceffer and Kouhler (1993) reported that using organic materials in yarrow caused biomass and oil increment.[31] In other experiments using compost qualitative and quantitative increasing in basil yield has been occured.[15]

Fruit pH

Variance analysis proved that both concentration of different concentration of biofertilizers and their interactions had significant effects on fruit pH (Table 1). While biological fertilizers types did not show any significant difference (P ≤ 5%). The current research showed that fruit pH also was increased by increasing of fertilizers concentrations (Figure 1g). The most effect was observed in 6 per thousand concentration of algae. According to Adam (1999) who has produced tomatoes in hydroponic cultivation, it has less resistant than pH and the most production were obtained between 4.5 to 5 pH and in pH 7 productions has been decreased to 25%.[2]

Conclusion Using vermicompost and algae extracts increased photosynthesis and aerial parts and had positive effects on root development. Totally, it seems that investigated extracts had positive effects on growth index rather than controls because of having benefits such as effect on nutrition efficiency that would be increased and root volume and maintenance of existed moisture around root and hormone-like attributes. The most effective level of brown algae extract consumption and also vermicompost extract obtained in 6 per thousand levels; however, more studies should be done regarding other concentrations. The most important point in this study is plant healthiness during experiment without using chemical fertilizers and pesticides in sensitive productions such as cherry tomato. Using of the biofertilizers in agricultural crops production can be a start for new studies and producing other important productions.

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مجله بوم‌شناسی گیاهان زراعی
جلد ۱۰، شماره ۴ (زمستان ۹۳)
صفحات ۸۳ – ۷۷

اثر کاربرد جلبک قهوه‌ای و ورمی‌کمپوست بر برخی صفات گوجه‌فرنگی گیلاسی در سیستم هیدروپونیک

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چکیده به منظور تعیین اثر سطوح مختلف عصارهٔ جلبک قهوه‌ای *Ascophyllum nodosum* و عصاره ورمی‌کمپوست بر عملکرد و اجزای عملکرد گوجه‌فرنگی گیلاسی، آزمایشی گلدانی به صورت فاکتوریل در قالب طرح پایه کاملاً تصادفی با سه تکرار در گلخانه‌ای در مشهد در سال ۹۳-۱۳۹۲ به صورت آبکشت انجام شد. تیمارهای آزمایش جلبک قهوه‌ای و عصاره ورمی کمپوست در غلظت‌های ۰، ۲، ۴ و ۶ در هزار بود. ابتدا بذور گوجه فرنگی گیلاسی در غلظت‌های مذکور از هر تیمار خیسانده شده و در سینی کشت قرار گرفتند، نشای تولید شده گوجه‌فرنگی چهار یا پنج برگی به بستر کشت ۱:۱ پیت ماس و پرلیت منتقل شدند.. شاخص‌های رشدی شامل تعداد برگ و ارتفاع گیاه، قطر ساقه، وزن تر و خشک ساقه و صفات کیفی شامل ویتامین ث و اسیدیته میوه در انتهای آزمایش مورد ارزیابی قرار گرفتند. با کاربرد این دو کود بیولوژیک ویژگی‌های گیاه به طور محسوسی بهبود یافت. افزایش غلظت در هر دو نوع کود بیولوژیک سبب بهبود ویژگی‌های کمی و کیفی در گوجه‌فرنگی گیلاسی گردید.. در مجموع کاربرد این دو نوع کود در غلظت ۶ در هزار برای افزایش کیفیت و کمیت گوجه‌فرنگی گیلاسی را می‌توان توصیه نمود.

شناسه مقاله:
نوع مقاله: **پژوهشی**
تاریخ پژوهش: **۹۳-۱۳۹۲**
تاریخ دریافت: **۹۳/۰۹/۱۵**
تاریخ پذیرش: **۹۳/۱۲/۰۸**

واژه‌های کلیدی:
- **آب‌کشت**
- **آسکوفیلوم نودوسوم**
- **بیوآمینوپالیس**
- **تولید اکولوژیک**
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