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Research Article

The Quantitative Effects of Liquid Vermicompost and Seaweed Practices on the Seedling Quality of Organic Tomato (*Solanum lycopersicum* L.)

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Abstract

In this study, it is aimed to enhance organic seedling cultivation in terms of both seedling quality and seedling growth process to such an extent that it can compete with its conventional rivals. To this end, seaweed extract, liquid vermicompost and their mixtures of various doses were employed in the research. In this study, the effects of various organic fertilizer practices were investigated. Including the control practice, 16 separate applications based on random blocks were conducted three times and within each repetition 24 plants were grown. At the end of the seedling growth process, dry weight of the tomato plants' root, stem and leaf was detected. In addition to the increase in the dry weight of the root, stem and leaf brought about by the rise in the dose of seaweed and vermicompost individual applications, direct and positive effects of the fertilizing materials on the seedling growth were suggested. According to the results acquired, the application SW3 stands out with the 0.458 g total dry weight of tomato seedlings. The highest proportional dry weight rate in the seaweed applications was observed in the application SW3 (0.225). The highest rate in the proportional stem weight was detected in the application V3+SW1. Based on the data on the proportional leaf weight, the highest rate (0.614) was seen in the application SW2. Taking the significant criteria of seedling quality into consideration, SW3 application stands out as an advisable practice.

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Sıvı Vermikompost ve Deniz Yosunu Uygulamalarının Organik Domatesin (*Solanum lycopersicum* L.) Fide Kalitesi Üzerine Kantitatif Etkileri

Özet

Bu çalışmada organik fide yetiştiriciliğini gerek fide kalitesi gerekse fide gelişim süreci açısından konvansiyonel rakipleri ile mücadele edebilir seviyelere çıkarmak amaçlanmıştır. Bu amaçla deniz yosunu ekstraktı, sıvı vermikompost ve bu uygulamaların farklı doz karışımları araştırmada kullanılmıştır. Çalışmada fide gelişimi üzerine farklı organik gübre uygulamalarının etkileri araştırılmıştır. Bu çalışmada tesadüf blokları deneme desenine göre kontrol dahil 16 farklı uygulama, 3 tekerrür ve her tekerrürde 24 bitki yetiştirerek gerçekleştirilmiştir. Fide gelişim süreci sonunda domates bitkisinin kök, gövde ve yaprak kuru ağırlıkları tespit edilmiştir. Deniz yosunu ve sıvı vermikompostun münferit uygulamalarında doz artışı ile kök, gövde ve yaprak kuru ağırlıklarında meydana getirdiği artış, uygulanan gübreleme materyallerinin fide gelişimi üzerine doğrudan ve pozitif etkileri ortaya konulmuştur. Elde edilen sonuçlara göre domates fideleri toplam kuru ağırlık değeri açısından 0.458 g değeri ile SW3 uygulaması öne çıkmıştır. Deniz yosunu uygulamalarında en yüksek oransal kök ağırlığı (OKA) değerinin SW3 (0.225) uygulamasında olduğu gözlemlenmiştir. Oransal gövde ağırlığı (OGA) yönünden domateste en yüksek değer 0.237 ile V3+SW1 uygulamasında belirlenmiştir. Oransal yaprak ağırlığı (OYA) verileri incelendiğinde en yüksek değer SW2 (0.614) uygulamasında tespit edilmiştir. Fide kalitesi açısından önemli kriterler göz önüne alındığında SW3 uygulamasının tavsiye edilebilir uygulama olarak belirlenmiştir.

Anahtar Kelimeler
Deniz yosunu
Vermikompost
Fide
Gelişim

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INTRODUCTION

Being of great nutritional value, tomato ranks the first in vegetable production, grown in the open air or greenhouse. Turkey has a pivotal position among other countries in terms of both the number and the variety of cultivated vegetables [1, 2]. About 12.841.990 tons of annual tomatoes are grown in Turkey, 8.836.055 of which is for food and 4.005.934 include the types of tomato sauces [3]. This great production rate is of utmost importance in seedling cultivation as well and when looked at the types of seedlings grown in 2013, tomato seedling ranks the first with the rate of 43.6 % [2]. Despite not being a much selective in soil type, but grown ideally in lands rich in organic matter and having high water holding capacity, tomato is a vegetable whose fruit is edible. In tomato production, which can be practiced in the open air or greenhouse, production with seedling is quite high [4].

One of the most important factors having an impact on the quantity and quality of crops in herbal production is fertilizing. With the recent excessive synthetic chemical input in food production, health concerns have come into prominence and environmentally friendly production systems have made a great comeback with the rise in chemical residues [5]. As a result of using excessive and unconscious chemical fertilizers and growing the same type of plant, the natural form of soil spoils and problems such as saltiness and soil exhaustion emerge. Organic fertilizer is considered to be a significant solution for the prevention of these problems. When compared with the individual uses of chemical fertilizers and soil regulators, organic fertilizer combinations were often observed to yield better outcomes [1, 6].

Instead of synthetic chemicals employed to provide health and fast plant growth, most businesses utilize seaweed solutions in order to provide more natural, healthier, faster and more efficient plant growth [7, 8]. In many countries, seaweed is applied more and more either in extract form or directly on the soil. Its extracted form is preferred more to yield more organic crops. Seaweed has an increasing impact on both fertility and quality by enabling the crops to get the macro and micro nutritional elements from the soil moderately and steadily [9]. Algae are of utmost significance not just in that they are resistant to saltiness but also they contain high amount of proteins, vitamins and minerals. Even if they were harnessed for several purposes throughout history, the main purpose of algae use is fertilizing [10]. Even though their solid form is still used, many producers today have increased the amount of liquid algae extracts and promoted its liquid form [11].

97 % of the nutritional elements in vermicompost is in absorbable form and it is known to be rich in N, P and K elements that are also known to be in the absorbable form by the plant. In accordance with these features, it has a positive impact on the root and sprout growth as well as fruit set [12-14]. Some researchers concluded that pathogens and insect activities are essential for the plant growth and improvment and therefore developed vermicompost [15, 16]. Despite its lack of prominence and uncommon use, vermicompost, a fertilizer produced by worms is used in many countries worldwide [12]. Even a slight amount of vermicompost was observed to exert a positive effect on germination, seedling growth and the performance of ornamental flowered plants in various studies [17, 18]. Moreover, it was detected to have a supportive effect on such fields as improving sprout length and enlarging leaf surface of tomato seedling under greenhouse conditions [19]. In this study, it was aimed to suggest the quantitative effects of the seaweed extract and vermicompost practices on tomato seedlings in organic seedling production.

MATERIAL AND METHOD

This study was carried out in 2019 in the polycarbonate greenhouse located within the campus area of Selçuk University Sarayönü Vocational School. Asgen H-2274 tomato seed was used as the crop material as well as İgsaş liquid seaweed and Ekosol Farm liquid worm fertilizers. For the seedling environment material, 3 units of turf and a unit of perlit was used as the standard cultivation area. Including the control application, 16 separate applications based on random blocks were performed three times and 24 plants were grown in each repeat. The standard cultivation area was applied various doses of seaweed extracts and liquid vermicompost as well as their various mixtures. These applications were repeated once a week until the seedlings got ready for plantation with the order 24 cells of 250 ml viols. Randomized test blocks were planned in test design. The rates of the seaweed extract and the liquid vermicompost applied in the tested cultivation area are given in Table 1. The tested seedlings were removed for quantitative measures after they outgrew 3-4 leaves. During each measure, seedlings were removed in three pieces without giving any harm to their roots. The roots, stems and leaves of the seedlings prepared for measurement were each removed. The roots and the stems of the seedlings were separated just at their intersection. The leaves were removed by cutting just at their intersection with the stem (leaving the stalks on the leaves).

Table 1. Seaweed extract, liquid vermicompost and their different mixing ratios used in the experiment.

NO	Application	Application Doses
1	Seaweed (SW1)	100 ml / 100 lt
2	Seaweed ((SW2)	200 ml / 100 lt
3	Seaweed ((SW3)	300 ml / 100 lt
4	Vermicompost (V1)	100 ml / 100 lt
5	Vermicompost (V2)	200 ml / 100 lt
6	Vermicompost (V3)	300 ml / 100 lt
7	V1 + SW1	100 ml / 100 lt + 100 ml / 100 lt
8	V1 + SW2	100 ml / 100 lt + 200 ml / 100 lt
9	V1 + SW3	100 ml / 100 lt + 300 ml / 100 lt
10	V2 + SW1	200 ml / 100 lt + 100 ml / 100 lt
11	V2 + SW2	200 ml / 100 lt + 200 ml / 100 lt
12	V2 + SW3	200 ml / 100 lt + 300 ml / 100 lt
13	V3 + SW1	300 ml / 100 lt + 100 ml / 100 lt
14	V3 + SW2	300 ml / 100 lt + 200 ml / 100 lt
15	V3 + SW3	300 ml / 100 lt + 300 ml / 100 lt
16	Control	-

In order for each seedling's biomass to be determined, the root, stem and leaves were each dried at 80 ^{o}C in JSR JSON-150 model stove for 72 hours. For their dry weights, Precisa XB 220A model scales with a delicacy of 0.0001 g and 220 g capacity. In the light of these practices, the dry weights of the root, stem and leaves were proportionated and their quantitative analyses were conducted in accordance with Uzun, S. [20]. Their growth paradigms and measurement models are suggested with details in Table 2. Their multiple regression analyses were prepared using Microsoft Office Excel Program. In the statistical comparisons of the acquired data, standard error bars were used and they were attached on the data at $P<0.05$ and $P<0.01$ scales.

Table 2. The plant growth parameters and calculation models used in quantitative analysis [20]

Parameters	Calculation models
Root weight ratio (RWR)	Total Root Dry Weight (g) / Total Plant Dry Weight (g)
Stem weight ratio (SWR)	Total Stem Dry Weight (g) / Total Plant Dry Weight (g)
Leaf weight ratio (LWR)	Total Leaf Dry Weight (g) / Total Plant Dry Weight (g)

RESULT AND DISCUSSION

In this study, when stem dry weights of tomato seedlings were analyzed, the highest result was obtained as 0.091 g in the SW3 application while the lowest 0.037 g in the control application. The leaf dry weight of the tomato seedlings were observed to be highest with 0.264 g in the SW3 application and the lowest value 0.117 g was obtained in the control application. The root dry weight of the seedlings were seen to be highest with 0.103 g in SW3 application (Fig. 1). Özer, H. and Uzun, S. [21], found the lowest root dry weight to be between 0.06 and 0.11 g with the seedlings grown of different organic fertilizers in different environments. Demir, N. at all. [22], noted that the algae materials used in suspension form on tomato, pepper and eggplant seedlings affected the germination of these vegetables favorably. Seaweed extract was found to be rich in some growth hormones (auxin and cytokinin), micro nutrients (Fe, Cu, Zn, Mo, Co, Mn and Ni) and vitamins [23]. The highest total seedling dry weight was identified be 0.458 g in SW3 application and found to be promising, while the lowest weight was 0.199 g in the control application (Fig. 2). The SW3 application stands out to be a recommendable application not only in terms of total dry weight rates and the dry weights of the root, stem and leaves but also in terms of the dry matter accumulation rate which is one of the important seedling quality criteria.

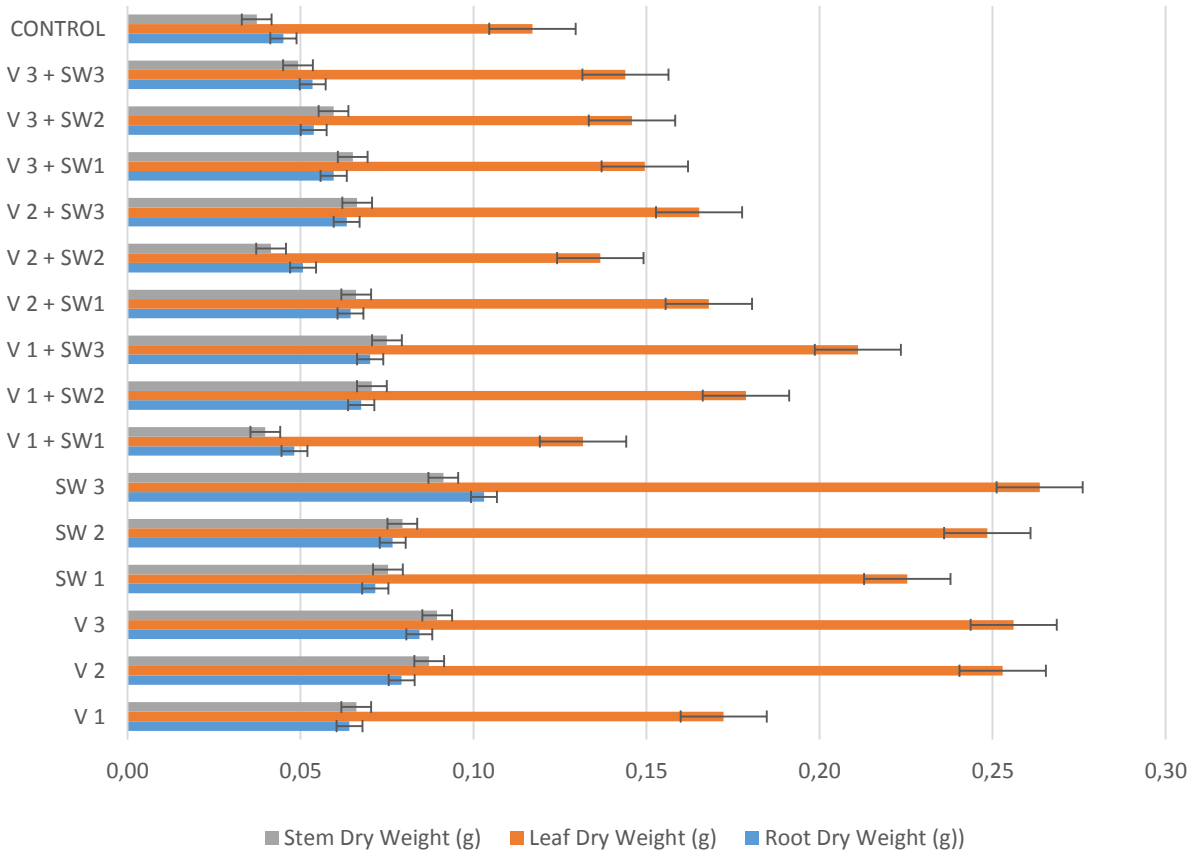

Figure 1. Root, stem and leaf dry weight values of tomato seedling.

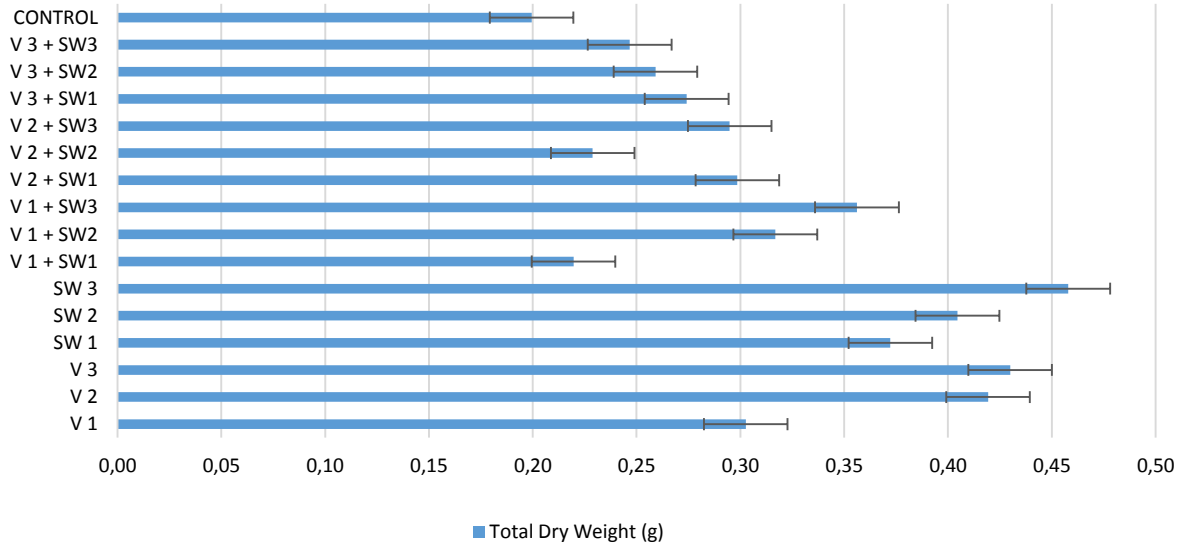

Figure 2. Total dry weight values in tomato seedling.

According to the scale of the tomato root weight ratio, SW3, V1+SW2, V2+SW1 and V1+SW1 applications are statistically standing out. As far as the proportional root weight rate is concerned, there was no statistical distinction identified to be between these applications

and the control group. In the seaweed applications, the highest proportional root weight rate was found to be 0.225 in SW3 and in the vermicompost practices it was in V1 application with the rate of 0.212 (Fig. 3). Applying liquid seaweed on the soil at different growth stages, Özenç, D. B. and Osman, Ş. [24] identified the best growth at the seedling stage with the water-dose of 400 ml100 L^{-1}. The researchers studying the effects of the seaweed fertilizer applications on most horticultural and field crops have suggested that the vegetative growth gains speed with the increasing root and sprout growth upon seaweed applications [25-28].

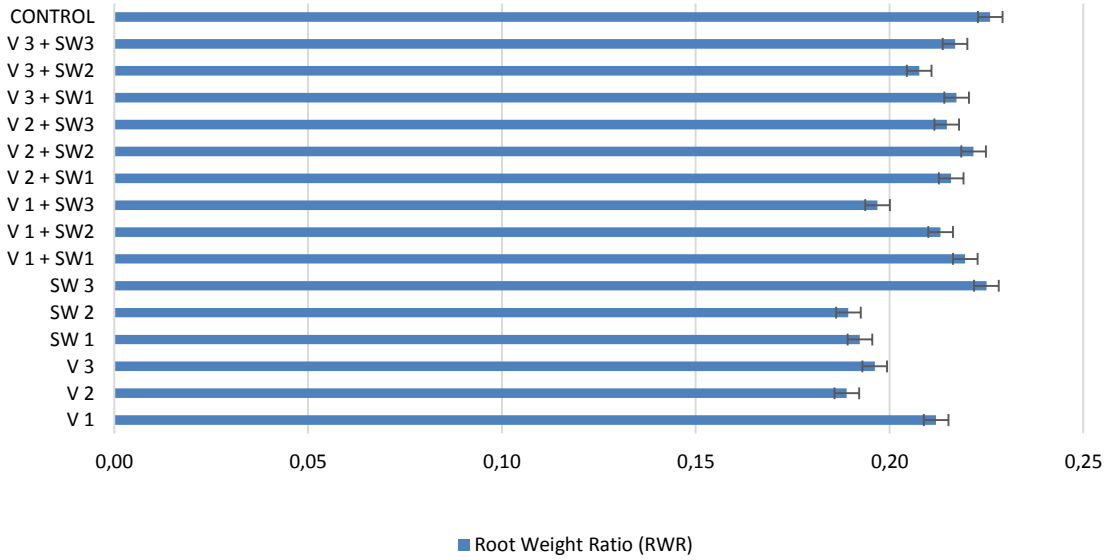

Figure 3. Root weight ratio change in tomato seedling.

The highest rate in the proportional stem weight of tomato was found to be in V3+SW1 application with the degree of 0.237 (Fig. 4). In addition to this application, V3+SW2, V2 + SW3, V1+SW2 and V2+SW1 mixture applications were identified to stand out among others statistically. In seaweed applications, the highest proportional stem weight was observed in SW1 application with the rate of 0.202, while the same rate was in V1 application with 0.219. Demirsoy, M. [29], the proportional stem weight rates of the tomato seedlings grown under different light conditions were observed to be between 0.2801 and 0.4092.

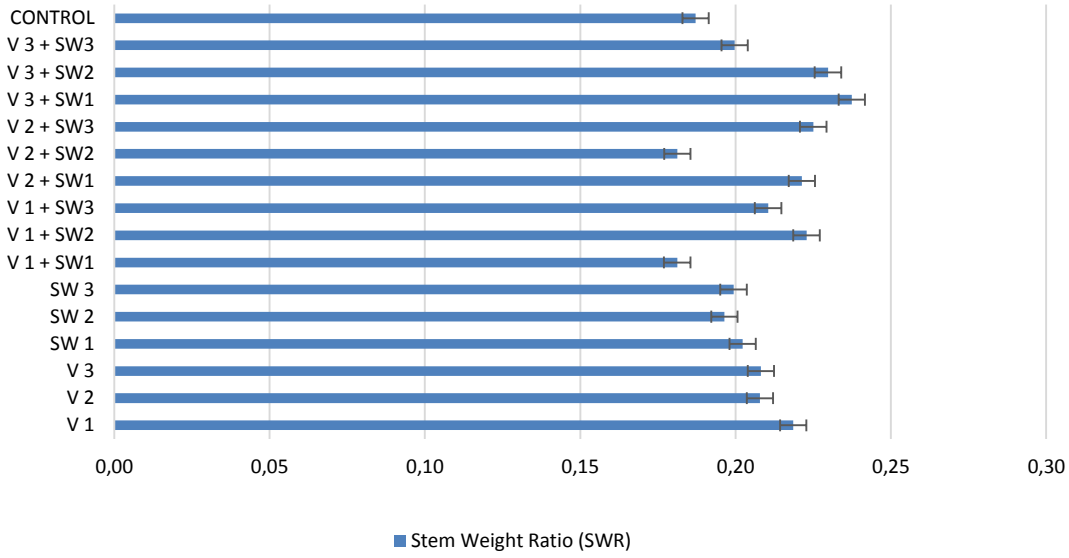

Figure 4. Stem weight ratio change in tomato seedling.

The highest rate in the proportional leaf weight was in SW2 application with 0.614. Application rations in the proportional leaf weight were found to fluctuate between 0.545 and 0.614 (Fig. 5). Demirsoy, M. [30], identified the proportional leaf weight rates to be between 0.48 and 0.66 in his study conducted on tomato seedlings he grew in various environments. Seaweed extract enhances fertility and quality by enabling the seedling to get the nutritional elements from the soil moderately and steadily as well as improving the rate of offshooting and fruit set in fruit trees. Likewise, it augments 30 % increase in fertility by lessening flower and fruit loss [25, 31].

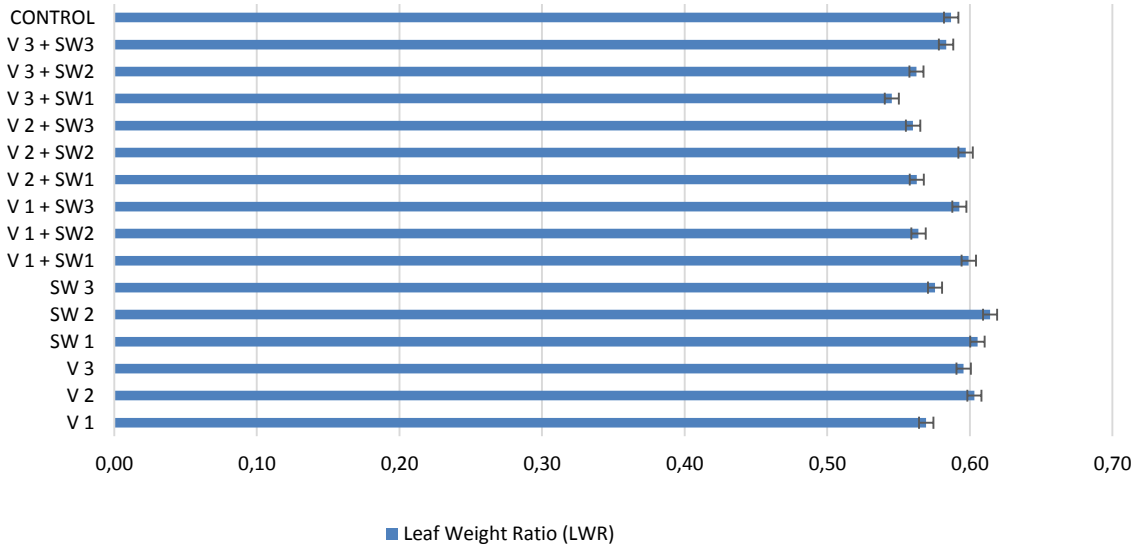

Figure 5. Leaf weight ratio change in tomato seedling.

CONCLUSION

Seedling production industry has an ever-increasing economic value and tomato ranks the first among the most frequently grown types of seedlings across the country. In many studies, it has been emphasized that plant nutritional back-up is essential just after germination of a seedling. To this end, various chemical and synthetic materials are employed. When the organic agriculture principles are especially taken into consideration, the ban on such fertilizers and growth regulators leads to great economic losses. As far as the growth procedure of the seedlings prepared for tomato cultivation is concerned, there appears to be statistical differences between the applied materials and their doses. The rise in the dose of the individually applied seaweed and vermicompost and the increase it brings about in the dry weight of the root, stem and leaf especially shows the direct and positive impacts of using fertilizing materials on the seedling growth. The fact that both materials promotes the intake of the nutritional elements from the soil enabled the root growth naturally to be better. The highest proportional root weight in the seaweed applications was found to be SW3 with 0.225. The highest proportional stem weight in tomato seedling was detected to be 0.237 in the V3+SW1 application. The highest proportional leaf weight was seen in the SW2 application with 0.614. In the light of the data acquired out of the tests, the results of the SW3 application that came to the front in terms of the total dry weight of tomato seedlings were found to be remarkable. Based on the dry matter residue rates which are among important criteria for seedling quality, SW3 application was concluded to be a recommendable practice.

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