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The Effect of Algae on Some Quantitative Characteristics of Dwarf and Normal Periwinkle

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ABSTRACT

Periwinkle is a shrubby or herbaceous plant that is grown and farmed in the tropics. Seaweed contains a high concentration of salts and mineral compounds, which meet plant nutritional requirements and play an essential role in soil fertility. In this study, the addition of algae in the growth medium was found to be an effective factor in boosting the quality and quantity of two species, Periwinkle Rosea and Burgundy, using a factorial design with three replications. The studies were carried out at the greenhouse of Persian Gulf University's College of Agriculture and Natural Resources in Borazjan, Iran's Bushehr Province. Green, red, and brown algae were created at volume levels of 0, 10, 25, 35, and 50% for this investigation. A few traits were documented, including the number of leaves, stem height, root length, total weight of plants with wet basis (WW) and dry basis (WD). Periwinkle flowers cultivated in the substrate with 50% green algae and 10% red algae had the maximum concentration; for brown algae, dwarf periwinkles had a 25% concentration, while normal periwinkles had a 35% concentration. The substrate with no algae has the most lateral branches of any of the three forms of algae. The substrate with 50% green algae, 35% brown algae, and 10% red algae produced the high amounts of height of periwinkle, root length, number of leaves, total periwinkle plant weight with wet (WW) and dry (WD) basis.

Alglerin Cüce ve Normal Pervane Çiçeğinin Bazı Kantitatif Özellikleri Üzerindeki Etkisi

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ÖZ

Pervane çiçeği, tropik bölgeler ile çiftliklerde yetiştirilen çalımsı veya otsu bir bitkidir. Deniz yosunu, bitki besin gereksinimlerini karşılayan ve toprak verimliliğinde önemli bir rol oynayan yüksek konsantrasyonda tuz ve mineral bileşikleri içermektedir. Bu çalışmada, üç tekrarlamalı faktöriyel tasarım kullanılarak, büyüme ortamına alg eklenmesinin Rosea ve Burgundy adlı iki türün kalitesini ve miktarını artırmada etkili bir faktör olduğu tespit edilmiştir. Çalışmalar, İran'ın Buşehr Eyaleti, Borazjan'daki Basra Körfezi Üniversitesi Tarım ve Doğal Kaynaklar Koleji'nin serasında yürütülmüştür. Bu araştırma için %0, 10, 25, 35 ve 50 seviyelerinde yeşil, kırmızı ve kahverengi algler kullanılmıştır. Yaprak

sayısı, gövde yüksekliği ve kök uzunluğu dahil olmak üzere birkaç özellik saptanmıştır. %50 yeşil alg ve %10 kırmızı alg içeren substratta yetiştirilen pervane çiçeklerinin maksimum konsantrasyona sahip olduğu görülmüş; kahverengi algler için, cüce pervane çiçeği %25 konsantrasyona sahipken, standart pervane çiçeği %35 konsantrasyona sahip olmuştur. Alg içermeyen substratın, üç alg formunun en fazla yan dalına sahip olduğu görülmüştür. %50 yeşil alg, %35 kahverengi alg ve %10 kırmızı alg içeren substrat, ıslak ve kuru bazda yüksek miktarda pervane çiçeği yüksekliği, kök uzunluğu, yaprak sayısı, toplam pervane çiçeği bitki ağırlığı üretmiştir.

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Introduction

The expansion of urbanization and population in recent years has forced cities to face a lack of space, and as a result, living in apartments has increased. As a result of these changes, green space in cities has diminished (Salehifard and Alizadeh, 2008). The periwinkle plants impart a characteristic smell to their surroundings. It is due to the presence of volatile compounds in their leaves and flowers. The leaves contained 0.05% of essential oils, while flowers 0.07%. There were 52 leaves essential oil compounds and 41 compounds of the flower essential oil (Salari et al., 2016).

In addition to physical health, suitable green spaces in cities promote mental relaxation, increased productivity, and a higher quality of life (Ebrahim-Zadeh et al., 2008). Using chemical fertilizers has resulted in numerous environmental issues, including soil erosion, water pollution, and a decline in crop output over time. To address these issues, plants' nutritional requirements and the long-term viability of agricultural systems should be considered.

One of the most effective strategies to safeguard the environment is to utilize organic fertilizers. Organic matter is an essential component of soil. It serves variety of functions in agriculture, including preventing soil compaction, increasing the source of carbon and energy for microorganisms, maintaining and stabilizing soil particles, improving root penetration conditions, increasing the quality of saline soils, providing soil's ability to store and transfer water, reducing soil adhesion, and reducing pesticide's negative environmental effects (Cooperband, 2002). Seaweed products promote plant development and yield (Metting et al., 1990).

Algae is an organic component that has long been utilized in agriculture (Dhargalkar and Neelam, 2005; Abdel-Raouf et al., 2012). Seaweed is one of the organic and natural compounds used in agriculture because it contains growth hormones like auxin and cytokine

and nutritional elements like iron, copper, zinc, molybdenum, manganese, vitamins, and amino acids (Uthirapandi et al., 2018; Uthirapandi et al., 2019).

Seaweeds contain micro and macro elements, auxin, gibberellin, and cytokinin (Taiz and Zeiger, 1998; Mukherjee and Patel, 2020). The increase in the growth characteristics of the branch may be due to the content of auxin in seaweed, which has an effective role in cell division, and this factor leads to an increase in plant stem growth (Thomas, 1996). Elements such as nitrogen, potassium, and phosphorus in seaweeds have very important roles in plants' nutrition, growth, and development (Attememe, 2009).

The use of algae increases chlorophyll levels, which leads to increased photosynthetic activity and plant growth (Geeta et al., 2016). The use of seaweed can increase photosynthesis by increasing the amount of chlorophyll, which can increase growth and, ultimately, the diameter and length of the stem (Eris et al., 1995; Paul and Yuvaraj, 2014; Sharma et al., 2014). Rathore et al., (2009) in their experimental test on soybean plants reported that increasing algae concentration the height of the plant is increased.

According to Preza (2019), applying algae on the portulaca grandiflora flower can increase its height. According to Herrera et al. (2014) and Crouch and Staden (1993), green algae affect tomato growth. Popescu and Popescu (2014) found that treatments with algae extract increased the height of grapevine plants compared to the control group. Al-Shareefi et al. (2019) showed that using algae increased the height of the stem in freesia flowers. Because phosphorus is very absorbent in soil, it does not migrate to the roots, so the roots must develop through the soil to obtain the phosphorus that the plant requires. Seaweeds promote root growth and boost beneficial fungi in the soil (Kuwada et al., 2006).

The use of algae in decorative plant bedding can naturally improve plant growth, health, and crop output by improving nutrient absorption. Algae include uncommon carbohydrates, vitamins, and hormones. Algae can stimulate plants' physiological and biochemical processes, resulting in the generation of biologically active chemicals. In this approach, primary and secondary metabolism can be modified, resulting in products that are more resistant to various living and non-living stimuli. Algae can also impact plant development media, causing root growth and nutrient availability (Paul and Yuraj, 2014).

The stimulating effect of seaweed extract on growth traits can be attributed to its basic function in strengthening cell division because it contains more amounts of micro and macronutrients, vitamins, hormones, and antioxidants. These compounds also play an important role in plant protection (Soliman et al., 2000). These compounds play an important role in protecting plants, improving cell division and biosynthesis of organic matter (Stirk and

Van Staden, 1997). Providing food and stimulating growth, on the one hand, causes the production of leaves, and on the other hand, their protective role causes the preservation of leaves, which together leads to an increase in the number of leaves.

Using organic compounds like humic acid and marine algae in poor soils has positive effects on the physicochemical properties of the soil, increases the quality of soils, and organic matter over time can reduce the consumption of chemical fertilizers (Mao et al., 2008; Chojnacka et al., 2015). Numerous research has demonstrated that using seaweed promotes plant development, stimulates root growth, and enhances tolerance to environmental challenges such as drought, salinity, and high temperatures (Khan et al., 2009; Battacharyya et al., 2015; Mukherjee and Patel, 2020). Turan and Kose (2004) found that seaweed extracts improve N, P, K, Ca, Cu, Fe, Mg, Mn, and Zn absorption under optimal nutritional element circumstances. This study examined how green, red, and brown algae affected same characteristics of dwarf and normal Periwinkle.

Material and Methods

To assess the influence of green, red, and brown algae on the growth and yield of dwarf and normal Periwinkle plants, a factorial experiment with three replications was conducted. The studies were carried out at Persian Gulf University's College of Agricultural and Natural Resources in Borazjan, located in the center of Bushehr province, 75 meters above sea level, and is semi-desert and tropical. The faculty's latitude and longitude coordinates on the map are 29 degrees and 22 minutes north and 51 degrees and 24 minutes east. The substrates were a combination of dirt and algae green, red, and brown (Figure 1) in quantities of 0, 10, 25, 35, and 50 percent by volume.

Figure 1 (a) Red algae, (b) Green algae (c) Brown algae

The algae under study were gathered from the Persian Gulf Sea in Bushehr Province. The algae were collected, cleaned with seawater, and washed twice with water before being dried in the shade and ground into powder. The field soil was then sieved until it was uniform, and the soil and algae were mixed in volume ratios of 10:90, 25:75, 35:65, and 50:50 to

produce beds containing 10, 25, 35, and 50% green, red, and brown algae, respectively. Finally, two types of Periwinkle seeds (Rosea and Burgundy) were planted in the pots, and all of the pots were moved to the greenhouse.

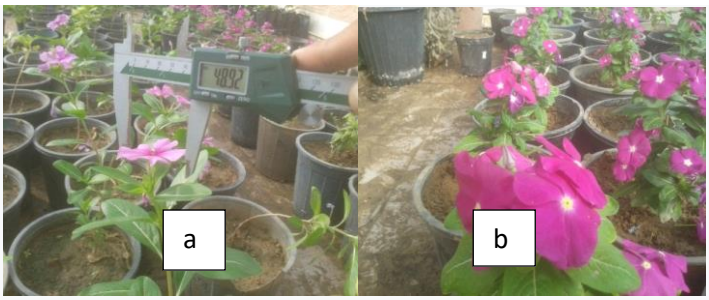

Figure 2 (a) regular periwinkle (b) Dwarf periwinkle

The height of the plants was measured weekly beginning the first week after planting, using a ruler with a one millimeter accuracy from the crown of the plants. The dirt around the roots was cleansed to measure root length, and the lengths were measured with a one millimeter accuracy ruler. In order to measure the weight of the plants, the plants were cut from the collar and the roots were removed from the soil. Then, the shoots and roots were washed with distilled water and after removing the excess water due to washing, they were weighed based on wet (WW) and recorded using a digital scale (AND EK_1200A) with an accuracy of 0.001 grams. To measure the weight with dry basis (WD), plants were kept in oven at 70°C for 48 hours, then the dry weight of plants were measured.

Results and Discussion

The comparison of the average effect of algae levels on Periwinkle flowers revealed that the highest and lowest lengths were obtained in periwinkle flowers growing in the substrate containing 50% green and red algae, 32.12 cm and 19.30 cm, respectively. The findings of the study of the influence of algae levels on the height of the periwinkle flower revealed that the periwinkle flowers produced in the substrate containing 50% green algae had the longest stem length (43.93 cm) and the shortest stem length in the substrate containing 50% red algae (27.4 cm). Periwinkle flowers cultivated in soil containing 50% red algae show a significant decrease in plant length when compared to the control, and periwinkle flowers grown in a bed containing 10, 35, and 50% brown algae, and all levels of green algae have a significant increase in length compared to control samples. The length of plants for dwarf periwinkle flower had a downward trend with increasing the concentration of red algae, and increasing the concentration of brown algae from 35% to 50% algae the length of plants decreased. The

highest and lowest length of dwarf periwinkle 20.31, and 11.21 cm, were found in a bed containing 50% green and red algae, respectively. It was also discovered that dwarf periwinkle green algae have no noticeable variation in height from the control. Both plants grew longer as the concentration of green algae rose. In the instance of brown algae, dwarf and standard periwinkle flowers reached their maximum length in substrates containing 25% and 35% algae, respectively. There was also a significant difference in the flowers of Periwinkle in the substrate containing 25, 35, and 50% brown algae, all levels of green algae, and control (Table 1).

Table 1. Comparison of the average effect of green, red, and brown algae on the flower height of dwarf and normal Periwinkle

Supplement added to the soil	Percentage of algae	Normal periwinkle	Dwarf periwinkle	Mean
		The height of periwinkle		
	0	32.95 $^{(ed)}$	12.98$^{(ed)}$	22.92^{F}
Red algae	10	34.70$^{(cd)}$	13.53$^{(ed)}$	24.11^{EF}
	25	30.36$^{(ef)}$	12.79$^{(ed)}$	21.58GF
	35	29.80$^{(ef)}$	11.49$^{(e)}$	20.64^{GH}
	50	27.4$^{(f)}$	11.21$^{(e)}$	19.30^{G}
Brown algae	10	34.9$^{(cd)}$	13.48$^{(ed)}$	24.19^{EF}
	25	37.6$^{(cb)}$	15.02$^{(cd)}$	26.31^{ED}
	35	40.36$^{(ab)}$	14.87$^{(cd)}$	27.62^{C}
	50	38.03$^{(cb)}$	14.55$^{(cd)}$	26.29^{ED}
Green algae	10	40.96$^{(ab)}$	16.83$^{(cb)}$	28.9^{BC}
	25	42.00$^{(ab)}$	19.08$^{(ab)}$	30.54^{A}
	35	42.80$^{(ab)}$	20.10$^{(a)}$	31.54^{A}
	50	43.93$^{(a)}$	20.31$^{(a)}$	32.12A
Mean		36.6^{A}	15.09^{B}	

The letters above the numbers show the comparison of means based on Duncan's test. Averages with common letters are statistically not significantly different from each other at the 1% probability level.

Himanshu Kaushik et al. (2013) reported that applying algae and nitrogen fertilizer to parsley flowers resulted in an increase in height in all treatments when compared to the control. Kartikian et al. (2009) found that using nutrient-rich substances increased the height of periwinkle plants relative to the control group. The preceding research is compatible with the current study's findings on the use of algae in the culture media and its effect on the height of the flower periwinkle. Dominican (2019) reported that treating the Naz Sobani flower with algae increased its height. According to Soumia et al. (2017), using algae increased the height of Mina grass. The maximum concentration was recorded by Jatnayaji and Anbazhgan (2009)

using brown algae. According to Vijayanand et al. (2014), while varying the brown algae concentration applied, the bean plants' height increases with the concentration. According to Selvam et al. (2013), when using algae on Vigna mungo, increasing the concentration of algae initially causes the stem to grow longer, but higher concentrations inhibit this effect. In Ramya et al. (2010)'s investigation into the impact of brown and green algae concentrations on guar plants, the plant's height initially grew as the concentration of algae increased, but at high concentrations, the plant's height declined. Our findings were consistent with earlier investigations on other plants (Crouch and Staden, 1993; Jothinayagi and Anbazhagan 2009; Sridhar and Rengasamy, 2010; Zodape et al., 2011; Paul and Yuraj, 2014; El-Alsayed et al., 2018; Sumangala et al., 2019; Velasco et al., 2020).

Table 2. Comparison of the average effect of green, red, and brown algae on the root length of Periwinkle (cm**)**

Supplement added to the soil	Percentage of algae	Normal periwinkle	Dwarf periwinkle	Means
		The length of the root of periwinkle flower (cm)		
	0	8.3 $^{(ef)}$	7.05 $^{(cd)}$	7.67 ^{EF}
Red algae	10	8.43 $^{(efd)}$	7.26 $^{(c)}$	7.85 ^{E}
	25	7.70 $^{(efg)}$	6.43 $^{(d)}$	7.06 ^{GF}
	35	7.13 $^{(fg)}$	6.35 $^{(de)}$	6.74 ^{GH}
	50	6.55 $^{(g)}$	5.66 $^{(e)}$	6.1 ^{H}
Brown algae	10	8.70 $^{(ecd)}$	7.36 $^{(c)}$	8.03 ^{ED}
	25	9.75 $^{(cd)}$	8.16 $^{(ab)}$	8.95 ^{C}
	35	11.76 $^{(b)}$	7.7 $^{(cab)}$	9.7 3^{B}
	50	9.9 $^{(c)}$	7.46 $^{(cb)}$	8.68 ^{CD}
Green algae	10	11.8 $^{(b)}$	8.17 $^{(ab)}$	9.98 ^{B}
	25	12.15 $^{(ab)}$	8.23 $^{(ab)}$	10.19 ^{AB}
	35	12.6 $^{(ab)}$	8.33 $^{(a)}$	10.46 ^{AB}
	50	13.16$^{(a)}$	8.43 $^{(a)}$	10.8 ^{A}
Mean		9.84^{A}	7.43 ^{B}	

The letters above the numbers show the comparison of means based on Duncan's test. Averages with common letters are statistically not significantly different from each other at the 1% probability level.

The results of the analysis of the average influence of algal levels on root length showed that the highest and lowest root length was observed in the periwinkle flowers grown in the substrate containing 50% green and red algae 10.80 cm and 6.1 cm, respectively. It was found that the length of the roots increased as the amount of green algae-containing substrate increased. The findings indicated an inverse connection between root length and red algae-containing substrate. In a substrate containing 35% brown algae, the maximum root length

(11.76 cm) of periwinkle flower was observed. In normal and low periwinkle, the highest root lengths, 13.16 and 8.43, were observed in the substrate containing 50% green algae, and the lowest root lengths were observed in the substrate containing 50% red algae, 6.55 and 5.66 cm, respectively. This flower exhibited the inverse link between red algae concentration and root length, as well as the direct relationship between green algae concentration and root depth. In normal and low Periwinkle, maximum root lengths of 11.76 and 8.16 cm were reported in substrates harboring brown algae at 35% and 25%, respectively. Periwinkle flowers produced in all concentrations of green algae and concentrations of 25, 35, and 50% of brown algae showed enhanced root length compared to the control (Table 2). Seaweed chemicals generate highly strong polar groups, causing soil masses to form and increasing soil aggregates and porosity, all of which promote root growth (Brownlee et al. 2012). Crouch and Staden (1993) and Hernandez-Herrera et al. (2014) reported that the application of different concentrations of algae in the tomato cultivation bed increases the length of the root of the plant. Our results corroborated previous studies on various plants (Erulan et al., 2009; Karthikeyan et al., 2009; Selvam et al., 2013; Prisa, 2019; Velasco-Ramirez et al., 2020).

Table 3. Comparison of the average effect of green, red, and brown algae on the number of leaves of Periwinkle flower

Supplement added to the soil	Percentage of algae	Normal periwinkle	Dwarf periwinkle	Means
		Number of Leaves		
	0	30 $^{(e)}$	30 $^{(cde)}$	30^{EF}
Red algae	10	32 $^{(cde)}$	31.33$^{(cde)}$	31.66^{CD}
	25	27.33$^{(e)}$	29.66 $^{(cde)}$)	28.5^{D}
	35	18.66 $^{(fg)}$	29$^{(f)}$	23.83^{E}
	50	18.5$^{(f)}$	27.33$^{(e)}$	22.91^{E}
Brown algae	10	32 $^{(cde)}$	32$^{(cdbe)}$	32^{CD}
	25	33.5$^{(cdeb)}$	33.66 $^{(cadbe)}$	33.58^{CB}
	35	35 $^{(cab)}$	32$^{(cadbe)}$	33.5 ^{CB}
	50	34.66 $^{(cdb)}$	30$^{(cde)}$	32.33 ^{CD}
Green algae	10	39.66$^{(ab)}$	36.50 (cadb)	38.08 ^{AB}
	25	38.5$^{(cab)}$	37 $^{(cab)}$	37.75 ^{CB}
	35	41.66 $^{(ab}$)	39.33$^{(ab)}$	40.5^{A}
	50	43.00$^{(a)}$	40.33$^{(a)}$	41.66^{A}
mean		32.65^{B}	32.93^{A}	

The letters above the numbers shows the compare of means based on Duncan's test. Averages with common letters are statistically not significantly different from each other at the 1% probability level.

The average effect of algae levels on the number of leaves was compared, with the highest number of leaves in periwinkle flowers grown in the substrate containing 50% green

algae (41.66 leaves) and the lowest number in the substrate containing 50% red algae (22.91 leaves). Naturally, it should be mentioned that periwinkle flowers grown in beds containing 35 and 50% red algae showed a significant decrease in the number of leaves compared to the control, and flowers grown in beds containing 10, 35, and 50% green algae showed a significant increase in leaves compared to the control, but the difference was observed in brown algae did not show significance compared to the control in the number of leaves. When periwinkle flowers were cultivated in red algal-containing substrate, the number of leaves fell as the concentration of algae grew, whereas in green algae-containing substrate, the number of leaves increased as the concentration of algae increased.

In the substrate containing brown algae for dwarf periwinkle, the highest number of leaves (33.66) was observed in the substrate containing 25% algae, and for normal periwinkle the highest number of leaves (35) was found in the substrate containing 35% algae.

The findings of the comparison of the average in the case of dwarf periwinkle revealed the largest number of leaves in the dwarf flowers produced in the substrate containing 50% green algae (40.33 leaves) and the lowest number of leaves in the substrate containing 50% red algae (27.33 leaves), and only The number of leaves in the beds containing 35 and 50% green algae was significantly different from the control, but no significant change was seen in any of the brown or red algae concentrations compared to the control. In a substrate containing red algae, the number of leaves declined as the concentration of algae grew, whereas in a substrate containing green algae, the number of leaves fell as the concentration of algae climbed from 10 to 25% and from 35 to 50%.

The findings of the comparison of the average in the case of normal periwinkle flowers revealed that the periwinkle flowers in the substrate containing 50% green and red algae had the highest and lowest number of leaves, 43 and 18.5, respectively. The number of leaves in periwinkle flowers grown in beds containing 10 and 50% red algae decreased significantly, whereas in beds containing 35% brown algae and all levels of green algae, the number of leaves increased significantly as compared to the control. Abou El-Yazied (2012) found that algae treatment resulted in the largest number of leaves in green bean cultivation on a substrate containing 10% algae. Our results corroborated with the previous studies on various plants (Safinaz and Ragaa, 2013; Prisa, 2019; Velasco-Ramirez et al., 2020).

Table 4. Comparison of the average effect of green, red, and brown algae on total weight of Periwinkle flower with wet basis

Supplement added to the soil	Percentage of algae	Normal periwinkle	Dwarf periwinkle	Mean
The total weight of periwinkle with wet basis (g)				
	0	$17.18^{(cdb)}$	$13.41^{(d)}$	15.29^{D}
Red algae	10	$17.67^{(cb)}$	$13.74^{(d)}$	15.71^{D}
	25	$16.68^{(cde)}$	$11.26^{(e}$	12.97^{E}
	35	$13.34^{(de)}$	$11.01^{(e)}$	12.17^{E}
	50	$12.76^{(e)}$	$9.66^{(e)}$	11.21^{E}
Brown algae	10	$17.62^{(cb)}$	$13.66^{(d)}$	15.64^{D}
	25	$18.29^{(cab)}$	$16.18^{(bc)}$	17.23^{CD}
	35	$20.62^{(ab)}$	$16.10^{(bc)}$	18.36^{CB}
	50	$19.05^{(ab)}$	$14.34^{(dc)}$	16.69^{CD}
Green algae	10	$20.80^{(ab)}$	$16.46^{(b)}$	18.63^{CAB}
	25	$21.08^{(ab)}$	$18.48^{(a)}$	19.78^{AB}
	35	$21.39^{(ab)}$	$19.05^{(a)}$	20.22^{AB}
	50	$21.94^{(a)a}$	$19.44^{(a)}$	20.69^{A}
Mean		18.18^{A}	$14^{B}83$	

The letters above the numbers show the comparison of means based on Duncan's test. Averages with common letters are statistically not significantly different from each other at the 1% probability level.

The comparison of the average effect of algae levels on Periwinkle flowers revealed that the highest and lowest weight with wet basis (WW) were obtained in periwinkle flowers growing in the substrate containing 50% green and red algae, 20.69 g and 11.21 g, respectively. The findings of the study of the influence of algae levels on the (WW) of the periwinkle plants revealed that the normal periwinkle plants produced in the substrate containing 50% green algae had the highest weight (21.94 g) and the lowest weight in the substrate containing 50% red algae (12.74 g). The (WW) of plants for dwarf periwinkle flower had a downward trend with increasing the concentration of red algae, and increasing the concentration of brown algae from 35% to 50% algae the (WW) of plants decreased. The highest and lowest (WW) of dwarf periwinkle 19.44, and 9.66 g, were found in a bed containing 50% green and red algae, respectively. It was also discovered that dwarf periwinkle in green algae have a significant difference of (WW) with the control. In the instance of brown algae, normal and dwarf periwinkle plants reached their maximum (WW) in substrates containing 35% and 25% algae, respectively (Table 4).

Table 5. Comparison of the average effect of green, red, and brown algae on total weight of Periwinkle flower with dry basis (WD)

Supplement added to the soil	Percentage of algae	Normal periwinkle	Dwarf periwinkle	Mean
The total weight of periwinkle with dry basis (WD)				
	0	$2.54^{(efd)}$	$2.05^{(d)}$	2.29^{ED}
Red algae	10	$2.76^{(ecd)}$	$2.10^{(d)}$	2.43^{CD}
	25	$2.12^{(egf)}$	$1.72^{(e)}$	1.92^{EF}
	35	$1.86^{(gf)}$	$1.68^{(e)}$	1.77^{F}
	50	$1.69^{(g)}$	$1.48^{(e)}$	1.58^{F}
Brown algae	10	$2.65^{(ecfd)}$	$2.09^{(d)}$	2.37^{CD}
	25	$3.02^{(cd)}$	$2.48^{(bc)}$	2.75^{C}
	35	$3.97^{(ab)}$	$2.46^{(bc)}$	3.22^{B}
	50	$3.37^{(cb)}$	$2.20^{(dc)}$	2.78^{C}
Green algae	10	$4.01^{(ab)}$	$2.52^{(b)}$	3.26^{B}
	25	$4.16^{(ab)}$	$2.83^{(a)}$	3.49^{AB}
	35	$4.26^{(a)}$	$2.92^{(a)}$	3.59^{AB}
	50	$4.46^{(a)}$	$2.97^{(a)}$	3.72^{A}
Mean		3.14^{A}	2.27^{B}	

The letters above the numbers show the comparison of means based on Duncan's test. Averages with common letters are statistically not significantly different from each other at the 1% probability level.

Results of comparison of the average effect of algae levels on Periwinkle plants defined that the highest and lowest weight with dry basis (WD) were determined in periwinkle plants growing in the substrate containing 50% green and red algae, 3.72 g and 1.58 g, respectively. The findings of the study of the influence of algae levels on the (WD) of the periwinkle plants showed that the normal's periwinkle plants produced in the substrate containing 50% green algae had the highest weight (4.46 g) and the lowest weight in the substrate containing 50% red algae (1.69 g). The (WD) of plants for dwarf periwinkle plants had a downward trend with increasing the concentration of red algae and increasing the concentration of brown algae from 35% to 50% algae the (WD) of plants decreased. The highest and lowest (WD) of dwarf periwinkle 2.97 g, and 1.48 g, were found in a substrate containing 50% green and 50% red algae, respectively. In a substrate containing 10% and 50% red algae the (WD) of dwarf periwinkle were 2.10 g and 1.48 g, respectively. For substrate containing 10% and 50% brown algae the (WD) of dwarf periwinkle were 2.65 g and 3.37, respectively. Results showed that the substrate containing 10% and 50% green algae the (WD) of dwarf periwinkle were 2.97 g and 2.52 g, respectively. It was also discovered that dwarf periwinkle green algae have a significant differense in (WD) from the control (Table 5).

Seaweed extract comprehensively improved growth of tomato plant root and shoot dry weight and increased plant yield productivity (Hussain et al., 2021).

Norrie and Keathley (2006), indicated that the weight and yield of Thompson Seedless grapes treated with Ascophyllum nodosum seaweed increased by 39% and 60.4%, respectively, compared with the control.

Aminifard et al., (2021) reported that the highest leaf dry weight of corn (0.092 g per plant) were obtained at 30 L ha^{-1} of algae extract, while the lowest amounts leaf dry weight (0.076 g per plant) and were gained in the control treatment. Basimfar et al., (2015) reported that the highest foliar biomass of mung bean was produced by 4 times seaweed spraying, using vermicompost treatment and Partoo variety with 6240 kg ha^{-1}, 5880 kg ha^{-1} and 5880 kg ha^{-1} respectively. According to their results, seaweed extract spraying increased the vegetative growth. Haider et al., (2012) concluded that application of seaweed extract after 30 + 60 days of planting of potato plant significantly increased plant growth and yield. Our results corroborated with the previous studies on various plants (Norrie and Keathley, 2006; Basimfar et al., 2015; Aminifard et al., 2021; Hussain et al., 2021).

Conclusion

In general, the use of green algae in both experiments (dwarf and normal periwinkle plants) increased the level of plant performance, and with increase in the amount of algae, the plant traits also increased. In dwarf periwinkle, the highest yield was observed in the substrate containing brown algae at a concentration of 25%, and with the increase in algae concentration, the upward trend was not observed in other characteristics of plants compared to lower concentrations of algae. This situation was observed in normal periwinkle in the substrate containing 35% algae, and when it increased to 50%, a decrease in traits was observed. In red algae, the best performance was recorded in the substrate containing 10% algae, and with the increase in algae concentration, a drop in performance was observed, and the best performance was obtained at the lowest concentration of algae. In the comparison between the three used algae, different concentrations of brown and green algae and 10% of red algae caused the growth of the measured traits. So that the best levels of brown algae, which was 25% to 35%, were equal to the level of 10% of green algae.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Contributions

The authors declare that they have contributed equally to the article.

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