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The Impact of Different Levels of Azocompost on Growth Medium Chemical Characteristics, Growth and Nutrition of *Zinnia elegans*

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Abstract

Excessive accumulation of azolla in the wetlands of Guilan is currently an environmental problem. To this aim, a study was conducted to investigate the effect of *Azolla* compost on the growth medium of *Zinnia* ornamental plant. The treatment was a sandy loam soil and Azolla compost was replaced with 10, 20, 30, 40 and 50% by volume. The research was performed based on a completely randomized design with three replications and 54 pots. The chemical properties of the substrate including electrical conductivity, acidity, nitrogen content and phosphorus and potassium levels were measured. Growth indices including fresh and dry weight of leaves, stems, roots and flowers, and leaf chlorophyll content were also measured. Nutrient concentrations of nitrogen, phosphorus and potassium in the leaves of zinnia plant were measured. The results showed that the highest growth rate was observed in 20 and 30 % treatments of *Azolla* compost and the lowest growth rate was observed in control treatments. *Azolla* compost increased the concentration of nitrogen, phosphorus and potassium in the leaves, which indicated an increase in the quality of plant nutrition. Higher amounts of compost (40 and 50%) reduced plant growth indices compared to 20 and 30% compost treatments, but in the same treatments, plant growth was significantly higher than the control. In general, it can be concluded that *Azolla* compost can be used as a suitable organic matter in zinnia medium.

Keywords: Anthocyanin, Nitrate, Peat moss, Poinsettia, Quality.

INTRODUCTION

Azolla compost (Azocompost) is a mixture of various organic materials, especially *Azolla*, which is prepared by microorganisms in a warm and humid environment with proper ventilation. Azolla is a water-floating plant native to Southeast Asia and Africa. The rapid spread of this plant around the world and its rapid growth and nitrogen fixation has attracted the attention of many researchers, so that *Azolla* has been studied as a biological or organic fertilizer in many countries. Its positive effects on crop growth have been proven (Lumpkin *et al*., 1987).

Zinnia elegans belongs to family Asteraceae (Ghasemi Ghahsareh and Kafi, 2009; Brenzel, 2012). Zinnia is an annual plant that is grown in greenhouses as one of the most popular drought and salinity tolerant cut flowers due to its economic value as well as its long flowering period (Carter and Grieve, 2010; Reilly, 1978). There are more than 20 species of this plant, but the most famous are *Zinnia elegans*, *Zinnia angustifiloa* and *Zinnia haagenna*. Due to the high growth of sesame, it takes 1.5 to 2 months from sowing to flowering. The heat of summer has not stopped its flowering and new flowers can be seen on it all the time. Thus, it flowers throughout the summer and half of autumn (Ghasemi Ghahsareh and Kafi, 2009).

Organic waste from agriculture and forestry is used in the cultivation of flowers and ornamental plants. These materials are used in composted form and do not contain substances harmful to plants and have the appropriate physical and often chemical properties (Ramezanzadeh *et al*., 2014). Optimal plant growth and continuous accessibility are the economic criteria for a commercial growing medium, in addition to maintaining good drainage water and free from toxins, pests and diseases (Higaki and Imamura, 1985).

The bark of broadleaf, coniferous, decayed leaf, sewage sludge, edible fungal compost, municipal waste compost, etc. are some of the items used as a culture medium (Chen *et al*., 1988; Fred *et al*., 1997; Scharpenseel and Kunth, 1985). Research on *Ficus benjamina* 'Starlight' in culture medium containing one part peat and one part olive waste showed that this plant had the highest height over a period of 10 months (Chen *et al*., 1988). The mixture of perlite and vermiculite of coconut fiber with peat substrate affected the growth and development of tomatoes. Seedlings planted in peat-vermiculite and peat-perlite substrates had higher root weight, stem diameter and leaf area (Jankauskien and Brazaity, 2008). Some studies have shown that organic wastes such as municipal wastes, sewage sludge, animal manure, paper and pruning wastes after composting can replace peat in the culture medium and have good results (Gayasinghe *et al*., 2010; Ashoorzadeh *et al*., 2016). Papafotiou *et al.* (2005) used olive waste compost as a substitute for peat to grow several ornamental plants.

Zaller (2007) investigated the effect of vermicompost on germination, yield and fruit quality of three tomato cultivars. The results of this study showed that vermicompost significantly accelerates germination. It promoted the growth and biomass of tomato seedlings and has the potential to be replaced by peat in potting soil. Also, the effect of vermicompost is different on different cultivars and fruit quality can be affected by vermicompost. Mahboub Khomami and Padasht Dehkaei (2009) using *Azolla* compost in combination with growth medium in *Ficus benjamina* concluded that *Azolla* compost can supply the nutritional needs of the plant during the growing season. In an experiment, the effect of using fresh and composted azolla on grain yield and nutrient uptake by rice alone or with urea fertilizer (120 kg) was investigated and increasing yield of rice was confirmed.

In stagnant waters with little available nitrogen, *Azolla* is superior to other floating plants due to its ability to fixed nitrogen in symbiosis with the green alga *Anabaena*. Unfortunately, *Azolla* is spread on the surface of wetlands and reservoirs in the region, but due to its richness in some nutrients, it is used as a green manure. *Azolla* has been used as a green manure at the International Rice Research Institute of the Philippines since the mid-1970s. Since peat resources in Iran are limited and foreign peat enters the country at a high cost, the possibility of using *Azolla* compost as a substrate and also a suitable alternative to peat seems necessary.

MATERIALS AND METHODS

The seeds were sown on April 10 in a mixture of sand and leaf-soil medium. After 10 days and the seedlings reached the two-leaf stage, the plants were transferred to the main substrate where the pot was treated according to the desired treatments. One seed was planted in each pot. It was the turn of watering and dissolving one day after being transferred to the main bed. F_2 seeds of zinnia plant were obtained from Green Sazan Institute.

Experimental design and treatments

In this study, treatments were applied in a randomized complete block design. Six treatments and each treatment in 3 replications and in each replication three pots, a total of 54 pots were used in the experiment (Table 1). The soil characteristics used in the design are shown in table 2. During the growing season, plant growth indices such as plant height, fresh weight and dry weight of shoots, root length, fresh weight and dry weight of flowers, flowering life were measured. *Azolla* compost was prepared from flower and ornamental plants research station in Lahijan County. *Azolla* compost was applied after passing through a 20 mm sieve.

Nutrient solution

Prior to the use of nutrient solution, the plant was kept in pots for one week, during which time two irrigations were carried out. After this stage, growth indices including height, cuttings diameter and number of leaves were measured. After measuring the mentioned traits, Omex fertilizer containing 7.8% nitrogen, 18% phosphorus and 18% potash was used to prepare the solution. To prepare this solution, four and a half grams of Omex powder dissolve in 9 liters of

Table 1. The used treatments and its compounds of every treatment.

Azocompost (%)	Medium compounds
0	100% Soil + 0% Azo compost
10	90% Soil + 10% Azo compost
20	80% Soil + 20% Azo compost
30	70% Soil + 30% Azo compost
40	60% Soil + 40% Azo compost
50	50% Soil + 50% Azo compost

Table 2. The physico-chemical characteristics of the used soil in experiment.

Soil characteristics	Amount
Sand (%)	58
Silt (%)	18
Clay (%)	24
EC (dS/m)	1.1
pH	6.2
Organic carbon (%)	2.8
Total nitrogen (%)	0.15
Available phosphorus (mg/kg)	31
Available potassium (mg/kg)	370

Table 3. The chemical properties of the used Azocompost in treatments.

Chemical properties	**Amount**
Total nitrogen (%)	5.25
Available phosphorus (mg/kg)	7.60
Available potassium (mg/kg)	1840
Organic carbon (%)	21.80
C/N ratio	4.10
pH (1:10 extraction)	5.31
EC (dS/m)	1.44

water (200 ml per pot) and add the resulting solution to the pots seven times a day (Chen *et al*., 1988). It should also be noted that the treatments without nutrient solution received 200 ml of water.

Chemical characteristics of growth medium

To measure phosphorus in growth media the method of Page *et al*. (1982) was used. In this extraction method, 0.005 mol of diethylenetetriamine-pentaacetic acid (DTPA) was used to chelate trace elements, bicarbonate to extract phosphorus and ammonium to extract potassium. Phosphorus was then read with a spectrophotometer at 880 nm. A flame photometer was used to measure potassium. The elements iron, zinc and manganese were read by atomic absorption spectrometry. To measure total nitrogen in the growth medium, the Kjeldal method or Kjltek device was used (Goos, 1995). Verdonck and Gabriels (1992) method was used to measure pH and EC in the growth media. According to this method, to measure the pH, 10 g of the substrate was mixed in a volume ratio of 1 to 10 (one part of the bed to 10 parts of distilled water) in Erlenmeyer and then the samples were placed on a shaker for 30 minutes. In the final step, extraction was filtered and measured by pH meter. EC measurements of media were made from the saturated extracts of the media with water at a suction of 10 cm using an EC meter.

Measurement of growth indices of zinnia

Traits such as leaf fresh and dry weight, stem fresh and dry weight, flower fresh and dry weight, root fresh and dry weight, number of leaves, nodes and lateral branches, plant height, final stem diameter and distance between nodes was measured. Stem and root length were measured with a ruler. Stem and flower diameters were measured with a digital caliper. The average flower diameter was obtained by measuring the flower diameter in two perpendicular directions. To measure dry weight, the plants were placed in the oven for 48 hours at 75 °C after collection from the greenhouse and bagging.

Measurement of nutrients in leaves

First, 0.3 g of the dried and grounded leaf sample transfered to a 50 mm balloon. Then add 20 ml of distilled water into the Erlenmeyer flask and add six grams of salicylic acid and 100 ml of sulfuric acid. The mixture was left overnight and the next day the sample was heated to 180 °C for one hour and after drying five drops of oxygenated water were added and this process was repeated and the heat was increased. Increase to 280 °C until water evaporates and white steam appears. This operation continues until the sample is discolored. After drying, increase the digestion balloons to a volume of 50 ml and shake until the material is completely dissolved, then pass them through filter paper and transfer to test tubes. (Emami, 1996). Potassium measurement was carried out by flame photometery. Murphy and Riley (1962) methods were used to measure phosphorus. In this method, heptamolybdate ammonium solution was first prepared. In the next step, 5 ml of the prepared extract was transferred into a 25 ml flask and then 5 ml of heptamolybdate ammonium was added to it and with distilled water, the balloon was brought to a volume of 25 ml. The amount of yellow light absorbed was read by Apel-PD-303UV spectrophotometer at 480 nm and the amount of phosphorus was calculated using the prepared calibration curve (standard solutions). Plant nitrogen was measurement by titration method after distillation by Kjeldahl system (Goos, 1995). Transfer 5 ml of the prepared extract into a distillation flask by pipette and add 2 ml of sodium hydroxide solution to it. Then, distillation was performed and the acid consumption was read from the port during the titration step.

Statistical calculations

The experiment was conducted in a completely randomized and factorial design with 10 treatments in three replications and three plants in each treatment. SPSS software and LSD test were used to evaluate the results of data related to growth factors and plant chemical decomposition in ESNA. Relevant charts were drawn using Excel.

RESULTS AND DISCUSSION

Nowadays, human and environmental damages resulting from the use of chemical compounds used agricultural products have been proven. Therefore, the need to use healthy compounds to maintain human health and the environment has become well known. In recent years, the use of natural compounds of plant origin and replacing them with chemical compounds has been considered (Kalemba and Kunica, 2003). Therefore, it is possible to produce plants with better quality and longer life by using organic materials and proper nutrition.

Chemical characteristics of growth media

The chemical properties of the substrate should be considered, as they have a great impact on plant quality. Chemical properties directly affect the solubility and availability of nutrients. The results of table 4 show that the amount of medium nitrogen has increased with increasing the amount of *Azolla* compost. The highest amount of medium nitrogen was observed in the treatment of 50% *Azolla* compost. The amount of nitrogen increased with the replacement of *Azolla* compost compared to the control. This increase is due to the large amount of total nitrogen in the *Azolla* compost compared to the soil (Tables 2 and 3). These results are according to Mohammadi Torkashvand *et al*. (2015). They reported an increase in nitrogen by adding peanut shelles compost to peat replacement in the pot medium of *Dracaena*. The highest amount of nitrogen was related to 50% *Azolla* compost bed and the lowest amount of nitrogen was related to control bed. Also, Mahboob Khomami and Padasht Dehkaei (2009) reported an increase in nitrogen in substrates containing 100 and 400 g of *Azolla* compost with an increase in replacement compared to the control.

Addition of *Azolla* compost increased the available phosphorus in the growth medium. The amount of potassium in the treatment of 50% *Azolla* compost was 1.87 times higher than the control treatment (without *Azolla* compost) according to Grigatti *et al.* (2008) and Mohammadi Torkashvand *et al*. (2015). Mohammadi Torkashvand *et al*. (2015) concluded that azolla compost significantly increases the potassium content of the substrate. In this study, the highest amount of potassium (2560 mg/kg) was related to 100% *Azolla* compost bed and the lowest amount of potassium (560 mg/kg) was related to control bed. The results showed that a significant amount of potassium in *Azolla* compost compared to peat with increasing replacement percentage. Consideration the available potassium of the substrate is proportional to its amount. The highest pH was related to 50% *Azolla* compost bed and the lowest value was related to control bed, which was determined by Mohammadi Torkashvand *et al*. (2015). The pH of the substrate increased with increasing replacement of Azolla compost. In general, increasing compost in the plant growth environment increases the pH. According to Abad *et al*. (2001), the appropriate pH for optimal growth was set at 3.5-6.3. The amount of EC in the medium increased proportional to the used *Azolla* compost. The highest pH was related to 50% *Azolla* compost bed and the lowest pH was related to control bed. The highest EC amount of 1.81 dS / m was observed in 50% *Azolla* compost bed and the lowest EC amount of 0.29 dS / m was observed in the control bed. The amount of EC in the growth medium was in the appropriate range for ornamental plants (1-3 dS/m). Therefore, EC of control bed, 10, 20, 30, 40 and 50% of *Azolla* compost was within the allowable range for growing ornamental plants. Grigatti *et al*. (2008) reported an increase in pH and EC by adding green waste compost in ratios of 25, 50, 75 and 100% by volume in peat replacement in ornamental plants.

Variance analysis of data

Analysis of variance (Tables 5-7) showed that different levels of compost had a significant effect on all indices of plant growth, chlorophyll, nitrogen, phosphorus and potassium.

The effect of treatments on growth indices

The effect of *Azolla* compost treatments on growth indices can be seen in tables 8-10. Comparison of mean data (Table 5) showed that the highest fresh leaf weight (19.53 g) was related to the treatment of 20% *Azolla* compost which was significantly different from the control treatment (7.02 g), but there was no significant difference in 30% treatment with 17.71 g. The lowest leaf dry weight (12.51 g) was related to the control treatment which was not significantly different from the 10% *Azolla* compost treatment. The trend of changes in leaf dry weight was the same as fresh leaf weight. In general, increasing *Azolla* compost up to 20% caused to increase fresh weight and then decreased leaf fresh weight by 30, 40 and 50%, but in any case they were significantly higher than the control. As mentioned in the introduction, in plants suitable for landscape, leaf weight and flower weight are important indices of plant growth.

Table 4. The chemical characteristics of the used growth media.

Treatment	Azo compost (%)	Total nitrogen (%)	Available phosphorus (mg/kg)	Available potassium (mg/kg)	pH(1:10)	EC(dS/m)
1	0	0.151	31.0	370	5.19	0.29
2	10	0.151	28.0	358	5.36	0.40
3	20	0.174	32.5	425	5.58	0.63
4	30	0.188	33.5	450	6.06	1.10
5	40	0.189	37.5	575	6.46	1.54
6	50	0.197	40.0	695	6.53	1.81

Table 5. The data analysis variance related to the effect of treatments on dry and fresh weight of leaf, stem and root.

S.o.V	df	MS					
		Leaf dry weight	Leaf fresh weight	Stem dry weight	Stem fresh weight	Root dry weight	Root fresh weight
Block	2	1.95*	1.88 ns	3.83**	1.78 ns	13.75**	2.88 ns
Treatment	5	2.60**	61.70**	7.06**	13.67**	15.23**	99.9**
Error	10	0.53	4.36	0.83	2.35	2.70	2.19
CV (%)	-	6.11	13.1	5.82	16.09	12.86	20.41

*, ** and ns: significant at $P < 0.05$, $P < 0.01$ and insignificant, respectively.

Table 6. The data analysis variance related to the effect of treatments on plant height, stem diameter, leaf number, nodes and lateral branches.

S.o.V	df	MS					
		Plant height	Stem diameter	Leaf number	Nodes number	Nodes distance	Lateral branches number
Block	2	52.5**	0.19 ns	245.7**	0.38 ns	0. 49**	0.13**
Treatment	5	26.5**	0.77**	1410**	1.44**	0.17**	32.5**
Error	10	4.33	0.13	88.5	0.29	0.058	1.11
CV (%)	-	4.28	6.51	12.83	6.53	8.14	22.95

*, ** and ns: significant at $P < 0.05$, $P < 0.01$ and insignificant, respectively.

Table 7. The data analysis variance related to the effect of treatments on dry and fresh weight of flower, chlorophyl and NPK concentrations.

S.o.V	df	MS					
		Flower fresh weight	Flower dry weight	Total chlorophyll	Nitrogen	Phosphorus	Potassium
Block	2	28.7 ns	62.69**	16.29*	0.092**	3757**	72.60 **
Treatment	5	32.87*	17.47**	48.01**	0.688**	7990**	401.0**
Error	10	9.83	2.92	3.25	0.002	85	1.18
CV (%)	-	23.89	8.42	8.92	4.67	22.07	3.45

*, ** and ns: significant at $P < 0.05$, $P < 0.01$ and insignificant, respectively.

According to the results of table 8, the highest fresh and dry weight of the stem is seen in the 20% treatment of *Azolla* compost, and a similar trend is seen for leaf weight. In the root weight index, the highest fresh and dry root weight was seen in the 30% *Azolla* compost treatment, although the 20% *Azolla* compost treatment also had a significant increase compared to the control. The results of table 9 show that the plant height in the treatment of 20% *Azolla* compost increased by 9.44 cm and significantly compared to the control. The same increase was seen for the number of nodes in the main branch. Although, the highest fresh and dry weight of leaves was seen in 20% treatment, so the highest number of leaves was seen in 50% treatment. Leaves were seen in large numbers in this treatment but with small size.

Increase in plant growth, especially height, is due to improved physical properties of the substrate and increased macroelements in plant growth, including nitrogen and potassium. Also, increasing the acidic pH of the substrate to neutral can be one of the reasons for improving plant growth. Shadanpur *et al*. (2011) by adding vermicompost to the growth medium containing peat-perlite, concluded that the plant growth indices, especially the size and weight of parsley, were significantly increased than the control medium (peat- perlite). Atiyeh *et al*. (2000) investigated the effect of cow manure vermicompost on the growth of tomatoes and parsley. According to them, the number of flowers and the diameter of the flowers decrease when the concentration of vermicompost reaches more than 40%. Chen *et al*. (1988) conducted a study on *Ficus benjamina* in a medium containing one part peat and one part olive waste, they observed that this plant had the highest height during a period of 10 months.

Table 8. The effect of Azocompost treatment on the fresh and dry weight of leaf, stem and root.

Azocompost (%)	Root dry weight (g)	Root fresh weight (g)	Stem dry weight (g)	Stem fresh weight (g)	Leaf dry weight (g)	Leaf fresh weight (g)
0	1.10 c	6.71 b	1.47 d	8.04 c	1.12 b	12.51 e
10	1.32 ab	6.85 b	1.51 bc	8.61 c	1.23 a	13.67 de
20	1.40 a	7.32 ab	1.72 a	11.43 a	1.24 a	19.53 a
30	1.42 a	8.62 a	1.61 b	10.43 a	1.21 a	17.71 ab
40	1.24 bc	7.43 ab	1.49 cd	9.41 bc	1.19 a	16.66 bc
50	1.17 bc	6.60 b	1.55 bd	9.22 bc	1.12 b	15.03 cd

Table 9. The effect of Azocompost treatment on the plant height, stem diameter, leaf number, nodes and lateral branches.

Azocompost (%)	Lateral branches number	Node distance (cm)	Node numbers	Leaf number	Stem diameter (mm)	Plant height (cm)
0	3.00 c	2.66 de	7.00 d	45.6 f	4.92 fg	41.0 h
10	4.33 abc	3.10 abc	8.33 ab	62.0 de	5.38 cdef	47.8 ef
20	4.66 abc	3.00 bcd	8.66 ab	61.0 def	5.38 cdef	49.4 bcde
30	5.33 a	2.70 cde	8.33 ab	89.3 ab	4.73 g	44.7 fg
40	5.33 a	3.23 ab	8.33 ab	87.6 ab	6.02 ab	48.2 de
50	5.00 a	2.76 cde	8.33 ab	94.3 a	5.75 abcd	47.5 ef

Verdonck and Gabriels (1992) using tobacco waste compost (nitrogen source) and pine bark to grow two leafy figs and ficus leafy plants concluded that the compost from 10% tobacco waste and 90% tree bark had a positive effect on the height of these plants. Gayasinghe *et al*. (2010) used animal manure (CMC) compost and synthetic compounds (SA) as peat substitutes in the growth of parsley ornamental plant which increased plant height, number of flowers per plant, fresh and dry weight of stem, root length, weight fresh and dry roots (in the combination of SA and CMC by 40% and 60%), and it was proposed as a suitable alternative for peat.

Rani and Srivastava (1997) found that the replacement of one-third or one-fourth of the added nitrogen of chemical fertilizers with vermicompost increased the height of the rice plant. Peyvast *et al*. (2008) investigated the effect of growth medium and vermicompost on the growth and yield of parsley (*Petroselinum crispum*) in different ratios. The results of this experiment showed that the addition of vermicompost to the soil increases the plant height. Mohammadi Torkashvand *et al*. (2015) by studying the effect of cow manure compost on the *Strelitzia reginae* showed that the highest growth was achieved with 45% compost. Mohammadi Torkashvand *et al*. (2015) used *Azolla* compost in combination with other organic materials in the growth medium of English daisy. In another study, the effect of rice stem compost and vermicompost on sorghum growth in greenhouse conditions was investigated. When compost and vermicompost were used at a rate of 2.5 tons per hectare, the buds length increased by 1 to 12% and when compost was used at a rate of 5 ton/ha, the length of the buds increased 32% higher than control plants (Hameeda *et al*., 2007). Walker and Bernal (2008) reported that the use of compost and organic fertilizers significantly increased the growth of beetroot shoots.

Table 10 shows the effect of *Azolla* compost treatments on fresh and dry weight of flowers and leaf chlorophyll content. All treatments of *Azolla* compost caused a significant increase in fresh weight of flowers compared to the control, so the highest increase in fresh weight of flowers was related to treatments of 30 to 50% compost, which was even significantly higher than the treatment of 20%. The trend of change in flower dry weight with fresh flower fresh weight is slightly different; while the highest flower dry weight was related to 30% treatment, flower dry weight in control was higher than 40 and 50% compost treatments. In all treatments of *Azolla* compost, the amount of total leaf chlorophyll was higher than the control and in higher amounts of compost (40 and 50%), the amount of chlorophyll was higher.

The effect of treatments on nutrient concentrations in leaves

According to the results of table 11, the amount of nitrogen of leaf increased significantly proportionalto the used Azocompost compared to the control. The same increase in leaf phosphorus and potassium is seen with increasing compost, but some treatments do not differ significantly. Comparison of the mean data related to the effect of different levels of *Azolla* compost on nutrient concentrations showed that there was an increasing trend in nutrient concentrations between treatments. Such a trend by Mohammadi Torkashvand *et al.* (2015) has been reported. By adding ratios of 0, 15, 30, 45 and 100% by volume of peanut shelles compost instead of peat, they reported a significant increase in the measured nutrients compared to the control. Mahboub Khomami and Padasht Dehkaei (2009) stated that the effect of compost on the growth of *Ficus benjamina* can be due to the similar role of growth regulators in the plant.

Table 10. The effect of Azocompost treatment on the fresh and dry weight of flower and total chlorophyll.

Azocompost (%)	Fresh weight of flower (g)	Dry weight of flower (g)	Total chlorophyll
0	10.28 c	2.03 b	17.7 h
10	12.19 bc	1.98 b	19.4 c
20	12.07 bc	2.03 b	17.6 d
30	15.25 a	2.29 a	21.0 bc
40	14.39 b	1.89 b	22.8 a
50	14.54 ab	1.94 b	22.5 ab

Table 11. The effect of Azocompost treatment on the NPK concentrations in leaves.

Azocompost (%)	Nitrogen (%)	Phosphorus (mg/kg)	Potassium (mg/kg)
0	0.026 d	0.66 f	0.079 c
10	0.032 d	0.71 e	0.126 b
20	0.028 c	0.89 d	0.127 b
30	0.030 b	1.00 d	0.163 a
40	0.030 b	1.16 b	0.147 ab
50	0.044 a	1.39 a	0.150 ab

Since the concentration of nutrients in plant organs is affected by factors such as plant growth rate, ionic competition and sediment, so sometimes it is not possible to use the concentration of elements in the plant as a reliable parameter in studying plant growth (Rahmani Khalili *et al*., 2020; Tashakori *et al*., 2020). Therefore, using the amount of nutrients uptake by the plant from the bed is a better parameter. Since the amount of uptake is obtained by multiplying the concentration of nutrients in the plant and the dry weight of the plant organs, the effect of dilution of nutrients is eliminated. The effect of dilution is due to plant growth and reduced concentration of elements in the plant due to the larger size of the plant (Tofighi Alikhani *et al*., 2021). It should be noted that the amount of nutrients in the plant indicates a qualitative characteristic and the favorable concentration of elements in the plant indicates the favorable conditions for plant nutrition and better plant growth (Poorghadir *et al*., 2021).

CONCLUSIONS

Based on the results, it was observed that increasing *Azolla* compost to soil in the groth medium led to an increase in height, number of leaves and plant growth compared to the control. In most growth indices, replacement of 20% and 30% *Azolla* compost had a better effect on plant growth. Nutrient concentrations as a qualitative indicator in compost treatments increased significantly compared to the control and this was due to the better quality of plants grown in substrates containing *Azolla* compost compared to the control. Increasing the level of *Azolla* compost by 40 and 50% of replacement compared to 20 and 30%, respectively, increased growth indices, less. According to the findings of this study, the following suggestions are presented: 1. To collect azolla from the surface of paddy fields and wetlands of Guilan and by converting to compost; this material as a cheap and available material as a substrate for cultivating ornamental plants. 2. Azo compost should be used in combination with other agricultural and industrial wastes. 3. The possibility of using *Azolla* compost in the culture medium of different cultivars of ornamental plants should be investigated.

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