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Original article

Effects of Additives Application to the Growth Media on Seedling Development

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Abstract

In some countries, which have the field of seedling production, it is very important to produce at an advanced level in vegetable cultivation. In Turkey, already traditional methods of seedling production are widely available. However, in recent times the use of soil conditioners has attracted considerable attention in organic and conventional breeding. Soil conditioners are divided into organic (such as straw-straw, compost, vegetable wastes, worm or poultry stew, plant extracts) or inorganic (such as perlite, sand, clay, vermiculite). In this context, studies on suitable environments and methods for growing seedlings are ongoing. In our study, lettuce, rocket, tomato and cabbage leaf extracts were applied in different combinations like liquid fertilizer. Number of leaves and shoots, leaf width, crown thickness, seedling height, chlorophyll measurement and presence of anthocyanins were determined from cauliflower, broccoli, parsley, cabbage and lettuce. The effects of these applications varied according to the species, and almost all applications were found to increase the measured parameters.

Keywords: Seedling production, Organic and inorganic soil additives, Plant–leaf extract.

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INTRODUCTION

When considering the exhaustion of the agricultural lands in Turkey in terms of both physical and microbiological activity, the loss of its productivity is the most important problem of agriculture. The use of dense chemical fertilizers and pesticides, erosion, salinity, deterioration of the soil texture, and loss of organic substance are the reasons for the deterioration of this feature. As the contribution of organic substances improves the soil structure and porosity, it also creates an ideal environment for plant structure. Together with the increase in agricultural production in the world and in Turkey, the amounts of both the vegetable harvest residues and the agricultural industrial wastes have increased from year to year. Such vegetable-origin wastes have an important potential in terms of the nutrients in their content besides being a serious organic substance source. These wastes are an important source of organic substance, especially for the soils of Turkey, which are poor in terms of organic substance. Additionally, today these wastes can be used as a plant cultivation media with the suitable mixtures of these wastes. Knowing the features of these wastes will be helpful in providing an increase in the success rate in agricultural production. These plant-based wastes are seen as an alternative for peat-moss, which is used at excessive amounts in the world and in Turkey and the reserves of which are being reduced, as a cultivation media and its useable possibilities of instead of turf have been investigated. It has been determined that the total yield of seedling vegetable production in Turkey is around 3.5 billion (Yanmaz et al., 2015). Seedling is preferred in production of both warm and cold-season vegetable species such as tomato, pepper, aubergine, leek, celery, cabbage, cauliflower, broccoli, lettuce and red beet. Additionally, transplanting is realized after seedling production in species such as summer zucchini, melon, cucumber, water melon, and green beans in forced crop and greenhouse growing. Starting production with seedlings save land, seed and energy and provide healthy and homogeneous production and earliness (Demir and Ozcoban, 2007). Seedling production has an important place in the production system of garden plants due to its effect on total yield.

Cultivation media plays a directly efficient role for germination, seedling emergence, seedling development and seedling quality. Easy germination, drainage of the excessive water in the soil and thus sufficient nutrient for the development and growth by supporting the root system of the seedling are provided with a good growth environment (Olaria et al., 2016). The growth media includes organic materials such as rice husk, vermi-compost, coconut fiber, tree husk, turf and compost, and inorganic materials such as perlite and vermiculite (Vaughn et al., 2011). The media obtained from organic materials are generally used for seedling and vegetable production in the greenhouses. Mineral soil and sand are actively used in vegetable cultivation (Olle et al., 2012), and are also preferred for tree seedling production (Sekepe et al., 2013). Growth environments support physically the plant with root development by providing air and water to soil (Olle et al., 2012). Organic media such as vermi-compost have been identified as the best media for encouraging seedling development (Arancon et al., 2008).

The aim of the study was to determine the effect of different plant extracts on seedlings growth of some vegetable species. Within the scope of this effect, the number of leaves, leaf blade width, root-crown thickness, seedling height, chlorophyll content and the presence of anthocyanin were determined.

Material and Methods

The study was conducted in the pots in the climate chamber of Usak University, Faculty of Agriculture and Natural Sciences in 2016. In the trial, leaf extracts of lettuce (*Lactuca sativa* L.) of Asteraceae family, garden rocket (*Eruca sativa* L.) and cabbage (*Brassica oleraceae* L.) of Brassicaceae family and tomato (*Lycopersicum esculentum* L.) of Solanaceae family were treated one week to seedlings of parsley (*Petroselinum crispum* L.) of Apiaceae family, cabbage (*Brassica oleraceae* L.var capitata), cauliflower (*Brassica oleracea* var. Botrytis), broccoli (*Brassica oleracea* var. Italica) and lettuce (*Lactuca sativa* L.) of Asteraceae family. These seedlings were supplied from the seedling company in 4-5 leaf periods. The trial was set with a total of 68 seedlings (including the control) including 4 seedlings from each plant species for each treatment as quadruplicate. Garden soil was used as plant cultivation media. These leaves for water extracts were the harvest residues of the species belonged (garden rocket, tomato, lettuce, cabbage). Leaves (without disease and harmful contamination) were kept at ambient temperature in tap water within 1 day and water extracts were obtained. These extracts and the pots were watered once a week. The measurements were taken 3 times every 21 days.

Table 1. Combination of treatments

Treatments	Species	Plant extracts
1	Parsley	Rucola
2	Cauliflower	Rucola Tomato
3	Broccoli	
4	Lettuce	Lettuce
5	Cabbage	Cabbage
6	Control	Tap water

Measurements

a) **Seedling lenght:** The distance from the root to the top leaf is determined by the ruler.

b) **Stem thickness:** were measured by digital calipers under the cotyledon leaves.

c) **Presence of anthocyanin in the leaves and stems*:*** The presence of anthocyanins is scored between 0 and 5.

d) **Leaf width:** Measurements were taken from two points on the widest part of true leaves.

e) **Number of leaves and shoots:** The true leaf and shoot number of the plant is determined.

f) **Chlorophyll content:** three of the leaflets were taken from the leaf in the 4th node of the three selected plants for each application will be measured with the chlorophyll meter 'Apogee-CCM-200 plus'.

Statistical analysis

The experiment was set up according to the experiment design of chance parcels. Data analysis was conducted using SPSS software. Duncan's multiple range test was used to determine statistical significance with $P \leq 0.05$ for each domesticated species.

Results and Discussion

When examining the effect of tomato, cabbage, and tomato leaf extracts, applied to cauliflower, cabbage, and broccoli, respectively on seedling height, root-crown thickness, and blade width; it was found that the highest increase was observed in cabbage. There was no significant effect on the leaf and the stem regarding the presence of anthocyanin. In chlorophyll measurement, all the treatments increased in species compared to control and the most effective increase was observed in cabbage (Table 2). The difference between the chlorophyll content of the seedlings treatment and control groups in all the three species was found to be statistically significant ($P \leq 0.05$).

Table 2. Results of cabbage, cauliflower and broccoli seedlings measurements

Species	**Measurement dates**	**Treatments**	**S.L. (cm)**	**C.T. (mm)**	**L. A.**	**S.A.**	**L.W. (mm)**	**C.M. (CCI)**
Cauliflower	08.11.2016	**Tomato**	5.8b	3.5a	1a	3a	24.6a	30.1a
	29.11.2016		5.7b	4.4a	3a	5a	25.1a	32.5a
	20.12.2016		9a	4.1a	3a	5a	33.2a	34.5a
Mean			**6.8**	**4**	**3**	**4**	**27.6**	**32.4**
Control	08.11.2016	**Tap water**	6a	2.6b	1a	2b	24.9a	18.0b
	29.11.2016		5a	4.3a	3a	5a	24.9a	31.8a
	20.12.2016		7a	4.4a	3a	5a	24.7a	30.8a
Mean			**6**	**3.7**	**3**	**4**	**24.5**	**24.7**
Significance			**ns**	**ns**	**ns**	**ns**	**ns**	*****
Cabbage	10.11.2016	**Cauliflower**	7.8a	3.1b	2a	3a	34.4b	22.3b
	30.11.2016		8.3a	4.2a	2a	4a	41.2a	29.2b
	20.12.2016		9.5a	4.4a	2a	5a	44.9a	67.8a
Mean			**8.5**	**3.9**	**2**	**4**	**40.2**	**39.8**
Control	08.11.2016	**Tap water**	7.8a	2.9s	2b	3a	32.2a	16.0b
	29.11.2016		7a	3.8a	4a	4a	35.0a	20.6b
	20.12.2016		8a	3.9a	4a	5a	30.4a	47.1a
Mean			**7.6**	**3.5**	**3**	**4**	**32.5**	**27.9**
Significance			**ns**	**ns**	**ns**	**ns**	*****	*****
Broccoli	08.11.2016	**Tomato**	8.2a	4.4a	1a	2a	30.3a	56.2b
	29.11.2016		8.3a	5.0a	3a	4a	31.3a	53.1ab
	30.12.2016		9.4a	4.8a	3a	4a	35.6a	66.4a
Mean			8.6	4.7	2	3	32.4	58.6
Control	08.11.2016	**Tap water**	8.0a	3.9a	1a	1a	30.1a	59.9a
	29.11.2016		8.2a	4.9a	5a	5a	30.9a	37.0b
	30.12.2016		8.5a	4.5a	5a	5a	37.5a	53.9a
Mean			**8.2**	**4.4**	**3**	**3**	**32.8**	**50.3**
Signifinace			**ns**	**ns**	**ns**	**ns**	**ns**	*****

S.L.: Seedling length, C.T.: Crown thickness, L.A.: Leaf anthocyanin, S.A.: Stem anthocyanin, L.W.: Leaf width, C.M.: Chlorophyll measurement; ns- non significant; * P≤0.05. Different letters in the same column show statistical significance (P ≤ 0.05)

Brassicaceae species covers a large part of garden plants having an economic importance in the world. The phenolic composition of this family has been an important research subject in the recent times and especially provides resistance against environmental conditions. Broccoli is an important source of phytochemicals containing essential minerals (Ca, Na, Mg, K, Zn, Fe, etc.), vitamins (C, A, B2 and K1) and phenolic antioxidants. Antioxidant capacity processed and phenolic compounds constitute important groups among the phytochemicals (Jahangir et al., 2009).

Table 3. Results of lettuce seedlings measurement

Species	**Measurement data**	**Treatments**	**Leaves number**	**C.T. (mm)**	**L.W.**	**C.M. (CCI)**
Lettuce	08.11.2016	**Lettuce**	5b	4.7b	40.6b	7.1a
	29.11.2016		8a	5.9a	38.2b	5.9a
	20.12.2016		10a	5.7a	54.7a	5.4b
Mean			**7.7**	**5.4**	**44.5**	**6.1**
Control	08.11.2016	**Tap water**	5b	5.1a	40.8a	8.4a
	29.11.2016		8a	5.5a	43.3a	3.0b
	20.12.2016		11a	5.8a	32.8b	2.9b
Mean			**8**	**5.5**	**38.9**	**4.8**
Signifcance			**ns**	**ns**	*****	*****

C.T.: Crown thickness, L.W.: Leaf width, C.M.: Chlorophyll measurement; ns- non significant; * P≤0.05. Different letters in the same column show statistical significance ($P \leq 0.05$)

Flavonoids are found in the fruit and leaf epidermis at high concentrations and have an important role as secondary metabolites and thus take place in the activities such as resistance to diseases, activation of the nitrogen-fixing nodules, pigmentation and UV protection (Pereira, 2009). The chemical structure of the anthocyanin manages the strength, color intensity and biological activity potential. The most common anthocyanins in Brassica products are pelargonidin, cyanidin, delphinidin, peonidin, petunidin, and malvidin (Moreno et al., 2010). Phenolic compounds undertake an attractive role for the insects performing pollination, seed distribution and transport. They are also natural protectors against pests and diseases by controlling plant hormones (Jahangir et al., 2009). The most positive effect of lettuce leaf extract treated to lettuce seedlings compared to control was observed in leaf blade width (approximately 4 cm) and chlorophyll content (approximately 2 CCI) (Table 3). The chlorophyll level in the control group significantly reduced compared to the treatment group. The difference between treatment and control groups in terms of blade width and chlorophyll content in lettuce seedlings was found to be statistically significant ($P \leq 0.05$).

Table 4. Results of parsley seedlings measurement.

Species	**Measurement data**	**Treatments**	**S.L. (cm)**	**C.T. (mm)**	**Shoot number**	**C.M. (CCI)**
Parsley	08.11.2016	**Rucola**	15.8a	3.9b	4a	7.4a
	29.11.2016		15.4a	4.9a	5a	5.5b
	20.12.2016		16.0a	5.7a	6a	4.7b
Mean			**15.7**	**4.9**	**5**	**5.9**
Control	08.11.2016	**Tap water**	17.1a	4.7a	2b	10.4a
	29.11.2016		17.3a	4.9a	5a	2.2b
	20.12.2016		17.8a	4.8a	5a	4.0b
Mean			**17.4**	**4.8**	**4**	**5.6**
Signifcance			**ns**	**ns**	**ns**	**ns**

S.L.: Seedling length, C.T.: Crown thickness, C.M.: Chlorophyll measurement; ns- non significant; * P≤0.05; Different letters in the same column show statistical significance (P ≤ 0.05)

The effect of the rocket leaf extract treated to the parsley seedlings on the seedling height, root-crown thickness, number of shoots and chlorophyll value could not be determined (Table 4). It was observed that the treatment decreased the height rise in the parsley seedlings compared to the control. No statistically significant difference was found between the treatment and control groups in the parsley seedlings in terms of measurements (P> 0.05)

Conclusions

In the last century, as the use of chemicals in agricultural production has exceeded the mean value, it becomes quite dangerous for living being and nature. As a result, the eco-friendly production techniques, which enhance the yield and quality of the seed or the seedling nowadays, and preserve the ecological balance, have begun to gain importance. The use of nutrients, antioxidants, organic and inorganic chemicals, and plant growth regulators is limited for the producer in both economic terms and in the area of use. In this trial, it was aimed to determine whether a difference in plant development can be created by using leaf extracts of organic solid environments rather than these environments in particular. According to the results, it was determined could be concluded that the extract treatment of the same species on the same species gave more positive results; whereas, the best result was obtained from cabbage among the species. The effects of these treatments varied according to the species, and almost all the treatments were found to increase compared to the control.

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