Research Article/Araştırma Makalesi

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MEDITERRANEAN AGRICULTURAL SCIENCES
(2019) 32(Special Issue): 79-84
DOI: 10.29136/mediterranean.558333

Effect of seedlings obtained from different growing media on tobacco growth and mineral nutrition

Farklı yetiştirme ortamlardan elde edilen fidelerin tütünün gelişimi ve besin elementi içeriklerine etkisi

Ayşegül SALUK, İbrahim ERDAL

Isparta University of Applied Sciences, Faculty of Agricultural Sciences and Technologies, Department of Soil Science and Plant Nutrition

Corresponding author (*Sorumlu yazar*): İ. Erdal, e-mail (*e-posta*): ibrahimerdal@isparta.edu.tr
Author(s) e-mail (*Yazar(lar) e-posta*): aysegulsaluk@hotmail.com

ARTICLE INFO

Received 12 March 2019
Received in revised form 19 April 2019
Accepted 26 April 2019

***Keywords*:**

Growth media
Seedling
Tobacco
Plant growth
Mineral nutrition

ABSTRACT

In this study it was aimed to investigate the effect of seedlings grown on different seedling growing media on growth and nutrient concentrations of tobacco plant. For this reason, study was carried out in two stages. At first stage, seedlings were growth in different growing media (manure, compost, turf and vermicompost) that were mixed with the soils at rate of 1/1 (volume/volume). At second stage, these seedlings were transferred to the pots containing 4 kg of soil under greenhouse condition and left for growth during 3 months. Seedling growth and nutrient concentrations varied with the seedling growing media. Also tobacco plant growth and mineral composition showed changes depending on seedling's origin. Results showed that the most favorable seedling growing media was found to be as manure + soil mixture.

MAKALE BİLGİSİ

Alınış tarihi 12 Mart 2019
Düzeltilme tarihi 19 Nisan 2019
Kabul tarihi 26 Nisan 2019

***Anahtar Kelimeler*:**

Fide
Fide ortamı
Mineral beslenme
Tütün
Verim

ÖZ

Bu çalışmada farklı ortamlarda yetiştirilen tütün fidelerinin tütünün gelişimi ve besin elementi içeriklerine etkisini incelemek amaçlanmıştır. Bu nedenle araştırma iki aşamalı olarak yürütülmüştür. Birinci aşamada farklı fide ortamlarının(ahır gübresi, kompost, torf ve vermikompost) toprak ile olan 1/1 (hacim/hacim) karışımından oluşan ortamlarda tütün fideleri yetiştirilmiştir. İkinci aşamada ise bu fideler sera koşullarında 4 kg toprak alan saksılara aktarılarak 3 ay süreyle gelişime bırakılmıştır. Elde edilen sonuçlar, fide gelişimi ve fidelerin mineral beslenme durumlarının, ortamlarının özelliğine göre değiştiği görülürken; fide ortamı ve fide özelliklerinin de asıl bitkinin verim ve mineral beslenmesini etkilediği saptanmıştır. Elde edilen sonuçlar en iyi fide ortamının ahır gübresi + toprak karışımı olduğunu göstermiştir.

1. Introduction

Tobacco cultivation is mostly carried out in two stages in the World. Because the seeds of tobacco are too small, they are not suitable direct cultivation in to the soil. For this reason, seedlings are grown at different seedling beds first, and then these are transferred to the soil. Obtaining well growth, healthy seedlings is important to get good yielded and quality tobacco cultivation. In Turkey, the most common tobacco seedling beds are made up of soil + manure mixtures at the rate of 1/1 by volume or soil + manure + sand mixtures at rates of 1/1/1 by volume. It is undisputed that seedling growth medium have an importance significance on good seedlings and thus good main plants. Manures are the basic and the first materials used as a soil amenders. There are many positive effects on the soil fertility with direct and indirect ways. Manures carry all the positive properties of organic matters improving soil physical and chemical properties. Manure, by improving soil physical chemical and biological properties of the soil, provides plants with favorable growing conditions. At the same time it is an important nutrient reservoir during plant growth, especially in terms of N, P and S.

Composted materials are the other common substrates for seedling media. There are many results that composts and vermicomposts can affect the mineral nutrition, growth and yield of wide range of plants under greenhouse or field conditions (Edwards 1998; Atiyeh et al. 2000; Agegnehu et al. 2015). Whether as soil conditioners or as a part of growing media for seedlings, composts and vermicomposts have improved seed germination, enhanced seedling growth, increased plant nutrient concentrations and increased overall plant productivity (Lazcano et al. 2009; Levinsh 2011).

Due to favorable physical properties and available nutrient contents, leading to better growing environment for plants, vermicompost are desirable materials (Edwards and Burrows 1988; Edwards 1988). Some researchers recorded that there had been some growth improving products such as hormone like substances, cytokinins, auxins, and humates produced with some microorganism and earthworms (Krishnamoorthy and Vajrabhiah 1986; Grappelli et al. 1987; Tomati et al. 1988; Atiyeh et al. 2002). Because of the high content of humic materials in the vermicomposts, they affect the plant growth as growth promoters or hormones when applied to the soil (Muscolo et al. 1999). They contain nutrients in forms that are readily taken up by the plants such as NO_3^-, exchangeable P, and soluble K, Ca and Mg (Orozco et al. 1996).

Turf is another substrate used widely as directly or as a part of growth medium for direct plant or seedling growth. Usage of turf as growing substrates especially for soilless cultivation under controlled conditions is very common. There are many studies mentioning the effect of turf on plant or seedling growth and quality. Most of the researches indicates that it has a positive effect and turf is a medium grade material when compared to other substrates (Çinkılıç 2008; Adak and Pekmezci 2011; Eren 2014). Also researches showed that characteristics and quality of turf strongly affect the effectiveness of turf on seedling and plant growth (Ece and Ulukan 2011). Plant uses their reserve nutrients as starter growth until their roots can absorbe nutrients from the media. Fort this, interior nutrient concentration is vitally important for a good start of a plant. In the literature it was well documented that plant growth are closely related to the seed quality and nutrient concentration (Ellis 1992; Rengel and Graham 1995; Milberg and Lamont 1997; Erdal et al. 2017). As in seed effect on plant growth and mineral nutrition, seedlings may have on tobacco growth, yield and mineral nutrition.

We aimed to investigate the effect of the different growing substrates on seedling and cultivar growth and mineral nutrition and we also aimed to examine the correlations among substrate, seedling and cultivar in terms of growth and mineral nutrition of tobacco plant.

2. Materials and Methods

2.1. Preparation of seedling beds and seedling growth

Manure (M) vermicompost (VC), compost (C) and turf (T) were used to prepare seedling media. Compost materials (VC and C) consisted of the mixture of open market wastes, rose- oil processing wastes, manure and straw mixtures at the rates of 20, 32, 35 and 8% (w/w). These growth media were mixed with the soil (S) at the rate of 1/1 (V/V) and 200, 100 and 100 mg kg^{-1} N, P, and K as ammonium nitrate, triple super phosphate and potassium sulphate were given as starter fertilization. Soil was used as control media. Seedling growth was made in viols under controlled conditions. Sowing was made on the first week of March at the rate of 4 g seeds m^{-2}. After two months later when the plants about 15 cm in length were pulled up for planting.

2.2. Planting of seedlings

Study was conducted under greenhouse conditions as pot experiment according to the randomized parcel design as 3 replications. Seedlings were planted on pots containing 3 kg soils and study was conducted 3 months. As basal fertilization, 300, 200 and 100 mg kg^{-1} N, P and K as ammonium nitrate, triple super phosphate and potassium sulphate were given to the soils before planting.

2.3. Soil and substrate analysis

To determine soil available nutrients, measurement of P extracted with NaHCO3 (Olsen 1954); K, Ca, and Mg extracted with NH_4AOC (Jackson 1967) and Mn, Zn, Fe, and Cu extracted with DTPA (Lindsay and Norvell 1969). Phosphorus measurement was performed using spectrophotometer; the others were measured with atomic absorption spectrophotometer. $CaCO_3$ content was determined with calcimeter (Allison and Moodie 1965), texture was measured by using hydrometer (Bouyoucos 1951), pH was measured in a soil with deionized water mixture (1:2.5, w/w) using a glass electrode (Peech 1965). Soil organic matter was determined according to Walkley and Black (1934).

2.4. Dry weight (DW) measurements

Seedlings were pulled out from the growing media after two mouths growing period. Then they were washed with top and pure waters and soils dried at 70^0C until constant weight. After three months later planting, plants were harvested above the soil surface. Leaf and stem were separated, washed, dried at 70^0C until constant weight and weighted.

2.5. Plant analysis

For N analysis, 0.5 g grounded sample was digested with 10 ml concentrated H_2SO_4 and 5 g of salt mixture in 250 ml macro-Kjeldahl tubes in at 350 - 400C^0. Then, samples were distilled with 40% NaOH for during 3 minutes. The ammonium N was fixed in H_3BO_3 (2%) and titrated with 0.1 N H_2SO_4.

In order to determine, P, K, Ca, Mg, Fe, Zn, Mn, and Fe, plant samples were wet digested with microwave digesting system. Phosphorus was determined calorimetrically using UV–Vis spectroscopy (UV-1601 PC Shimadzu Spectrophotometer) at 430 nm (Barton 1948). Other nutrients were measured with atomic absorption spectrophotometer (Jones et al. 1991). The same methods used for all plant materials.

2.6. Statistical analysis

All date were submitted for statistical analyses using MSTAT program for one way analysis of variance applied to determine any significant difference at 0.05%.

3. Results

3.1. Some soil properties and mineral composition of substrates

Some characteristics of the soil before the experiment used for both as a part of seedling media and pot experiment and total nutrient concentrations of substrates used for seedling media were given in Table 1 and Table 2, respectively. The soil was a clayey loamy, slightly alkaline, high in $CaCO_3$, low in organic matter. Soil nutrient concentrations, except Mn, were sufficient (Lindsay and Norwell 1969; FAO 1990).

Mineral composition of substrates varied with origin of the materials. Vermicompost had higher nutrient concentrations for most of the nutrients. Nutrient concentration of compost was close to vermicompost. Turf was the poorest material for all nutrients.

3.2. Dry weight and nutrient concentrations of seedlings

Seedling substrates significantly affected seedling DW and nutrient concentrations (Table 3). C+S and VC+S were the most effective media on DW of seedlings. On the contrary, M+S and T+S had lower effect on DW of seedlings. M+S seems to be more effective media on the seedling nutrient concentrations. Concentrations of P, K, Ca, Zn, Mn and Cu were higher in the seedlings grown on M+S. Seedlings obtained from VC+S had the highest N, Mg and Fe concentrations. Seedling which was prepared with turf and soil (T+S) was the lowest effective media on seedling nutrient concentrations.

3.3. Plant growth and leaf nutrient concentration of tobacco

Although steam + leaf dry weight did not vary with the seedlings origin, the highest value was measured from M+S originated seedling's plant. Leaf DW changed significantly with the seedling origin. The highest dry weight were obtained from the plants that were grown M+S originated seedling but VC+S and T+S showed the statistically similar effect on DW as M+S. Leaf mineral compositions of tobacco showed variations depending on the seedlings origin, generally. As a general statement, it can be said that leaf P, K, Mg concentrations of plant grown with the M+S, C+S and T+S originated seedlings were higher than VC+S and they took place in same statistical group. Leaf of tobacco grown with the VC+S, C+S and had higher Fe. The highest Zn was measured from the leaf of tobacco grown with T+S seedlings. C+S and T+S had higher and same effect on leaf Cu concentrations comparing other seedling origin. Effect of The Leaf N, Ca and Mn did not vary with the seedling origin (Table 4).

3.4. Nutrient uptake by means of leaves

Most of the nutrients removed with tobacco leaves from the soil significantly varied with the seedlings obtained from different media (Table 5). Leaves of tobacco growth with seedlings from M+S media removed the highest P, K, Ca, Mg and Mn from the soil when compared to others. Although, N removal by leaves of M+S plants was not the highest, removal of N took place with same statistical group with C+S and T+S. Leaves of plants growth with the T+S seedlings removed the highest Fe, Zn and Cu from the soil.

4. Conclusion

Nutrient concentration of compost was close to vermicompost. This was because of the same originated material with vermicompost (Erdal et al. 2018). Looking at the results of substrate and seedlings mineral compositions it can be said that substrate nutrient concentrations effected seedling nutrient concentrations, generally. Looking at nutrient concentrations of seedling, it is seen that for most nutrients, seedlings had higher nutrients that were grown higher nutrient containing substrates. Correlations for Mg, Fe and Cu can be given as example for this (Fig. 1). Also, these can be seen clearly from the seedlings grown in turf containing substrate. These seedlings have the lowest mineral concentrations in terms of most nutrients. These may be due to the effects of growth media nutrient concentration on seedling nutrient composition (Piya et al. 2018). Also plant growth was effected from the growing media composition (Brohi et al. 1995; Akın 2009;

Table 1. Some characteristics of the soil used for seedling media and pot experiment.

OM (%)	$CaCO_3$ (%)	Texture	EC (µS)	pH	P	K	Ca	Mg (mg kg^{-1})	Fe	Zn	Mn	Cu
1.1	18.5	CL	226	8.1	13.6	1154	6844	374	3.1	1.4	12.2	0.94

Table 2. Total nutrient concentrations of the substrates used for seedling media.

Substrates	N	P	K (%)	Ca	Mg	Fe	Zn (mg kg^{-1})	Mn	Cu
Manure	1.30	0.29	1.32	1.42	0.57	1264	113	111	31.7
Vermicompost	1.87	0.80	0.97	3.80	0.79	5585	166	352	30
Compost	1.73	0.47	0.91	2.66	0.49	2114	110	239	28.5
Turf	0.50	0.07	0.16	0.79	0.25	356	13	30	9.5

Table 3. Effect of seedling media on dry weight and nutrient concentrations of seedlings.

Property	Seedling media			
	M+S	VC+S	C+S	T+S
DW (g $plant^{-1}$)	1.27 C*	2.20 AB	2.65 A	1.76 BC
N (%)	2.21 B	3.11 A	2.37 B	1.38 C
P (%)	0.55 A	0.46 B	0.45 B	0.29 C
K (%)	3.73 A	2.35 B	2.28 B	2.33 B
Ca (%)	2.51 A	1.77 BC	1.81 BC	1.52 C
Mg (%)	0.43 B	0.58 A	0.47 B	0.23 C
Fe (mg kg^{-1})	124 B	169 A	110 C	77 D
Zn (mg kg^{-1})	107 A	56 B	110 A	35 B
Mn (mg kg^{-1})	160 A	81 C	104 B	61 C
Cu (mg kg^{-1})	33.5 A	15.0 C	19.4 B	13.0 C

*Values followed by the same letters, within rows, are not significant ($p<0.05$).

Table 4. Dry weight and leaf nutrient concentrations of tobacco originated from the seedlings obtained from different seedling media.

Property	Seedling origin			
	M+S	VC+S	C+S	T+S
DW (Stem + leaf, g plant^{-1})	40.6	37.0	35.2	39.3
DW (Leaf, g plant^{-1})	19.9 A	17.1 AB	16.3 B	17.6 AB
N (%)	1.97	1.94	2.50	2.22
P (%)	0.16 A*	0.12 B	0.15 AB	0.15 AB
K (%)	2.35 AB	1.83 B	2.56 A	2.29 AB
Ca (%)	3.36 A	3.47 A	3.18 AB	2.95 B
Mg (%)	0.21 A	0.17 C	0.20 AB	0.18 ABC
Fe (mg kg^{-1})	127 C	152 A	142 AB	154 A
Zn (mg kg^{-1})	48 B	48 B	52 B	60 A
Mn (mg kg^{-1})	126	132	139	137
Cu (mg kg^{-1})	10.4 B	10.0 B	16.0 A	16.0 A

*Values followed by the same letters, within rows, are not significant ($p<0.05$).

Table 5. Leaf nutrient removal of tobacco originated from the seedlings obtained from different seedling media.

Nutrient removal (mg plant^{-1})	Seedling media			
	M+S	VC+S	C+S	T+S
N	390 A*	330 B	410 A	390 A
P	32 A	20.5 C	25 B	26 B
K	467 A	313 C	417 B	403 B
Ca	670 A	590 B	520 C	520 C
Mg	42 A	28 C	33 B	32 B
Fe	2.52	2.59	2.31	2.71
Zn	0.96	0.82	0.85	1.06
Mn	2.51	2.26	2.27	2.41
Cu	0.21 B	0.17 C	0.26 A	0.28 A

*Values followed by the same letters, within rows, are not significant ($p<0.05$).

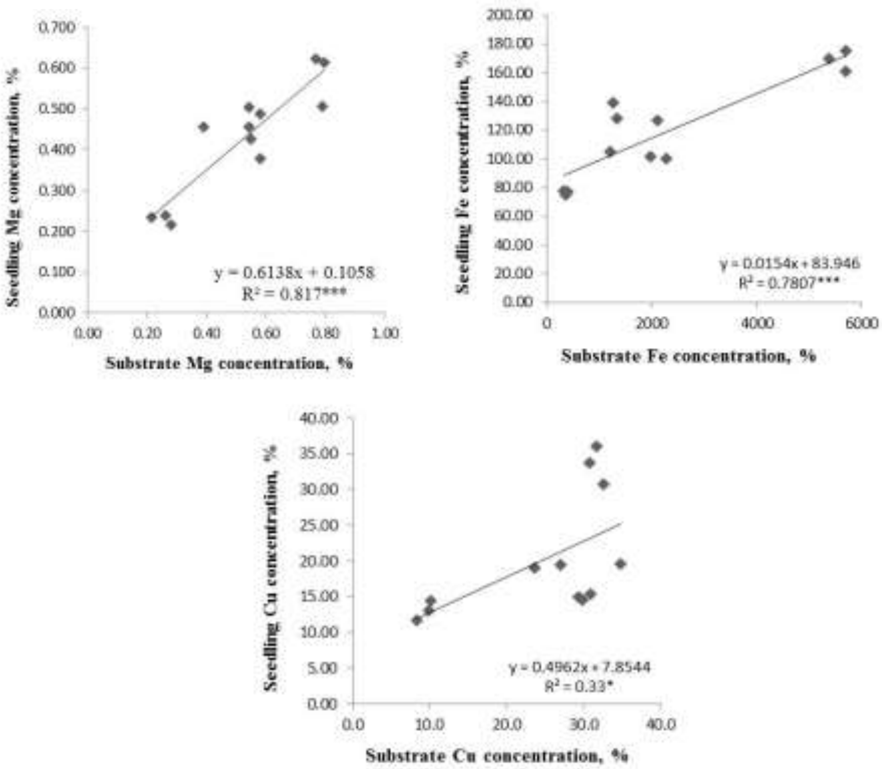

Figure 1. Correlations between substrate and seedling Mg, Fe and Cu concentrations.

Emre 2014; Neto et al. 2018). Composted materilas (C and VC) gave the best results on seedling growth. This may be due to their promoting effects on plants because they had several phytohormones, enzymes etc (Nada et al. 2011; Manh 2014; Ahirwar and Hussain 2015; Ravindran et al. 2017).

Plant nutrient concentrations were higher that were grown with higher nutrient containing seedlings, at least for some nutrients. This is may be explained with the explanations by Rengel and Graham (1995), Milberg and Lamont (1997), Hojjat (2011) and Erdal et al. (2017) for seed and plant relation. But for some nutrients we saw negative or no relation between seedling and plant nutrient concentrations. We can explain these with dilution or concentration effect related to leaf dry weight (Jarrell and Beverly 1981). In order to minimize dilution or concentration effect, we calculated nutrient uptake by leaves. An interesting finding we observed is that although seedlings grown on M+S media had the lowest dry weight, plants that were grown from these seedlings had the highest dry weights. Higher nutrient concentrations of these seedlings might have been boosted plant growth for the next of the life. By looking these results, M+S was the most effective seedling media for better nutrient uptake and plant growth (Raghav and Kasera 2012)

As conclusion, seedling media composition had significant effects on growth and mineral nutrition of tobacco seedlings. Among the seedling substrates, seedling media composed of manure (M+S) was more favorable than others for most parameters.

Acknowledgement

Study was supported by SDU, BAP (4020-YL1-14).

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