

Evaluation of Some Growth Media Mixtures for Tomato Transplants Production

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ABSTRACT

The seedlings growth media plays a very important role in factory seedling cultivation. High quality growth media could provide healthy and high-quality seedlings for high yield of vegetable crops. This study has attempted to use some agricultural organic wastes and mineral substrates, with different ratios, as growth media mixtures. To select the best growth media, which are suitable for the growth of tomato seedlings (*Solanum lycopersicum*). Eighteen different (growth media) mixtures were prepared from mineral fraction (sand and vermiculite) and agricultural organic wastes (palm seeds, rice straw and coffee grounds) then compared. Seven growth media mixtures were selected based on the best growth performance of tomato seedlings. The experiment was arranged in a completely randomized design with 7 treatments and 3 replications with 5 observations per treatment. After the seedlings growth period, seedlings were harvested to determine the effect of the growth media mixtures on the different growth parameters (plant dry matter and leaf area) and (percentage of seedlings, fresh weight and chlorophyll content). The highest seed emergency rate was achieved with T 13, T14 and T 15 mixtures and the next ones were obtained with T2 mixture. The emergency rates of all treatments were higher than control, and the lowest one was control. The results showed that SPAD value (leaf chlorophyll content) of T2 and T15 mixture was biggest for 47.18 and 46.2 followed insignificantly by T 5, T13 and T4, which were 45.2, 43.55 and 41.96 and value for control was smallest which was 38.33 without significant difference than T 13, T14 and T4. It could be generally noticed that for fresh weight and leaf area characters, mixture of T15 (the commercial media with an addition 15% of date palm seed ground) had the highest values of plant growth and exceeded the rest of the formulas followed by a mixture of T13 with a significant difference. Concerning dry matter content the results indicated that T4, T5 and T2 of growth media mixtures achieved the highest values 11.78, 11.53 and 11.32 % for dry matter without significant difference. On the other hand, the control media mixture gave the lowest value of dry matter of the tomato transplants.

Key words: Tomato seedlings, growth media mixtures, chlorophyll, organic matter, leaf area, seedling %, fresh weight, date palm seeds, rice straw, coffee ground, vermiculite.

INTRODUCTION

Tomato (*Solanum lycopersicum*) from family solanaceae is a popular cultivated vegetable crop in the world. It has a high nutritive value and a good source of vitamins (A, C, E), calcium, niacin and minerals (Olaniyi et al., 2010). The most commercial and economical method to cultivate tomato crop worldwide is by transplanting. A transplant can be defined as a seedling or sprouted vegetative propagation material grown in growth media or in the field, for transfer to the final cropping site. Strong transplants production is one of the most important steps in tomato production, which is an effective way in terms of their time production, quality, and stable vegetable seedlings (Ge et al., 2012).

An eligible growth media must provide a secure growth substrate, enough nutrients and water, and permit oxygen absorbed by the roots as well as gas exchange freely through the growth media mixtures (Tam and Wang, 2015). Growth media mixture should have the basic properties such as proper drainage, water holding capacity, and right cation exchange capacity well as a lack of weed seeds, pests and diseases and other harmful materials (Gauar et al., 1990; Mitchell et al., 1991). They should preferably have organic sources which are more easily returned to nature and be relatively inexpensive or available to reduce production costs (Delshad et al., 2011). Finally, if possible, they should be by-products of other industries or agricultural production systems which are produced and their cycling can decrease costs or help in environmental sustainability. A good growing media provides sufficient anchorage or support to the plant, serves as a reservoir for nutrients and water, allows oxygen to diffuse to the roots and permits gaseous exchange between the roots and growth media.

However, different growth media have various materials and structure which could have direct and/or indirect effects on plant growth and development. These growing media can be composed of one material or mixtures of several materials such as peat and perlite, coir and clay, peat, coconut fiber, rice straw, vermiculite and compost (Gutierrez et al. 2012). The

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main goal of mixing materials in specific proportions is to eliminate the problems that may arise by combining the superior properties of materials. For example, the water-holding capacity can be increased by using inorganic and organic media at certain ratios which eliminate problems related to nutrition (Albaho et al. 2009; Johnson 2010; Gutierrez et al. 2012).

Nursery producers know that the better the growth media, the better the transplants, and this assumption is confirmed by the scientific literature (Cantliffe 1993; Leskovar and Stoffella 1995; Gruda and Schnitzler 2004; Paul and Metzger 2005; Hasandokht and Nosrati 2010; Kubota et al. 2012). Nurseries use various growing media in the production of transplants, and the quality of growth media may also be defined in terms of its feasibility for the intended use and according to the climatic condition of the production area (Hasandokht and Nosrati 2010; Schmilewski 2009). For this reason, a wide number of chemical, physical, biological, and economic characteristics of the constituents must be considered when developing media formulations (Schmilewski 2009).

A successful growth media must perform under practical conditions and constraints equal or better as a commercially available standard to be accepted by growers. They suggested that any new material should be tested in a commercial context before conducting detailed studies on the performance of Barrett et al. (2016). The testing of different kinds of agro-industrial by-products, to obtain alternative materials and fertilizers for agricultural productions, were investigated by several researchers (Antón et al., 2012; Gruda., 2009; Padem et al., 1994)

Using waste material and plant remains in commercial transplants production has the benefits of reducing negative impacts on the environment for uncontrolled harvesting of peat, the accumulation of waste and has economic advantages of lower cost compared to other common growth media (Youssefian et al., 2009). Therefore, exploration of the localized formula for matrix with easily taken material and low price has received widespread attention at home and abroad Jeong 2001, Hummel et al. 2000 and Lugtvander 1996. Studies showed that solid wastes from agricultural farming and breeding industry could be used as high value-added matrix and formulated as composite substrates which achieved certain physicochemical property standards to replace coir and peat and to be used for vegetables' tray seedling cultivation. Many studies also showed that some materials, such as cottonseed hull, saw dust, carbonized rice hull, a sugar residue, sludge and waste material, etc., could be used for matrix of seedling cultivation Lin et al. 2011, and Jrufus et al. 1980. Consequently, alternatives to high

quality and low-cost growing media to peat are needed in horticulture soon (Abad et al., 2001). A major factor that might help to solve these problems is the possibility of using different substrate materials, locally available and less costly than those imported, with no pollution limitations, but with adequate physical and chemical properties.

The purpose of this study was to examine responses of the tomato seeds emergency, seedlings growth, that grown in different transplanting growth media with using different mat, such as peatmoss, vermiculite, rice straw, date palm seed ground and coffee ground under greenhouse conditions.

MATERIAL AND METHODS

This experiment was carried out in the green house at the department of Soil and Water Sciences department, the Faculty of Agriculture, Alexandria University, Egypt.

Tomato seeds:

Tomato Seeds (*Solanum lycopersicum*) variety of (Shifa - GS558, Syngenta Company) were used in this study.

Growth media materials

At the beginning of the experiment, raw materials required to form the growth media for tomato seedlings were collected from different sources. Vermiculite, peatmoss were purchased from the commercial market and sand was collected from El-Bostan area. Moreover, rice straw was collected from the farm of the faculty of agriculture, Alexandria University, and then cleaned, air dried and crushed into small pieces. The coffee ground was collected from the coffee shop in Alexandria, Egypt. While, date seeds were purchased from date palm factory at Cairo, Egypt. Then seeds were grounded and packed in bags.

Characteristics of the growth media materials:

In order to determination of characteristics the chemical properties of growth media materials, their distilled water extracts were prepared at ratio of 10:1 with of water and dry material shaken for 30 minutes. Electric conductivity (EC) and pH were measured in the extract according to Page (1982). Organic matter content (O.M %) was determined according to Wakly Black Method (Black, et al., 1989), available potassium with ammonium acetate method and available phosphorous using the Olsen method with a spectrophotometer at 450 nm wavelength (Black et al., 1989). The result of the chemical analysis of substrates are shown in Table 1.

Table 1. Analysis of the materials used in the research

properties	Substrates				
	Peatmoss (PM)	Vermiculite (V)	Coffee Ground (CG)	Rice Straw (RS)	Date Seeds Ground (DSG)
Ph	7.33	6.86	5.52	6.09	5.09
EC (dS/m)	0.6	0.6	1.46	7.57	1.43
Na + (meq/l)	2.8	1.47	10.43	0.09	6.95
K+ (meq/l)	1.4	0.35	12.00	0.18	8.20
Ca ²⁺ (meq/l)	2.0	3.50	1.50	3.0	5.00
Mg ²⁺ (meq/l)	1.5	2.50	--	1.4	1.0
C %	7.7	0.10	33.6	35.00	28.8
OM %	13.3	0.17	57.9	60.30	49.6
N %	0.6	0.42	2.80	1.47	2.1
C/N ratio	22.1	0.23	12.00	23.8	13.71
T P %	0.05	0.03	0.1	0.08	0.10
T K %	0.12	0.09	0.53	2.50	0.44
Fe ppm		351.60	139.94	147.80	103.32
Mn ppm		33.71	44.66	100.39	26.12
Cu ppm		23.70	26.72	17.74	26.33
Zn ppm		31.44	13.27	24.94	52.79
Ni ppm		Nd	nd	nd	nd

Screening, Selection and Composition of Growth Media:

At the beginning of the experiment, initial screenings for eighteen combinations on a weight basis were prepared. A visual selection of the best media was done after three weeks from cultivation based on the seed emergency and observations on the appearance and general performance of the tomato seedlings.

The suggested combinations and the percentage of each substrate are as shown in table 2. The growth

media include different combinations of one mineral component sand (S) or vermiculite (V) and /or three organic components rice straw (RS), coffee grounds (CG), and date palm seeds ground (DPSG) at different ratios on a weight basis compared to the traditional media (TM, enriched peat moss) as a Control treatment (C) (peatmoss : vermiculite 1:1) .

Table2. Percentage of components used in preparing the treatments (%)

No of treat.	composite	S	V	RS	CG	DPSG	TM
1	C	0	0	0	0	0	100
2	A2	0	30	10	10	50	0
3	A4	50	0	2	5	43	0
4	A5	30	0	10	10	50	0
5	A13	0	0	40	10	50	0
6	A14	0	0	33.3	33.3	33.3	0
7	A15	0	0	0	0	15	85

S=Sand, V= vermiculite, RS= rice straw, DPSG= date palm seeds, TM= traditional media and C=Control treatment (peatmoss: vermiculite 1:1).

Experimental Design:

Greenhouse study was conducted in winter of 2019 to evaluate the suitability and efficiency of new growth media for growing the tomato seedlings and compare them to commercial media. A randomized complete block design and seven treatments were carried out with three replicates and five measurements per replication were practiced.

Tomato Seed Emergence:

In the greenhouse, the seeds were sowed in Styrofoam seed trays (38cm wide*66cm length*7 cm depth) consist of 209 cells (2*2 cm) which were filled with different the growth media treatments, then one tomato seed was planted in each cell Seed Trays are irrigated with tap water then covered with black plastic sheet for one week. Seed trays were randomly distributed within the experiment and rotated once a week until the end of the experiment. The seedlings were irrigated with distilled water equally for all treatments according to their demand for water. The nutrient solution was prepared and used during the transplants growth period. Throughout the growth period of tomato transplants all general practices such as the irrigation rate, temperature, humidity, pest control as well as spraying with fertilizers or protection for all treatments were similar. The average temperature of day and night was 20 and 15 °C respectively.

Measured Characters of Tomato transplant:

After 45 days after sowing seeds, the tomato plants reached the size of commercial transplants, 20 transplants were selected randomly from 20 cells per plug tray. In this experiment, the emergence seed emergence percentage, fresh weight, Dry weight, chlorophyll content, and leaf area characters were determined as the indicators to the effectiveness of the composites as a growing media.

Seed emergence: was measured after ten days from cultivation.

Measurement of biomass:

The transplant fresh and dry weights were measured and after 45 days from sowing seeds The fresh weight of the whole transplant was measured with an analytical balance. Then the transplants were dried at 105 °C in an oven for 5 min and then further dehydrated at 70 °C for 48h to complete dryness and dry matter was measured.

Chlorophyll content:

The LEAF Chlorophyll meter was used in this experiment to measure the leaf chlorophyll content. Plant relative chlorophyll concentration is measured by inserting Green leaves of up to 0.1 inch (3mm) thickness of the plant into the device aperture.

Leaf area:

The leaf area was measured in fresh five transplants samples that collected from each treatment at the end of the experiment by using the AutoCAD 2012. It is a new leaf area determination methods using digital photographs processed in Computer Aided Design (CAD) software. (Rico - Garcia, et. al. 2009).

Statistical analysis:

All Data were analysed by SAS software. The analysis of variance and Duncan multiple range tests were used to find significant differences in the means at 5% Level, and graphs were drawn with Excel software.

RESULTS AND DISCUSSION**Chemical properties of selected nursery growth media mixtures**

Through comparison on the effects of seedling cultivation for tested tomato, growth media mixtures of T15 and T13 were regarded as a potential matrix for seedling cultivation of tomato and vegetables, so it was necessary to test their physicochemical property. Seen from Table 2, pH value of the matrix is an important parameter, and appropriate range was generally from 5.8 to 7.0 under acidic condition Cheng, 2006. Coffee ground and date palm presented weakly alkaline which could be an important factor in nutrient uptake especially micronutrients. Total nitrogen and phosphorus contents were high in Coffee ground and date palm. However, content of total potassium was over two times in rice straw. Carbon content of rice straw, coffee ground and date palm seed ground were higher. In addition, Ec value is an index to reflect the content of matrix's soluble salt. Studies showed that, secure Ec value for crop's growth should be ~2.6 mS/cm, most appropriate value was 2.0 mS/cm Cheng et al. 2001. Seen from table 2, Ec value of rice straw was four times higher than CK, but within the appropriate range.

In general, adding a substrate increased the water holding capacity value (by weight) of the growth media mixture. The vermiculite also increased the capacity to hold moisture, Samiei et al. (2005), Verdonck and Demeyer (2004) stated that the use of coarse perlite due to the high pore space (57.7 %) causes nutrient losses and therefore should receive less nutrient solution and can be watered more frequently (Pete and Willits, 1995). The highest percentage of pore volume obtained for perlite is higher than the values reported by Verdonck and Demeyer (2004). This is probably due to differences in particle size, the percentage of content in the growth media or the nature of certain organic components.

Samiei et al. (2005) reported the CEC of beds prepared with cocopeat; peat moss; palm peat and bagasse were 120, 165, 96 and 64 meq/100g, respectively. Khalighi and Padasht (2000) reported a 87 meq/100g cation exchange capacity for the tree bark bed. High levels of phosphorus in treatment 11 can be due to the bagasse and the higher CEC of this component.

Tomato seed Emergency percentage of different growth media formulas

The emergency rate of all treatment were higher than control, and the lowest one (58.18%) was achieved of the control growth media for (Fig.,1). Where at the tenth day after sowing, tomato seeds, all growth media formulas exceeded 70% of emergency rates (Fig.,1). The Highest emergency rates were achieved with T 13, T14 and T15 growth media formulas, which were exceeded 72.7%, and the next ones and then next ones was obtained with T2 of growth media formula 69.09% with a significant difference. The fact that the emergency of seedlings that were grown on organic growth media was higher than in the other growth media could be attributed to the higher growth media temperature that recorded, on average by 1.6°C and 2°C higher during day and night, respectively. The increased temperature of the organic growth media should be caused by the microbial decomposing activities. Similarly, the highest early yield was observed in pepper plants grown on the peat media compared with

perlite, pumice, sand and soil (Padem, Alan 1994). Growing media based on peat and peat with cocos derivatives were tested against mineral wool for tomato. Results showed that plants grown in the pure peat rooted more easily than those grown in the peat-coco or mineral wool but the total yield was similar for all media (Gruda et al., 2009).

Generally, believed that SPAD value is a parameter to measure the relative content of leaf chlorophyll content and the size of its value is positively correlated to the content of chlorophyll inside the leaf. Fig 2 shows the SPAD values, for leaves tomato transplanting, which produced in 7 mixtures of different growth media. The results showed that SPAD values of T2 and T15 growth media mixtures were biggest for 47.18 and 46.2 followed insignificantly by T 5, T13 and T4, which were 45.2, 43.55 and 41.96 and the value for control was smallest, which was 38.33 without a significant difference than T 13, T14 and T4 Fig 2. These results are in accordance with some extents with the findings of (HongLiu, 2008 .Where, Seedlings were grown in 30% rice hulls amended peat had nursery and field performance similar to, or better than, those grown in the peat control media. Seedlings grown in media containing kenaf performed poorly, likely due in part to the lower organic matter content and volume shrinkage of kenaf-amended media. In addition, media amended with 30% or 50% rice hulls required frequent irrigation due to their lower water holding capacity

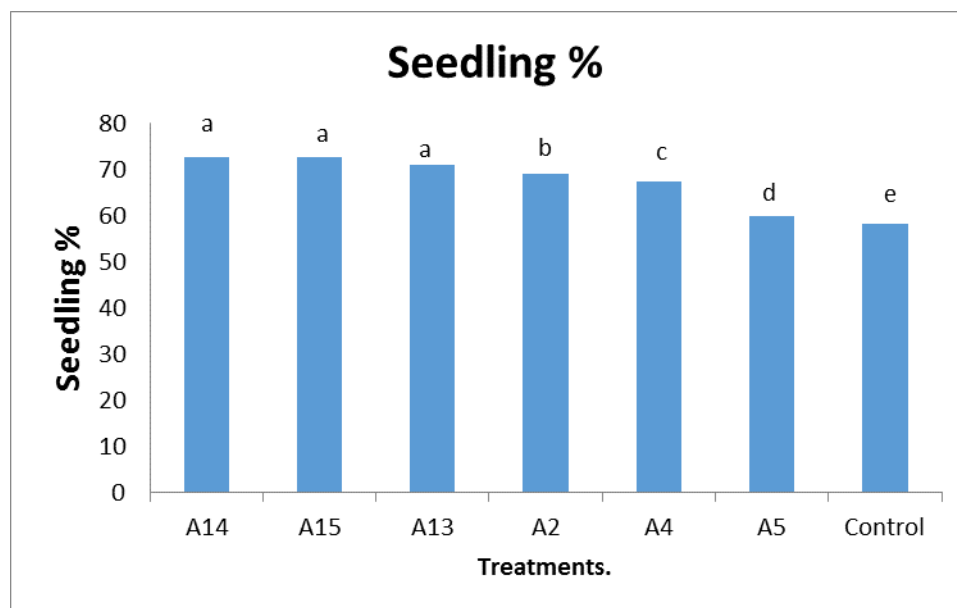


Fig. 1. Emergency percentage as affected by different studied growth media mixtures. Content for tomato transplanting's

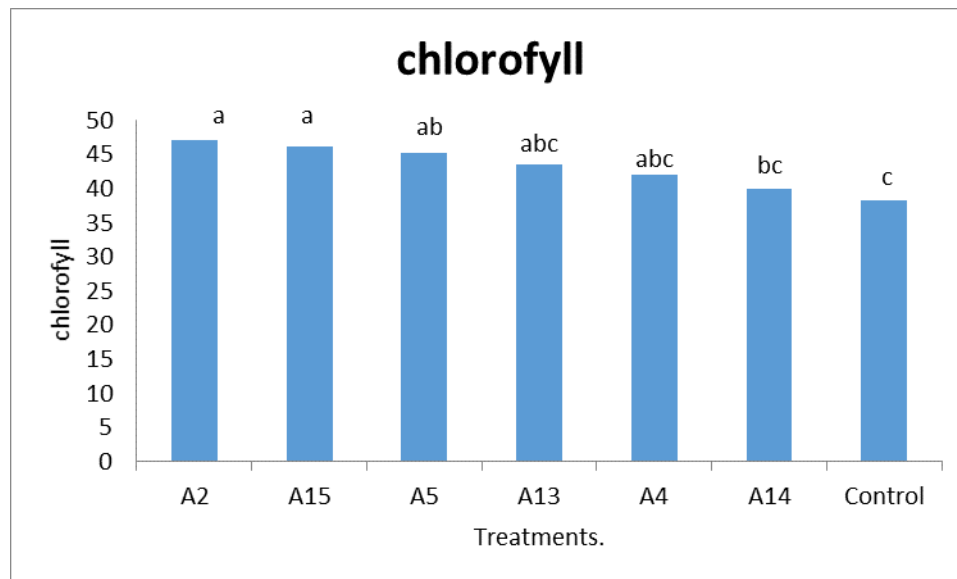


Fig. 2. chlorophyll content (SPAD) as affected by different studied growth media mixtures. Morphological index for tomato transplants

At full stage of tomato transplants (stage of 4 true leaves), the fresh weight, dry matter and leaf area characters were detected to reflect the general growth and performance of tomato transplants (Fig.,3,4 and 5). It could be generally noticed that for both the fresh weight and leaf area, the result showed that T15 (the commercial media with the addition of 15% date palm seed ground) had the highest significant value of plant growth and exceed the rest of the formulas followed by T13 (40 % rice straw, 10% coffee ground and 50% date palm seed ground). However, T4 (50% sand) gave the lowest values for both fresh weight and leaf area. Concerning, dry matter content T4, T5 and T2 represent the highest values 11.78, 11.53 and 11.32 % for dry matter without significant difference. On the other hand, the control growth media gave the lowest value of dry matter of the tomato transplants without a significant difference than T14. Rice is a low cost, worldwide available and effective organic material that should be used for tomato transplants growing as growth media more efficiently in a condensed form (compressed) because of quick decomposition under the Mediterranean conditions. The overall effect of the type of growth media on the tomato transplants growth and

yield in the present experiment suggests that the examined materials are suitable materials for tomato transplanting cultivation Fig.,3,4 and 5. Furthermore, the investigation is however needed to determine if the presence of coffee ground and date palm seed ground could promise the prolonged reuse of the mixture. Moreover, more studies are necessary to specify the point of condensation (compression) of rice straw in order to assure their successful use (bio stability) as substrate as well as the alternative use of rice straw substrate on tomato culture introducing plants with shorter lifecycle i.e. lettuce and spinach. The fact that addition date palm seed ground gave higher yields than commercial media substrates suggested better nutritional conditions in the latter being in accordance with Padem and Alan (1994) in pepper cultivation. However, no differences between organic (coconut-fiber) and inorganic (Perlite and Rockwool) substrates on the yield of cucumber plants. Comparing perlite and pumice as substrates in tomato cultivation reported no significant difference in yield between them, which is in accordance with the present results.

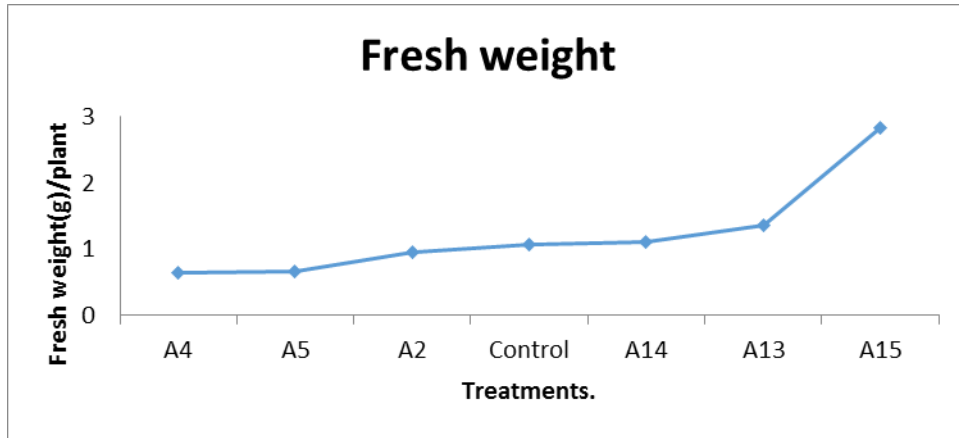


Fig. 3. fresh weight as affected by different studied growth media mixtures

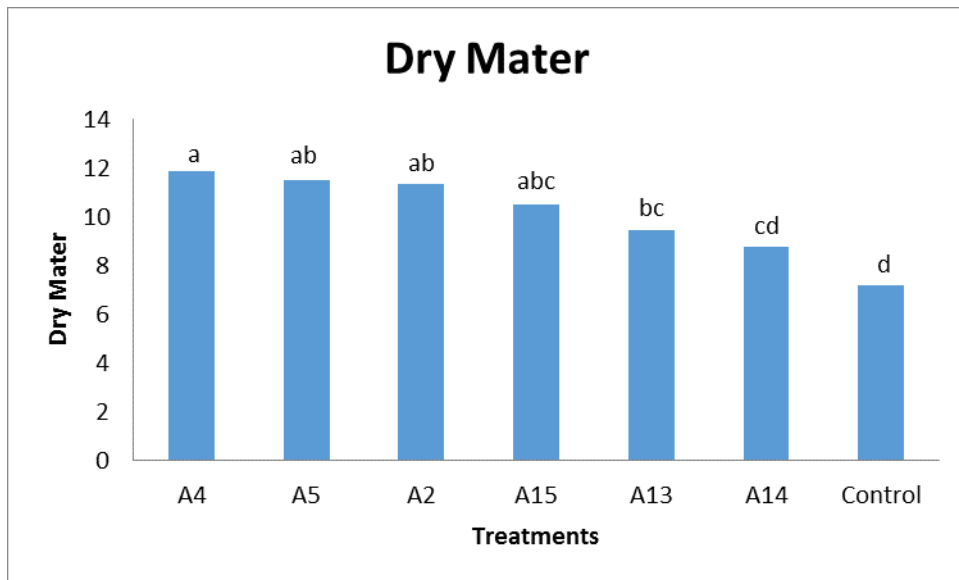


Fig. 4. dry matter as affected by different studied growth media

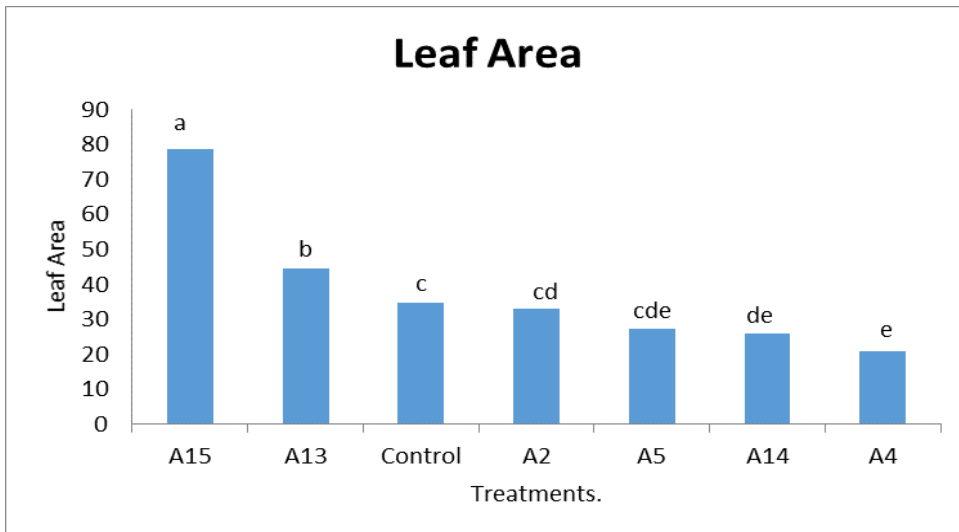


Fig. 5. leaf area cm² as affected by different studied growth media mixtures



Fig.6. Tomato transplants from different treatments of the studied growth media mixtures

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الملخص العربي

تقييم بعض مخاليط بيئات النمو المحلية لاستخدامها في إنتاج شتلات الطماطم

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T 15 والمعاملة التالية كانت T2 وكانت معدلات الإنبات لجميع المعاملات أعلى من control، وأقلها كانت الcontrol. ، وقد أظهرت النتائج أن قيمة SPAD ل T2 ، و T 15 كانت الأكبر كانت ٤٧.١٨ ، و ٤٦.٢ تليها ، T 5 و T13 ، و T4 ، والتي كانت ٤٥.٢ ، و ٤٣.٥٥ ، و ٤١.٩٦ وكانت قيمة control الأصغر ٣٨.٣٣ دون اختلاف معنوي عن T 13 ، و T14 ، و T4. يمكن ملاحظة أن لكل من الوزن الطازج، ومساحة الأوراق لمخلوط بيئة النمو T15 (الوسط التجاري مع إضافة ١٥٪ من بذور نخيل التمر) كانت قد حققت أعلى قيم لنمو الشتلات، وتتجاوز باقي المعاملات تليها المعاملة T13 مع اختلاف معنوي. فيما يتعلق بمحتوى المادة الجافة فان مخاليط بيئات النمو T4، و T5 ، و T2 أحرزت أعلى القيم ١١.٧٨ ، و ١١.٥٣ ، و ١١.٣٢٪ من المادة الجافة بدون فرق معنوي. من ناحية أخرى ، أعطى control أقل قيمة من اللامدة الجافة لشتلات الطماطم.

تستخدم أنظمة الزراعة بدون تربة لتحقيق أداء أعلى، وتحسين جودة المحاصيل، والحفاظ على المياه والأرض، وحماية البيئة بشكل أفضل. حاولت هذه الدراسة استخدام بعض المخلفات الزراعية والمواد العضوية المحلية الملائمة لنمو شتلات الطماطم (*Solanum lycopersicum*) وذلك تمهيدا لاستخدامها كبديل للبيت موس المستورد. تم تحضير ومقارنة ثمانية عشر مزيجًا مختلفًا من بيئات النمو والتي كانت تتكون من مع جزء معدني (الرمال والفيرميكولايت) و المواد العضوية (بذور النخيل وقش الأرز والقهوة). تم ترتيب التجربة في تصميم عشوائي بالكامل مع ١٨ معاملة و ٣ مكررات مع ٥ مشاهدات لكل معاملة. بعد فترة نمو الشتلات ، تم حصاد الشتلات لتحديد تأثير وسط النمو على صفات النمو المختلفة (المادة الجافة للنبات ومساحة الأوراق) و (النسبة المئوية للشتلات ، الوزن الطازج ، الكلوروفيل). . كان أعلى معدل إنبات للبذور هو معاملة T 13 ، و T14 ، و