EFFECT OF PHSICO-HYDRAULIC PROPERTIES ON TOMATO NURSERY

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ABSTRAT

The main objective of this study was to find the best mixture (growth media) for planting tomato nursery by mixing sand, peatmoss, and vermiculite. The mixtures were devided to three groups (sand + peatmoss), (sand + vermiculite), and (sand + peatmoss + vermiculite). Each group contains different ratio of sand and other component. Also, one sample was (40% petmoss + 60% vermiculite) as a control. Laboratory experiments were conducted to quantify real density (g/cm3), bulck density (g/cm3), hydraulic conductivity (cm/min), total porosity (%), and water holding capacity (g/g) as affected by different mixtures. The tomato nursery was planted into trays in greenhouse. The results show that in the media of "sand + peatmoss" increased sand ratio gave an increase in total porosity and a decrease in water holding capacity. At mixtures of "sand + vermiculite", the total porosity decreased with increase in sand ratio and water holding capacity decreased with an increase in sand ratio. The highest values of total porosity and water holding capacity were at mixture of (70% peatmoss + 30% sand). Also, the highest growth parameter of nursery as seedling weight and length was obtained with the same mixture.

INTRODUCTION

Favorable media (good drainage, absence of toxicity, fertility, etc.) are indispensable for the success of a nursery. When nursery plants are raised in pots, polybags, seed boxes or trays, it may not be necessary for soils on the nursery site to be fertile. Media must perform 4 functions (1) provide a stable substrate for root anchorage, (2) provide a reservoir of nutrients, (3) provide oxygen (gas exchange) for roots and provide water for roots.

Therefore, best media should contain 50 to 85% pore space. Total porosity of media is important, but probably more crucial is the portion

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of air space versus water holding capacity "WHC.". Some plants prefer wet soil while others prefer dry soils. An average of 10 to 30% of the media volume should be composed of air space while 45 to 65% should be water. In some ways, vermiculite is similar to perlite in that they both originate as mined minerals that are then heated to produce a finished product. Perlite and vermiculite differ, however, in the rationale for including them in a mix. Perlite is usually included in a mix to increase drainage, but does not increase the retention of nutrients. In contrast, vermiculite with its plate-like structure holds large quantities of water and positive charged nutrients like potassium, magnesium and calcium. The pH of vermiculite will vary depending on where it is mined. Most US sources are neutral to slightly alkaline, whereas vermiculite from Africa can be quite alkaline (pH = 9). Vermiculite is used extensively in the greenhouse industry as a component of mixes. Sand is a common amendment used in propagation applications and is occasionally used in a greenhouse or nursery mix. Sand is typically selected as a media component to improve the drainage. While sand represents a wide range in particle sizes, growers generally use medium to coarse sands (0.25 to 2 mm). Peat is a very common component in mixes. Peat is usually included in a mix to increase the water-holding capacity or to decrease the weight. Peatmoss is the least decomposed form of the peat types, is typically light tan to brown in color, lightweight, high in moisture-holding capacity and very acidIC (pH 3.8 to 4.3). A significant problem with peatmoss derived from reed-sedge or hypnum peatmoss represents an advanced stage of decomposition. This type of peat is usually dark brown to black and has a low moisture-retention capacity **James (2011)**.

Yusef (2011) stated that the best mixture (growth medium) for planting Dahli, Marigold, Zinnia and Cosmos is by mixing date palm leaves compost with vermiculite, perlite, sand and clay. He reported that generally, date palm leaves compost + vermiculite mixture improved the vegetables growth of plants better than other mixtures. On relative basis, the mean biomass of all the plant grown in date palm leaves compost was 80% and 71% of those plants grown in date palm leaves compost + vermiculite (2 : 1) respectively. Mean plants height of marigold was about 29.6% higher in date palm leaves compost + vermiculite (1: 2) as compared to pure date palm leaves compost.

Prasad (1978) stated the effect of addition of sand, perlite, polystyrene and pumice in helf and proportions and in various particle sizes, on physical properties of peat mixes. He found that coarse sand had no effect on air space, while fine sand reduced air space and at higher rate, the value fell to unsatisfactory level. At the higher rate of coarse sand additions, easily available water fell to unsatisfactory level. Fine sand increased easily available water, total porosity reduced as a result of sand addition. The addition of coarse perlite at the higher rate increased the air space, while fine perlite at both rates and medium perlite rate reduced air space. The effect of addition of coarse and fine perlite on easily available water was similar to sand addition. Total porosity was reduced by coarse perlite and by medium perlite addition at the higher rate. The addition of polystyrene increased air space, but decreased easily available water and the value fell to unacceptable level at the high rate of application.

In this study some growth parameters were measured as nursery seedling height, leaves number, nursery weight, and germination ratio, by using different media which had different ratios of sand, peatmoss, and vermiculite, to produce tomato nursery production.

MATERIALS AND METHODS

MATERIALS

Laboratory experiments were carried out in the Irrigation Laboratory, Agriculture Engineering Department, Al-Azhar University, Nasr City, Cairo. The main objective of the laboratory experiments were to determine the characteristics of different mixture media samples such as: real density, bulck density, hydraulic conductivity, total porosity, and water holding capacity for cultivating the tomato nursery.

Eleven samples were made for mixtures which varied in volumetric proportions of sand, peatmoss, and vermiculite. The coarse sand ratio varied from 30% to 50%; peatmoss from 35% to 80% and vermiculite from 20% to 80% (**Table: (1)**).

Tomato:

Tomato (*Lycopersicon esculentum* Mill), which is cultivated in trays for home consumption and commercial domestic market, processing plants and exporting, is one of the world's most popular vegetables **(FAO, 1989)**. It also possesses valuable medical properties, an excellent purifier of blood and a rich source of vitamins like vitamin A and C than any other vegetables **(Villareal, 1978)**. Good quality of seedling usually leads to higher yield and earlier maturity. Tomato that mature early not only could receive higher price on fresh market, but also could reduce the risk involved in growing tomatoes in the tropics. The growth parameters were measured as: seedling length, leaves number, weight, and germination ratio.

Table (1): Ratios of sand (%), peatmoss (%), and vermiculite (%) for each treatment in the present study.

Treatment	Mixture ratios		
	Peat. %	Vermi. %	Sand %
A	50	--	50
B	60	--	40
C	70	--	30
D	80	--	20
E	--	60	40
F	--	70	30
G	--	80	20
H	60	40	--
I	35	35	30
J	40	30	30
K	60	20	20

Cell trays:

Cell trays are used by commercial growers to produce seedlings for planting out. The seedlings are easily removed from the tray for transplanting, and the growth check to transplants from cell trays is minimal when planted in the field, compared to the use of other types of transplants. The dimension of trays was (40 × 80 cm) and (11 × 19) csells. The trays were made from foam.

METHODS

Saturated hydraulic conductivity "K_s":

Saturated hydraulic conductivity "K_s" (cm/h) of the media samples were measured (three replicates per treatment) using the constant head method as described by **Stolte (1997).**

Real density, bulck density, and total porosity:

Dry bulck density (g/cm^3) was calculated (dry weight basis) for each sample by weighting 400 ml of beakers filled with the soil mixture. Samples were oven dried at 105^o for 24 hour, and weighted again. The bulck density was determined as dry soil mass per media volume. Real density (g/cm3), bulck density (g/cm3), and total porosity (%) were determined according to **Klute (1988)**.

Moisture holding capacity:

Moisture holding capacity was measured on a dry weight basis according to the following equation **(Thompson et al. 2008)**:

$$M.H.C = \frac{M_f - M_d}{M_d}$$

Where:

M_f : is the mass (g) of the sample at field capacity,

M_d : is the mass (g) of the dry sample.

RESULTS AND DISCUSSION

The main objective of this study was to determine some physical properties and watering characteristics of different media samples and their effects on growth parameters of tomato nursery.

Sand peatmoss mixture:

Fig. (1) illustrate the relation between real density (g/cm^3), bulck density (g/cm^3), and hydraulic conductivity (cm/min) at different ratios of sand with peatmoss.

It will be noticed that at increasing sand ratio from 20% to 50% leads to decrease the hydraulic conductivity from 4.5 to 2.1 cm/min respectively, while the bulck density increased from 0.45 to 0.86 g/cm^3 and real density increased from 1.5 to 2 g/cm^3.

Fig. (2) revealed that represent total porosity (%) at different sand ratios which increased from 20% to 50% . The figure shows an increase of total porosity from 59.6 to 65.1 % with the increase sand ratio.

Sand vermiculite mixture:

Fig. (3) shows the relations between real density (g/cm^3), bulck density (g/cm^3), and hydraulic conductivity (cm/min) at different ratios of sand with vermiculite. It is indicated that the real density, bulck density, and hydraulic conductivity were increased with the increased of sand ratio. However, **Fig. (4)** illustrates that the total porosity decreased with sand + vermiculite ratio.

Treatments of H, I, J and K:

Figs. (5) and (6) show the effect of different mixture ratios from (sand + peatmoss + vermiculite) on the real density, bulck density, total porosity, and hydraulic conductivity. From these figures, the highest total porosity was 72.9% at "H" treatment (60% peatmoss + 40% vermiculite). Also, the highest hydraulic conductivity was 2.6 cm/min at "H" treatment (60% peatmoss + 40% vermiculite).

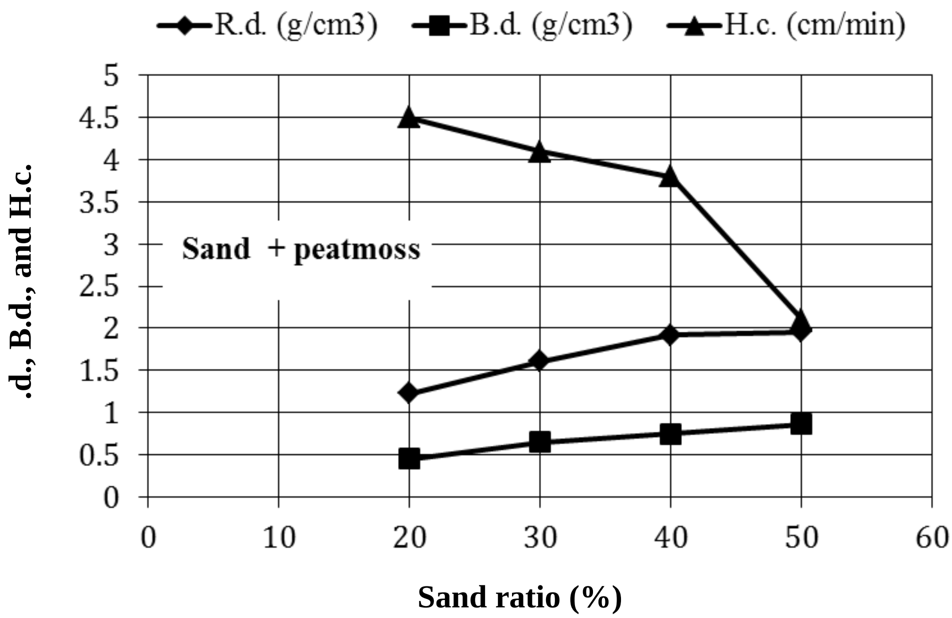

Fig. (1): Relation between real density "R.d" (g/cm3), bulk density "B.d" (g/cm3), and hydrualic conductivity "H.c" (cm/min) and sand ratio for sand peatmoss mixture.

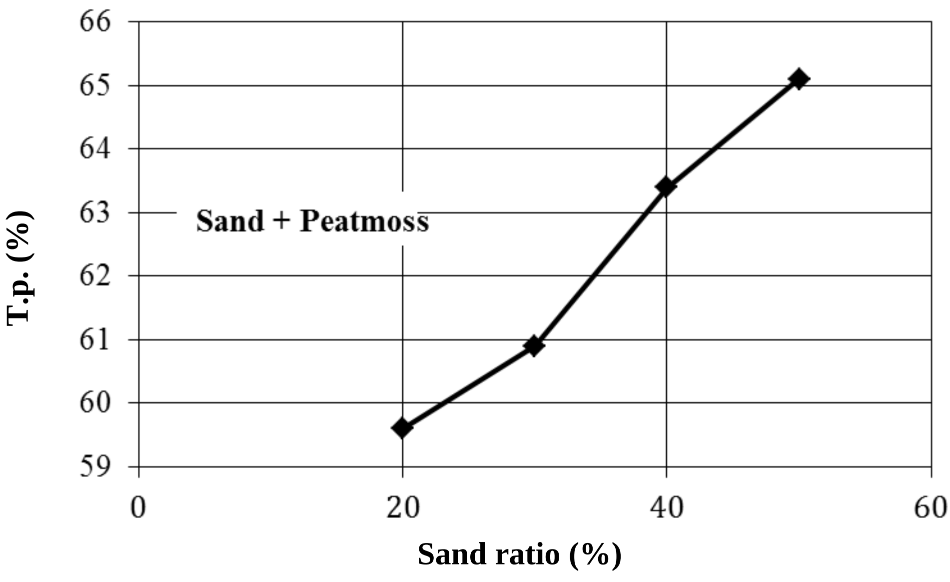

Fig. (2): Relation between total porosity "T.p." (%) and sand ratio for sand peatmoss mixture.

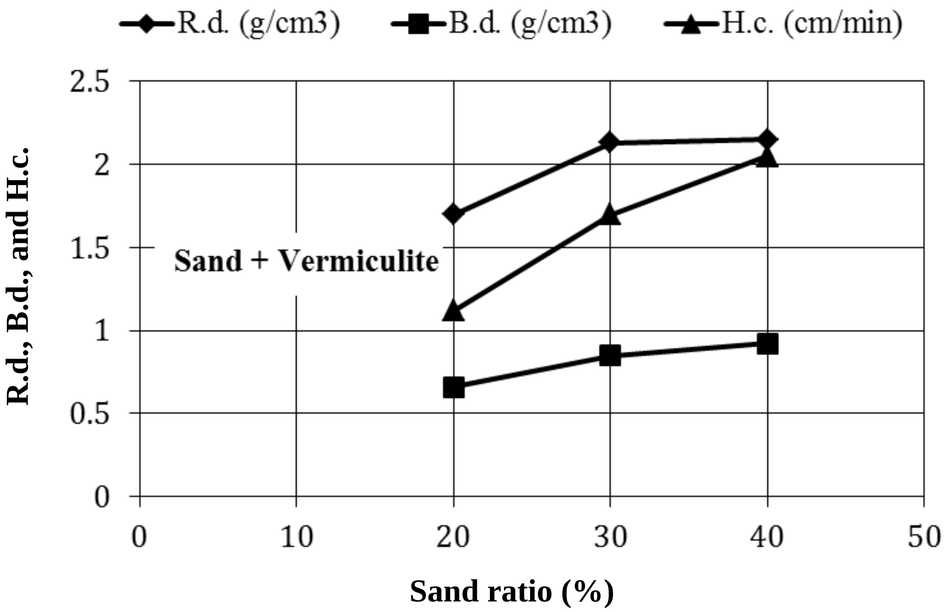

Fig. (3): Relation between real density "R.d" (g/cm3), bulk density "B.d" (g/cm3), and hydraulic conductivity "H.c" (cm/min) and sand ratio for sand vermiculite mixture.

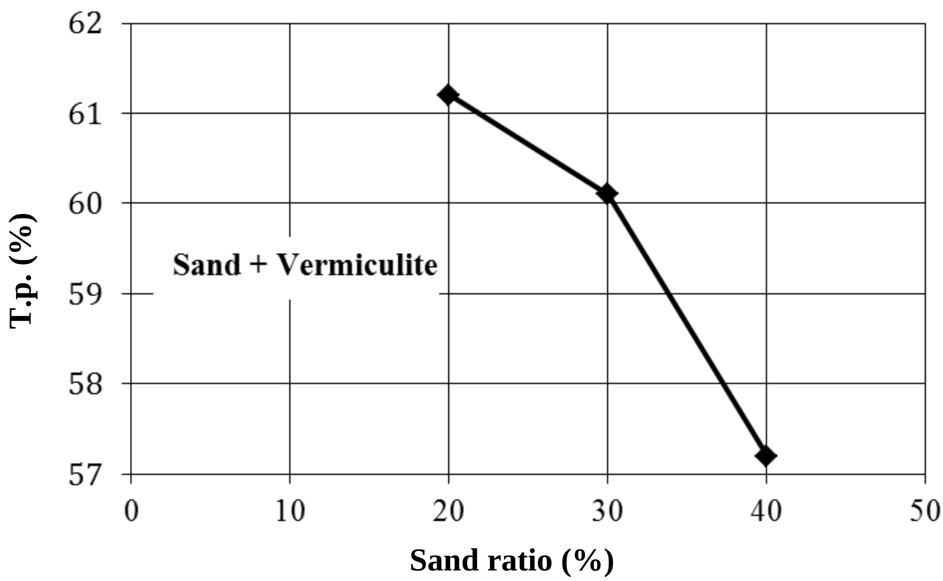

Fig. (4): Relation between total porosity "T.p." (%) and sand ratio for sand vermiculite mixture.

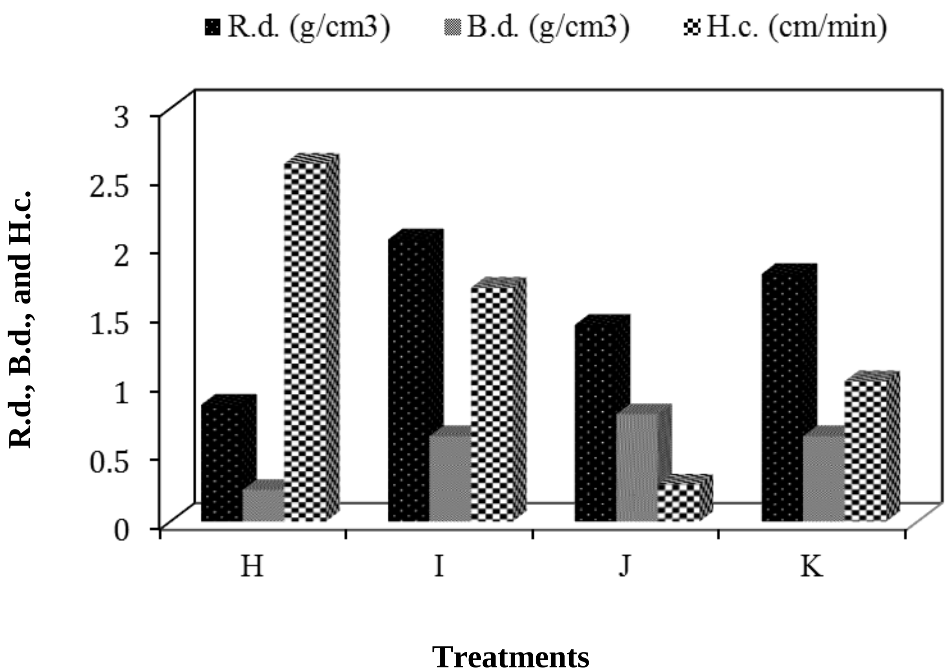

Fig. (5): Relation between real density "R.d" (g/cm3), bulk density "B.d" (g/cm3), and hydraulic conductivity "H.c" (cm/min) and treatments of I, J, and K.

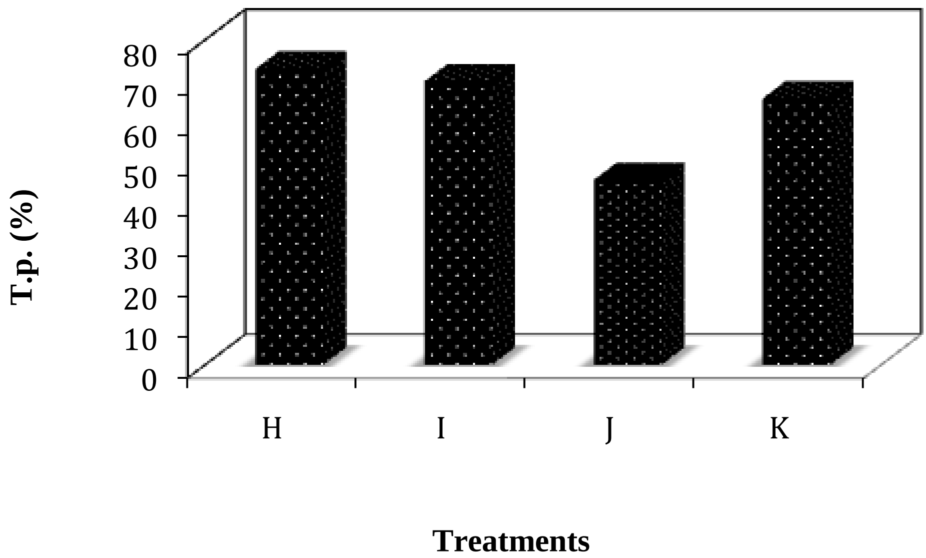

Fig. (6): Relation between total porosity "T.p." (%) and treatments of I, J, and K.

Fig. (7) shows water holding capacity (g/g) for different treatments. Its clear that the highest value of water holding capacity was 3.82 g/g for "H" treatment (60% peatmoss + 40% vermiculite) and the lowest value was 0.52 g/g for "I" treatment (35% peatmos + 35% vermiculite + 30% sand).

Growth parameter:

Growth parameter as: nursery length, nursery weight, nursery leaves number, and germination ratio which influenced by media components are shown in **Figs. (8), (9), and (10)**. The results showed that the highest values of growth parameters were obtained at media "C" (30% sand + 70% peatmoss). These results may be at reputed to balance of air and water in media. Also, the best germination ratio was at the same media.

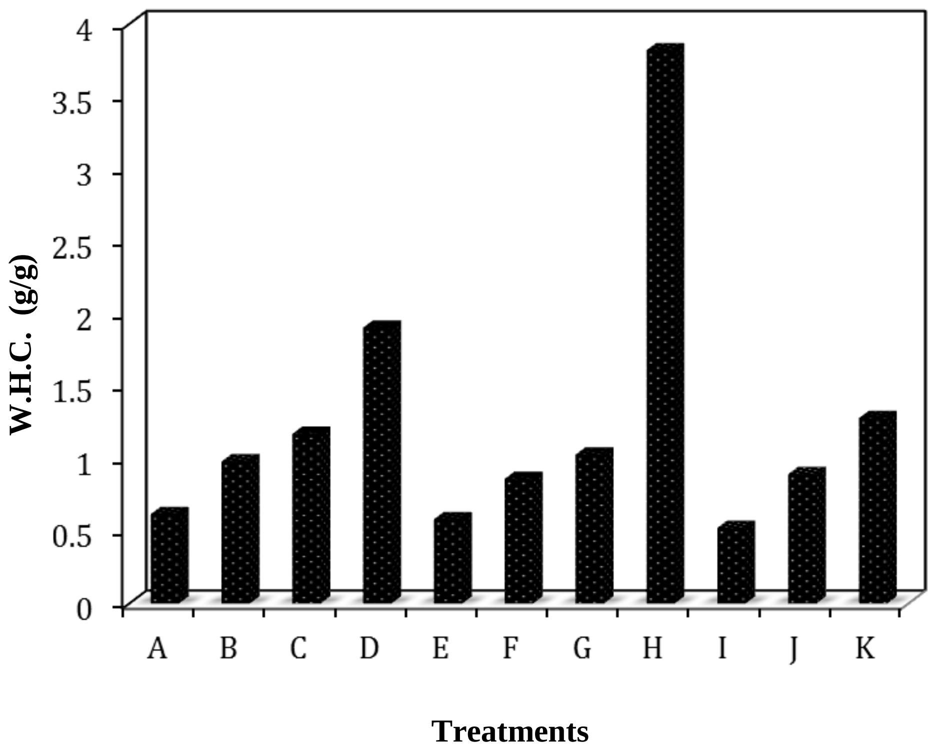

Fig. (7): Relation between water holding capacity "W.H.C" (g/g) and different treatments.

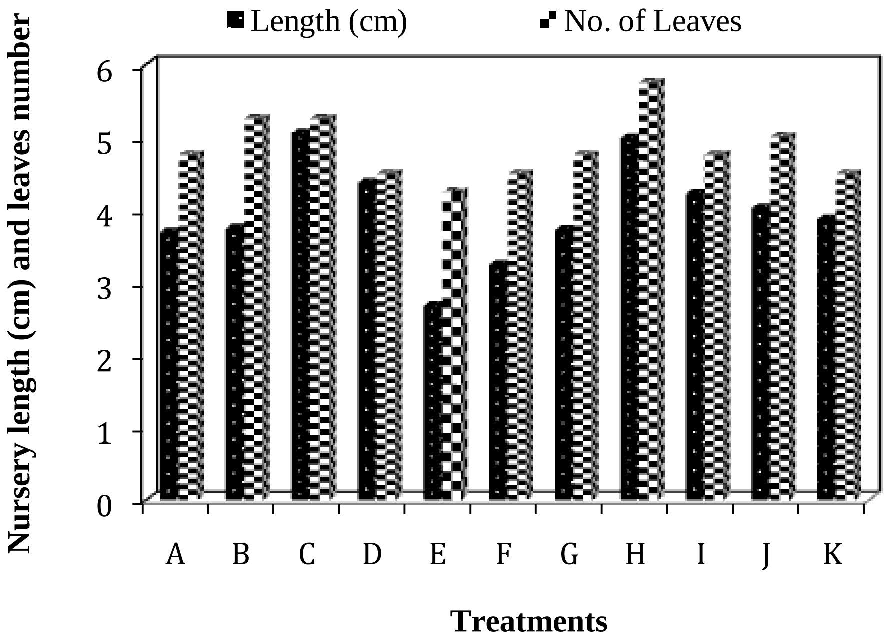

Fig. (8): Relation between growth parameters of nursery length (cm) and leaves number for different treatments.

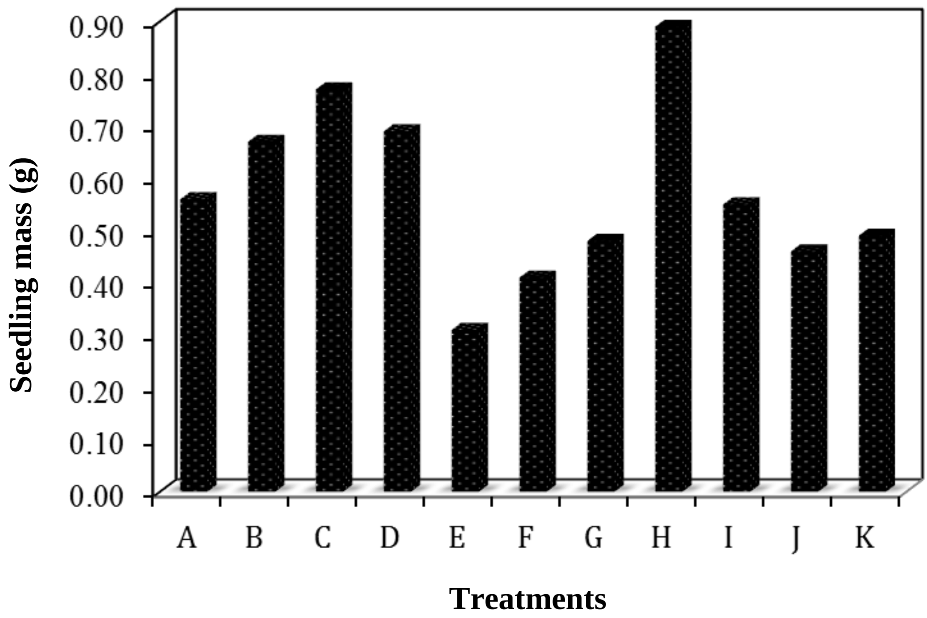

Fig. (9): Relation between seedling mass (g) and different treatments.

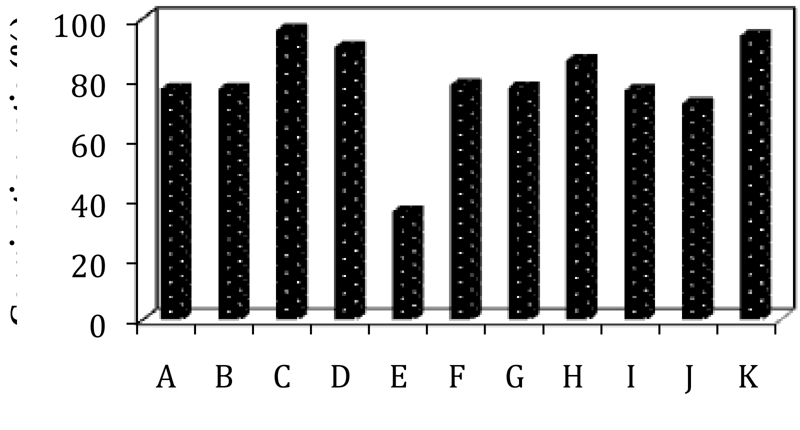

Fig. (10): Germination ratios for different treatments.

CONCLUSIONS

For the first four mixture samples "A, B, C, and D", by increase of peatmoss (50% – 80%) and decrease of coarse sand (50% - 20%) in media, the hydraulic conductivity and water holding capacity increased. Meanwhile, the bulck density and total porosity decreased. With the next three treatments "E, F, and G", increase of vermiculite (60% – 80%) and decrease of coarse sand (40% - 20%) of media, increased the water holding capacity and total porosity. Meanwhile the bulck density and hydraulic conductivity decreased.

For the last four mixture samples "H, I, J, and K", which have different ratio (sand + peatmoss + vermiculite), the highest values of hydraulic conductivity, total porosity, and water holding capacity were obtained with treatment "H" (0% sand + 60% peatmoss + 40% vermiculite). The highest value of growth parameters as nursery weight and length were obtained at treatment of (30% sand + 70% peatmos).

Plant media influenced the growth of tomato nursery, in which media of treatment "H" (60% peatmoss + 40% vermiculite) was the best, since seedling height and weight were morer than those with the other media.

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الملخص العربى

تأثير الخواص الفيزيائية الهيدرولية على بيئة شتلات الطماطم

فتحى إبراهيم زبادي*

تعتبر الشتلة هى اللبنة الأولى فى حياة النبات. وفى الآونة الأخيرة زاد الطلب على شتلات الخضر خاصةً شتلات الطماطم، وذلك لارتفاع ثمن البذور الهجين والتى تعطى إنتاجية عالية من المحصول. وتعتبر بيئة نمو الشتلة هى المحور الأكثر تأثير فى نجاح هذه الشتلة، حيث توفر للشتلة كمية الرطوبة المناسبة وكذلك الصرف الجيد والتهوية اللازمة.

ويهدف هذا البحث إلى:

دراسة بعض الخواص الهيدرولية والطبيعية مثل الكثافة الحقيقية والظاهرية والمسامية الكلية والتوصيل الهيدروليكى والسعة التخزينية المائية للتربة لمجموعة من الخلطات ودراسة تأثير ذلك على نسبة الإنبات وكذلك بعض محددات النمو مثل طول الشتلة ، ووزن الشتلة الرطب وكذلك عدد الأوراق لشتلات الطماطم.

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وكانت الخلطات كما يلى:

المعاملة	نسب الخلط		
	بيتموس (%)	فيرموكليت (%)	الرمل (%)
A	٥٠ %	--	٥٠ %
B	٦٠ %	--	٤٠ %
C	٧٠ %	--	٣٠ %
D	٨٠ %	--	٢٠ %
E	--	٦٠ %	٤٠ %
F	--	٧٠ %	٣٠ %
G	--	٨٠ %	٢٠ %
H	٦٠ %	٤٠ %	--
I	٣٥ %	٣٥ %	٣٠ %
J	٤٠ %	٣٥ %	٣٠ %
K	٦٠ %	٢٠ %	٢٠ %

وهذه النسبة حجم/حجم. وتم زراعة بذور الطماطم فى صوانى الشتلات ١١ × ١٩ جورة (٢٠٩ شتلة) وتم رى وتسميد الشتلات بطريقة موحدة لكل المعاملات وتم قياس الخواص الطبيعية والهيدرولية فى المعمل بقسم الأراضى والمياه – كلية الزراعة بالقاهرة – جامعة الأزهر. كما تمت زراعة الصوانى داخل صوبة بمشتل خاص بالقُرين – محافظة الشرقية.

وكانت النتائج كما يلى:

١) بتخفيض نسبة الرمل من ٥٠% ألى ٢٠% وزيادة نسبة البيتموس من ٥٠% إلى ٨٠% أدى ذلك إلى زيادة نسبة التوصيل الهيدروليكى من ٢,١ إلى ٤,٥ سم/د، وكذلك السعة التخزينية للتربة من ٠,٦٢ إلى ١,٩ ج/ج، كما انخفضت المسامية الكلية من ٦٥,١% إلى ٥٩,٦% ، وكذلك انخفضت الكثافة الظاهرية من ٠,٨٦ إلى ٠,٤٥ ج/سم^{3}.

٢) بتتخفيض نسبة الرمل من ٤٠% إلى ٢٠% وزيادة نسبة الفيرموكليت من ٦٠% إلى ٨٠% أدى ذلك غلى زيادة المسامية الكلية من ٥٧,٢% إلى ٦١,٢ وزيادة سعة التربة التخزينية من ٠,٥٨ ألى ١,٠٣ ج/ج، وأدى أيضاً إلى انخفاض الكثافة الظاهرية من ٠,٩٢ إلى ٠,٦٦ ج/سم^{3} وكذلك التوصيل الهيدروليكى من ٢,٠٥ إلى ١,١٢ سم/د.

٣) أما بالنسبة للمعاملة (٦٠% بيتموس + ٤٠% فيرموكليت) فأعطت أعلى سعة تخزينية للتربة ٣,٨٢ ج/ج وكذلك أعلى مسامية كلية ٧٢,٩% وأعطت أقل كثافة ظاهرية ٠,٢٣ ج/سم^{3}.

٤) أما بالنسبة للمعاملات I, J, K ثلاثية الخلط (رمل + بيتموس + فيرميكليت) فدلت النتائج بزيادة نسبة البيتموس من ٣٥% إلى ٦٠% وتخفيض نسبة الفيرموكليت من ٣٥% إلى ٢٠% وكذلك تخفيض نسبة الرمل من ٣٠% إلى ٢٠% إلى زيادة السعة التخزينية ٠,٥٢ إلى ١,٢٨ ج/ج وانخفض التوصيل الهيدروليكى من ١,٧٠ إلى ١,٠٢سم/د كما انخفضت المسامية الكلية من ٩٦,٨% إلى ٦٥,٦% ولم تتأثر الكثافة الظاهرية كثيراً.

٥) نسبة الإنبات كانت أعلى قيمة لها عند المعاملة (٧٠% بيتموس + ٣٠% رمل) وكانت ٩٦,١٧% وكانت أقل قيمة عند المعاملة (٦٠% فيرمو + ٤٠% رمل)وكانت ٣٥,٨٩%.

٦) أما بالنسبة لمحددات النمو (طول الشتلة وعدد أوراق الشتلة والوزن الرطب فأعطت المعاملة (٧٠% بيتموس + ٣٠% رمل أعلى قيمة لها وكانت ٥,٠٥ و ٥,٢٥ و ٠,٧٧ على الترتيب. وكانت أقل قيمة لها عند المعاملة ٦٠% فيرمو + ٤٠% رمل) وكانت ٢,٦٨ و ٠,٣١ على الترتيب.