

The Effects of Peat and Sand Amended Spent Mushroom Compost on Growing of Tomato

Gökhan ÇAYCI¹ Abdullah BARAN¹ Damla BENDER²

Gelişi Tarihi : 02.02.1998

Abstract : In this study, the effects of peat and sand amended spent mushroom compost (SMC) on growing of tomato (*Lycopersicon esculentum* Mill. cv.H 2274.) were investigated, and 100% Peat and SMC, mixtures of SMC with 25%, 50%, 75% Peat, and 50% SMC + 25% Peat + 25% Sand and 50% Peat + 25% SMC + 25% Sand were used as growing media. Plant growing in SMC mixing with peat and sand was compared with 100 % Peat as control. 25% P + 75% SMC was ascertained the most appropriate mixture for plant growing in SMC mixtures. Shoot and root dry weights of control was found higher than other treatments. There was no statistical difference among 100% SMC, 50% Peat + 50% SMC and 75% Peat + 25% SMC whereas sand significantly negatively affected plant growth ($P < 0.01$).

Key Words: Spent mushroom compost, peat, sand, plant growth medium, tomato

Peat ve Kum Karıştırılmış Atık Mantar Kompostunun Domates Bitkisinin Gelişimi Üzerine Etkisi

Özet: Bu araştırmada, peat ve kum karıştırılmış atık mantar kompostunun domates bitkisinin (*Lycopersicon esculentum* Mill. cv.H 2274.) gelişimi üzerine etkisi araştırılmıştır. Araştırmada, yetiştirme ortamı olarak %100 Peat ve % 100 AMK(atık mantar kompostu), % 25, % 50 ve % 75 oranlarında peat ile karıştırılmış AMK ve % 50 AMK+%25 Peat+%25 Kum, %50 Peat+%25 AMK+%25 Kum karışımları kullanılmıştır. Kontrol olarak % 100 Peat'teki bitki gelişimi esas alınmıştır. %25 Peat+%75 AMK nın atık mantar kompostlu karışımlar içerisinde en uygun karışım olduğu saptanmıştır. Kontrolde, tepe ve kök kuru ağırlıkları diğer uygulamalardan daha yüksek bulunmuştur. %100 AMK, %50 Peat + %50 AMK ve % 75 Peat + % 25 AMK karışımları arasında istatistiksel olarak fark bulunamazken, kum ilavesi bitki gelişimini negatif olarak etkilemiştir ($P < 0.01$).

Anahtar Kelimeler: Atık mantar kompostu, peat, kum, bitki yetiştirme ortamı, domates

Introduction

Turkey, especially, Mediterranean Region has a large horticultural potential because of ecological conditions. However, present production with respect to quality and income level is lower than other countries because of unsolved cultivation problems in greenhouses (Abak and Çelikel, 1994).

In recent years, plant growing in soilless culture has a great of importance both in world and Turkey. The effects of growing media on quality and yield of plant are outstanding. Imported peat is the most commonly used growing medium in Turkey. Native peat, occurs in eutrophic conditions, also, is used. The cost of imported peat is higher on the other hand the physical and chemical properties of native peat as plant growing medium are insufficient (Çaycı et al., 1989). It has been studied on different materials that will be used substitute of peat in the world. It has been reported that spent mushroom compost (SMC) also will be used as plant growing medium (Lohr et al., 1984a, Maher, 1991). However, it has been found that mixtures of SMC with high quality growing medium such as peat, vermiculite and bark were

given well results than used alone in studies on SMC (Calvin et al., 1994).

The objective of this study was to evaluate the growing of tomato in different SMC mixtures with peat and sand.

Material and Method

SMC used in trial are consisted of decomposed wheat, horse manure, chicken manure, urea, gypsum and lime. It has known that SMC with high salt content has negatively affected on plant growing (Lemaire et al., 1985). For this reason, SMC was leached at the early of trial and electrical conductivity (EC) was decreased to 1.94 dSm^{-1} from 9.2 dSm^{-1} . Coarse sand (S) and native peat (P), taken from Bolu-Yeniçağa decomposition degree classed as H5 and botanical composition is sedge-grass, were used in trial (Baran and Ataman, 1995).

¹ Ankara Üniv. Ziraat Fak. Toprak Bölümü- Ankara

² Karadeniz Teknik Üniv. Ordu Ziraat Fak. Toprak Bölümü- Ordu

Tomato seeds (*Lycopersicon esculentum* Mill. cv. H 2274) used in trial were rooted into a medium which contains 50 % peat + 50 % perlite and then were potted in 6.9 liter (20 cm diameter x 22 cm deep) containers. Trial was arranged separately in a randomised complete-block design with four replications of all seven treatments under greenhouse condition. SMC and peat were screened through a 6.35 mm sieve and containers filled those materials as follows:

- 100 % peat (Control)
- 50 % peat + 50 % SMC
- 75 % peat + 25 % SMC
- 25 % peat + 75 % SMC
- 50 % peat + 25 % SMC + 25 % sand
- 25 % peat + 50 % SMC + 25 % sand
- 100 % SMC

Initially, it was applied to each container 100 ppm N, 150 ppm P and 200 ppm K as $(\text{NH}_4)_2\text{SO}_4$, triple super phosphate and K_2SO_4 , respectively. In addition, 100 ppm N was applied to all containers after one month from putting.

All mixtures were analysed for dry bulk density, aeration capacity (AC), easily available water (EAW) and water buffering capacity (WBC) (De Boodt et al., 1973), organic matter (DIN 11542), pH and EC in saturation paste (Lucas et al., 1972). The roots were washed according to Böhm (1979) and Anova was used for assessing statistical significance. After growing periods of two months, shoot part of plants were harvested and roots were washed, and shoot and root dry weights of plants were determined.

Results and Discussion

Table 1 shows that 100 % peat, 100 % SMC and mixture of 25 % peat + 75 % SMC are appropriate for physical properties as growing media in accordance with De Boodt and Verdonck (1972). It was reported that EC of 2-4 dSm^{-1} in saturation paste desirable range for most of the plants (Kirven, 1986). Thus, it can be considered there is no salt problem of mixtures, pH value of SMC was over 7.0 therefore mixtures with SMC were over desirable level.

As nutrient contents of media were examined there were considerable differences in mixtures especially, in potassium content. Michigan State University reported optimal values of NO_3^- -N, P and K in saturated media extract (SME) are 100-199 ppm, 6-10 ppm and 150-249 ppm, respectively. However, optimal values for those elements are reported as 100-175 ppm, 8-14 ppm and 175-225 ppm by Ohio State University, and 80-139 ppm, 3-13 ppm and 110-179 ppm by University of Georgia (Kirven, 1986). As we compare our findings with above mentioned values, K was found insufficient in 100% Peat, otherwise 100 % SMC has much K than desirable levels. There is no data about soluble NH_4^+ -N content in SME. Acceptable ammonium amount in root zone of tomato grown in Rockwool medium is lower than 9 ppm (Sonneveld, 1992).

Shoot and root dry weights of plants were given Table 2. It can be seen that the highest yield of shoot dry weight (SDW) and root dry weights (RDW) were found in 100 % peat (Control). SDW decreased with increasing levels of SMC compare with control. There was no statistically difference between 75 % peat + 25 % SMC, 50 % peat + 50 % SMC and 100 % SMC ($P < 0.01$). 25 % peat + 75 % SMC differed from these treatments. Sand also extremely decreased SDW in mixtures.

Table 1. Some physical and chemical properties of mixtures.

| Mixtures | pH | EC dSm^{-1} | Org. Mat. % | NO_3^- ppm | NH_4^+ ppm | P ppm | K ppm | AC | EAW | WBC | Dry bulk density g cm^{-3} |
|------------------------|------|-------------------------|-------------------|------------------------|------------------------|----------|----------|-------|-------|------|---|
| | | | | | | | | | | | |
| 100%P | 6.60 | 0.96 | 62.07 | 193.44 | 35.64 | 2.65 | 15 | 19.29 | 31.67 | 5.04 | 0.215 |
| 75% P + 25% SMC | 7.12 | 2.00 | 57.01 | 125.24 | 45.60 | 6.89 | 195 | 15.11 | 30.80 | 7.63 | 0.245 |
| 50% P + 50% SMC | 7.32 | 2.04 | 52.01 | 147.52 | 37.44 | 7.16 | 510 | 13.77 | 29.29 | 6.24 | 0.252 |
| 25% P + 75% SMC | 7.64 | 2.40 | 49.62 | 154.04 | 52.64 | 10.87 | 855 | 18.29 | 23.38 | 4.64 | 0.314 |
| 50% P + 25% SMC +25% S | 7.38 | 1.80 | 18.19 | 111.96 | 25.92 | 10.34 | 270 | 9.30 | 25.25 | 5.22 | 0.645 |
| 25% P + 50% SMC +25% S | 7.52 | 1.88 | 20.17 | 135.57 | 19.80 | 12.19 | 600 | 10.66 | 28.83 | 3.51 | 0.657 |
| 100% SMC | 7.89 | 1.94 | 46.54 | 124.00 | 61.56 | 24.92 | 1230 | 20.67 | 22.16 | 4.14 | 0.301 |

Table 2. Changes in shoot and root dry weights of tomato plant grown in mixtures (g/pot).

| Mixture | Shoot dry weight | Root dry weight |
|-------------------------|------------------|-----------------|
| 100% P | 26.90 a | 1.64 a |
| 75% P + 25% SMC | 14.92 c | 1.02 b |
| 50% P + 50% SMC | 13.88 c | 0.96 b |
| 25% P + 75% SMC | 18.62 b | 1.26 b |
| 50% P + 25% SMC + 25% S | 10.05 d | 0.57 c |
| 25% P + 50% SMC + 25% S | 8.43 d | 0.58 c |
| 100% SMC | 14.89 c | 0.98 b |

LSD($P < 0.01$):

1.80

0.35

The most suitable media dealing with physical characteristics were determined as 100% Peat, 25%P+75% SMC, respectively, and crop yield was in accordance with this order. Crop yield difference in 100% SMC mixture, has similar physical characteristics, may result from high potassium level in 100 % SMC that it can bring about inequilibrium with regard to uptake of plant nutrients in medium (Wang et al., 1984). As the rate of SMC rose, RDW has decreased in all SMC added treatments. Control values are the highest in RDW similar to SDW. There was no statistical difference among 75 % peat + 25 % SMC, 50 % peat + 50 % SMC, 25 % peat + 75 % SMC and 100 % SMC ($P < 0.01$). Decreasing of RDW was found more intensively in sand added mixtures.

Maher (1988) reported that composted SMC was more effective than fresh SMC for plant growing and, he found that the best mixture was three parts peat and one part SMC. Lohr and Coffey (1987), experienced that the highest yield and quality of tomato seedlings grown in mixtures with SMC, was found in mixtures of 25 % aged SMC + 50 % vermiculite + 25 % peat. Wang et al. (1984) reported that, yield of tomato increased with increasing rates of SMC, and salinity caused by SMC under natural condition was decreased due to leaching and nutrient uptake of plant in fine sandy loam soil. They also noted that the effect of SMC on tomato growth considerably changed with time according to weather conditions.

High ammonium level depending on the use of fresh SMC (Lohr et al., 1984b; Baran et al., 1995), and high pH may cause to weak tomato growth in media mixing with fresh SMC comparing with 100 % peat in our study. In organic materials, high pH decrease, availability of some elements such as P, Mn and B (Lucas and Davis, 1961) and also high ammonium level may impede growing of plant due to either salinity effects or causing in high ammonium concentration in the root zone (Lohr and Coffey, 1987).

As a result, we can conclude that SMC can be used as plant growth medium because of its low price and high organic matter and plant nutrients content. Especially, 25% P+ 75% SMC is the most appropriate medium among the SMC mixtures for plant growing due to its physical and chemical properties. However, It will be more suitable removing of salts by leaching and decreasing ammonium level by weathering before the use of fresh SMC as growing medium.

References

- Abak, K. and Çelikel, G. 1994. Comparison of some Turkish originated organic and inorganic substrates for tomato soilless culture. In: Second Symposium on protected cultivation of Solanacea in mild winter climates, Adana, Turkey, 13-16 April 1993, Acta Hortic, 366: 423-427.
- Baran, A. and Ataman, Y. 1995. Türkiye'deki bazı peat çeşitlerinin fiziksel özellikleri ile ayrışma dereceleri arasındaki ilişki. İlhan Akalan Toprak ve Çevre Sempozyumu Tebliği Cilt I, 132-141.
- Baran, A., Çaycı, G. and İnal, A. 1995. Some physical and chemical properties of different agricultural wastes. Pamukkale University Engineering College, J. Engineering Sciences. 2-3:169-172.
- Böhm, W. 1979. Methods of studying root systems. Ecological studies. Vol.33. Springer-Verlag. Berlin, Heidelberg, New York.
- Calvin, C., Cline, R.A. and Rinker, D.L. 1994. Bark and peat amended spent mushroom compost for containerized culture of shrubs. Hort Science 29:781-784.
- Çaycı, G., Ünver, İ., Ataman, Y. and Munsuz, N. 1989. Distribution and horticultural values of the peats in Anatolia. In: Symposium on substrates in horticulture other than soil in situ. Dublin, Ireland, 12-16 September 1988. Acta Hortic., 238:189-196.
- De Boodt, M., and Verdonck, O. 1972. The physical properties of the substrates in horticulture. Acta Hortic., 26:37-44.
- De Boodt, M., Verdonck, O. and Cappaert, I. 1973. Method for release curve organic substrates. In: Proceeding Symposium Artificial Media in Horticulture, pp 2054-2062.
- DIN, 11542. Torf für Gartenbau und Landwirtschaft.
- Kirven, D.M. 1986. An industry viewpoint: Horticultural testing-is our language confusing. Hort Sci., 21:215-217.
- Lemaire, F., Dartigueuse, A. and Riviere, L.M. 1985. Properties of substrate made with spent mushroom compost. Acta Hortic., 172:13-29.
- Lohr, I.V., Wang, S.H. and Wolt, J.D. 1984a. Physical and chemical characteristics of fresh and aged spent mushroom compost. Hort Sci., 19:681-683.
- Lohr, I.V., O'Brien, G. and Coffey, D.L. 1984b. Spent mushroom compost in soilless media and its effects on the yield and quality of transplants. J.Amer. Soc. Hort. Sci., 109:693-697.
- Lohr, I.V., and Coffey D.L. 1987. Growth responses of seedlings to varying rates of fresh and aged spent mushroom compost. Hort Sci., 22:913-915.
- Lucas, R.E., and Davis, J.F. 1961. Relationships between pH values of organic soils and availabilities of 12 plant nutrients. Soil Sci., 92:177-182.
- Lucas, R. E., Rieke, P. E. and Doll, E. C. 1972. Soil saturated extract method for determining plant-nutrient levels in peat and other soil mixes. 4th Int. Peat Congr., 2:221-230.
- Maher, M.J. 1988. Spent mushroom compost as an organic manure and potting compost component. In: Compost processes in waste management. Brussels., pp 71-82.
- Maher, M.J. 1991. Spent mushroom compost as a nutrient source in peat based potting substrates. In: M.J. Maher(Editor), Science and Cultivation of Edible Fungi. Balkema, Rotterdam, pp 645-650.
- Sonneveld, C. 1992. Nutrient Solutions for Vegetables and Flowers Grown in Water or Substrates, Proefstation Voor Tuinbouw Onder Glas Te Naaldwijk, Nederland, No 8, 9th ed. Voedingsoplossingen glastuinbouw serie.
- Wang, S.H., Lohr, V.I. and Coffey, D.L. 1984. Spent mushroom compost as a soil amendment for vegetables. J.Amer. Soc. Hort. Sci., 109(5): 698-702.