

Nutrient Supplying Potential of Different Spent Mushroom Substrate Preparations as Soil Amendment in a Potting Media

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Abstract. A three consecutive cropping experiment was conducted to evaluate the nutrient supplying potential of different preparations of the spent mushroom substrate as an amendment of growing media for potted plants using pechay as test plant. There are 12 treatment combinations consisted 4 types of growing media containing soil alone and mixtures of soil with fresh SMS (FSMS), weathered SMS (WSMS) and carbonized SMS (CSMS) in combination with 0%, 50% or 100% recommended rate (RR) of nitrogen fertilizer. Succeeding two trials were conducted on the same pots and treatment assignments. The high yield of pechay during the first and second crop was observed on WSMS and CSMS treatments FSMS media produced high yields only during the 3rd crop. Yield was increased by N fertilizer in WSMS and CSMS treatments but not in FSMS. The growth differences is attributed to differences in available nutrients and C/N ratio between treatments. WSMS and CSMS increased the available N while FSMS immobilized N and other nutrients indicating that weathered SMS and carbonized SMS are more suitable as a component of potting media or as soil amendments without detrimental effect on immobilization and availability of nutrients.

1. Introduction

Nurseries and the emerging popularity of urban agriculture/containerized crop production resulted in high demands of growing medium for potted plants. Currently, peat is utilized as the main component of the growing media [1] and depleted the peatlands [2]. In agriculture, alternative sources of nutrients and soil amendments is needed to combat land degradation due to excessive chemical fertilizer application that utilization organic wastes into soil amendments or as a substrate component for nursery potting media instead of peat will provide solutions for waste disposal and conserve peat areas [3].

The boom of the mushroom industry is a global phenomenon with the market value of \$35 billion in 2015 [4]. The production is 6,535,542 tons in 2009 and still increasing annually at 9.2% between 2002 to 2016. However, mushroom production system is accompanied with the generation of millions of tons of residue referred to as spent mushroom substrate (SMS) [5], [6]. The SMS by-product in mushroom cultivation amounts to 5 kg of SMS generated from the production of 1 kg of mushrooms [7]. It has high levels of residual nutrients which may result in environmental pollution if it is dumped as waste [6], [8]. Thus, if properly utilized, SMS could serve as an important agricultural resources that would increase farmer's productivity and at the same time protect the environment.



Current practices in the different production area are carried out on substrates formulated with lignocelluloses materials from different sources (such as wheat, rye or rice straw, sawdust and corncobs), either alone or mixed with supplements to overcome nutritional limitations and to provide suitable substrate structure and pH [7]. The SMS by-product from these process have a stabilized organic matter that make them a potential candidate as soil amendments or as a substitute for peat for horticultural growing media. Previous studies have shown some benefits of using SMS in several agricultural application such as soil amendment which increased the organic matter, improved soil structure and provided plant-available nutrients [9]; while as surface mulch controlled the weeds [10]. Therefore, this study evaluated the potential of different preparations of SMS as soil amendments or component of a growing medium in horticulture by evaluating the growth of pechay grown in the different combination of SMS preparation, nutrient availability and nutrient supplying/retention capacity in the presence of different N levels of fertilization.

2. Materials and methods

2.1. Treatment description and experimental design

Using pechay as test plant, a two-factorial experiment consisted of four kinds of growing media and three levels of N fertilization was laid out following complete randomized design with three replications. The 12 treatment combinations include: T1 - Garden soil (GS) only, T2 - GS + FSMS (1:2), T3 - GS + WSMS(1:2), T4 - GS + CSMS (1:2), T5 - GS only + 50% RR of N, T6 - GS + FSMS(1:2) + 50% RR of N, T7 - GS + WSMS(1:2) + 50% RR of N, T8 - GS + CSMS(1:2)+ 50% RR of N, T9 - GS only + 100% RR of N, T10 - GS + FSMS (1:2) + 100% RR of N, T11 - GS + WSMS(1:2) + 100%RR of N and T12 - GS + CSMS (1:2) + 100%RR of N. Pots designated 100% RR of N (160 - 0- 0) were fertilized with 7g of urea (46-0-0) while and 3.5 g for 50% RR of N.

2.2. SMS and growing media preparation

The garden soil in the experiment was collected from a surface soil of the UEP experimental station. The soil samples were sieved and heat sterilized prior to mixing. One (1) part of the soil was amended with two (2) parts of SMS (fresh, weathered or carbonized) by weight basis. The SMS was obtained from *Volvariella volvacea* grown in the Mushroom Production Project of UEP, Catarman, Northern Samar, Philippines. One hundred twenty (120) kilos each of weathered and FSMS was mixed separately with sixty (60) kilos of sterile garden soil. Another 120 kg of fresh SMS was subjected to carbonization based on the method of Orge & McHenry [11] and after cooling was mixed with sixty kilos sterile garden soil. The different growing medium preparations were potted at 4kg per pot using a 6 x 11 inches polyethylene bag. The CSMS amended medium which was potted at 3 kg per pot.

2.3. Seedling Preparation and plant establishment

Seedlings were germinated on a sterile mixture of garden soil, compost and carbonized rice hull (1:1:2) for 14 days before transplanting at the rate of one (1) seedling per pot, The plants were irrigated twice each day and maintained under screen house condition.

2.4. Plant yield measurements

Twenty-three days after transplanting, plants were harvested and the fresh weight (shoots and roots) was recorded after washing and subsequent blot drying.

2.5. Chemical analysis

Before and after the experiment during each cropping, soil and growing media samples were collected for chemical analysis. Samples were immediately frozen after sampling and maintained frozen while on transient for laboratory analysis. The samples were freeze-dried prior to analysis at the Laboratory of Environmental Science, Catholic University of Daegu, South Korea. The pH and electrical conductivity (EC) of the soil/growing media samples were measured on a 1:2.5 and 1:5 soil: water (w/v) ratio, respectively [12] while the oxidizable organic C (oxidizable OC) by the Walkley and Black modified method [13]. The total nitrogen by the Kjeldahl method while the available N (NH₄-N

and NO₃-N) was determined by 1N KCl extraction (1:5 w/v, 2 hours shaking) followed by close-system steam distillation. Available P was determined colorimetrically [14]. Exchangeable Na, K, Ca and Mg in soil were determined in the ammonium acetate extract [15] by flame photometry (Na, K) and atomic absorption spectrometry (Ca, Mg). Available Fe, Cu, Mn and Zn in soil were measured in the DTPA extract [16] by atomic absorption spectrometry.

2.6. Statistical analysis

Fresh yield and chemical properties data were subjected to 2-way analysis of variance followed by treatment mean comparison using Tukey's Honesty Significant Difference (HSD) Test at 5% level of significance.

3. Results

3.1. Growth performance of pechay on different growing media preparations as affected by N fertilization

Table 1. Fresh weight, number of leaves and root length of pechay grown for 27 days after transplanting as affected by different growing media and N fertilization at different cropping period.¹

Treatments	Fresh Weight (g/plant)		
	1st Crop	2nd Crop	3rd Crop
T1 –soil	14.96 d	20.12 e	47.83 c
T2 –soil + F SMS	2.00 d	2.84 f	110.00 b
T3 –soil + WSMS	83.80 c	63.84 c	93.60 b
T4 –soil + CSMS	20.20 d	35.27 e	91.63 b
T5 –soil + ½ N	26.70 d	25.26 e	81.19 b
T6 –soil +FSMS + ½N	15.40 d	49.8 d	128.13 a
T7 –soil + WSMS + ½N	182.30 a	116.27 b	117.70 b
T8 –soil + CSMS + ½N	167.30 a	147.34 a	143.20 a
T9 –soil + 100% N	60.50 c	17.85 e	36.50 c
T10 –soil + FSMS + 100%N	20.80 d	44.4 d	144.97 a
T11 –soil + WSMS + 100%N	214.60 a	71.67 c	53.30 c
T12 –soil + CSMS + 100%N	140.00 b	57.16 c	51.40 c

¹Means followed by the same letter(s) are not significantly different from each other based on Tukey's HSD test at 5% level of significance.

The fresh weight of pechay was significantly affected by different growing media and N fertilization at different cropping (Table 1). During the first crop, the average fresh weight of pechay from T11 was highest at 214.6 g while the lowest value of 2.0 g was from T2. Treatments with WSMS as soil amendments with 100% and 50% of urea added had higher yield compared to other treatments. Plants grown in CSMS + 100% RR of urea performed better than those with FSMS and pure soil but inferior to those with WSMS. N fertilization significantly enhanced growth in terms of average fresh weight since T3 (with WSMS) and T4 (with CSMS) which have 0% RR of urea added gave a significantly lower gross weight of 83.3 g and 20.2 g, respectively. Lowest yield was obtained in T2 which is composed of GS + FSMS only. During the second crop, significantly higher fresh yield was obtained in treatments with WSMS and CSMS at 1/2 RR of N fertilizer. Plants from treatments with FSMS are consistently inferior compared to other media regardless of the N fertilization. The full rate of N fertilization did not result in high yield as compared to 1/2 RR of N fertilizer. Lowest yields were observed from growing media in soil + FMS, soil alone at all levels of N fertilizer and soil + CSMS without N fertilizer. On the 3rd crop, plants grown in treatments with FSMS had higher or comparable

yield to other treatments across different levels of N fertilizer application. A significantly lower yield was obtained from treatments with WSMS and CSMS with a full rate of N fertilizer and those from the control (soil alone) and soil + full RR of N fertilizer.

3.2. Chemical properties and nutrient availability of the growing media

The chemical properties of the different growing media were presented in Tables 2a, 2b, and 3a, 3b. Significance differences were observed on pH, EC, Total C, Total N, C/N ratio, available N and available P before and after cultivation of pechay for three cropping (Table 2). Before plant cultivation

Table 2a. The pH, electrical conductivity (EC), total C, total N, C/N ratio, available N and available P of growing media used in the experiments before planting and after the first cropping.¹

Treatments	pH	EC uS/m	Total C (g/kg)	Total N (g/kg)	C/N ratio	Avail. N (mg/kg)	Avail. P (mg/kg)
Before planting							
Soil	5.92 c	126 e	42 c	1.44 c	28.82 c	12.00 e	62.00 a
Soil + FSMS	7.02 b	1021 b	68 a	1.8 b	37.78 b	5.20 f	54.00 b
Soil + WSMS	8.39 a	2640 a	62 b	2.7 a	22.96 c	14.85 d	65.00 a
Soil + CSMS	8.02 a	803 c	78 a	1.1 d	70.91 a	6.80 f	32.00 c
After First Crop							
T1 –soil	6.54 c	145 e	42 c	1.6 c	26.25 c	4.20 f	59.00 b
T2 –soil + F SMS	8.17 a	466 d	74 a	2.0 b	37.00 b	3.20 f	52.92 b
T3 –soil + WSMS	8.68 a	837 c	67 a	2.6 a	26.15 c	12.80 e	63.70 a
T4 –soil + CSMS	8.16 a	417 d	77 a	0.92	83.70 a	5.40 f	31.36 c
T5 –soil + ½ N	5.83 c	428 d	42 c	2.3 b	18.26 c	18.20 d	58.00 a
T6 –soil +FSMS + ½N	7.85 b	432 d	66 a	1.8 b	36.67 b	6.24 f	53.13 b
T7 –soil + WSMS + ½N	8.44 a	986 c	60 b	2.9 a	20.69 c	28.00 c	63.95 a
T8 –soil + CSMS + ½N	8.05 a	709 c	76 a	1.5 c	50.67 b	26.80 c	31.49 c
T9 –soil + 100% N	6.00 c	426 d	41 c	2.1 b	19.52 c	42.00 a	42.00 c
T10 –soil + FSMS + 100%N	7.81 ab	473 d	70 a	2.2 b	31.82 c	8.42 ef	51.54 b
T11 –soil + WSMS + 100%N	8.29 a	1037 b	66 a	2.9 a	22.76 c	32.28 b	62.04 a
T12 –soil + CSMS + 100%N	7.88 ab	744 c	76 a	1.9 b	40.00 b	27.54 c	30.54 c

¹Means followed by the same letter(s) are not significantly different from each other based on Tukey's HSD test at 5% level of significance.

mixing of different SMS preparation increased the pH, EC and total C of growing media compared to soil alone (Table 2a). The magnitude of pH increase was higher due to WSMS and CSMS addition than the FSMS. The EC was increased significantly by SMS addition to growing media with the highest increase due to WSMS. The total C also increased due to the mixing of SMS especially the CSMS. FSMS and WSMS increased slightly the total N content but CSMS decreased the total N of the

growing media. Consequently, highest C/N ratio was observed due to the addition of CSMS. The available N and P were significantly enhanced by WSMS addition but reduced due to FSMS and CSMS based on the control soil.

After the first (Table 2a) and second crop cultivation (data not shown), the pH, EC, and total C followed the same trend to that observed before crop cultivation regardless of the N fertilization. On the other hand, the total N, C/N ratio, available N, and P showed considerable differences and patterns. The total N was increased due to N application that consequently decreased the C/N ratio. However, the available N levels showed greater variability and behave differently compared to total N (Figure 1). Addition of N fertilizer increased the available N concentration in growing media with WSMS and CSMS but not in growing media with FSMS. The available P followed the same trend with available N but of lower magnitude. In table 2b, noticeable increase EC, available N and P and the decrease in total C and C/N in FSMS amended treatments as compared to other treatments and to its previous values obtained after the first and second crop. On the other hand, the available N and P of treatments with WSMS and CSMS supplied with 100% RR of N fertilizer declined and the values were even lower compared to WSMS and CSMS treatments with 1/2 N fertilizer.

Table 3a, showed a significant increased on the exchangeable K, Ca, Mg and Na and available Cu, Mn, and Zn due to mixing of different preparations of SMS before planting and after the first crop. Although the three preparations did not differ significantly, a higher concentration of exchangeable basis and available micronutrient was observed due to carbonized SMS. Only the available Fe were not altered significantly by mixing different SMS preparations with soil in the growing media. After the second crop (data not shown) and after the 3rd crop (Table 3b), a general decrease of the exchangeable K, Ca, Mg and Na and available Cu, Mn, and Zn were observed. However, after the 3rd

Table 2b. The pH, electrical conductivity (EC), total C, total N, C/N ratio, available N and available P of growing media used in the experiments.¹

Treatment	pH	EC uS/m	Total C (g/kg)	Total N (g/kg)	C/N ratio	Availabl e N (mg/kg)	Availabl e P (mg/kg)
After 3rd Crop							
T1 –soil	6.12 c	146 d	42 c	1.5 b	28.00 c	4.38 e	32.28 b
T2 –soil + F SMS	7.94 a	824 a	52 b	1.7 b	30.23 b	38.28 b	64.22 a
T3 –soil + WSMS	8.04 a	423 b	61 a	1.6 b	38.13 b	16.28 d	36.12 b
T4 –soil + CSMS	7.72 a	386 c	76 a	0.8 c	90.48 a	12.18 d	21.48 c
T5 –soil + ½ N	5.82 c	468 b	41 c	1.8 b	22.78 c	19.22 c	32.18 b
T6 –soil +FSMS + ½N	7.41 ab	892 a	46 b	2.3 a	20.00 c	48.24 a	52.12 a
T7 –soil + WSMS + ½N	7.88 a	827 a	48 b	2.5 a	19.20 c	43.24 b	42.13 b
T8 –soil + CSMS + ½N	7.62 ab	726 a	74 a	2.4 a	30.83 b	39.48 b	24.18 c
T9 –soil + 100% N	5.68 c	548 b	42 c	1.8 b	23.33 c	24.12 c	24.17 c
T10 –soil + FSMS + 100%N	7.54 ab	926 a	48 b	2.3 a	20.87 c	58.34 a	48.26 a
T11 –soil + WSMS + 100%N	8.00 a	724 a	49 b	2.7 a	18.15 c	19.24 c	24.00 c
T12 –soil + CSMS + 100%N	7.58 ab	634 b	72 a	2.1 a	34.29 b	18.26 c	16.21 d

¹Means followed by the same letter(s) are not significantly different from each other based on Tukey's HSD test at 5% level of significance

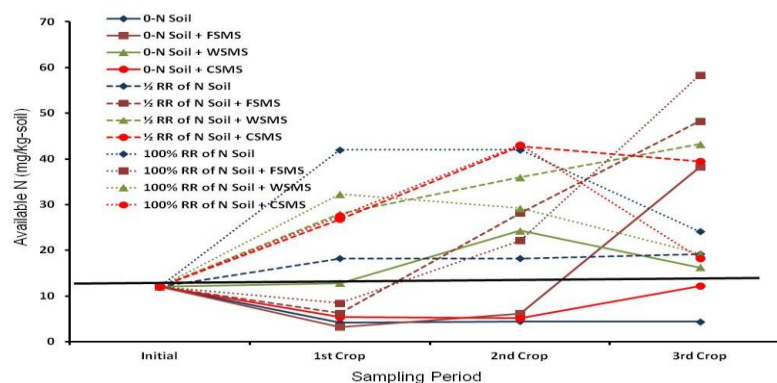


Figure 1. Amount of available N in the growing media before and after each crop of pechay for 3 consecutive cropping. Solid black line indicate the initial level of available N in soil. crop, the amounts of exchangeable K and Ca in WSMS and CSMS in 1/2 RR and 100% RR N fertilized were significantly lower compared to other treatments. The exchangeable K and Ca in WSMS and CSMS in 1/2 RR and 100% RR N fertilized decreased in higher magnitude compared to others while those with FSMS had increased considerably.

4. Discussion

The variable growth based on the fresh yield of pechay grown in different growing media with different levels of N fertilization and at different successive cropping is an indication of the potential of different preparation of SMS as a component growing medium of potted plants. Our results showed how these different preparations would affect nutrient availability especially on N and P. The variable growth of pechay could be attributed to differences in the chemical properties of the different soil: SMS mixtures with different preparation as affected by time. Based on the initial chemical analysis

Table 3a. Exchangeable K, Ca, Mg and Na and the available Fe, Cu, Mn, and Zn of growing media used in the experiments after the first crop.¹

Treatments and Soil Preparations	Exchangeable Bases				Available Micronutrients			
	K (g/kg)	Ca (g/kg)	Mg (g/kg)	Na (g/kg)	Fe (mg/kg)	Cu (mg/kg)	Mn (mg/kg)	Zn (mg/kg)
Before planting								
Soil	0.38 c	3.67 b	0.58 b	0.35 b	1.85 a	1.38 b	6.40 b	2.12 b
Soil + FSMS	0.43 b	4.11 a	0.65 a	0.39 a	2.07 a	1.55 a	7.47 a	2.37 a
Soil + WSMS	0.45 a	4.32 a	0.68 a	0.41 a	2.18 a	1.62 a	7.53 a	2.49 a
Soil + CSMS	0.46 a	4.80 a	0.70 a	0.42 a	2.22 a	1.66 a	7.68 a	2.54 a
After First Crop								
T1 –soil	0.39 c	3.62 b	0.58 b	0.34 b	1.70 a	1.43 b	6.24 b	2.18 b
T2 –soil + F SMS	0.42 c	4.03 a	0.64 a	0.38 a	2.03 a	1.51 a	7.02 a	2.33 a
T3 –soil + WSMS	0.44 a	4.23 a	0.67 a	0.40 a	2.13 a	1.59 a	7.38 a	2.44 a
T4 –soil + CSMS	0.45 a	4.70 a	0.68 a	0.41 a	2.17 a	1.62 a	7.52 a	2.49 a
T5 –soil + 1/2 N	0.32 d	3.58 b	0.59 b	0.36 b	1.78 a	1.39 b	6.45 b	2.01 b
T6 –soil +FSMS + 1/2N	0.42 b	4.04 a	0.64 a	0.39 a	2.04 a	1.52 a	7.05 a	2.34 a
T7 –soil + WSMS + 1/2N	0.44 a	4.25 a	0.67 a	0.40 a	2.14 a	1.60 a	7.41 a	2.45 a
T8 –soil + CSMS + 1/2N	0.45 a	4.72 a	0.68 a	0.41 a	2.18 a	1.63 a	7.55 a	2.50 a
T9 –soil + 100% N	0.28 d	3.64 b	0.52 b	0.42 a	1.68 a	1.32 b	6.14 b	2.21 ab
T10 –soil + FSMS + 100%N	0.41 c	3.92 ab	0.62 a	0.39 b	1.98 a	1.48 a	6.84 a	2.27 ab
T11 –soil + WSMS +	0.43b	4.12 a	0.65 a	0.39 a	2.08 a	1.55 a	7.18 a	2.38 a

100%N

T12 –soil + CSMS + 0.44 a 4.58 a 0.66 a 0.40 a 2.12 a 1.58 a 7.33 a 2.43 a

100%N

¹Means followed by the same letter(s) are not significantly different from each other based on Tukey's HSD test at 5% level of significance.

conducted before cropping, SMS mixture would increase the pH of soil which could be attributed to the liming contents of SMS during its preparation. Calcium sulfate is added on the mushroom substrate during preparation to neutralize the pH of the composting mixture of residues and to supply the suitable level of Ca for mushroom [17]. The pH observed in the growing media is quite high than the normal pH for crops which is about 6.5 [18]. Increase in pH will affect nutrient dynamics especially the availability of P and other micronutrients (Table 2a and Table 3a). Similarly, the EC values in SMS amended growing media was increased due to SMS preparations indicating the capacity of SMS preparation to increase the soluble nutrients in the growing media. This is supported by a higher concentration of exchangeable basis and available micronutrients determined after crop cultivation. However, it should be noted that before crop cultivation, the EC of the growing media with different SMS exceed the suggested reference level ($605 \mu\text{S m}^{-1}$) [17].

Based on the data presented, the different preparations of SMS had greatly affected the N availability in the growing media. It appeared that FSMS will result to high N immobilization throughout the duration of the first and 2nd cropping period resulted in an inferior growth of pechay even in the presence of full rate of N fertilizer. This could be attributed to high C/N ratio and the nature of organic C present in the growing media containing FSMS (Figure 1). It should be noted that the N-immobilization in FSMS containing growing media was occurring at a very high rate because the added N fertilizer did not improve the growth of pechay (low fresh weight) and that the available N levels after crop cultivation remained low (Table 1, 2a, 2b). In contrast, WSMS and CSMS showed higher N availability (Table 2a and 2b) which implied that net N mineralization takes place. Weathering of SMS prior to mixing in the growing media resulted to low C/N ratio that favored mineralization [19], [20]. In fact, the addition of WSMS slightly increased the available N in the growing media indicating that WSMS released some available N ready for plant uptake. Consequently, additional N fertilizer increased the available N for plant use resulted in enhanced growth of pechay during the first and second crop. On the other hand, carbonization process of SMS transformed the SMS-C into a non-bioavailable form that is not reactive to microbial attack [21], [22]. Even if the C/N ratio of the growing media containing CSMS is high, this did not result to biological N immobilization. Probably, CSMS had increase available N absorption into the C matrix that resulted to N-fixation (physical N-immobilization) as can be observed by low growth of pechay receiving half rate of fertilizer N [20]. During the 3rd crop, a considerable increased in the fresh yield of pechay in growing media containing FSMS while those plants grown in media containing WSMS and CSMS had low fresh yield regardless of the N fertilizer level (Table 1). The increase in yield in FSMS containing growing media could be attributed to an increase in available N and P, and other nutrients as indicated in the residual nutrients after the 3rd crop. This would imply that at this stage, FSMS was able to reach a condition that promotes nutrient mineralization rather immobilization as observed during the 1st and 2nd cropping, hence an increase of nutrients occurred (Table 2c and 3c). In contrast, the decline in fresh yield of pechay from WSMS and CSMS containing growing media despite the supply of N fertilizer would indicate that some other nutrient became limiting for optimal growth as indicated in lower K and Ca contents in these treatments. It appeared that at 3rd-crop, nutrient imbalance occurred in WSMS and CSMS containing media causing slow growth of test plant. This nutrient imbalance could be due to previous nutrient uptake depleting some nutrients.

Table 3b. Exchangeable K, Ca, Mg and Na and the available Fe, Cu, Mn, and Zn of growing media used in the experiments after the third crop.¹

Treatments	Exchangeable Bases				Available Micronutrients			
	K	Ca	Mg	Na	Fe	Cu	Mn	Zn
	(g/kg)				(mg/kg)			
<i>After Third Crop</i>								
T1 –soil	0.35 c	3.56 b	0.50 c	0.32	1.68	1.42	6.02	2.10 b

				b	a	b	b	
T2 –soil + F SMS	0.48 a	4.28 a	0.62 b	0.43 a	2.16 a	1.56 a	6.52 b	2.46 a
T3 –soil + WSMS	0.42 b	4.12a	0.63 b	0.38 a	2.06 a	1.32 b	7.06 a	2.42a
T4 –soil + CSMS	0.40 b	4.24 a	0.62 b	0.39 a	2.01 a	1.46 b	7.04 a	2.48 a
T5 –soil + ½ N	0.32 d	3.46 b	0.58 b	0.34 b	1.84 a	1.36 b	6.33 b	2.15 b
T6 –soil +FSMS + ½N	0.46 a	4.38 a	0.68 a	0.46 a	2.13 a	1.65 a	6.76 a	2.53 a
T7 –soil + WSMS + ½N	0.36 c	3.08 b	0.60 b	0.41 a	2.02 a	1.56 a	7.16 a	2.38 a
T8 –soil + CSMS + ½N	0.38 c	3.34 b	0.55 c	0.42 a	2.00 a	1.52 a	7.24 a	2.42 a
T9–soil + 100% N	0.31 d	3.64 b	0.51 c	0.40 a	1.79 a	1.34 b	6.14 b	2.22 a
T10 –soil + FSMS + 100%N	0.48 a	4.53 a	0.69 a	0.44 a	2.56 a	1.64 a	6.96 a	2.48 a
T11 –soil + WSMS + 100%N	0.32 d	3.20 b	0.57 c	0.37 a	2.19 a	1.48 b	6.88 a	2.30 a
T12 –soil + CSMS + 100%N	0.31 d	3.14 b	0.62 b	0.40 a	2.15 a	1.54 a	7.02 a	2.26 a

[†]Means followed by the same letter(s) are not significantly different from each other based on Tukey's HSD test at 5% level of significance.

5. Conclusions

Overall, our study has shown that the different preparation of SMS as a component in growing media of potted plants resulted to varying biochemical properties affecting nutrient dynamics and availability. Based on our results, WSMS is the best preparation for the component in growing media as it increases the N and P availability, favorable C/N ratio and increased micronutrient contents. CSMS could be favorably used as a component of growing media as it also improves nutrient availability especially increasing the exchangeable basis and available micronutrient essential for plant growth. This would also follow that WSMS and CSMS will be appropriate as soil amendments in the field compared to the addition of FSMS which could be detrimental to N availability immediately after application. Application of FSMS may cause nitrogen immobilization for a prolonged period which may result in nitrogen deficiency of existing crops or newly planted crops when applied directly to the soil. Therefore, WSMS and CSMS could be used in the preparation of growing media or as soil amendments that will contribute to their disposal in an environment-friendly way and reduces the need for peat simultaneously.

6. References

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