SOME NUTRITIONAL ASPECTS OF SOIL-LESS MIXTURES USED IN GROWING STRAWBERRY IN A RAISED BED TROUGH SYSTEM

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Summary. The research team composed of the California Strawberry Commission, collaborating researchers and growers initiated the trials on the use of soil-less substrates as alternatives to the production of strawberry eliminating the need for fumigation. The primary motivation is to find a cost-effective strawberry production system that does not require soil fumigants. Strawberries are produced on raised beds in substrates or soil plus substrate mixtures that are isolated from field study by a landscape fabric. The field trials were initiated near Santa Maria, CA and at Monterey Bay Academy near Watsonville, CA in Fall 2010. The treatments consisted of 100% coir, 50:50 mix of peat:perlite, 50:50 mix of steamed soil + amendments, fumigated and untreated growerôs standard. The main objective of this paper is to present some nutritional properties of the soil-less substrates monitored periodically. The properties monitored were pH, electrical conductivity (EC), nitrate (NO_3-N), ammonium (NH_4-N) and phosphorus (P). It took about 3-4 months for the pH of the coir and peat:perlite mixture to reached the target value of 5.7. The amended soil had generally low pH (3.14 to 5.21) at all sampling periods. The ECs of coir and peat:perlite were generally low while the amended soil had high ECs at all sampling periods. The NO_3-N and P were high in the coir and peat:perlite and low in the standard bed soil. At all sampling periods, the NH_4-N was below the target value of 14ppm.

Methods. The studies were set-up in randomized complete block design consisting of 5 treatments replicated 4 times. The treatments were 1.) 100% coir, 2.) 70:30 peat:perlite mixture, 3.) 50% steamed soil + 50% amendments (25% rice hulls and 25% coir), 4.) fumigated grower standard and 5.) non-fumigated grower standard. Soil-less substrates and soil (from the growerôs standard bed) samples were collected from each strawberry bed before planting and periodic sampling thereafter. The initial samples were collected from the center of the plot in each bed using a trowel. Once the strawberry were established, the samples were collected from at least 1-m distance from the border of each plot in the bed. The samples were air-dried for 2-3 days, crushed and sieved in no. 10 mesh. The samples were analyzed for pH, EC, NO_3-N, NH_4-N and P. The pH and EC were analyzed from saturated paste and extract, respectively. This was done by mixing gradually and uniformly an amount of dry soil or soil-less substrate with deionized water in plastic cup until saturation was reached. After one-hour, the pH was determined by inserting the electrode attached to a calibrated pH meter directly into the saturated paste. Then, the saturated paste was transferred to a

filtration cup lined with 0.45-υm membrane filter and suction was applied to obtain an extract which was used to determine the EC. The NO_3-N and NH_4-N of the soil and soil-less substrates were analyzed by treating the sample with 2*N* KCl, shaken in a mechanical shaker, and filtered through filtration cup lined with 0.45-υm membrane filter by applying suction. NO_3-N of the extract was determined by color development with chromotropic acid, and quantified by UV-VIS spectrophotometer set at 420-nm wavelength. Twenty-mL of the extract was also used for determination of NH_4-N which was carried out by inserting an ammonia electrode connected to a pH/mV meter (Thermo Orion Model 720A) calibrated for ammonium analysis and the electrode potential was recorded. The analysis of P was done from an aliquot of the 2*N* KCl extract for the coir and peat:perlite samples. For the amended soil and soil from the growerôs standard bed, 0.5*M* $NaHCO_3$, pH 8.5 (Olsen) was used as the extractant. P analysis and quantification was done by the Murphy-Riley color development and the absorbance was read on UV-VIS spectrophotometer set at 720-nm wavelength. The actual amount of NO_3-N, NH_4-N and P was calculated from a calibration curve prepared from a set of standards which was also run together with the samples.

Results. The results of monitoring some nutritional aspects of soil-less substrates and soil are presented in Tables 1 and 2 for the Santa Maria and MBA sites, respectively. The highlights of the results are as follows:

1. The pH of 100% coir and 50:50 mix of peat:perlite was lower in the early sampling periods but increased with time reaching the targeted value of 5.7. It took almost 3-4 months for the pH to increase and reached the target value which could be attributed to the high buffering capacity of these soil-less substrates. The pH of the amended soil treatment (AS) at both sites were generally low (ranged from 3.14 to 5.21) at all sampling periods and did not reached the target value.
2. The EC target values are 2.0 and 1.5 mS/cm for soil-less substrates and mineral soil, respectively. However, the ECs of 100% coir and peat:perlite mixtures at the MBA site were generally below the target value of 2-mS/cm, but those in the Santa Maria site were within the target range. The amended soil had consistently higher ECs in both sites at all sampling periods. The soil in the growerôs standard bed of the Santa Maria site had higher ECs compared to the MBA.
3. The soil-less substrates are considered to be low in nutrients; thus, fertilization is one of the key issues in using these for strawberry production. Surprisingly, the initial NO_3-N of 100% coir and peat:perlite mixture in both sites was higher. In Santa Maria, a target value of 100ppm NO_3-N was maintained in beds with coir and mixture of peat:perlite except for the sampling on 12-09-2010. However, the NO_3-N of the coir and peat:perlite treatments in the MBA site was below the target value at sampling periods on 06-16-2011 and 07-18-2011. The growerôs standard beds had generally low NO_3-N.
4. At all sampling periods, the NH_4-N was lower than the target value of 14 ppm.
5. The available P significantly differed among media treatments in both sites at all sampling periods. The target P-level (~30 ppm) was maintained in all of the media treatments.

Table 1. Some chemical properties of soil and soil-less substrates collected from Santa Maria*

Treatment	Sampling Period					
	11-12-10	12-09-10	02-08-11	04-09-11	06-14-11	07-14-11
			a. pH			
CO	5.50 b[z]	5.63 b	5.55 b	6.02 b	6.10 b	6.16 b
PP	5.19 c	5.59 b	5.19 c	5.77 b	6.16 b	6.32 b
AS	4.41 d	4.08 c	3.57 d	3.14 c	3.47 c	4.30 c
FUM	7.69 a	7.52 a	7.44 a	7.42 a	7.59 a	7.61 a
UTC	7.62 a	7.71 a	7.55 a	7.48 a	7.60 a	7.76 a
			b. Electrical Conductivity, mS/cm			
CO	3.23 a	2.44 ab	1.82 b	1.33 b	3.41 b	2.42 c
PP	2.83 a	1.50 c	1.69 b	1.86 b	2.78 b	2.17 c
AS	3.14 a	2.89 a	3.28 a	2.55 a	5.03 a	3.60 a
FUM	1.84 b	2.05 b	2.71 a	1.83 b	3.60 b	3.14 ab
UTC	1.18 c	0.97 d	1.19 b	1.94 b	2.74 b	2.65 bc
			c. Nitrate-N (NO_3-N), ppm			
CO	160.41 b	56.64 ab	126.06 a	46.32 b	141.76 a	125.83 a
PP	210.93 a	34.75 b	130.91 a	209.77 a	155.11 a	97.69 a
AS	94.29 c	36.50 b	127.95 a	104.19 c	14.98 a	61.30 b
FUM	38.46 d	70.24 a	12.96 b	14.91 d	21.24 b	9.78 c
UTC	39.58 d	80.36 a	8.38 b	24.10 d	7.26 b	8.29 c
			d. Ammonium-N (NH_4-N), ppm			
CO	2.86 d	3.84 c	4.43 b	3.01 c	3.44	3.82
PP	10.27 a	6.35 bc	4.45 b	5.86 a	3.33	5.10
AS	2.79 d	7.06 ab	9.10 a	4.84 ab	4.48	6.19
FUM	9.60 b	9.29 a	4.92 b	5.15 ab	4.23	6.48
UTC	3.81 c	4.46 bc	4.10 b	4.34 b	4.34	5.95
			e. Available P, ppm			
CO	38.39 a	24.28 b	46.01 a	32.14 b	55.04 a	91.08 a
PP	34.67 a	16.12 c	43.02 a	22.49 c	61.54 a	118.11 a
AS	9.30 b	21.23 bc	15.04 b	11.02 d	21.96 b	29.34 b
FUM	39.00 a	33.89 a	46.56 a	50.84 a	48.20 a	48.75 b
UTC	34.71 a	37.63 a	48.47 a	46.10 a	51.66 a	55.94 b

*CO = 100% Coir PP = Peat:Perlite (70:30)
AS = Soil (50%) + Amendment (25% Rice Hulls:25% Coir)
FUM = Growerôs Standard, Fumigated UTC = Growerôs Standard, Untreated

[z]Means with the same letter and those without letters within a column are not significantly different using leas significant difference at $P \leq 0.05$.

Table 2. Some chemical properties of soil and soil-less substrates collected from Monterey Bay Academy*

Treatment	Sampling Period					
	11-12-10	12-09-10	02-08-11	04-09-11	06-14-11	07-14-11
			a. pH			
CO	5.58 b[z]	5.47 c	5.45 c	6.20 a	6.13 a	6.33 b
PP	4.81 c	4.96 d	6.00 b	6.16 a	6.40 a	6.83 a
AS	4.45 d	4.06 e	4.09 d	3.81 b	5.09 b	5.21 c
FUM	5.76 a	6.73 a	6.28 a	6.23 a	6.32 a	6.35 b
UTC	5.76 a	5.80 b	6.14 ab	6.31 a	6.37 a	6.23 b
			b. Electrical Conductivity, mS/cm			
CO	2.99 b	1.28 ab	1.09 b	0.95 b	0.89 bc	0.61 bc
PP	2.44 c	1.02 b	1.13 b	0.85 b	1.01 b	0.89 ab
AS	3.82 a	1.67 a	1.80 a	2.35 a	1.51 a	1.16 a
FUM	1.03 a	0.45 c	0.49 c	2.25 a	0.73 c	0.58 c
UTC	1.03 a	0.55 c	0.55 c	1.41 b	0.66 c	0.58 c
			c. Nitrate-N (NO_3-N), ppm			
CO	145.91 a	18.84 ab	121.39 a	116.35 a	39.52 b	26.73 b
PP	92.24 b	25.00 a	138.94 a	95.83 a	68.73 a	79.29 a
AS	32.36 c	27.79 a	56.23 b	50.47 b	12.63 c	16.09 bc
FUM	15.03 d	11.59 b	2.36 c	9.66 c	1.21 c	9.65 bc
UTC	15.03 d	9.60 b	4.25 c	5.26 c	0.94 c	3.22 c
			d. Ammonium-N (NH_4-N), ppm			
CO	6.69 c	9.14 b	2.68 b	2.95 b	2.17	4.50 b
PP	10.66 a	10.50 b	9.52 a	3.35 b	2.56	5.48 b
AS	4.26 d	10.65 b	8.23 a	3.50 b	2.56	4.99 b
FUM	8.48 b	14.51 a	9.46 a	5.74 a	3.38	7.10 a
UTC	8.48 b	11.38 ab	3.79 b	3.54 b	2.81	6.89 a
			e. Available P, ppm			
CO	29.82 a	18.83 c	24.77 b	27.56	35.89 b	33.22 c
PP	29.44 a	9.20 c	70.43 a	30.05	46.46 b	54.83 bc
AS	18.77 b	49.05 a	60.67 a	44.30	91.45 a	80.68 a
FUM	29.76 a	32.70 b	35.31 b	33.89	51.07 b	57.70 ab
UTC	29.76 a	37.56 ab	34.60 b	34.24	51.90 b	52.01 bc

*CO = 100% Coir PP = Peat:Perlite (70:30)
AS = Soil (50%) + Amendment (25% Rice Hulls:25% Coir)
FUM = Growerôs Standard, Fumigated UTC = Growerôs Standard, Untreated

[z]Means with the same letter and those without letters within a column are not significantly different using leas significant difference at $P \leq 0.05$.