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A Comparison of Coconut Coir and Sphagnum Peat as Soil-less Media Components for Plant Growth

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INTRODUCTION

Coconut coir, a by-product of the coconut industry, has been promoted as an alternative to peat moss in soil-less media. Sphagnum peat moss has long been a standard component of soil-less media, but some people have expressed concern that it is a non-renewable resource. Although it does not appear that world peat resources will be in short supply for a very long time (see www.peatmoss.com), coconut coir may have characteristics that make it a useful component of soil-less media mixes. Coir has been considered to promote excellent plant growth but there are few rigorous studies that have compared it with peat moss control plants. However, ten years ago, Meerow (1994) found that growth of *Ixora coccine* was significantly reduced compared to growth in a sphagnum peat moss control. Vavrina (1996) found that there were no adverse effects of coir to tomato and pepper transplants, but a subsequent study in the same lab (Arenas et al., 2002) found that media with more than 50% coir had reduced growth compared to peat-grown control plants. They suggested that a high N immobilization by microorganisms and a high C:N ratio in the coir may have caused the reduced growth. Lopez-Galarza (2002) found that root development of strawberry plants grown in peat moss was better than in coir in some, but not all, studies.

Handreck and Black (2002), in a comprehensive textbook on soil-less media, review the chemical and physical properties of coir dust that are being sold in Australia. They indicate that since all coir products have extremely high K contents and low Calcium contents, it is critical to add a source of Ca to improve plant calcium uptake. Since the pH is already close to 6, liming materials cannot be used because they would increase the pH above optimum. Handreck and Black says that “Therefore, all coir-based media must be amended with gypsum, which also overcomes their low sulfur status.”

Ma and Nichols (2004) recently reported that the problems with coir extend beyond its high salinity. Their data indicate that high concentrations of phenolic compounds in fresh coir are at least partly responsible for the growth reductions observed in other studies. Several studies at the USU Crop Physiology Laboratory indicated that monocots grown in coconut coir were extremely chlorotic and stunted. The objective of this study was to see if there are differences among plant species and types of coconut coir compared to growth in sphagnum peat moss.

MATERIALS AND METHODS - TRIAL 1

All trials were performed in a greenhouse, using natural sunlight with supplemental high pressure sodium lamps. Two brands of coconut coir were used: Tropic Gro® and Germinaza Paca®, both products of Mexico. Sunshine® brand peat moss, a product of Canada, was used as the control. Paxlite® brand perlite was mixed at a 50/50% ratio with the coir or peat in all of the planting media.

Six species of crops were used: sunflower cv. *Aztec Gold Hybrid,* soybean cv. *Hoyt,* corn cv. *Phenomenal,* wheat cv. USU-*Apogee*, radish cv. *Cherry Belle,* and broccoli cv. *Green Goliath.* Each treatment included two replicate pots containing three plants each.

Treatment 1: **Our standard greenhouse mix.** A 50/50% mix by volume of peat moss and perlite to get 12 cubic feet of media with 800g of dolomite lime. This was blended in a soil mixer for twenty minutes. Five-inch pots, two for each cultivar, were filled with the mix. The pots were then watered. Once the substrate had settled, seeds were then planted in three areas of the pot. Depending on seed size, more than one seed may have been planted in each area. Once emerged, pots were then thinned to only one plant per area.

Treatment 2: A 50/50% mix by volume of **Tropic Gro® coconut coir** and perlite. The mix was made by combining a volume of five gallons each of coconut coir and perlite, then mixing by hand in a plastic storage bin.

Treatment 3: A 50/50% mix by volume of **Germinaza Paca® coconut coir** and perlite. The ingredients were then mixed by shovel until there was an even distribution of coir and perlite.

Treatments 2 and 3 did not require dolomite lime because they have a pH suitable for growing all of the crops tested. The planted pots were placed in a greenhouse. A fertigation emitter was placed in the center of each pot. The pots were watered twice a day, at 8 am and 6 pm, with a dilute solution of Peters® 20-10-20 fertilizer, Fe EDDHA, and Na_2SiO_3. The nutrient solution provided 7.0 mM of N, 1.4 mM of P, 2.0 mM of K, 10 µM of Fe, and 10µM of Si.

After 24 days of growth, pictures were taken of the crops side by side in the appropriate treatments. Chlorophyll content was measured on each plant with a Minolta® SPAD chlorophyll content meter. Five measurements were taken per rep, and ten sub-measurements were taken for every measurement. Sub-measurements were averaged and recorded as a single measurement.

Electrical conductivity was measured on all of the planting mixes. EC was measured by combining a 1:1 ratio of media to DI-water. The resulting slurry was then stirred for thirty minutes and measured. The electrical conductivity of tap water was also measured for comparison.

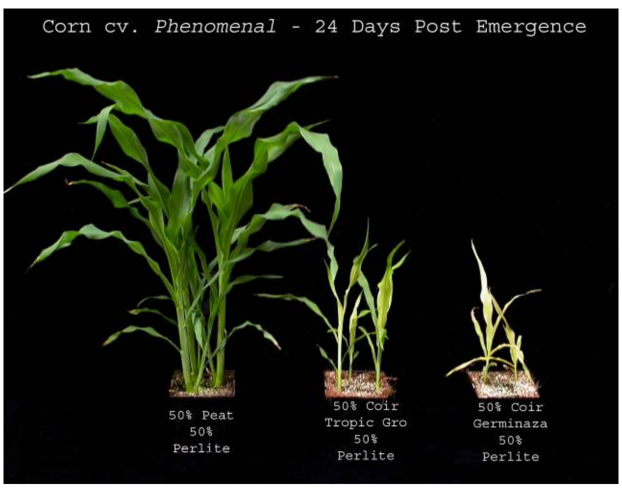
RESULTS – TRIAL 1

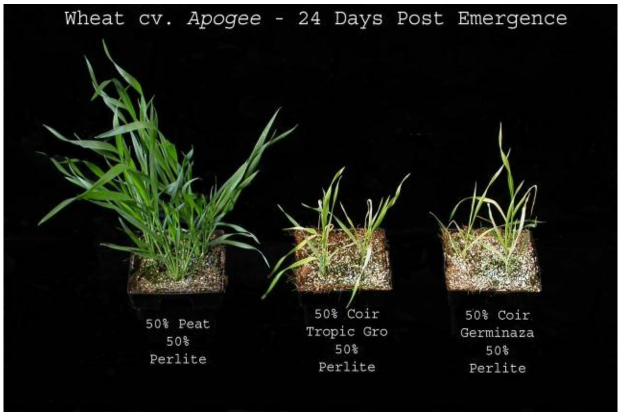
Chlorophyll content was a good indicator of plant health. Although some nutrient imbalances cause leaves to be more dark green than they would be under optimal conditions, in this study higher chlorophyll readings and darker green leaves (Table 1) were correlated with better plant growth (see photos).

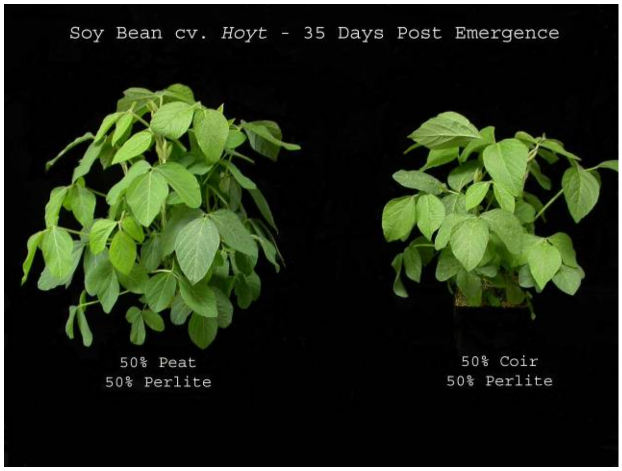
Table 1. Chlorophyll content of plants of each species in each treatment. SPAD data are presented as % of the Peat/Perlite control.

	Peat/Perlite	Germinaza Paca Coir/Perlite	Tropic Gro Coir/Perlite
Sunflower	100	86	93
Soybean	100	N/A	92
Corn	100	51	20
Wheat	100	32	31
Radish	100	92	91
Broccoli	100	93	66

N/A: Soybean plants were grown only in peat/perlite and Germiniza Paca coir/perlite.







Electrical conductivity, a measure of the soluble salts in a solution, can reduce plant water potential and thus plant growth. The EC of both the coir/perlite mixes was significantly higher than the peat/perlite mix, while the EC of tap water was much closer to the EC of peat/perlite (Figure 1). This high EC may have contributed to the reduced growth, but wheat is among the most tolerant plants to high salinity. Furthermore, frequent irrigation should have leached out excess salts.

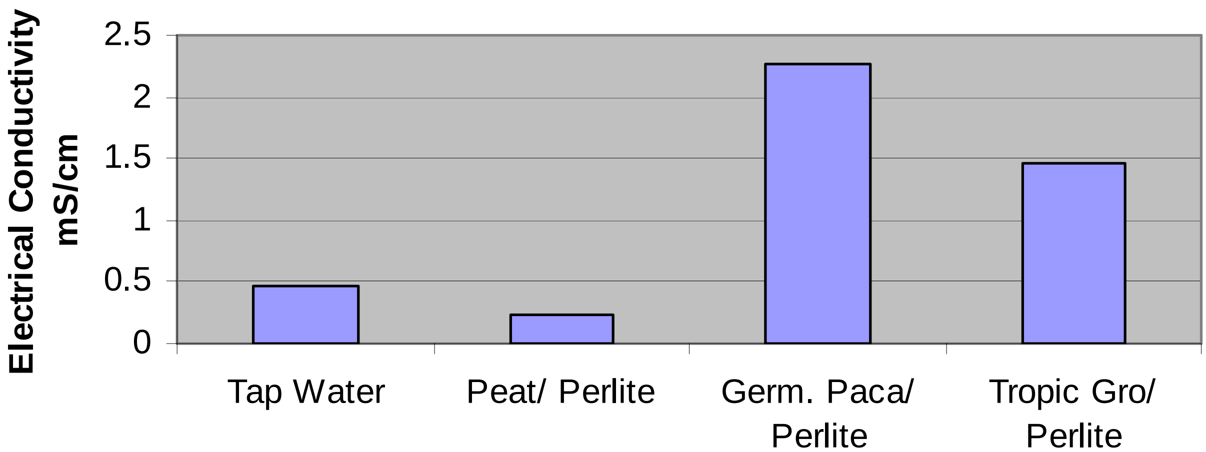


Figure 1. Electrical conductivity of tap water and of the planting media in Trial 1.

MATERIALS AND METHODS- TRIAL 2

A second trial was conducted to compare coconut coir from both Mexico and Sri Lanka. The coir from Mexico was the same as used in the previous trial. The Sri Lankan coir brands were Grow Coir®, Canna®, and Sun Leaves®. Media was mixed using a 1 to 1 ratio, by volume, of substrate and perlite. Corn and broccoli were selected for this trial because of the poor development of these species in the previous trial. Two levels of calcium sulfate (0.5 and 1.5 g/L) were added to the coir treatments to increase the calcium availability to the plants. Because of the low electrical conductivity of the Sri

Lanka based coir brands only one replication was used for each treatment of calcium sulfate. Two replications were used for each calcium sulfate treatment in the Mexican coir brands. Sphagnum peat/perlite (1:1) was the control. All coir brands had a control without calcium sulfate. The plants were watered twice a day, at 8 am and 6 pm, with a dilute solution of Peters® 20-10-20 fertilizer, Fe EDDHA, and Na_2SiO_3. The nutrient solution provided 7.0 mM N, 1.4 mM P, 2.0 mM K, 10 µM Fe, and 10µM Si. This treatment applied ample chelated iron for normal growth.

RESULTS – TRIAL 2

The electrical conductivity of all three Sri Lankan coir brands was significantly lower than either of the two the Mexican coir brands (Figure 2).

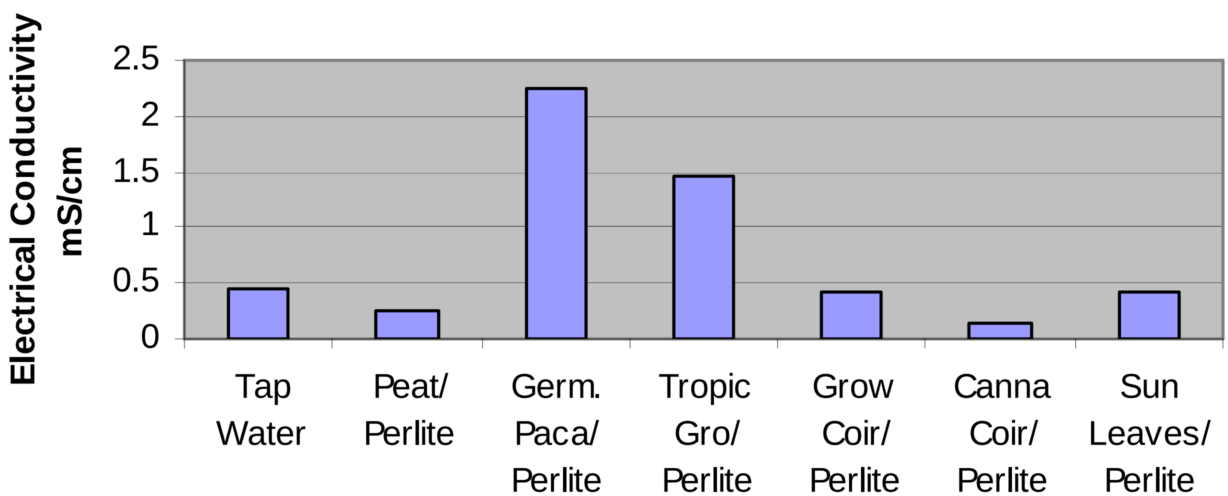


Figure 2. Electrical conductivity of tap water and of the media in Trial 2.

The results of this trial varied with species, brand of coir, and calcium sulfate treatment. While sphagnum peat performed the best of any media, Grow Coir® performed the best of any of the coir brands for both species. The addition of calcium sulfate appeared to be of some benefit in some treatments. Sri Lanka based coir brands performed better than the Mexico based coir brands.

Two representative plants from each treatment were selected and harvested just above the soil surface. As expected, increased fresh and dry weight (Table 1) was correlated with better looking plants (Table 2 and photos).

Table 1. Fresh and dry weights of corn and broccoli expressed as percent of the peat control.

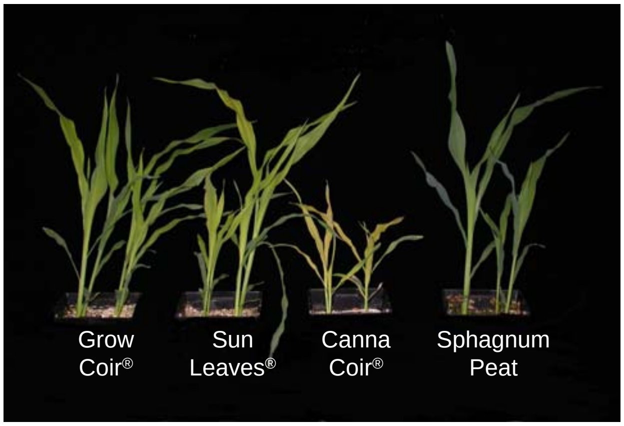
	CORN Treatment	Avg. Fresh Mass	Avg. Dry Mass	BROCCOLI Treatment	Avg. Fresh Mass	Avg. Dry Mass
Control	Peat	100	100	Peat	100	100
Coir from Mexico	Tropic Gro	20	18	Tropic Gro	16	15
	0.5 g/L	17	23	0.5 g/L	9	9
	1.5 g/L	2	3	1.5 g/L	15	12
	Germ. Paca	26	12	Germ. Paca	35	32
	0.5 g/L	29	10	0.5 g/L	122	113
	1.5 g/L	23	1	1.5 g/L	78	81
Coir from Sri Lanka	Sun Leaves	21	46	Sun Leaves	76	62
	0.5 g/L	76	76	0.5 g/L	99	106
	1.5 g/L	57	52	1.5 g/L	137	144
	Canna	23	80	Canna	101	112
	0.5 g/L	5	3	0.5 g/L	99	122
	1.5 g/L	12	7	1.5 g/L	31	35
	Grow Coir	76	71	Grow Coir	66	73
	0.5 g/L	86	86	0.5 g/L	103	126
	1.5 g/L	20	78	1.5 g/L	95	122

Table 2. Average plant health scores for corn and broccoli.

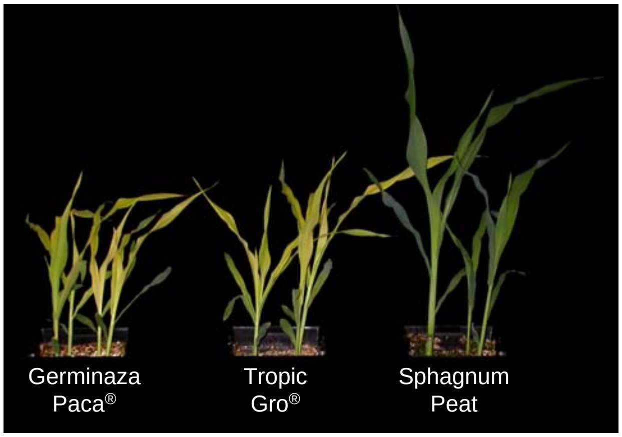
	Treatment	CORN	BROCCOLI
Control	Peat	4	4
Coir from Mexico	Tropic Gro	2	1
	0.5 g/L	1.5	1
	1.5 g/L	1	1
	Germ. Paca	2	1
	0.5 g/L	2	2.25
	1.5 g/L	1	2.25
Coir from Sri Lanka	Sun Leaves	2.25	1.75
	0.5 g/L	2	4
	1.5 g/L	2	4
	Canna	1.5	2.5
	0.5 g/L	1	3
	1.5 g/L	1	1
	Grow Coir	3	2.5
	0.5 g/L	3	4
	1.5 g/L	3	3

Score	CORN	BROCCOLI
1	Very chlorotic.	Very stunted, chlorotic and very little green.
2	Chlorosis but some green.	Stunted, mostly chlorotic some green.
3	Mostly green but some chlorosis.	Good overall health, mostly green, some chlorosis.
4	Very green.	Vigorous, very green, no chlorosis.

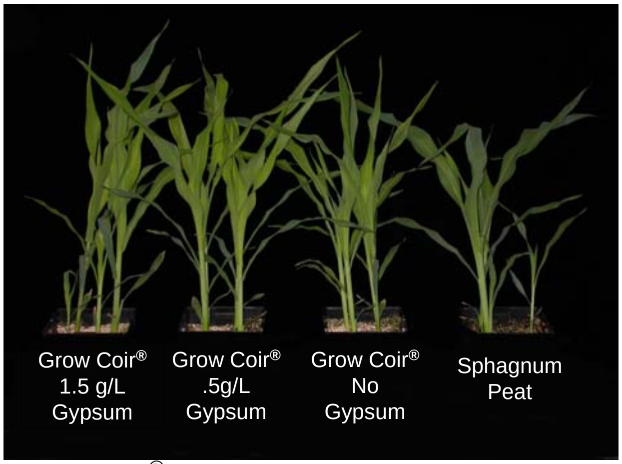
Results of corn cv. *Phenomenal* - 15 Days Post Emergence
All Media Contain 50% Perlite



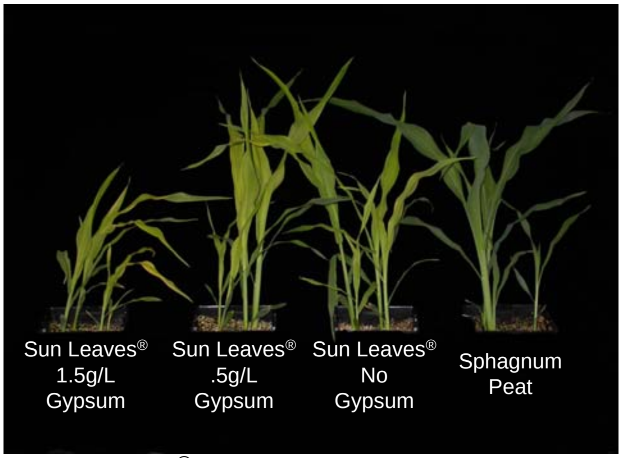
Sri Lanka Coir Brands



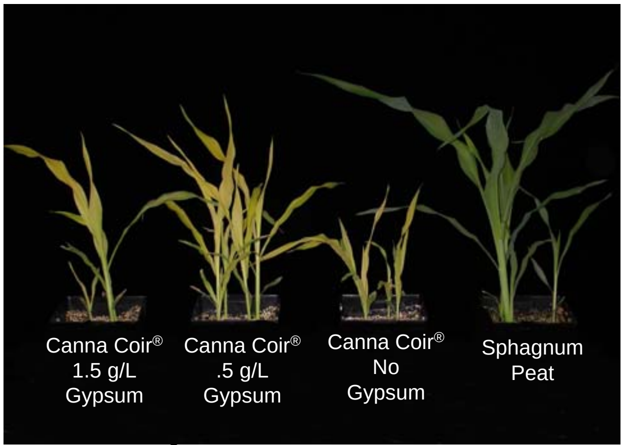
Mexico Coir Brands



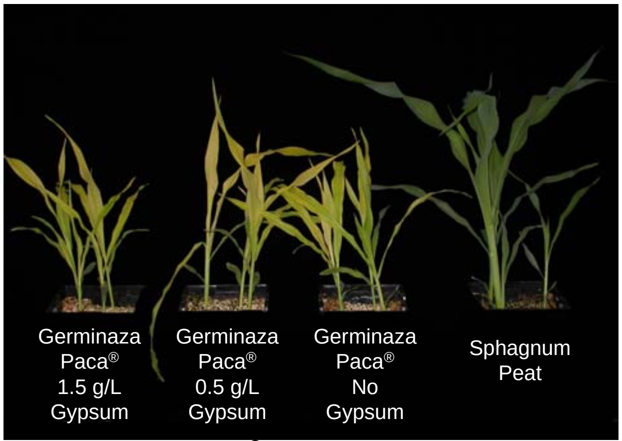
Grow Coir®



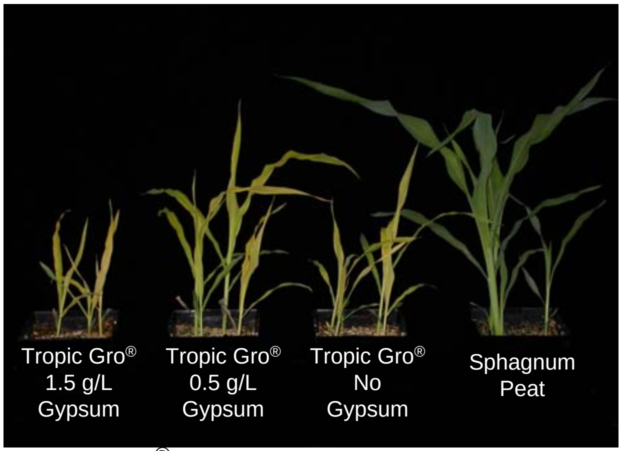
Sun Leaves®



Canna Coir®

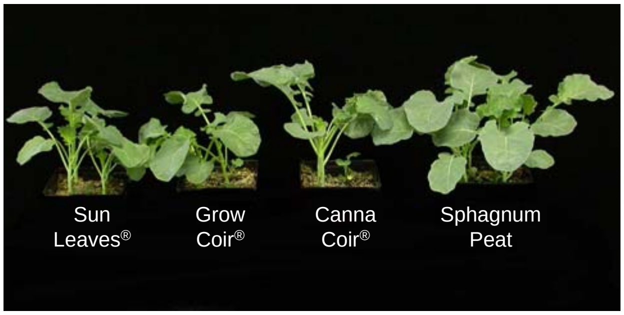


Germinaza Paca®



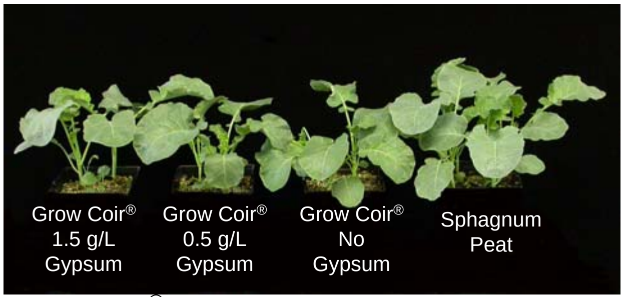
Tropic Gro®

Results of Broccoli cv. *Green Goliath*-25 Days Post Emergence
All Coir Contain 50% Perlite

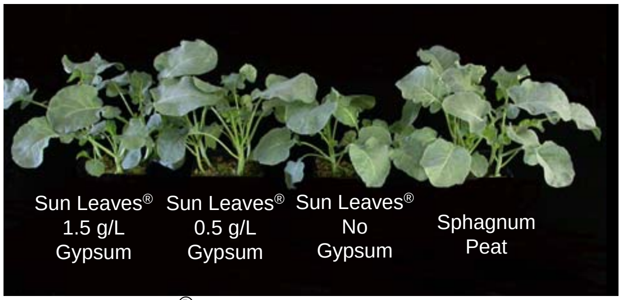


Sri Lanka Coir Brands

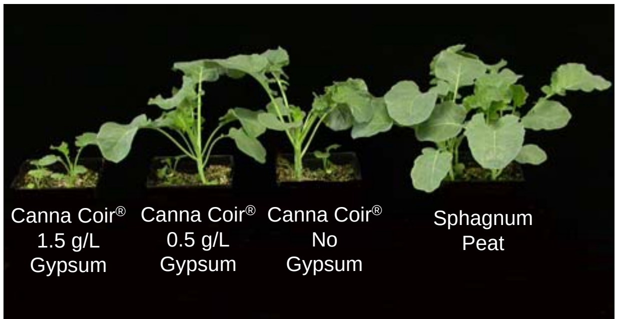
Mexico Coir Brands



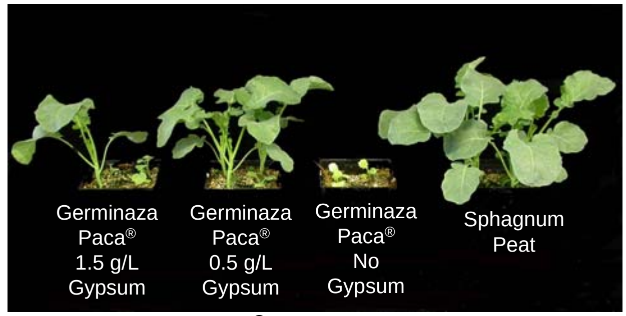
Grow Coir®



Sun Leaves®



Canna Coir®



Germinaza Paca®

Tropic Gro®

Foliar analysis was done on selected plant tissues (Tables 5 and 6). This did not indicate significant nutritional differences among treatments. Surprisingly, the addition of calcium sulfate did not significantly increase the calcium level in the corn leaves. As expected, the potassium levels were increased in the treatments with coir.

Table 5. Foliar analysis of corn leaves.

Treatment	P	K	Ca	Mg	S	Al	Fe	Cu	Zn	Mn	Na	B
	%	%	%	%	%	---------------------mg/kg----------------------						
Peat	0.45	1.41	0.33	0.32	0.08	5.57	42.9	3.79	7.35	42.7	126	11.9
Tropic Gro 0 g/L	0.84	3.74	0.34	0.25	0.37	28.2	68.8	9.51	22.7	107	149	8.00
Tropic Gro 0.5 g/l	0.75	3.50	0.30	0.29	0.27	21.8	57.7	7.03	15.1	59.4	161	9.02
Sun Leaves 0 g/L	0.69	2.74	0.33	0.33	0.16	5.60	40.4	5.63	9.54	43.8	127	10.8
Grow Coir 0 g/L	0.59	1.79	0.28	0.30	0.09	4.21	28.3	4.00	6.66	31.7	121	12.3

Table 6. Foliar analysis of broccoli leaves.

Treatment	P	K	Ca	Mg	S	Fe	Cu	Zn	Mn	Na	B	Mo
	%	%	%	%	%	---------------------mg/kg----------------------						
Peat	0.71	2.99	1.86	0.345	0.18	47.57	4.77	25.8	106	644	44.5	52.5
Canna	0.60	2.90	1.48	0.316	0.14	34.20	4.23	20.4	39.3	756	36.0	12.0
Sun Leaves	0.77	3.92	2.17	0.491	0.22	53.40	4.92	24.5	77.8	941	49.2	32.1
Grow Coir	0.64	3.79	1.69	0.460	0.20	47.78	3.52	19.3	62.1	636	39.0	22.2

SUMMARY

These studies show that coconut coir should be used with great caution. Although the Sri Lanka brands performed better than the Mexican brands, no brand performed consistently better than sphagnum peat. Some species tolerate coir better than others. The addition of calcium sulfate to the media did not have a consistently beneficial effect on growth and in some cases it reduced growth. The best growth in coir media occurred in the Grow Coir® brand. We are continuing these studies to determine the underlying causes of poor plant growth in coir.

LITERATURE CITED

Arenas, M., C.S. Vavrina, J.A. Cornell, E.A. Hanlon, and G.J. Hochmuth. 2002. Coir as an alternative to peat in media for tomato plant production. HortScience 37:309-312.

Handreck, K. and N. Black. 2002. Growing Media for Ornamental Plants and Turf. 3rd Ed. University of New South Wales Press Ltd. Sydney, Australia. ISBN 0 86840 7968.

Lopez-Galarza, S., J.V. Maroto, E. Cano, A. San Bautista, and B. Pascual. 2002. Enhancing root systems of waiting-bed strawberry plants grown on substrates. J. Hort. Sci. Biotech. 77:58-61.

Ma, Y. and D. Nichols. 2004. Phytotoxicity and detoxification of fresh coir dust and coconut shell. Comm. Soil Sci. Plant Anal. 35:205-218.

Meerow, A. 1994. Growth of two subtropical ornamentals using coir (coconut mesocarp pith) as a peat substitute. HortScience 29:1484-1486.

Vavrina C.S., K. Armbrester, M. Arenas, and M. Pena. 1996. Coconut Coir as an Alternative to Peat Media for Vegetable Transplant Production. SWFREC Station Report, Immokalee, Florida.