Substitution of Hemp Hurd for Peat in Media Produced Similar Growth and Yield of a Determinate Tomato Cultivar

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ABSTRACT. The ability of hemp hurd fiber to substitute for peatmoss in container production of the determinate tomato cultivar *Solanum lycopersicum* Little Bing™ was studied. There were four experimental media composed of different proportions of the substrates hurd, peat, and vermiculite as follows 1:0:1, 0.33:0.66:1, 0.66:0.33:1, and 0:1:1 (control). Plants produced in hurd-containing media grew vigorously, were visually indistinguishable from, and had similar height and width to control plants. Number of fruits per plant and fruit yield by weight was lower for the full hurd containing medium (1:0:1) than the control medium, whereas foliar and fruit N content was greater for the full hurd medium than the control. These findings suggest that plants in full hurd medium may have grown more vegetatively than reproductively in response to greater N uptake. The full hurd medium had the greatest porosity and plant growth in this medium may have been impacted by reduced water availability. Future studies could examine alternative irrigation applications to compensate for the higher porosity in hurd medium. Hurd substituted for ~30% to 60% of peat in a peat:vermiculite medium will produce similar quality Little Bing™ tomato plants to traditional peat-based medium.

Hurd is the short, lignified fibers from the inner core of the hemp (*Cannabis sativa*) stem, which develop within the xylem tissue (Small et al. 2003). The outer core of the hemp stem, primarily phloem tissue, contains the long fibers called bast that are desired for the textile industry. Hurd accounts for ~70% of the stem, and it has long been considered a byproduct of the hemp industry (Smart et al. 2023). Hurd fiber has been used for animal bedding and building materials. Recent research demonstrated that hurd can substitute for peatmoss in potting media to grow bedding plants such as petunia and geranium (Caballero Mejia et al. 2025). Alternative substrates for peat are highly sought because of the rising cost of peat and concerns over the environmental damages caused by peat mining from natural bogs (Mander et al. 2024).

Tomato (*Solanum lycopersicum*) can be produced in the field and in greenhouses to provide product for various markets. In greenhouse production, tomatoes have historically been grown in peat-based media. The objective of this study was to evaluate how greenhouse produced tomato plants would respond to substitution of hurd for peat in the growing media. Specifically, we wanted to understand how the substitution of hurd for peat impacts vegetative growth and fruiting performance.

Materials and methods

There were four experimental media composed of different proportions of the substrates hurd (100% powdered hurd 2 mm; Hemp Traders, Los Angeles, CA, USA), sphagnum peatmoss (Canadian sphagnum peatmoss 0–20 mm; Lambert, Quebec, Canada), and vermiculite (horticultural grade fine vermiculite; Whittemore Company, Lawrence, MA, USA) as follows: 1:0:1, 0.33:0.66:1, 0.66:0.33:1, and 0:1:1 (control). The determinate tomato cultivar Little Bing™ was used for this study. Seedlings with four leaves were transplanted to 3-gal containers on 13 Sep 2024 and containers were top-dressed with 36 g of 15N–3.9P–10K controlled-release fertilizer (Osmocote Plus 5- to 6-month formulation; Everris NA, Dublin, OH, USA). The experimental unit was a single container plant and units were arranged as a completely random design with nine replications in a greenhouse with heating set point of 18 °C, ventilation set point of 23 °C, and 14-h photoperiod supported by 1000-W high pressure sodium lamps (Gavita Pro 1000 DE; Gavita Holland, Aalsmeer, the Netherlands).

After transplanting seedlings were watered in by hand with 15N–2.2P–12.5K water-soluble fertilizer (Jack's 15–5–15; JR Peters Inc., Allentown, PA, USA) at 100 $mg \cdot L^{-1}$ N. Plants were fertigated again with the same fertilizer and N rate on the 7th day after transplanting (DAT) with each container receiving 2.5 L by drip irrigation. For the rest of the study, plants were fertigated daily using the same fertilizer and drip irrigation and the volume and N rate were as follows: 8 to 10 DAT, 2.5 L at 100 $mg \cdot L^{-1}$ N; 11 to 20 DAT, 2.5 L at 200 $mg \cdot L^{-1}$ N; 21 to 32 DAT, 3.0 L at 200 $mg \cdot L^{-1}$ N;

Table 1. Shoot weight, plant height and width, number of fruits, and fruit yield per plant of *Solanum lycopersicum* Little Bing™ grown in four container medium formulations with varying proportions of hurd, peat, and vermiculite.

Media formulation hurd:peat:vermiculite	Shoot wt (kg)	Plant ht (cm)	Plant width (cm)[i]	No. fruits	Fruit yield (kg)
1:0:1	1.9 b[ii]	71.8 a	94.3 a	473 b	2.7 b
0.66:0.33:1	1.9 b	72.5 a	96.3 a	510 ab	2.9 ab
0.33:0.66:1	2.0 b	75.6 a	92.4 a	535 ab	3.1 a
0:1:1 (control)	2.3 a	76.4 a	91.8 a	551 a	3.1 a

[i] Plant width was measured twice at right angles to each measurement and averaged.
[ii] Mean separation within columns indicated by different letters, according to Tukey's honestly significant difference test at $P \leq 0.05$ and n = 9.

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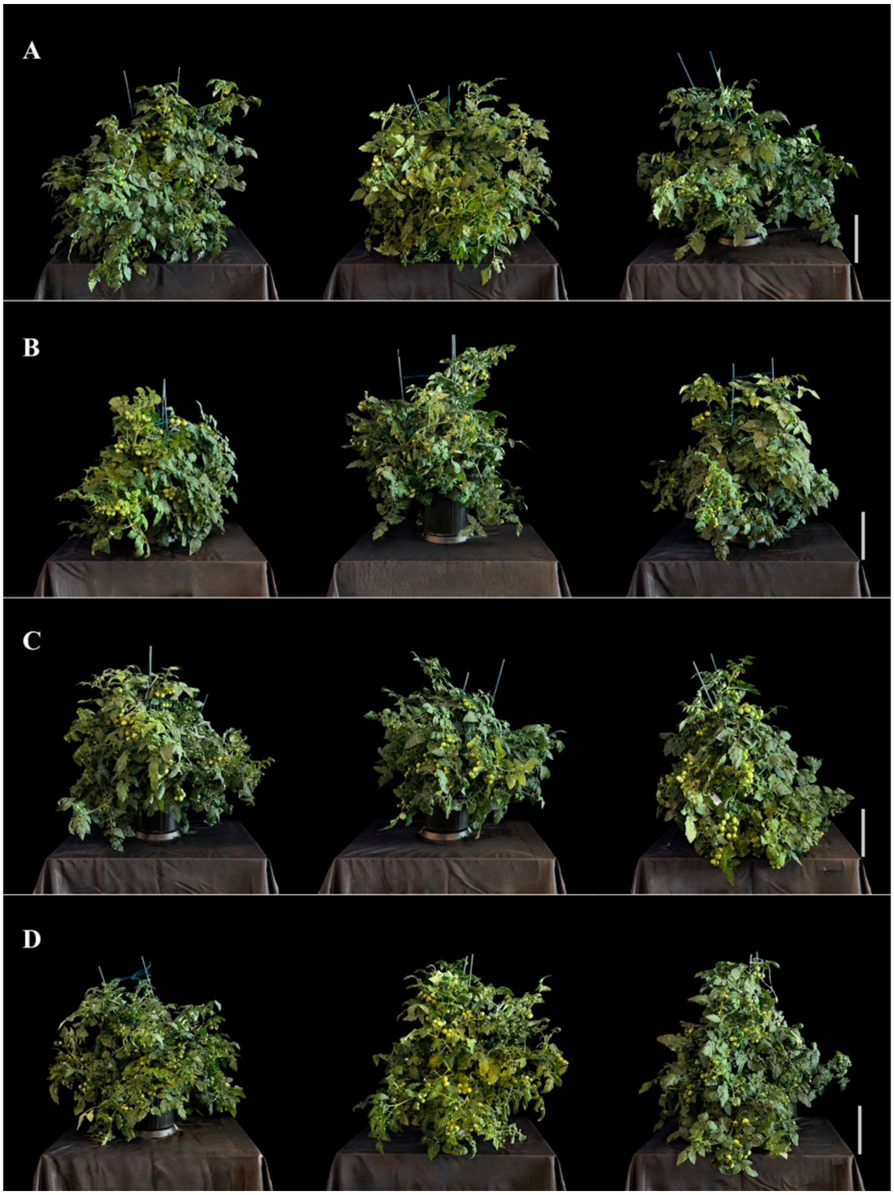

Fig. 1. ***Solanum lycopersicum*** **Little Bing™ in 3-gal containers grown in four container media formulations with varying proportions of hurd, peat and vermiculite as follows: (A) 1 hurd:1 vermiculite; (B) 0.66 hurd:0.33 peat:1 vermiculite; (C) 0.33 hurd:0.66 peat:1 vermiculite; and (D) 1 peat:1 vermiculite (control). Scale bars = 20 cm.**

33 to 38 DAT, 3.6 L at 200 mg·L^{-1} N; 39 to 42 DAT, 4.5 L at 200 mg·L^{-1} N; 43 to 48 DAT, 6.1 L at 200 mg·L^{-1} N; 49 to 51 DAT, 7.7 L at 200 mg·L^{-1} N; 52 to 58 DAT, 7.7 L at 100 mg·L^{-1} N; and 59 to 61 DAT, 8.3 L at 100 mg·L^{-1} N. Pour-through testing, according to Cavins et al. (2004), was conducted on day 11 of the study and every 7 d thereafter for the same three replicate plants per treatment, selected at random at the start of the experiment. Electrical conductivity (EC) and pH of the leachate were measured with a portable meter (HI 9813-6; Hanna Instruments, Smithfield, RI, USA).

On day 60 of the study, the number of fruits per plant was counted, and the total fruit weight per plant was recorded. On day 61 of the study, plant height (measured from the base to the tallest point) and width (measured twice at right angles and averaged), and total shoot weight per plant was recorded. For five plants per treatment selected at random leaf and fruit samples were taken and analyzed for nutrient content by the University of Connecticut Soil Testing Laboratory

Table 2. Nutrient content of leaves and fruits for *Solanum lycopersicum* Little Bing™ grown in four container medium formulations with varying proportions of hurd, peat, and vermiculite.

Media formulation hurd:peat:vermiculite	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (mg·kg^{-1})	B (mg·kg^{-1})	Mn (mg·kg^{-1})	Zn (mg·kg^{-1})	Cu (mg·kg^{-1})	Mo (mg·kg^{-1})
Leaves											
1:0:1	4.70 a[i]	0.445 a	3.08 a	1.674 a	0.799 a	94.14 a	79.58 a	181.82 b	35.66 ab	15.96 a	29.48 a
0.66:0.33:1	4.00 b	0.493 a	3.26 a	1.704 a	0.843 a	83.56 a	86.32 a	127.40 c	32.64 b	13.50 a	27.36 a
0.33:0.66:1	4.08 b	0.495 a	3.31 a	1.692 a	0.920 a	94.60 a	85.94 a	170.88 b	44.42 a	15.84 a	26.98 a
0:1:1 (control)	4.13 b	0.476 a	3.30 a	1.532 a	0.836 a	97.86 a	81.50 a	219.38 a	36.86 ab	13.96 a	23.58 a
Fruits											
1:0:1	1.79 a	0.385 a	3.36 a	0.090 a	0.152 a	39.92 a	12.76 a	10.34 a	18.04 a	0.30 a	0.98 a
0.66:0.33:1	1.75 a	0.394 a	3.40 a	0.078 a	0.151 a	41.72 a	11.84 a	9.44 a	16.78 a	0.00 a	1.08 a
0.33:0.66:1	1.61 ab	0.375 a	3.23 a	0.085 a	0.154 a	44.16 a	11.34 a	11.04 a	17.92 a	0.50 a	0.62 a
0:1:1 (control)	1.53 b	0.373 a	3.38 a	0.088 a	0.142 a	42.20 a	10.92 a	10.14 a	16.54 a	0.30 a	0.98 a

[i]Mean separation within columns, within leaves or fruits, indicated by different letters, according to Tukey's honestly significant difference test at $P \leq 0.05$ and n = 5.

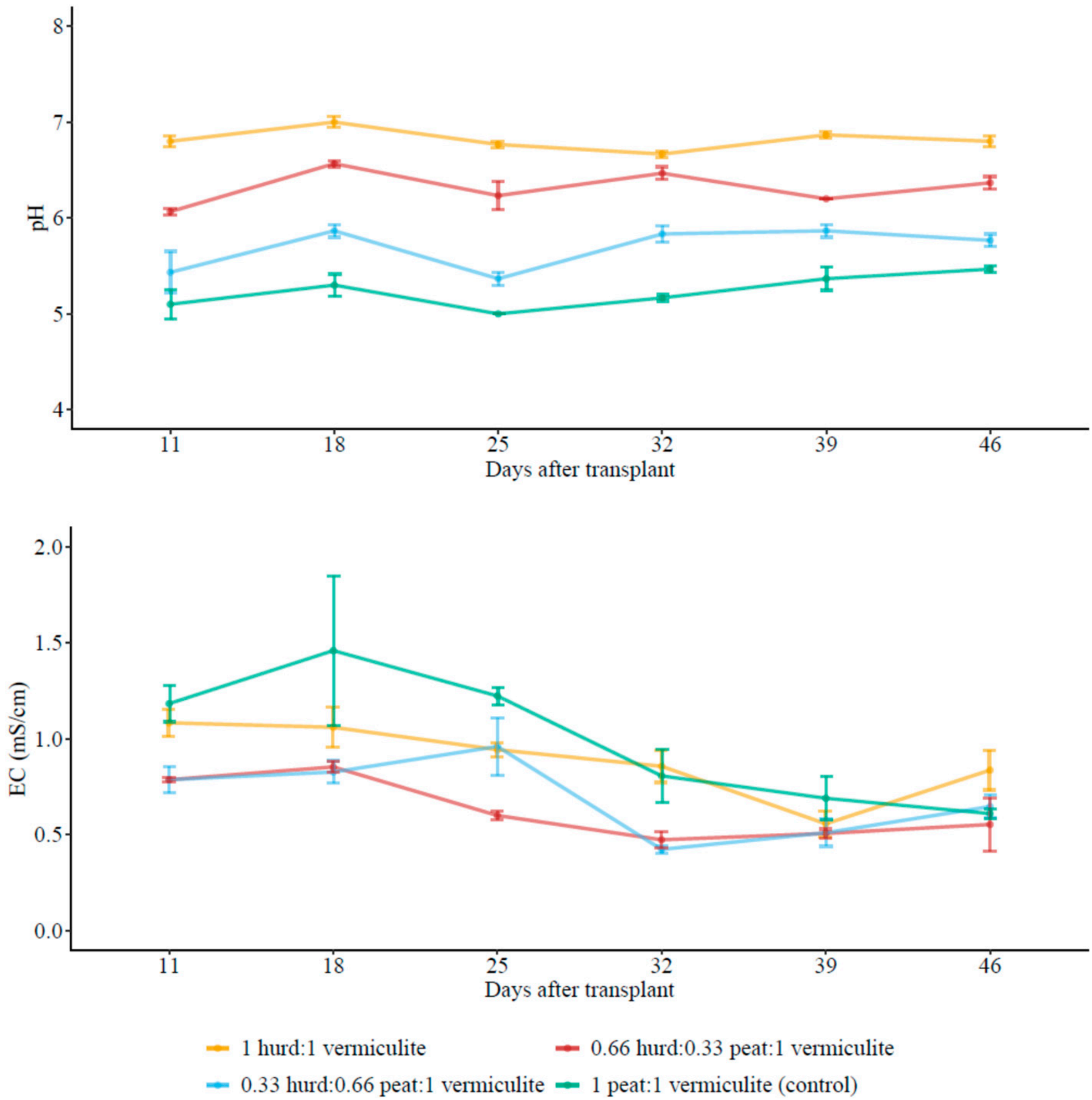

Fig. 2. Pour-through values for pH and electrical conductivity (EC) from four container media formulations with varying proportions of hurd, peat, and vermiculite planted with *Solanum lycopersicum* Little Bing™. Vertical bars indicate ± standard error.

(Storrs, CT, USA). Leaf samples were collected from the third to sixth leaf back from the shoot apex. Data analysis was conducted using RStudio software version 4.4.0 (Posit, Boston, MA, USA) and the packages ‘agricolae’ version 1.3.7 and ‘ggplot2’ version 3.5.1. Data were subjected to analysis of variance and mean separation with Tukey’s honestly significant difference test at $P < 0.05$.

Results and discussion

Media containing hurd in full or partial substitution of peat produced tomato plants of similar height and width as the control peat:vermiculite medium (Table 1). Tomato plants grown in hurd containing media were large, vigorous, and visually indistinguishable from control plants (Table 1; Fig. 1). Although shoot weight was slightly greater for the control plants, this is not necessarily an advantageous outcome because heavier shoots may lead to shoot breakage. Plants from all media had similar foliar nutrient content, except for the nutrients N, Mn, and Zn (Table 2). Tomato plants grown in full hurd medium (1:0:1) may have absorbed more N because this medium had a higher pH over the course of the study [Fig. 2 (Bailey 1996)]. Control plants may have accumulated more Mn due to the low pH of the medium, which was at or slightly above 5.0 over the course the study. Content of Zn did not follow any logical trends and differences are likely attributable to inherent variability of the data or sensitivity of the measuring technique (Table 2). EC gradually decreased for all media over the course of the study, likely because of increasing plant vegetative growth and uptake of nutrients (Fig. 2).

Plants grown in the medium with full replacement of peat with hurd (1:0:1) had less fruits per plant and total fruit yield by weight (Table 1). For plants grown in medium with partial replacement of peat with hurd (0.66:0.33:1 and 0.33:0.66:1), fruit production was the same as plants grown in control medium. There was greater N in the leaves and fruits of plants from the full hurd medium compared with the control medium, which may have been partially responsible for full hurd grown plants producing more vegetative than reproductive growth.

Tomato plant performance in the experimental hurd media was like that of petunia and geranium tested in the same media mixed from the same substrates (Caballero Mejia et al. 2025). Tomato, petunia, and geranium produced in peat:vermiculite medium with hurd in substitution of peat at ~30% to 60% performed similarly to or better than control plants for most measures of vegetative growth and performance (Table 1; Fig. 1). Over the course of the tomato study, pH for the full hurd and control media was above and below, respectively, the recommended range (5.5 to 6.2) for Little Bing™ (PanAmerican Seed 2024). Similar findings were reported for petunia and geranium in the same media (Caballero Mejia et al. 2025). As demonstrated with petunia, use of an acidifying soluble fertilizer can help to counteract the natural rise in pH over time of hurd containing media.

A recent study found that hemp fiber exhibited N immobilization at a higher rate than rock wool in a hydroponic system (Nerlich et al. 2022). Despite this, plant growth and fruit yield and quality for the tomato cultivar studied, Avalantino F1, was similar for the two substrates. The composition of the hemp fiber substrate as far as amount of hurd and/or bast was not provided. In our study, there was minimal indication of N immobilization, but this was not directly measured. The complete substitution of hurd for peat increased medium air filled and total porosities (Caballero Mejia et al. 2025), which may have reduced water availability. These observations suggest that tomato grown in high hurd containing medium may benefit from more frequent pulse irrigation.

Hemp hurd fiber has been demonstrated to be a promising new substrate for greenhouse container production of tomato. Hurd substituted for ~30% to 60% of the peat portion of a 1:1 peat:-vermiculite medium will produce high-quality tomato plants of equivalent size and similar fruit yield to control plants. When using hurd fiber at peat substitution rates >60% with a peat:vermiculite medium, it may be possible to adjust irrigation and/or fertilization to improve plant performance.

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