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ease. We have a novelty-driven market and the rapidity with which we must accommodate the new trends from Madison Avenue surpasses the speed of climate change.

How do we ensure market stability in a time of climate change? We can take a passive approach. We can rely on our confidence that the industry has the tools to handle this change and acknowledge that this change is no different than the normal tendency of new product development. The main benefit of this restful quiescence approach is that it allows us to respond with spontaneous actions that may be best suited to the unpredictable nature of climate change. Alternatively, we can assume an active role. We can attempt to determine which cultivars will benefit by the change in climate specifically for our region. Focusing on products that are suitable to the new climate may strengthen the confidence of consumers in our ability to develop products that can withstand changing times.

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## Kenaf Fiber—A New Basket Liner!

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Kenaf fibers are derived from *Hibiscus cannabinus* (Malvaceae), native to Africa (W. Sudan), and grown throughout the world. In the southern U.S., Louisiana, Texas, and Mississippi are major producers (Taylor, 1995). While Kenaf has been grown in Africa for thousands of years, in recent decades interest arose in its use as an annually renewable resource that is cheaper than peat moss (Taylor, 1995). Kenaf stem fibers are used in a variety of products, from newsprint, paper products, soilless potting mixes, oil absorbents, textiles, seeded grass mats, to insulation (Goforth and Fuller, 1994). Leaves of *H. cannabinus* are also food sources for humans and livestock. Kenaf, a relative of cotton and okra, is predominantly a short day plant (some day neutral types are used in Central America) with showy hibiscus flowers (Fig. 1) (Dempsey, 1975). There are ~50 tropical hibiscus species related to Kenaf, all in the *Fucaria* section of the genus.

Two types of fibers, bast (outer bark) and core (inner), are derived from Kenaf (Taylor, 1995). A special process, developed by Willett & Associates, mechanically

separate the bast and core fibers, since they are used for different products (Taylor, 1995). Core fibers are used as amendments in soilless potting mixes (Core Products, Charleston, MS). Recent studies have shown that foliage plants had superior size and increased dry mass when grown in a Kenaf:peat (70:30, v/v) mix (Wang, 1994). Bedding plants grown in this Kenaf:peat mix performed as well as in non-Kenaf peat medium (Reichert and Baldwin (1996). Cost comparisons also indicated that kenaf-peat soilless mixes were less expensive. Subsequent research showed that a 1:1 Kenaf:peat mix was a viable bark replacement for vinca production (Webber, et al. 1997).

Bast fibers—after retting (rotting or breakdown in water)—may be used to weave hanging basket liners. A new product, Scenic Home basket liners, is being woven using Kenaf bast fibers (ThinkMint, Inc., Northfield, MN; [www.scenichome.com](http://www.scenichome.com) or [www.thinkmint.net](http://www.thinkmint.net)). This is a new use for the bast fibers, which have previously been used for mats, textiles, and secondary products. Kenaf is a new alternative to coco



Figure 1. Close-up of flowering *Hibiscus cannabinus* (left) and Kenaf harvest (right) (Taylor, 1995).

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fiber liners. Kenaf is woven with a 100% recycled binder and cut into pre-shaped basket liners. Scenic Home liners can be readily inserted into wire baskets. Due to the thinner thickness of the Kenaf weave, they are easier to put into baskets (no leather gloves are necessary!) and cut to the desired shape. The tight weave means smaller holes in the Kenaf, which could increase water-holding capabilities and reduce irrigation frequency. Additionally, Kenaf is grown within the U.S., which means cheaper shipping costs than coco fibers and a consistent thickness due to the weave.

Coco fiber baskets are currently the commonly used material for wire hanging basket liners. They are made from 100% coir fiber, grown and processed in the Philippines. While providing a natural effect, coco fibers are very difficult to cut and place into basket liners due to their uneven thickness and tough fibers. In addition, as you may have noticed after watering coco liners provide little water holding capacity. Most of the water applied readily leaches out with insufficient soil moisture reserves in coco baskets during hot summer days.

We tested the potential use, water-holding capabilities, plant growth characteristics, and consumer preferences of the Scenic Home Kenaf fiber liners in a research trial this summer (2003) at the St. Paul Display & Trial Gardens. These were grown in 10 side-by-side (paired) comparisons with coco fiber liners (Cocoliner™, Austram, Durham, NC) in 16" wire baskets. Each paired set had the same cultivars (Table 1)



Figure 2. Examples of flowering hanging baskets comparing coco fiber and kenaf liners in wire baskets. (A) Coco liners (left) showed equally vigorous growth but less flower coverage of trailing petunias than kenaf liners (right). (B) A photo of some of the paired trials (the closest basket in each pair has a Kenaf liner).

and number of plants per basket. Each pair was hung side-by-side on double-hooked hangers in sun or shade. Data was collected on plant height, width, stem length, basket coverage (1-10 scale where 1=0-1%, etc.), dry (measured 24+hrs. after watering) and wet (measured immediately after watering) basket weights at monthly intervals after planting on May 23, 2003. Random consumer ratings were conducted during the summer by placing survey forms in the Display & Trial Garden information kiosk. Consumers answered the question "What type of hanging basket do you think is better?" and "Why?".

#### Results & Discussion.

Less assembly time and relative ease of liner placement in the wire baskets was noticeable with the Kenaf fiber liners. One cultivar (*Impatiens hawkeri* 'Sweetie Pink') in all baskets and was excluded from data analysis. In basket pair Nos. 1, 5-10 plant height was greater in the Kenaf liners (Table 1). Plant heights were highly significantly different for basket pairs ( $P \leq 0.001$ ), liners ( $P = 0.003$ ), and cultivars ( $P = 0.005$ ). Plant widths and stem lengths were greater in the Kenaf liners for basket pair Nos. 1 (*Petunia* 'Lavender Wave' only), 2 (*Nemesia* 'Sunsation Peach'), 5 (*Nemesia* 'Sunsation Coconut'), and 6 (*Dichondra* 'Silver Falls'.) (Table 1). Plant widths, but not stem lengths,

were greater in the Kenaf liners for basket nos. 3 (*Phlox* 'Neon Pink'), 4 (*Catharanthus* 'Jaio Dark Red'), 6 (all cvs.), 8 (*Impatiens* 'Riviera Fire'), 9 (*Verbena* 'Rapunzel Pink'), and 10 (all cvs.). These width differences between cultivars and basket pairs meant that cultivars and pairs were highly significantly different ( $P \leq 0.001$ ), but liners were not ( $P = 0.51$ ). Overall, mean stem lengths were greater, but not significantly different ( $P = 0.34$ ), in Kenaf (24.2 cm) than Coco fiber (17.7 cm) liners.

Basket coverage was not significantly different between liner types ( $P = 0.06$ ), although the basket pairs differed significantly ( $P \leq 0.001$ ) which is most likely attributable to the plants included. Both wet ( $P \leq 0.001$ ) and dry ( $P \leq 0.001$ ) weights of the Kenaf liner baskets were significantly higher than those with coco fibers. Thus, it would appear that Kenaf retains significantly more soil moisture, which would translate into decreased irrigation frequency and water loss through the basket liner.

Consumer surveys showed a slight preference for coco fiber (56%) over kenaf fiber (44%) baskets, although the sample size was small ( $n = 16$ ). Most visitors to the garden made verbal comments on the basket trials but chose not to take the time to fill out the survey forms. Positive

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comments regarding the Kenaf baskets included that they were made in Minnesota and would be easier for assembly. Several participants commented that they liked the rough coco fiber appearance better.

This study demonstrates that Kenaf fiber liners are useful for hanging basket planting combinations for a wide variety of bedding plant species and may, in several instances, out-perform coco fiber liners. The most noticeable increased performance in flower coverage and vigor was with all trailing petunias. Kenaf fiber liners were easier to handle and place in the basket frames. Further research

would be necessary before drawing conclusions on the particular advantages of Kenaf over coco fibers on plant growth, species or cultivar differences. Nonetheless, Kenaf fibers did not have any observable detrimental effects on basket appearance or salability. Growers and retailers should try these new products on a small-scale and determine basket performance in their growing environments.

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Table 1. Mean plant performance of bedding plants and basket measurements for 10 paired comparisons of kenaf and coco fiber hanging baskets, pooled over the summer 2003 collection dates.

Basket Pair	Cultivars planted	KENAF BASKETS					COCO FIBER BASKETS							
		Height (cm)	Width (cm)	Stem Length (cm)	Coverage	Wet Wt. (lbs.)	Dry Wt. (lbs.)	Height (cm)	Width (cm)	Stem Length (cm)	Coverage	Wet Wt. (lbs.)	Dry Wt. (lbs.)	
1	<i>Petunia x hybrida</i> 'Lavender Wave' <i>Verbena x hybrida</i> 'Royal Purple w/Eye'	23.0	75.5	63.0	7.5	9.3	13.3	16.5	67.0	49.0	8.5	9.0	11.2	
		22.5	42.0	30.0					14.5	43.5	34.0			
2	<i>Nemesia</i> 'Sunsation Peach' <i>Iresine</i> 'Purple Lady' <i>Argyranthemum</i> 'Butterfly Vanilla'	20.5	39.0	12.5	7.0	9.3	14.7	23.0	34.5	6.5	6.0	9.9	14.8	
		17.0	35.0	--z					8.5	17.5	-- z			
		33.5	33.5	--					35.0	34.5	--			
3	<i>Nemesia</i> 'Sunsation Banana' <i>Phlox intensia</i> 'Neon Pink' <i>Capsicum annuum</i> 'Explosive Ember'	21.0	51.5	36.5	9.5	11.7	15.6	23.5	60.5	42.0	9.0	9.6	12.9	
		26.0	54.0	22.0					20.5	50.0	26.5			
		20.0	16.5	--					24.0	30.0	--			
4	<i>Nemesia</i> 'Sunsation Cranberry' <i>Petunia x hybrida</i> 'Pirouette Red' <i>Catharanthus roseus</i> 'Jaio Dark Red'	17.5	62.5	30.5	9.0	10.8	12.1	22.0	66.0	33.5	8.0	9.6	12.7	
		31.5	29.0	7.5					30.5	43.0	22.5			
		23.0	24.5	--					26.5	20.5	--			
5	<i>Nemesia</i> 'Sunsation Coconut' <i>Nemesia</i> 'Sunsation Lemon' <i>Angelonia angustifolia</i> 'Carita Purple'	23.0	60.5	27.0	8.0	12.2	15.9	21.5	55.5	25.0	9.0	10.4	13.9	
		26.0	43.0	24.5					26.5	57.5	14.5			
		44.0	24.5	--					34.0	27.0	--			
6	<i>Begonia x hiemalis</i> 'Fuga Cream' <i>Impatiens hawkeri</i> 'Sweetie Pink' <i>Dichondra argentea</i> 'Silver Falls'	31.0	22.5	--	5.0	11.7	14.3	24.0	21.0	--	3.0	7.8	9.3	
		0.0	0.0	0.0					0.0	0.0	0.0			
		6.0	16.0	67.0					5.0	15.0	74.5			
7	<i>Petunia x hybrida</i> 'Surprise Cream' <i>Pelargonium</i> 'Rocky Mountain White'	19.0	52.0	40.0	8.0	9.1	11.5	16.5	57.5	41.5	8.5	8.9	11.0	
		28.0	30.0	--					26.5	32.0	1.0			
8	<i>Impatiens hawkeri</i> 'Riviera Fire' <i>Impatiens wallerana</i> 'Accent Apricot' <i>Impatiens wallerana</i> 'Accent Coral Star'	20.0	18.0	--	8.0	10.6	12.0	16.0	16.5	--	6.5	11.5	13.5	
		29.5	25.0	--					23.5	35.0	--			
		28.0	43.5	--					33.0	57.5	--			
9	<i>Verbena x hybrida</i> 'Rapunzel Pink' <i>Fuchsia x hybrida</i> 'Shadowdancer Violet'	18.5	27.5	6.5	5.0	9.9	12.7	14.0	15.5	6.5	4.5	8.4	10.3	
		18.0	18.5	--					18.5	27.5	--			
10	<i>Verbena x hybrida</i> 'Lanai White' <i>Diascia</i> 'Flying Colors Trailing Red' <i>Lobelia erinus</i> 'Laguna Sky Blue'	23.5	46.5	26.5	7.0	7.8	10.6	14.5	34.0	28.0	6.0	7.8	9.3	
		20.0	44.5	25.5					13.5	37.0	20.5			
		17.5	36.5	11.0					14.0	31.0	15.0			

<sup>z</sup>Upright-growing plants were not measured for stem length cascading over the basket rim.