

# Variety Trials

## Organic Leafy Greens Variety Trials in Kentucky: Identifying Superior Varieties for Small-scale Organic Farmers

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**SUMMARY.** Thirty-eight leafy greens, eight kale (*Brassica oleracea acephala* group), nine mustard (*Brassica juncea*), six arugula (*Eruca sativa*), five swiss chard (*Beta vulgaris* var. *cicla*), five collards (*B. oleracea acephala* group), and five turnip (*Brassica rapa* ssp. *rapa*) varieties were evaluated during Spring and Fall 2007–08 to determine suitability for organic production with respect to yield and stability. Trials were conducted on certified organic land using organic production practices. For mustard, kale, collards, and arugula, there were significant variety by season by year interactions. Despite these interactions, some varieties consistently performed well throughout the trial. ‘Florida Broadleaf’ was the highest yielding mustard in three of the four seasons evaluated. ‘Siberian’, ‘White Russian’, and ‘Red Russian’ were in the highest yielding group of kale varieties for overall yield. For collards, ‘Georgia/Southern’ and ‘Flash’ were part of the highest yielding group as determined by Duncan’s multiple range test in three of the four seasons examined. Turnip and swiss chard had significant year by variety interactions. Overall yields of ‘Alamo’ and ‘Alltop’, both F<sub>1</sub> hybrids, were better than other turnip varieties assessed. Despite the interaction, ‘Fordhook Giant’ had superior yields in both years of the study. Arugula performance was significantly and negatively affected in Spring 2008. Overall, ‘Astro’, ‘Apollo’, and ‘Arugula’ had the greatest yields. This trial was designed to provide recommendations specifically for organic growers marketing directly to consumers.

Leafy greens are a rich dietary source of nutrients including calcium, magnesium, potassium, and iron (Kopsell et al., 2004). In addition, many leafy greens, particularly those of the Brassicaceae family,

contain high levels of plant secondary metabolites such as S-methyl cysteine sulfoxide, carotenoids, flavonoids, and

anthocyanins (Manchali et al., 2012). Compounds such as sulforaphane, a phytochemical evolved from hydrolysis of glucoraphanin by the enzyme myrosinase, have been reported to have chemopreventive properties (Liang and Yuan, 2012). Consumption of kale and collard greens, which are rich in carotenoids, has been shown to increase macular pigment optic density in humans, which has been associated with improved eye health (Kopsell et al., 2009).

Leafy greens may be attractive to consumers wanting a nutrient-rich diet. It is noteworthy that those consumers concerned with health and diet may also be regular purchasers of organically grown fruits and vegetables (Zanoli and Naspetti, 2002). In a review of consumer behavior toward organic foods, Hughner et al. (2007) reported that a majority of previously published studies noted perceived positive effects on health as the primary reason for choosing organic food. Thus, it is not surprising that the authors have observed that leafy greens are frequently grown by organic farmers in Kentucky.

Organic fruit and vegetable production has risen steadily in the past decade, reaching more than 156,000 acres in 2008, a nearly 100% increase from 2002 levels [U.S. Department of Agriculture (USDA), 2010]. Organically certified production represented ≈11% of total U.S. fruit and vegetable sales in 2010 (Organic Trade Association, 2011). Despite rapid growth of organic farming nationwide, variety recommendations specifically for organic growers are lacking. Recently, partnerships such as the Northern Organic Vegetable Improvement Cooperative (NOVIC) have initiated variety trials for a number of organically grown vegetables including broccoli (*Brassica oleracea italica* group), sweet corn (*Zea mays*), tomato [*Solanum lycopersicum* (synonym

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### Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
1	cbar	kPa	1
0.3048	ft	m	3.2808
3.7854	gal	L	0.2642
2.54	inch(es)	cm	0.3937
1.1209	lb/acre	kg·ha <sup>-1</sup>	0.8922
70.0532	oz/acre	g·ha <sup>-1</sup>	0.0143
1	ppm	mg·L <sup>-1</sup>	1
(°F – 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

*Lycopersicon esculentum*), bell pepper (*Capsicum annuum*), winter squash (*Cucurbita* sp.), and snap pea (*Pisum sativum* var. *macrocarpon*) (NOVIC, 2012). Continued field evaluation of varieties for suitability in organic farming systems is necessary. It has been estimated that more than 95% of varieties grown organically were originally developed for conventional farming systems (van Bueren et al., 2011). However, it has been reported that there can be significant genotype by farming system interaction when evaluating varieties grown conventionally and organically (Murphy et al., 2007). It is often suggested varieties that yield highest in conventional systems would likely perform equally as well when grown organically. However, in a trial evaluating conventionally bred varieties in organic farming systems, Murphy et al. (2007) reported that this was not necessarily correct. This suggests the long-term need for breeding programs focused on developing such varieties. Varieties developed specifically for organic production may differ from their conventional counterparts in terms of nutrient use efficiency and the ability to form symbiotic relationships with soil microorganisms, as well as have a greater tolerance to mechanical cultivation and disease resistance (van Bueren et al., 2011). Until breeding for organic production systems becomes more common, we must rely on trials of organically grown varieties previously bred for conventional production.

In addition to genotypic variability, phytonutrients—an essential quality attribute of edible greens, particularly those in the Brassicaceae family—have been shown to be significantly affected by environmental conditions (Farnham and Kopsell, 2009). Air temperature, fertility, and light levels have been reported to affect secondary phytonutrient content of Brassicaceae (Kopsell and Randle, 2001; Lefsrud et al., 2005, 2006). Because of the impact of environmental conditions on growth and quality attributes of leafy greens, regional variety trials are necessary to make informed decisions regarding the best performing varieties for a particular area. Olson and Freeman (2008) reported results from four years of conventionally managed collard trials in northern Florida, with several

hybrid varieties performing well. However, published information regarding the performance of leafy greens in organic production systems for the mid-south region of the United States is not widely available. Therefore, the objective of this research was to evaluate several types of organically grown leafy greens over multiple seasons and years to determine the most suitable varieties for organic growers in the midsouth growing region. Because many organic farmers grow a diverse array of crops in a given season (van Bueren et al., 2011), multiple types of leafy greens were evaluated. In addition, only varieties for which organically certified or untreated seeds were available were examined. Many of the varieties that are available as untreated or organically certified seeds are open-pollinated, with relatively few hybrids. Although there are numerous additional hybrid varieties marketed with treated seed for several of the crops tested, these varieties were not included because of their inability to be used on certified organic farms.

## Materials and methods

This study was conducted in the Spring and Fall 2007–08 at the University of Kentucky Horticulture Research Farm in Lexington, KY (lat. 38°3' N, long. 84°30' W), using land certified for organic crop production according to USDA standards. The soil was a Maury silt loam series (0% to 2% slope), a fine, mixed, mesic Typic Alfisol.

Thirty-eight varieties of leafy greens were evaluated (Tables 1–6). Nine mustard, eight kale, five collards, five turnip, five swiss chard, and six arugula varieties were evaluated for their performance in an organic production system. The majority of varieties assessed were open-pollinated and available from multiple sources. Hybrid varieties included the following: 'Savannah' mustard; 'Blue Ridge', 'Redbor', and 'Winterbor' kale; 'Flash' collards; and 'All Top', 'Alamo', and 'Topper' turnip. With the exception of 'Redbor' kale, which was available from multiple sources, the remaining hybrids were sourced from Sakata Seeds America (Morgan Hill, CA). All varieties evaluated were commercially available at the time this publication was prepared. Certified organic or untreated seeds were planted on 19 Mar.

and 20 July 2007 and 18 Mar. and 22 July 2008 into 98-cell trays filled with an organic transplant mix consisting of soilless media (Sunshine Organic Media; Sun Gro, Bellevue, WA) mixed with worm castings (Prather's Castings, Salvisa, KY) in 5:1 ratio, respectively. Plants were watered daily as needed and twice fertilized with a 120 mg·L<sup>-1</sup> nitrogen (N) solution [6N–2.5P–5K (Omega 6–6–6; Peaceful Valley Farm Supply, Grass Valley, CA)]. Seedlings were greenhouse-grown with temperature set points of 28/20 °C (day/night). Seedlings were transplanted using a waterwheel planter on 20 April and 29 Aug. 2007 and 24 April and 26 Aug. 2008. Plants were set into 4- to 5-inch-tall raised beds spaced on 6-ft centers covered with 1-mil embossed plastic mulch with a single line of drip irrigation tubing [12-inch emitter spacing, 0.45 gal/min per 100 ft (Aqua-Traxx; Toro, El Cajon, CA)] placed ≈1 inch below the soil surface in the center of each bed. Black plastic mulch was used for spring plantings and microembossed white on black plastic mulch (Pliant Corp., Schaumburg, IL) with the white side up was used for fall plantings. Plants were set in two rows ≈15 inches apart on each bed with 12-inch in-row spacing for a population of 14,520 plants/acre. Four beds of each variety were planted. Tensiometers (12 inches long; Irrometer Co., Riverside, CA) were placed in each row about midway between adjacent plants and were monitored to determine irrigation frequency. Irrigations were initiated when the tensiometers reached ≈–30 kPa and were ended at ≈–10 kPa. Weather data were obtained from a nearby weather station, which read temperatures every minute and recorded an hourly average (University of Kentucky, 2012).

Ground preparation and tillage were accomplished with a rotary spading machine (Imants, Reusel, The Netherlands), and secondary tillage was accomplished with an offset disc. Cover crops were tilled directly into the soil using the spading machine. Spring 2007 crops were transplanted into plots that had been in an alfalfa (*Medicago sativa*) and sweet-clover (*Melilotus officinalis*) cover crop for the preceding two years, and the subsequent plantings (Fall 2007, Spring 2008, and Fall 2008) followed a fescue (*Festuca* sp.) and white clover (*Trifolium*

*repens*) pasture sod that had been in place for more than five years. Pre-plant fertility consisted of 8N–2.2P–4.2K fertilizer (Nature's Safe 8–5–5; Griffin Industries, Cold Spring, KY) mixed 1:1 with 13N–0P–0K (Nature's Safe 13–0–0, Griffin Industries). Fertilizers were applied in bands before laying plastic mulch based on the N supplied by the previous cover crop, soil test results, and commercial vegetable production recommendations for Kentucky (Coolong et al., 2011).

No fungicides or bactericides were applied to this trial. Disease pressure was low with only isolated occurrences of gray mold (*Botrytis cinerea*), white mold (*Sclerotinia sclerotiorum*), and damping off (*Fusarium*, *Rhizoctonia*, and *Pythium* sp.) observed. The organic insecticide pyrethrum (Pyganic; MGK Corp., Minneapolis, MN) was applied at a rate of 16 oz/acre 7, 18, and 28 d after planting to control flea beetle (*Phyllotreta cruciferae*) in turnip, arugula, and mustard plantings. Cabbage looper (*Trichoplusia ni*) and imported cabbage worm (*Pieris rapae*) were found exclusively on collards and kale and were controlled using *Bacillus thuringiensis* ssp. *kurstaki* (Dipel DF; Valent Bioscience, Libertyville, IL) applied at a rate of 1 lb/acre 14 and 28 d after transplanting. Weeds were controlled by hand cultivation throughout the trial.

For each planting, the experimental design was a randomized complete block with four experimental units. Individual plots consisted of 10 plants of each variety. Varieties were evaluated throughout the trial for overall appearance and vigor. At maturity, five of the plants in each plot were harvested. A second harvest was conducted on those crops where typical production practices include multiple harvests (Coolong et al., 2011). Harvested products were graded using USDA fresh market vegetable grade standards when available (USDA, 1953a, 1953b, 2005). Data from all seasons and years were analyzed using analysis of variance (ANOVA) (PROC GLM), and mean separation using Duncan's multiple range test ( $P < 0.05$ ) with SAS (version 9.1; SAS Institute, Cary, NC). ANOVA included plant variety, season, and year and their interactions as sources of variance. Because year and season were considered random factors, F tests

**Table 1. Yields of harvested leaves of several varieties of organically grown mustard produced in Lexington, KY, in Spring and Fall 2007–08. Values are the means of four replications.**

Variety	2007		2008		Overall avg <sup>z</sup>	CV <sup>y</sup> (%)
	Spring	Fall	Spring	Fall		
	Yield (lb/acre) <sup>x</sup>					
Florida Broadleaf	43300 a <sup>w</sup>	62900 a	17800 c	37700 a	40240 a	45
Savannah <sup>v</sup>	23400 c	49200 bc	42150 a	28300 b–e	35760 b	36
Old Fashioned	36850 ab	53050 b	18400 c	31230 abc	34880 bc	29
Tendergreen	29750 bc	53050 b	18900 c	33980 ab	33920 bcd	39
Miike Giant	27650 c	36250 de	38000 ab	24800 cde	31680 b–e	21
Mustard						
Southern Giant	27950 bc	37800 d	32350 b	25200 b–e	30830 cde	28
Red Giant	40650 a	29200 e	30200 b	19880 e	29980 de	28
Pung Pop	29500 bc	41350 cd	17000 c	29180 a–d	29260 e	33
Mustard						
Gene Pool						
Green Wave	23450 c	33500 de	33400 b	20620 de	27740 e	29

<sup>z</sup>Overall average is yield averaged from Spring and Fall 2007–08.

<sup>y</sup>CV determined using all data from Spring and Fall 2007–08.

<sup>x</sup>1 lb/acre = 1.1209 kg·ha<sup>-1</sup>.

<sup>w</sup>Means within a column followed by the same letter are not significantly different according to Duncan's multiple range test at  $P \leq 0.05$ .

<sup>v</sup>F<sub>1</sub> hybrid.

and mean separations were designed accordingly.

## Results and discussion

Several of the crops experienced a variety by season by year interaction. This suggests that environment can play a significant role in the performance of a given variety and that it should be evaluated in multiple years and seasons before making recommendations. Fall 2007–08 growing seasons were similar with average air temperatures of 73 °F for the growing period both seasons and 1.89 and 1.19 inches of rain in the Fall 2007 and 2008 growing seasons, respectively. The Spring 2007 growing period had an average temperature of 65 °F with rainfall of 1.98 inches. Spring 2008 was cooler and wetter than the others with an average temperature of 60 °F and 4.45 inches of rain during the trial period (University of Kentucky, 2012).

Mustard variety significantly interacted with season and year (Table 1). 'Florida Broadleaf' had the highest overall average yield for the entire experiment with 40,240 lb/acre; however, it was not significantly different from 'Red Giant' in Spring 2007 or 'Tendergreen' in Fall 2008. In Fall 2007, 'Florida Broadleaf' had a significantly greater yield than any other variety tested that season with 62,900

lb/acre. In Spring 2008, 'Florida Broadleaf' was not significantly different from the lowest yielding varieties, 'Pung Pop Mustard Gene Pool', 'Old Fashioned', and 'Tendergreen'. The best performing varieties in Spring 2008 were 'Miike Giant' and 'Savannah'. Interestingly, 'Miike Giant' and 'Savannah' were generally poor performers for the other seasons tested. As noted previously, average air temperatures were lower and rainfall was greater in Spring 2008 than the other trial seasons. 'Pung Pop Mustard Gene Pool', 'Green Wave', and 'Southern Giant' were part of the lowest yielding group of varieties in multiple seasons. CVs were determined for all varieties as well. For many growers, the CV may be just as important as yield potential because a low CV is a general indication of yield consistency over multiple seasons or years. Being able to reliably predict yield is important for growers making planting decisions. A variety with a low CV may be preferred over a variety with high yield potential, but greater variability. Interestingly, 'Florida Broadleaf' had the greatest CV of mustard varieties at 45%. This was likely the result of the high yields reported in Spring and Fall 2007 combined with low yields in Spring 2008. 'Miike Giant' had the lowest CV at 21% and provided consistent

yields during the trial; however, it was one of the poorest yielders overall, with the exception of Spring 2008. When main effects were tested, season was not significant and yield differences between spring and fall depended on variety. It is noteworthy that 'Old Fashioned', 'Pung Pop Mustard Gene Pool', and 'Tendergreen' had greater yields in fall than in spring during the two years of the trial. In contrast, 'Red Giant' yielded higher in spring in both years. These results suggest that there were significant genotype by environment interactions for yield of mustard varieties. However, under the growing conditions of this trial, 'Florida Broadleaf' had the greatest yield potential in three

of the four seasons in which it was assessed.

As with mustard, kale variety interacted with season and year (Table 2). On the basis of Duncan's mean separation test 'Siberian', 'Red Russian', and 'White Russian' were part of the highest yielding group of kale in every season. There were no varieties that consistently performed better in spring or fall. 'Redbor' and 'Lacinato' were the lowest yielding varieties over the course of the trial and were always part of the lowest yielding group in any season tested. As was the case with mustard greens, the lowest yielding varieties had the lowest cv values. 'Redbor' and 'Lacinato' had cv values of 16% and 13%, respectively. 'Lacinato'

had the lowest cv of any green tested in this trial. It should be noted that 'Lacinato' has a smaller leaf than many other varieties but is often grown because it is believed to be of a higher eating quality by many producers. Unlike mustard greens, there was not a notable change in performance of varieties in Spring 2008, suggesting that the kale varieties included in this trial, compared with the mustard varieties, may not have been affected by weather conditions during Spring 2008.

There was a significant season by year by variety interaction for collards. When yields for these varieties were averaged over entire trial, 'Georgia/Southern', 'Flash', and 'Morris Heading Collards' were not significantly different from each other and were the highest yielding varieties (Table 3). No variety tested yielded significantly more in spring compared with fall or vice versa. 'Green Glaze' was the lowest yielding variety in two of the seasons in which it was evaluated and had an overall average yield of 19,040 lb/acre. Interestingly, in Spring 2008, there were no differences among any of the varieties tested with yields ranging from 21,600 to 24,450 lb/acre. 'Flash' had a cv value of 22% while the other high-yielding variety, 'Georgia/Southern' had a cv of 31%. This suggests that 'Flash' maintained high yields with less variability than 'Georgia/Southern', which may make it a better choice for growers wanting high yield potential but less variability. Olson and Freeman (2008) noted that 'Flash' was among the highest yielding varieties in a trial of nine varieties of collards in Quincy, FL. However, 'Georgia/Southern', which performed well in the present trial, was the lowest yielding variety in their trial. This indicates that although some varieties may perform well in a range of environments, others can vary substantially, underscoring the need for regional variety trials.

Turnip variety significantly interacted with year to affect yield (Table 4). There were no year by season by variety interactions present for turnip. 'Alamo' and 'Alltop' were not significantly different when yields were averaged over all seasons and years. In 2007, 'Alamo' and 'Alltop' were the highest yielding varieties, but in 2008, 'Alamo' and 'Nozawana' were the highest yielding varieties. 'Seven Top'

**Table 2. Yields of harvested leaves of several varieties of organically grown kale produced in Lexington, KY, in Fall and Spring 2007–08. Values are the means of four replications.**

Variety	2007		2008		Overall avg <sup>z</sup>	cv <sup>y</sup> (%)
	Spring	Fall	Spring	Fall		
	Yield (lb/acre) <sup>x</sup>					
Siberian	24710 ab <sup>w</sup>	37700 a	31950 a	25090 a	29860 a	26
White Russian Kale	27320 a	30800 abc	31600 a	20660 ab	27600 a	32
Red Russian	23570 abc	35150 ab	29250 a	18590 ab	26640 a	32
Winterbor <sup>v</sup>	21860 a–d	28400 bcd	21100 b	20960 ab	23080 b	21
Blue Ridge <sup>v</sup>	18960 bcd	26200 cd	15700 bc	16120 b	19250 c	28
Vates (blue curled)	15720 d	22650 de	18350 bc	16690 b	18350 c	24
Lacinato	16750 cd	16250 ef	15600 bc	15810 b	16100 cd	13
Redbor <sup>v</sup>	14860 d	13550 f	13000 c	14340 b	13940 d	16

<sup>z</sup>Overall average is yield averaged from Spring and Fall 2007–08.

<sup>y</sup>cv determined using all data from Spring and Fall 2007–08.

<sup>x</sup>1 lb/acre = 1.1209 kg·ha<sup>-1</sup>.

<sup>w</sup>Means within a column followed by the same letter are not significantly different according to Duncan's multiple range test at  $P \leq 0.05$ .

<sup>v</sup>F<sub>1</sub> hybrid.

**Table 3. Yields of harvested leaves of several varieties of organically grown collards produced in Lexington, KY, in Fall and Spring 2007–08. Values are the means of four replications.**

Variety	2007		2008		Overall avg <sup>z</sup>	cv <sup>y</sup> (%)
	Spring	Fall	Spring	Fall		
	Yield (lb/acre) <sup>x</sup>					
Georgia/Southern	23500 ab <sup>w</sup>	36200 a	24450 a	21790 a	26490 a	31
Flash <sup>v</sup>	28430 a	30150 ab	22900 a	24180 a	26400 a	22
Morris Heading Collards	20960 ab	29300 ab	21750 a	19760 a	22940 ab	19
Champion	20960 ab	23400 b	21600 a	19940 a	21480 bc	22
Green Glaze Collards	16320 b	24400 b	23250 a	12190 b	19040 c	32

<sup>z</sup>Overall average is yield averaged from Spring and Fall 2007–08.

<sup>y</sup>cv determined using all data from Spring and Fall 2007–08.

<sup>x</sup>1 lb/acre = 1.1209 kg·ha<sup>-1</sup>.

<sup>w</sup>Means within a column followed by the same letter are not significantly different according to Duncan's multiple range test at  $P \leq 0.05$ .

<sup>v</sup>F<sub>1</sub> hybrid.

and ‘Topper’ were the lowest yielding turnips in 2007–08. ‘Alamo’ and ‘Alltop’ were in the highest yielding group of turnips when averaged over the entirety of the trial. ‘Seven Top’ had a cv of 19%, which was the lowest among the varieties examined. ‘Alamo’ and ‘Alltop’ had cv values of 24% and 32%, respectively. This suggest that ‘Alamo’ can provide a high yield potential with less variability in different growing conditions compared with ‘Alltop’ and may be a preferred variety for organic growers in Kentucky.

Swiss chard yield was significantly affected by a year by variety interaction (Table 5). There were no other significant interactions for yield in swiss chard. For all swiss chard varieties, yields decreased in 2008 compared with 2007. The reduction in yield was most notable in ‘Fordhook Giant’, which yielded 39,490 lb/acre in 2007 and 23,540 lb/acre in 2008. Despite variation, ‘Fordhook Giant’ yielded significantly more than all other varieties in 2007 and remained in the highest yielding group of varieties in 2008. ‘Bright Lights’ and ‘Ruby Red’ were the lowest yielding varieties on average in this trial. It may be notable that these two varieties have multicolored, ‘Bright Lights’, or red, ‘Ruby Red’, petioles, whereas the higher yielding varieties all had white petioles and green leaves. Although the sample size is small, this suggests that perhaps the presence of additional pigments in petioles or leaves may be associated with reduced yield potential in swiss chard. ‘Bright Lights’ had a cv of 18%, the lowest of the varieties tested, whereas ‘Fordhook Giant’ had the highest cv value, 28%. Similar to other crops evaluated in this trial, those varieties with the lowest cv yielded consistently less than other varieties.

The yield of arugula was significantly affected by a variety by year by season interaction ( $P = 0.08$ ) (Table 6). Yields of arugula were highly variable over the four seasons evaluated. This was reflected in the cv values, which ranged from 40% to 54%. Most notably, yields of all varieties were significantly reduced in Spring 2008. The cool-wet growing conditions negatively affected arugula more than any other crop evaluated in this trial. Yields ranged from 3300 to 8800 lb/acre in Spring 2008, but ranged from 16,500 to 27,600 lb/acre in Spring 2007.

**Table 4. Yields of harvested leaves of several varieties of organically grown turnip produced in Lexington, KY, in 2007–08. Values are the means of four replications and presented for fall and spring growing seasons.**

Variety	2007	2008	Overall avg <sup>z</sup>	CV <sup>y</sup> (%)
	Yield (lb/acre) <sup>x</sup>			
Alamo <sup>w</sup>	49750 a <sup>v</sup>	33950 a	41850 a	24
Alltop <sup>w</sup>	50280 a	27600 bc	38940 a	32
Nozawana	41100 b	30020 ab	35560 b	21
Topper <sup>w</sup>	30150 c	23500 c	26830 c	22
Seven Top	26180 c	23740 c	24960 c	19

<sup>z</sup>Overall average is yield averaged from Spring and Fall 2007–08.

<sup>y</sup>cv determined using all data from Spring and Fall 2007–08.

<sup>x</sup>1 lb/acre = 1.1209 kg·ha<sup>-1</sup>.

<sup>w</sup>F<sub>1</sub> hybrid.

<sup>v</sup>Means within a column followed by the same letter are not significantly different according to Duncan’s multiple range test at  $P \leq 0.05$ .

**Table 5. Yields of harvested leaves of several varieties of organically grown swiss chard produced in Lexington, KY, in Fall and Spring 2007–08. Values are the means of four replications and presented for 2007–08 growing seasons.**

	2007	2008	Overall avg <sup>z</sup>	
Variety	Yield (lb/acre) <sup>x</sup>			cv <sup>y</sup> (%)
Fordhook Giant	39490 a <sup>w</sup>	23540 ab	31520 a	28
Verde da Taglio	30560 b	26350 a	28450 b	23
Silverado	29270 b	24860 a	27060 bc	20
Bright Lights <sup>v</sup>	27370 bc	21960 ab	24660 cd	18
Ruby Red <sup>v</sup>	24680 c	19360 b	22020 d	22

<sup>z</sup>Overall average is yield averaged from Spring and Fall 2007–08.

<sup>y</sup>cv determined using all data from Spring and Fall 2007–08.

<sup>x</sup>1 lb/acre = 1.1209 kg·ha<sup>-1</sup>.

<sup>w</sup>Means within a column followed by the same letter are not significantly different according to Duncan’s multiple range test at  $P \leq 0.05$ .

<sup>v</sup>‘Bright Lights’ and ‘Ruby Red’ are multicolored and red-colored varieties of swiss chard, respectively.

**Table 6. Yields of harvested leaves of several varieties of organically grown arugula produced in Lexington, KY, in Fall and Spring 2007–08. Values are the means of four replications.**

Variety	2007		2008		Overall avg <sup>z</sup>	CV <sup>y</sup> (%)
	Spring	Fall	Spring	Fall		
	Yield (lb/acre)*					
Astro	24700 ab <sup>w</sup>	27950 ab	8800 a	19920 a	20340 a	40
Apollo	27600 a	24100 abc	7800 ab	17620 a	19280 a	47
Arugula	17700 c	28700 a	6500 ab	18990 a	17970 ab	49
Surrey	20650 bc	23500 abc	4500 ab	15620 ab	16070 bc	50
Icebred	16500 cd	22850 bc	6100 ab	16370 ab	15460 c	46
Runway	12450 d	20300 c	3300 b	11730 b	11950 d	54

<sup>z</sup>Overall average is yield averaged from Spring and Fall 2007–08.

<sup>y</sup>cv determined using all data from Spring and Fall 2007–08.

<sup>x</sup>1 lb/acre = 1.1209 kg·ha<sup>-1</sup>.

<sup>w</sup>Means within a column followed by the same letter are not significantly different according to Duncan’s multiple range test at  $P \leq 0.05$ .

‘Astro’ was grouped with the highest yielding varieties in all four seasons. Differences among varieties were greatest in Spring 2007, with ‘Apollo’ and ‘Astro’ being the highest yielders with 27,600 and 24,700 lb/acre, respectively, whereas the lowest yielder was ‘Runway’ with 12,450 lb/acre. When yields were averaged over seasons and years, three of the six varieties

examined were part of the highest yielding group of arugula. These results suggest that arugula was significantly affected by the environment, perhaps to a greater degree than the other greens evaluated in this trial. Despite significant seasonal variation, ‘Astro’ and ‘Apollo’ were always part of the highest yielding group of varieties. However, because of the high cv

values for all varieties evaluated, other greens with similar eating properties may be preferred for production in the midsouth region.

Although single crop species are assessed in the majority of variety trials, there is value in testing numerous crops with similar characteristics. In the present trial, all crops evaluated are crops sold as leafy greens. By evaluating several crops simultaneously, the ability of a given crop to tolerate a variety of environmental conditions compared with others can be evaluated. A diversified organic farmer with many choices for production of leafy greens may find this information useful. Recommendations based on these results may suggest planting fewer row feet of crops that were significantly and negatively affected by adverse weather conditions, such as arugula. Risk may be managed better by choosing to focus on leafy greens, which produced more consistently over multiple seasons and years. It is also notable that those varieties with the highest cv values were often the highest yielding varieties within a given crop and that the variability observed was often the result of one or two exceptionally high yielding seasons, as was the case with 'Florida Broadleaf' mustard. The data also suggest that those varieties having the lowest cv values often yielded poorly as well. This indicates that the stability observed in these varieties may be a genetic limitation for yield potential as they were consistent performers over multiple years and seasons. The varieties that performed well in this trial should be highly adaptable for organic vegetable farmers in the midsouth region.

## Literature cited

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